UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

MEMORANDUM

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Subj: **Permethrin**: Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document.

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The attached assessment is the occupational and non-occupational (residential) exposure and risk estimates for permethrin to support HED's Reregistration Eligibility Decision (RED) document.

This assessment was reviewed by HED's Science Council for Exposure (ExpoSAC) to ensure compliance with current HED policy for conducting occupational and residential exposure (ORE) assessments.

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Executive Summary

The Health Effects Division (HED) has conducted an occupational and non-occupational (residential) exposure assessment for the active ingredient permethrin [(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate] for the purpose of supporting HED's Reregistration Eligibility Decision (RED) document.

Use and Usage Summary

Permethrin is a broad spectrum, non-systemic, synthetic pyrethroid insecticide. Permethrin is formulated as emulsifiable concentrate (ECs), wettable powder (WPs), dust (D), granular (G) and a variety of ready-to-use (RTU) formulations. The application rates vary depending upon the exposure scenario and crop - or use-site.

Permethrin is registered for use in a variety of occupational and residential sites. The occupational uses include numerous food/feed crops, livestock and livestock housing, modes of transportation, and structures/buildings (including food handling establishments). The methods of application for the occupational uses are aerial, groundboom, and handheld equipment. The residential uses include pets, indoor surfaces, outdoor surfaces, ornamentals, and garden crops. The methods of application for the residential uses are handheld equipment.

Pharmaceutical Use

There is a non-FIFRA pharmaceutical use of permethrin for the treatment of head lice and scabies on humans. The Food and Drug Administration (FDA) has the legal authority to approve uses of pesticidal-containing pharmaceutical products under the Federal Food, Drug, and Cosmetic Act (FFDCA). HED is currently working with FDA to derive an appropriate methodology to determine how to assess exposure and risk from the pharmaceutical use of permethrin on humans.

Hazard Profile

The dermal toxicological endpoint of concern (25 mg/kg/day) is the same for short-, intermediate-, and long-term dermal exposures and is based on an acute neurotoxicity (oral) study in rats. The adverse effects for the dermal endpoint is based on observations of clinical signs (i.e., aggression, abnormal, and/or decreased movement) and increased body temperature. Since the dermal endpoints are based on an oral study, a dermal absorption factor of 30 percent was used to complete the dermal assessments. The inhalation toxicological endpoint of concern (11 mg/kg/day) is the same for short-, intermediate-, and long-term inhalation exposures and is based on a 15-day inhalation study in rats. The adverse effects for the inhalation endpoint is based on body tremors and hypersensitivity to noise. Since the inhalation endpoints are based on an inhalation study, no inhalation absorption factor is necessary to complete the inhalation assessments. The dermal and inhalation risks were combined for this assessment, because the

adverse effects for the dermal and inhalation routes of exposure were the same (neurotoxicity).

The Agency's level of concern for noncancer risks (i.e., target level for MOEs or Margins of Exposure) is defined by the uncertainty factors that are applied to the assessment. The Agency applies a 10X factor to account for inter-species extrapolation and a 10X factor to account for intra-species sensitivity. The total uncertainty factors that have been applied to noncancer risk assessments is 100 for occupational and residential scenarios.

Permethrin is currently classified as "**Likely to be Carcinogenic to Humans**". The Q_1^* for permethrin, based on female mouse lung adenoma and/or carcinoma combined tumor rates, is 9.567×10^{-3}.

The Agency has defined a range of acceptable cancer risks based on a policy memorandum issued in 1996 by then Office of Pesticide Programs director, Mr. Dan Barolo. This memo refers to a predetermined quantified "level of concern" for occupational carcinogenic risk. In summary, this policy memo indicates occupational carcinogenic risks that are 1×10^{-6} or lower require no risk management action. For those chemicals subject to reregistration, EPA is to carefully examine uses with estimated risks in the 10^{-6} to 10^{-4} range to seek ways of cost-effectively reducing risks. If carcinogenic risks are in this range for occupational handlers or postapplication workers, increased levels of risk mitigation would be warranted as is commonly applied with non-cancer risk estimates (e.g., additional PPE or engineering controls for handlers and increased entry restrictions for workers). Carcinogenic risks that remain above 1.0×10^{-4} at the highest level of mitigation appropriate for that scenario remain a concern. The level of concern for nonoccupational (residential) carcinogenic risk is 1×10^{-6}. Nonoccupational carcinogenic risks above 1.0×10^{-6} are a concern.

Occupational Handler Noncancer Risks

The noncancer occupational handler risk assessment indicates that some scenarios, risks do not exceed HED's level of concern (i.e., the MOEs are greater than 100) even at maximum feasible risk mitigation. These include:

- mixing/loading/applying liquids via high pressure handwand to mushroom houses;
- loading/applying dusts via shaker can to poultry;
- applying ready-to-use shampoo formulations via hands to dogs;
- applying ready-to-use formulations via wipe to horses and dogs; and
- applying ready-to-use formulations via trigger pump sprayer to horses and foals.

Occupational Handler Cancer Risks

In a memo dated March 24, 2004, BEAD (Brassard) provided HED information on the number of days permethrin is applied annually by occupational handlers. The information in this memo showed that for most crops and use-patterns, applicators apply permethrin less than ten days per

year. As a result, HED considered one handler population (small, medium, and large scale growers as well as commercial applicators) for the cancer risk assessment. It was estimated that all handlers would handle permethrin approximately 10 days per year over their working lifetime.

The cancer occupational handler risk assessment indicates that in most scenarios, estimated cancer risks are below OPP's target level of concern (i.e., risks are below 1×10^{-6}) at some level of risk mitigation. For the most part, cancer risk estimates are below OPP's level of concern for cancer risks (i.e., risks are below 1×10^{-4}) with the single layer clothing, gloves, and no respirator level of personal protection. Cancer risk estimates for handlers are greater than OPP's level of concern for cancer risks (i.e., risks are at or above **1.0×10^{-4}**) at maximum feasible mitigation for the following handler scenario:

- mixing/loading/applying liquids via high pressure handwand to mushroom houses.

Occupational Postapplication Noncancer Risks

Agricultural Crop Scenarios: Data from permethrin-specific studies were used along with the transfer coefficients to calculate the postapplication exposures. The noncancer occupational postapplication worker risk assessment indicates that for all, but a few, agricultural postapplication exposure scenarios in some crop groupings, postapplication occupational risks are below HED's level of concern (i.e., the MOEs are greater than 100) on day 0 – approximately 12 hours following application. In a few cases, postapplication occupational risks from certain high exposure activities do not fall below HED's level of concern for 1 to 4 days following application. Risks from corn detasseling – the highest exposure activity – did not fall below HED's level of concern until 9 days following application.

Impregnated Clothing Scenarios: The noncancer occupational postapplication worker risk assessment indicates that all postapplication exposure scenarios for permethrin-impregnated clothing are below HED's level of concern (i.e., the MOEs are greater than 100).

Occupational Postapplication Cancer Risks

Agricultural Crop Scenarios: For the cancer occupational postapplication worker risk assessment, two different occupational postapplication exposure scenarios were assessed – individuals employed solely by one establishment (i.e., "hired hands") were assumed to be exposed 10 days per year and individuals employed by multiple establishments (i.e., commercial or migratory farmworkers) were assumed to be exposed 30 days per year. Data from permethrin-specific studies were used along with the transfer coefficients to calculate the LADDs. Averages (of DFRs) were taken from the permethrin- specific data for specific crop groupings depending on the treatment interval listed on the labels. These averages were calculated beginning the day after the postapplication non-cancer risk exceeded the target MOE of 100 all the way through to the day when it was possible to retreat the crop. All of the postapplication cancer risk estimates for both "hired hands" and commercial/migratory farmworkers are less than 1×10^{-4} and most are

in the 10^{-6} to 10^{-7} range.

Impregnated Clothing Scenarios: For the cancer occupational postapplication worker risk assessment, two different occupational postapplication exposure scenarios were assessed – military personnel who *wear* battle dress impregnated with permethrin on a daily basis (i.e., approximately 250 days/year) and factory workers who work with fabric or clothing after impregnation during making of garments or packaging of clothing on a work-day basis (i.e., 250 days per year). The postapplication cancer risk estimates for both populations are less than 1 x 10^{-4}, but greater than 1 x 10^{-6}.

Residential Handler Noncancer Risks

The noncancer residential handler risk assessment indicates that for all scenarios, risks are below HED's level of concern (i.e., MOEs are greater than 100) assuming handlers are wearing short-sleeve shirt, short pants, shoes, and socks.

Residential Handler Cancer Risks

The cancer residential handler risk assessment indicates that for all but eight scenarios, cancer risk estimates are less than $1x10^{-6}$ (most are in the 10^{-7} to 10^{-9} range) when a single application per year is evaluated. The eight scenarios where cancer risk estimates are more than $1x10^{-6}$ include:

- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor surfaces;
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor trees;
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor wood surfaces and for perimeter treatments;
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to fire ant mounds;
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to outdoor trees;
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to stored lumber and wood pile;
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to ornamentals outdoors; and
- applying to dogs or horses using a ready-to-use wipe.

Residential Postapplication Noncancer Risks

Adult short-term residential postapplication risks from high contact activities following indoor sprays to carpet exceed HED's level of concern (i.e., the MOE is less than 100) on the day of

application. For all other scenarios, short-term MOEs do not exceed HED's level of concern (i.e., the MOEs are greater than 100) on the day of application.

Youth-aged children (10 to 12 years old) short-term postapplication risks are below HED's level of concern (i.e., the MOEs are greater than 100) for all scenarios.

Toddler (3 year old) short-term postapplication risks were calculated following the lawncare, indoor, and pet uses of permethrin as well as for exposure to clothing impregnated with permethrin. Short-term MOEs from dermal and incidental oral exposures to treated turf (in products labeled for direct application to turf) and inhalation exposures to ULV truck fogger mosquito treatments are below HED's level of concern (i.e., the MOEs are greater than 100).

Ingestion of permethrin granules is also a potential source of exposure, because children can eat them if they are found in treated lawns or gardens. This scenario is considered an episodic scenario by HED (i.e., acute dietary endpoints are used). The concentration of permethrin in granular products is 0.5 percent. The acute MOE resulting from incidental ingestion of granules is below HED's level of concern (i.e., the MOE is greater than 100).

The assessments for indoor and pet uses considered dermal and nondietary ingestion exposures. Several of the short-term postapplication risks from dermal and incidental oral exposures to treated indoor surfaces and pets exceed HED's level of concern (i.e., the MOEs are less than 100).

The assessments for exposure to permethrin impregnated clothing considered dermal and nondietary ingestion exposures. The short-term risks for postapplication risks from exposure to permethrin impregnated clothing are below HED's level of concern (i.e., the MOEs are greater than 100).

HED combines risk values resulting from separate postapplication exposure scenarios when it is likely they can occur simultaneously based on the use-pattern and the behavior associated with the exposed population. The combined risks for the turf spray scenario, the pet-dust scenario, and the impregnated clothing scenario are 1700, 160, and 430, respectively and are below HED's level of concern. The combined risks exceed HED's level of concern for the pet-shampoo scenario (MOE = 18).

Residential Postapplication Cancer Risks

The residential postapplication cancer risk estimates indicate that:

- for all scenarios on turf, home gardening, and mosquitos, cancer risk estimates are in the 10^{-7} to 10^{-8} range or less when a single reentry event per year is evaluated and entry on the day of the application (i.e., day 0) is assumed;
- for all indoor scenarios, estimated risks are in the 10^{-5} to 10^{-6} range and exceed HED's

level of concern when a single reentry event per year is evaluated and entry on the day of application (i.e., day 0) is assumed;

- for the pet scenarios, estimated risks are below HED's level of concern for postapplication dermal exposure to pets after dust applications when a single exposure event per year is evaluated and exposure on the day of application (i.e., day 0) is assumed. However, estimated risks are above HED's level of concern for postapplication dermal exposure to pets after spray applications when a single exposure event per year is evaluated and exposure on the day of application (i.e., day 0) is assumed; and
- for the impregnated clothing scenarios, estimated cancer risks (in the 10^{-7} range) are below HED's level of concern when a single exposure event per year is evaluated. HED believes that individuals will wear permethrin impregnated clothing more than one time a year. If multiple exposure events per year are considered, then estimated cancer risks exceed HED's level of concern.

Overall Risk Summary and Data Gaps

The short- and intermediate-term handler noncancer risk assessment for permethrin indicates that a few occupational handler scenarios have risks that exceed HED's level of concern at maximum risk mitigation. All of these scenarios are mixer/loader/applicator scenarios that have relatively high application rates or relatively high amounts treated daily relative to the rest of the uses in those particular scenarios. The short- and intermediate-term occupational handler cancer risk assessment for permethrin indicates that one handler scenario has a risk that exceed HED's level of concern at maximum risk mitigation.

Several data gaps were identified for permethrin in many different occupational use areas that include:

- dip treatments to animals and clothing;
- dust treatments via mechanical duster or dust bags on animals in agriculture;
- wettable powder treatments using backpack and high-pressure handwand sprayers; and
- microencapsulated liquids using fogger/mist generator equipment.

There are also several data gaps that were identified for permethrin such as the various specialized uses (i.e., ear tags, protective flanges, and vapor recovery system tubes), however, HED believes that the other assessed scenarios are protective of these specialized uses.

For all, but a few, exposure scenarios in some crop groupings, short-and intermediate-term noncancer occupational postapplication risks are below HED's level of concern (i.e., the MOEs are greater than 100) at day 0, approximately 12 hours following application. In a few cases, postapplication occupational risks from certain high exposure activities do not fall below HED's level of concern for 1 to 4 days following application. All of the postapplication cancer risk estimates for agricultural crop scenarios involving both "hired hands" and commercial/migratory farmworkers are less than 1×10^{-4} and most are in the 10^{-6} to 10^{-7} range. All of the estimated occupational postapplication cancer risk estimates for military personnel and garment workers

exposed to permethrin impregnated clothing are less than 1 x 10^{-6}, but greater than 1 x 10^{-4}.

HED has used the latest information to complete the occupational postapplication risk assessment for permethrin. Several data gaps exist such as a lack of postapplication studies in different crop groupings (e.g., cole crops, tall field crops) and lack of exposure data on mechanized or partially mechanized cultural practices where there is a potential for exposure. Additionally, because of the number and breadth of permethrin uses, there may be many exposure pathways where the transfer coefficient is not an appropriate model (e.g., working with treated animals or wearing treated clothing such as military uniforms) that have not been quantitatively addressed due to a lack of data.

Residential noncancer handler risks are below HED's level of concern (i.e., the MOEs are less than 100) for all scenarios. Residential handler cancer risk estimates for most scenarios are in the 10^{-7} to 10^{-9} range, although there are eight scenarios where the risks are greater than $1x10^{-6}$.

No key data gaps have been identified by HED at this time for residential handlers. However, there were some scenarios that remain unaddressed by HED at this time due to a lack of data or other information (i.e., rotary duster/dust gun applications, puffer-can applications, and the use of RTU furniture coasters and protective flanges). HED believes that the shaker can scenario is representative of the rotary duster/dust gun scenario and thus it can be considered not of concern.

Residential postapplication risks exceed HED's level of concern (i.e., the MOEs are less than 100) for exposures to adults contacting indoor surfaces, for hand to mouth and dermal postapplication exposures to toddlers from indoor pesticide treatments, and for toddlers that have contact with pets treated with dust or liquid products. Residential cancer postapplication risks were estimated for adults and most were found to be in the 10^{-7} to 10^{-9} range on the day of application (e.g., lawncare, golfing and gardening). Risks exceed HED's level of concern (1 $x10^{-6}$) on the day of application for all indoor scenarios and the pet contact scenario (after a liquid spray).

For permethrin, HED combined risk values (i.e., MOEs) for different routes of exposures associated with the turf (dermal, hand-to-mouth, object-to-mouth, and soil ingestion), pet scenarios (dermal and hand-to-mouth), and impregnated clothing scenarios (dermal and object-to-mouth). All of these combined risks are below HED's level of concern (i.e., the MOEs are greater than 100), except for the pet-spray combined risk (MOE = 26), which exceeds HED's level of concern.

No key data gaps have been identified by HED at this time for the residential postapplication scenarios.

1.0 Occupational and Residential Exposure/Risk Assessment

1.1 Purpose

This document is the occupational and residential non-dietary exposure and risk assessment for the synthetic pyrethroid permethrin from its use as an insecticide. In this document, which is for use in EPA's development of the HED chapter of the permethrin Reregistration Eligibility Decision (RED) Document, EPA presents the results of its review of the potential human health effects of occupational and residential/nonoccupational exposure to permethrin.

1.2 Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is a potential for exposure to handlers (mixers, loaders, applicators) during use or to persons entering treated sites or exposed to vapors after application is complete. Toxicological endpoints were selected for short- and intermediate-term dermal and inhalation exposures to permethrin. There is a significant potential for exposure in a variety of occupational agricultural and commercial settings as well as in numerous residential settings. Therefore, risk assessments are required for occupational and residential handlers as well as for occupational and residential postapplication exposures that can occur as a result of permethrin use.

1.3 Summary of Hazard Concerns

HED's Hazard Identification Assessment Review Committee (HIARC) met to determine appropriate toxicological endpoints of concern for permethrin. The toxicological endpoints that were used to complete the occupational and residential risk assessments are summarized below which have been extracted from the Permethrin HIARC report (05/12/04). Adverse effects were identified at all durations of exposure ranging from short-term (up to 30 days) to intermediate-term (1 to 6 months) to long-term (>6 months up to 1 year) durations. Cancer risk estimates were calculated for permethrin, since it is currently classified as "**Likely to be Carcinogenic to Humans**" via the oral route.

1.3.1 Permethrin

Permethrin is an insecticide with a wide variety of use patterns. Exposure durations are expected to range from short-term through long-term. The HIARC evaluated the permethrin toxicological database and selected endpoint doses for short-, intermediate-, and long-term exposures. Permethrin exposures are expected to occur to both occupational and residential users.

Acute Toxicity

Permethrin is classified as category III for acute oral and dermal toxicity and as category IV for

inhalation toxicity. It is classified as category IV for eye irritation potential and for skin irritation potential. Results were negative for dermal sensitization in guinea pigs.

Dermal Route (non-cancer)

The short-, intermediate- and long-term (non-cancer) dermal risk assessment for permethrin is based on an NOAEL of **25 mg/kg/day** from an acute neurotoxicity study in rats. The LOAEL of 75 mg/kg/day was based on observations of clinical signs (i.e., aggression, abnormal and/or decreased movement and increased body temperature). Long-term exposures to permethrin (i.e. greater than 6 months) are not expected for current registered uses, except for postapplication exposures to impregnated fabric or clothing. A dermal absorption factor of 30 percent was selected based on dermal absorption data from a permethrin penetration study performed on rats.

Inhalation Route (non-cancer)

The short- and intermediate-term (non-cancer) inhalation risk assessment for permethrin is based on a NOAEL of **0.042 mg/L (11 mg/kg/day)**, which was defined in a 15-day inhalation study in rats. The LOAEL of 0.583 mg/L (154 mg/kg/day) was based on body tremors and hypersensitivity to noise. Long-term exposures to permethrin (i.e. greater than 6 months) are not expected for current registered uses.

Non-cancer Level of Concern (LOC)

HED's level of concern (LOC) for permethrin is 100 (i.e., a margin of exposure - MOE - less than 100 exceeds HED's level of concern) for occupational scenarios and residential scenarios. The level of concern is based on 10x to account for interspecies extrapolation to humans from the animal test species and 10X to account for intraspecies sensitivity.

On September 9, 2003, the HIARC recommended a 10X Database Uncertainty Factor (UF_{DB}) to account for the lack of a developmental neurotoxicity study (DNT) in rats. The 10X UF_{DB} was determined based on a dose analyses as described in the HIARC report dated May 12, 2004 (TXR No. 0052543). Since then, HED has revised the dose analyses procedure to determine the need for and size of the UF_{DB} to account for the lack of a DNT study. This revised procedure was based on an analysis of the DNT data submitted and reviewed to date (Hot Sheet # 24).

Using the above procedure the Reregistration Branch re-analyzed the size of the UF_{DB} for the lack of the DNT study for permethrin. The re-analysis indicates that a UF_{DB} is not required for the DNT data gap. This decision is based on the following considerations:

- The dose levels tested in the subchronic neurotoxicity study (0, 15, 92 or 150 mg/kg/day) is lower than the doses tested in the three generation reproduction study (25, 50 or 125 mg/kg/day). Therefore, it is assumed that the doses used in a DNT study may be similar to those used in the subchronic neurotoxicity study in

rats. The NOAEL in the subchronic study was 15 mg/kg/day and the LOAEL was 92 mg/kg/day.

- It is presumed that the offspring NOAEL in the DNT would be the lowest dose tested (i.e, 15 mg/kg/day).

- The results of the DNT would have no impact on the risk assessment because:
  1) the endpoint of concern (neurotoxicity) is used for overall risk assessments;
  2) the DNT is not likely to identify new hazard at a lower dose since the potential NOAEL (i.e, 15 mg/kg/day) from that study is comparable to the current dose (25 mg/kg/day) used for dietary (acute and chronic), non-dietary (incidental oral and dermal), and inhalation (11 mg/kg/day) exposure risk assessments;
  3) because of the wide gap in the candidate study (i.e, subchronic neurotoxicity), the true NOAEL could have been higher than the one that was established (i.e, higher than the 15 mg/kg/day;
  4) the DNT is being requested as a "confirmatory" data due to clinical signs seen at high doses (125-450 mg/kg/day) in adult animals and there is a large margin of safety between these doses and the doses used for risk assessment; and
  5) it is also worth reiterating that there is no evidence (quantitative or qualitative) of increased susceptibility in the pre-natal developmental or the two generation reproduction study.

Therefore, HED is confident that although a DNT has been required, the existing reliable toxicity data for permethrin provided HED with the confidence that conducting the risk assessment with no additional factor will provide reasonable certainty of no harm to the safety of infants and children.

Aggregation

The dermal and inhalation margins of exposure were combined for the permethrin risk assessment, because the adverse effects for the dermal and inhalation routes of exposure were the same (neurotoxicity).

Cancer

HED's Cancer Assessment Review Committee met on August 21, 2002 to re-evaluate the carcinogenic potential of Permethrin (CARC Report, 10/23/02, TXR No. 0051220). In accordance with the EPA Draft Guidelines for Carcinogen Risk Assessment (July 1999), the CARC classified permethrin as **"Likely to be Carcinogenic to Humans"** by the oral route. This classification was based on evidence of two reproducible benign tumor types (lung and liver) in

the mouse, equivocal evidence of carcinogenicity in Long-Evans rats, and supportive SAR information. The Committee recommended using a linear low-dose extrapolation approach for the quantification of human cancer risk based on female mouse lung tumors (combined adenomas and carcinomas) using the data from the Pyrethrin Working Group (PWG) assessment. The unit risk, $Q_1^*(mg/kg/day)^{-1}$ for permethrin is 9.567×10^{-3} (Memo, L. Brunsman, 9/25/02, TXR No. 0051166).

Body Weight

Since the adverse effects for all studies utilized in the permethrin dermal and inhalation risk assessments are for the general population, the average weight of an adult (i.e., 70 kg) was used to estimate exposure.

1.4 Incident Reports

An analysis of the incident reports will be included in a separate memo by Jerome Blondell.

1.5 Summary of Physical and Chemical Properties of Permethrin

Permethrin (CAS registry number 52645-53-1) is an odorless, colorless crystalline solid or a viscous liquid that is pale brown with a molecular formula of $C_{21}H_{20}Cl_2O_3$ and a molecular weight of 391.3 g/mole. It is non-volatile with a vapor pressure of 4.4e-07 atmospheres at 25 °C. Permethrin is nearly insoluble in water and freely soluble in most organic solvents, except ethylene glycol.

1.6 Summary of Use Patterns and Formulations

1.6.1 End-Use Products

Permethrin is a widely used insecticide in the United States. Permethrin is used in agricultural, commercial, and residential settings. Permethrin is formulated as an emulsifiable concentrate, a wettable powder (including water soluble bags), a granular, a dust, as well as a number of ready to use formulations, such as aerosol cans, foggers, trigger pump sprayers, ear tags, etc.

1.6.2 Registered Use Categories and Sites

An analysis of the current labeling and available use information was completed by Special Review and Reregistration Division. Permethrin is registered for use in a variety of occupational and residential scenarios (see Tables 1 through 3) and thus both occupational and residential populations could be potentially exposed while making permethrin applications. It is also possible for occupational and residential populations to be exposed to permethrin during postapplication time periods.

Table 1: Summary of Maximum Application Rates for Registered Permethrin Agricultural Uses			
Crop Type/ Use Site	**Target of Application**	**Application Equipment**	**Maximum Application Rate**
pine seed orchard	foliage	backpack, low-pressure, handgun, airblast, aerial	1.2 lb ai/A
almonds, apples, filberts, pears: dormant & prebloom (combination), pistachios, walnuts	foliage	aerial, airblast	0.4 lb ai/A
almonds, pistachios	soil	aerial, tractor-drawn spreader	0.4 lb ai/A
artichokes, onions: dry bulb, garlic	foliage	aerial, groundboom	0.3 lb ai/A
nectarines & peaches	foliage	aerial, airblast	0.3 lb ai/A
alfalfa, cabbage, Chinese cabbage, corn: (field, popcorn, seed, sweet: fresh & processed), cucurbits, eggplant, horseradish, leafy vegetables, peppers: bell, potatoes, soybeans, tomatoes, tomatillos	foliage	aerial, groundboom	0.2 lb ai/A
avocados, cherries: sour & sweet, papayas	foliage	airblast	0.2 lb ai/A
alfalfa, corn (field, sweet: fresh & processed)	soil	aerial, tractor-drawn spreader	0.2 lb ai/A
conifers, ornamental nursery stock (nonbearing)	foliage	backpack, low-pressure, handgun, airblast	0.2 lb ai/A
roses: field grown	foliage	backpack, low-pressure, handgun, groundboom, aerial	0.2 lb ai/A
asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, range grasses, turnips	foliage	aerial, groundboom	0.1 lb ai/A
horseradish	plant	dip	0.1% ai dipping solution
mushroom house premises	houses and adjacent premises	low-pressure handwand	0.267 lb ai/gallon

Table 2: Summary of Maximum Application Rates for Registered Permethrin Commercial Uses

Crop Type/Use Site	Target of Application	Application Equipment	Maximum Application Rate
Animal Premises			
animal premises: pets	indoor surfaces	low-pressure handwand, backpack	0.039 lb ai/gallon of water
animal premises: livestock buildings, poultry houses	indoor surfaces	low-pressure handwand, backpack	0.113 lb ai/1000 sq ft
animal premises: livestock buildings, poultry houses	indoor spaces	compressed air-sprayer, cold mist fogger	0.012 lb ai/1000 sq ft
animal premises: swine	indoor surfaces	shaker can, mechanical duster	dust bedding
animal premises: dogs, cats	indoor surfaces	shaker can	dust bedding
Animals			
animal: cattle, goats, sheep, hogs, horses	body	trigger, pump or other type of sprayer	0.00067 lb ai/animal
animal: dairy cattle, beef cattle	body	dust bag, shaker can, mechanical duster	0.000031 lb ai/animal
animal: dairy cattle, beef cattle, calves	ear	ear tag	0.0044 lb ai/animal
animal: dairy cattle, beef cattle, calves, sheep	body	pour on	0.0034 lb ai/animal
animal: dairy cattle, goats, beef cattle, sheep, horses	body	low-pressure handwand, backpack, dip	0.0023 lb ai/animal
animal: dogs	body	dip	0.005 lb ai/gal
animal: dogs, horses	body	wipe (towelette)	0.0062 lb ai/animal
animal: dogs, cats	body	shaker can	0.00016 lb ai/animal
animal: dogs, cats	body	Rubber gloves (hands)	0.00014 lb ai/animal
animal: horses	body	dust bag, dust glove, shaker can, mechanical duster	0.000031 lb ai/animal
animal: horses	body	low pressure handwand	0.00079 lb ai/animal
animal: horses	body	pour on	0.005 lb ai/animal
animal: horses, foals	body	trigger-pump sprayer	0.016 lb ai/animal
animal: livestock	body	pour on	0.00072 lb ai/animal
animal: poultry	body	dust bag, shaker can	0.0025 lb ai/animal
animal: poultry	body	high-pressure handwand	0.00027 lb ai/animal
animal: sheep	body	pour on	0.0020 lb ai/animal
animal: swine	body	shaker can, mechanical duster	0.00016 lb ai/animal
animal: swine	body	low-pressure handwand, backpack, dip	0.002 lb ai/animal
Ants/Fire Ants			
ant and fire ant: mounds	mounds	low-pressure handwand, backpack, handgun	0.08 lb ai/mound
ants: impregnated coasters & covers indoor/outdoor commercial sites	ants	RTU coaster	Place coasters under table legs, chair legs, etc.
ants: impregnated gaskets for electrical wall plates, boxes, and plumbing flanges	ants	RTU protective flange	

Table 2: Summary of Maximum Application Rates for Registered Permethrin Commercial Uses

Crop Type/Use Site	Target of Application	Application Equipment	Maximum Application Rate
Residential Fruit and Nut Trees			
almond, filberts, pears, pistachios	foliar	handgun, low pressure handwand, backpack, airblast	0.4 lb ai/acre
apple, cherries	foliar	handgun, low pressure handwand, backpack, airblast	0.2 lb ai/acre
peaches	foliar	handgun, low pressure handwand, backpack, airblast	0.3 lb ai/acre
Clothing			
clothing: personal	clothing	dip	0.002 lb ai/shirt, pants, & bed net
clothing: military battle dress	clothing	dip	0.00000011 lb ai/cm^2 of fabric
clothing: personal/military	clothing	impregnated	0.125 mg ai/cm^2
Perimeter			
Perimeter treatment	soil & vegetation & lower buildings	backpack, low pressure handwand, handgun	0.8 lb ai/10 gallons treats 1000 sq ft
Indoor Spaces			
spaces: indoor		mechanical or compressed air equipment (non-thermal)	0.00036 lb ai/1000 cu ft
spaces: indoor		RTU fogger	0.035 lb ai/oz fogger (each oz fogger treats 1000 cu ft)
Outdoor Spaces (mosquitos)			
spaces: outdoor	mosquitos	backpack ULV fogger	0.1 lb ai/acre
spaces: outdoor barrier spray	mosquitos	backpack ULV fogger	0.1 lb ai/acre
Indoor Surfaces			
surfaces: indoor	carpets, crack and crevice	paintbrush, low-pressure handwand, backpack	0.1 lb ai/1000 sq ft
surfaces: indoor		trigger, pump or other type of sprayer	0.043 lb ai/RTU
surfaces: indoor	carpet, mattresses	low-pressure handwand, backpack	0.065 lb ai/1000 sq ft
Outdoor Surfaces			
surfaces: outdoor	building surfaces	paintbrush, low-pressure handwand, backpack, handgun	0.4 lb ai/1000 sq ft
surfaces: outdoor		Aerosol can	0.035 RTU-aerosol
Termites			
termites: soil around underground utilities	termites	handgun, low-pressure handwand, backpack	33.2 lb ai/1000 linear feet
termites: soil surrounding standing wood	termites	injector	0.08 lb ai/gallon
termites: soil, under concrete slabs, stoops , porches, structural voids,	termites	foam application	4.25 lb ai/1000 sq ft
Wood Treatment: trees, telephone poles, fence posts	nest openings	paintbrush, low-pressure handwand, backpack	0.04 lb ai/gallon
Turf			
turf: residential and commercial	foliar	handgun, low pressure handwand, backpack	0.87 lb ai/acre
Engines			
vapor recovery systems	engines	none	0.000189 lb ai/tube

Table 3: Summary of Maximum Application Rates for Registered Permethrin Residential Uses			
Crop Type/Use Site	Target of Application	Application Equipment	Maximum Application Rate
Animals			
dogs, cats	body	shaker can	0.016 lb ai/animal
dogs, cats	body	aerosol can	0.000538 lb ai/16 oz can
dogs, horses	body	low-pressure handwand, backpack	0.00078 lb ai/horse
horses	body	sponge on	0.005 lb ai/gal
dogs	neck	1, 2, or 4 cc applicator tube	0.0030 lb ai/animal
animal: horses	body	pour on	0.005 lb ai/animal
dogs, cats	body	Rubber gloves (hands)	0.0014 lb ai/animal
dogs	body	trigger, pump or other type of sprayer	0.043 lb ai/gal sprayer
horses, foals	body	trigger-pump sprayer	0.016 lb ai/animal
dogs, horses	body	wipe (0.28 oz towelette)	0.0062 lb ai/animal
Animal Premises			
animal premises: dogs, cats	indoor surfaces	shaker can	0.0025 lb ai/1 lb container
animal premises: dogs (outdoors)	body	low-pressure handwand, backpack	0.0046 lb ai/1000 sq ft
animal premises: dogs, cats	indoor surfaces	aerosol can	0.000538 lb ai/16 oz can
Indoor Ornamentals			
ornamentals	foliar	low pressure handwand, sprinkler can	0.0017 lb ai/gal
ornamentals	foliar	aerosol can	0.00213 lb ai/16 oz can
Outdoor Ornamentals			
asparagus fern, roses	foliage	shaker can, dust gun, rotary duster	0.0025 lb ai/1 lb container
flowers, roses, shrubs, trees	foliar	backpack, low pressure handwand	0.0017 lb ai/gal
ornamentals	foliar	hose-end sprayer, low pressure handwand, backpack	0.02 lb ai/gal
herbaceous/ woody plants & shrubs	foliar	hose-end sprayer, low pressure handwand, backpack	0.2 lb ai/acre
ornamentals: outdoor	foliar	Aerosol can	0.00213 lb ai/16 oz can
ornamentals: outdoor	foliar	trigger, pump or other type of sprayer	0.043 lb ai/gal sprayer
Indoor Surfaces			
surfaces: indoor		Aerosol can	0.00438 lb ai/16 oz can
surfaces: indoor	carpets	shaker or power duster	0.435 lb ai/1000 sq ft
surfaces: indoor		trigger, pump or other type of sprayer	0.043 lb ai/gal sprayer
Turf			
turf	foliar	hose-end sprayer, low pressure handwand, backpack	0.87 lb ai/acre
turf	foliar	push type spreader, belly grinder	0.65 lb ai/acre
Ants/Fire Ants			
ant mounds: not fire	mounds	teaspoon	0.000078 lb ai/mound
hummingbird feeder	ants	RTU protective disk	
electrical wall plates, boxes, and plumbing flanges	ants	RTU protective flange	
ant mounds: fire	mounds	spoon, cup	0.00156 lb ai/mound
ant mounds: fire	mounds	sprinkler can	0.10 lb ai/mound
ant mounds: fire	mounds	spoon, cup	0.00125 lb ai/mound

Table 3: Summary of Maximum Application Rates for Registered Permethrin Residential Uses			
Crop Type/Use Site	Target of Application	Application Equipment	Maximum Application Rate
Perimeter			
perimeter treatment	soil & vegetation & lower buildings	backpack, low pressure handwand	0.4 lb ai/1000 sq ft
perimeter treatment	soil, turf	push-type spreader, bellygrinder	0.08 lb ai/1000 sq ft
Outdoor Surfaces			
surfaces: outdoor		backpack, low pressure handwand	0.058 lb ai/1000 sq ft
surfaces: indoor		Aerosol can	0.00438 lb ai/16 oz can
surfaces: outdoor		tube	0.0008 lb ai/1000 sq ft
surfaces: outdoor wood		backpack, low pressure handwand	0.17 lb ai/1000 sq ft
surfaces: outdoor wood	standing wood	low pressure handwand, paintbrush	0.04 lb ai/gal
surfaces: outdoor wood	stored lumber, wood piles	hose-end sprayer, sprinkler can	0.04 lb ai/gal
Indoor Spaces			
spaces: indoor		RTU fogger (6 oz)	0.0023 lb ai/6 oz fogger
Garden Vegetables			
asparagus, broccoli, Brussel sprouts, cabbage, cauliflower, spinach	foliar	low-pressure handwand, backpack	0.0027 lb ai/1000 sq ft
celery, eggplant, horseradish, head lettuce, potatoes, peppers, sweet corn	foliar	low-pressure handwand, backpack	0.0053 lb ai/1000 sq ft
asparagus	foliage	shaker can, dust gun, rotary duster	0.0025 lb ai/1 lb container
asparagus, broccoli, Brussel sprouts, cauliflower, cabbage, celery cucumber, eggplant, garlic, lettuce: head & leaf, muskmelon, onion: dry bulb, parsley, pepper: bell, potato, pumpkin, rhubarb, squash, spinach, sweet corn, tomato, watermelon	foliage	shaker can, dust gun, rotary duster	0.0025 lb ai/1 lb container
vegetables (garden), ornamentals	foliar	FPO puffer can	0.00125 lb ai/1 lb container
Residential Fruit and Nut Trees			
apples, peaches, walnuts	foliage	shaker can, dust gun, rotary duster	0.0025 lb ai/1 lb container
almonds, filberts, pears, pistachios	foliar	hose-end, low pressure handwand, backpack	0.4 lb ai/acre
apples, peaches	foliar	hose-end, low pressure handwand, backpack	0.3 lb ai/acre
cherries	foliar	hose-end, low pressure handwand, backpack	0.2 lb ai/acre
Clothing			
clothing	clothing	dip	0.002 lb ai/shirt, pants, & bed net
clothing: personal/military	clothing	impregnated	0.125 mg ai/cm^2

1.6.3 Application Methods

Permethrin is applied with several types of application equipment – the major wide-area methods are aerial, groundboom, airblast, tractor-drawn spreader, mechanical duster, and truck-mounted ULV sprayer applications. Applications to smaller areas may be made with handheld equipment, including low-pressure handwand sprayers, backpack sprayers, sprinkling cans, hose-end sprayers, and handgun sprayers, and with ready-to-use application methods, including pump-trigger sprayers, foggers, aerosol cans, and dust (puffer or shaker) cans.

2.0 Occupational Exposures and Risks

There is a potential for exposure to permethrin in occupational scenarios from handling permethrin products during the application process (i.e., mixer/loaders, applicators, flaggers, and mixer/loader/applicators) and a potential for postapplication worker exposure from entering into areas previously treated with permethrin. As a result, risk assessments have been completed for occupational handler scenarios as well as occupational postapplication scenarios.

2.1 Occupational Handler Exposures and Risks

HED uses the term "handlers" to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct job functions or tasks related to applications and that exposures can vary depending on the specifics of each task. Job requirements (e.g., amount of chemical to be used in an application), the kinds of equipment used, the target being treated, and the level of protection used by a handler can cause exposure levels to differ in a manner specific to each application event.

Exposure scenarios can be thought of as ways of categorizing the kinds of exposures that occur related to the use of a chemical. The use of scenarios as a basis for exposure assessment is very common as described in the *U.S. EPA Guidelines For Exposure Assessment* (U.S. EPA; Federal Register Volume 57, Number 104; May 29, 1992). Information from the current labels; use and usage information; toxicology data; and exposure data were all key components in developing the exposure scenarios.

The first step in the handler risk assessment process is to identify the kinds of individuals that are likely to be exposed to permethrin during the application process. In order to do this in a consistent manner, HED has developed a series of general descriptions for tasks that are associated with pesticide applications. Tasks associated with occupational pesticide use (i.e., for "handlers") can generally be categorized using one of the following terms:

- **Mixers and/or Loaders:** these individuals perform tasks in preparation for an application. For example, prior to application, mixer/loaders would mix the permethrin and load it into the holding tank of the airplane or groundboom.

- **Applicators:** these individuals operate application equipment during the release of a pesticide product into the environment. These individuals can make applications using equipment such as airplanes or groundboom.

- **Mixer/Loader/Applicators and or Loader/Applicators:** these individuals are involved in the entire pesticide application process (i.e., they do all job functions related to a pesticide application event). These individuals would transfer permethrin into the application equipment and then also apply it.

- **Occupational Flaggers:** these individuals guide aerial applicators during the release of a pesticide product onto an intended target.

Next, assessors must understand how exposures to permethrin occur (i.e., frequency and duration) and how the patterns of these occurrences can cause the effects of the chemical to differ (referred to as dose response). Wherever possible, use and usage data determine the appropriateness of certain types of risk assessments. Other parameters are also defined from use and usage data such as application rates and application frequency. HED always completes non-cancer risk assessments using maximum application rates for each scenario because what is possible under the label (the legal means of controlling pesticide use) must be evaluated in order to ensure there are no concerns for each specific use.

HED believes that occupational permethrin exposures can occur over a single day or up to weeks at a time for many use-patterns and intermittent exposures over several weeks are also anticipated. Custom or commercial applicators may apply permethrin over a period of weeks completing applications for a number of different clients. HED classifies exposures up to 30 days as short-term and exposures greater than 30 days up to several months as intermediate-term. HED completes both short- and intermediate-term assessments for occupational scenarios in essentially all cases, because these kinds of exposures are likely and acceptable use/usage data are not available to justify deleting intermediate-term scenarios. Long-term handler exposures are not expected to occur for permethrin. The same toxicological endpoint (from an oral study) of concern was selected for short- and intermediate-term dermal permethrin exposures, therefore the risk results for all dermal durations of exposure are numerically identical. The same toxicological endpoint (from an inhalation study) of concern has been selected for short- and intermediate-term inhalation exposures to permethrin, therefore the risk results for all inhalation durations of exposure are numerically identical.

Occupational handler exposure assessments are completed by HED using different levels of personal protection. HED typically evaluates all exposures with a tiered approach. The lowest tier is represented by the baseline exposure scenario (i.e., long-sleeve shirt, long pants, shoes, and socks) followed by increasing the levels of personal protective equipment or PPE (e.g., gloves, double-layer body protection, and respirators) and engineering controls (e.g., enclosed cabs and closed mixing/loading systems). This approach is always used by HED in order to be able to define label language using a risk-based approach. In addition, the minimal level of adequate

protection for a chemical is generally considered by HED to be the most practical option for risk reduction (i.e., over-burdensome risk mitigation measures are not considered a practical alternative).

2.1.1 Data and Assumptions For Handler Exposure Scenarios

2.1.1.1 Assumptions for Handler Exposure Scenarios

A series of assumptions and exposure factors served as the basis for completing the occupational handler risk assessments. Each assumption and factor is detailed below on an individual basis. The assumptions and factors used in the risk calculations include:

- Permethrin is a widely used insecticide. It has a large number of use patterns that are difficult to completely capture in this document. As such, HED has patterned this risk assessment on a series of likely representative scenarios that are believed by HED to represent the vast majority of permethrin uses.

- Occupational handler exposure estimates were based on surrogate data from: (1) the Pesticide Handlers Exposure Database (PHED), (2) Outdoor Residential Exposure Task Force (ORETF), Chemical Manufacturers Association (CMA), and proprietary data.

- Average body weight of an adult handler is 70 kg because the toxicity endpoint values used for the assessments are appropriate for average adult body weight representing the general population.

- Generic protection factors (PFs) were used to calculate exposures when data were not available. For example, an 80 percent protection factor was assumed for the use of a quarter-face cup-style respirator equipped with dust/mist filter.

- Exposure factors used to calculate daily exposures to handlers are based on applicable data if available. For lack of appropriate data, values from a scenario deemed similar enough by the assessor might be used. As an example, for permethrin handler exposures, ORETF data for hose-end sprayer equipment were used to assess sprinkling can applications. The nature of these application methods are believed to be similar enough to bridge the data.

- Cancer risk assessments were completed using the Q_1* selected for permethrin.

- For cancer assessments, it was assumed that all handlers (commercial and private) may be exposed to permethrin for 10 days per year (based on average values). This assumption is based on a BEAD memo dated March 24, 2004 (Brassard), in which BEAD provided HED information on the number of days permethrin is applied annually by applicators. The information in this memo showed that for most crops, applicators apply permethrin

less than ten days per year. As a result, HED considered one handler population (small, medium, and large scale growers as well as commercial applicators) for the cancer risk assessment. All handlers were assumed to have a 35 year career and a 70 year lifespan.

- For non-cancer assessments, HED assumes the maximum application rates allowed by labels in its risk assessments (see tables 1 through 3). Maximum application rates were also utilized for the permethrin cancer assessment. Data provided by BEAD on the typical/average application rates differed very little from the maximum application rates and did not provide enough of a benefit to justify its use in the assessment.

- The average occupational workday is assumed to be 8 hours.

- The daily areas treated were defined for each handler scenario (in appropriate units) by determining the amount that can be reasonably treated in a single day (e.g. acres, square feet, cubic feet, or gallons per day). When possible, the assumptions for daily areas treated is taken from the HED ExpoSAC SOP #9: Standard Values for Daily Acres Treated in Agriculture which was completed on July 5, 2000. However, no standard values are available for numerous scenarios. Assumptions for these scenarios are based on HED estimates and could be further refined from input from affected sectors.
  - Aerial applications: 350 acres for most crops on which permethrin is registered, except 1200 acres for high acreage crops, 100 acres for aerial applications to pine seed orchards and conifers, and 60 acres for aerial applications to field-grown roses;
  - Groundboom: 80 acres for most crops on which permethrin is registered, except 200 acres for high acreage crops, and 40 acres for groundboom applications to field-grown chrysanthemums and roses;
  - Airblast: 40 acres treated for most crops on which permethrin is registered and 20 acres for airblast applications to pine seed orchards and conifers;
  - Tractor-Drawn Spreader: 80 acres for most crops on which permethrin is registered, except 200 acres for high acreage crops;
  - Flaggers: 350 acres for most crops on which permethrin is registered, except 100 acres for aerial applications to pine seed orchards and conifers, and 60 acres for aerial applications to field-grown roses.
  - Truck Mounted ULV Sprayer: 3,000 acres for all applications;
  - Mechanical Duster: 400 animals per day for all agricultural animals, except 100,000 animals for poultry applications;
  - Handgun: 8 acres for applications to commercial/industrial turf and 40 gallons per day for applications to all other crops/sites;
  - Low Pressure Handwand Sprayer: 400 animals per day for all agricultural animals, and 40 gallons per day for applications to all other crops/sites;
  - High Pressure/Volume Handwand: 100,000 animals for poultry applications and 1000 gallons per day for applications to all other crops/sites;
  - Fogger/Mist Generator: 1,000 sq ft for all applications;

- Termite Injector: 2,000 gallons per day for all applications;
- Backpack ULV Sprayer: 5 acres per day for all applications;
- Watering Can: 10 gallons per day for all applications;
- Paint Brush: 5 gallons per day for all applications;
- Open Pour: 400 animals per day for all agricultural animals and 1 container for clothing treatment;
- RTU Ear Rag: 400 animals per day for cattle;
- RTU Hand or Wipe: 8 animals for dogs/cats, and 400 animals for horses;
- Trigger Pump Sprayer: 400 animals per day for all agricultural animals and 2 gallons per day for indoor surfaces;
- Aerosol Can: 2 (16 oz) cans per day;
- RTU Foggers: 4 (6-ounce) foggers per day.

- Currently, EPA has no data for:
  - applying dust with mechanical dusters or dust bags,
  - mixing/loading/applying wettable powders with backpack sprayers or high pressure handwand sprayers,
  - mixing/loading/applying microencapsulated liquids via fogger/mist generators, and
  - numerous ready-to-use applications.

  There are other data gaps that have been identified for permethrin applications. Each is identified in the calculation tables and is also noted in the summary of risk calculations.

2.1.1.2 Exposure Data for Handler Exposure Scenarios

No chemical specific information was available for permethrin handler exposure assessments, all analyses were completed using acceptable surrogate exposure data for the scenario in question.

HED uses a concept known as *unit exposure* as the basis for the scenarios used to assess handler exposures to pesticides. *Unit exposures* numerically represent the exposures one would receive related to an application. They are generally presented as mg active ingredient exposure/pounds of active ingredient handled (mg ai/lb). HED has developed different unit exposures for different types of application equipment; job functions; and levels of protection. The *unit exposure* concept has been established in the scientific literature and also through various exposure monitoring guidelines published by the U.S. EPA and international organizations such as Health Canada and OECD (Organization For Economic Cooperation and Development).

Pesticide Handler Exposure Database (PHED) Version 1.1 (August 1998): PHED was designed by a task force of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts -- a database of measured exposures for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data.

Currently, the database contains values for over 1,700 monitored individuals (i.e., replicates)

Users select criteria to subset the PHED database to reflect the exposure scenario being evaluated. The subsetting algorithms in PHED are based on the central assumption that the magnitude of handler exposures to pesticides are primarily a function of activity (e.g., mixing/loading, applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and clothing scenarios (e.g., gloves, double layer clothing).

Once the data for a given exposure scenario have been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposures for each body part (e.g., chest upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposures for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part are composited into a "best fit" exposure value representing the entire body.

The unit exposures calculated by PHED generally range from the geometric mean to the median of the selected data set. To add consistency and quality control to the values produced from this system, the PHED Task Force has evaluated all data within the system and has developed a set of grading criteria to characterize the quality of the original study data. The assessment of data quality is based on the number of observations and the available quality control data. These evaluation criteria and the caveats specific to each exposure scenario are summarized in Appendix A, Table A1. While data from PHED provide the best available information on handler exposures, it should be noted that some aspects of the included studies (e.g., duration, acres treated, pounds of active ingredient handled) may not accurately represent labeled uses in all cases. HED has developed a series of tables of standard unit exposures for many occupational scenarios that can be utilized to ensure consistency in exposure assessments. Unit exposures are used which represent different levels of personal protection as described above. Protection factors were used to calculate unit exposures for varying levels of personal protection if data were not available.

ORETF Handler Studies (MRID 449722-01): A report was submitted by the ORETF (Outdoor Residential Exposure Task Force) that presented data in which the application of various products used on turf by homeowners and lawncare operators (LCOs) was monitored. All of the data submitted in this report were completed in a series of studies. The study that monitored LCO exposure scenarios using a low pressure, high volume turf handgun (ORETF Study OMA002) is summarized below as is the study that monitored homeowner exposures while using a hose-end sprayer (ORETF Study OMA004).

LCO Handgun Sprayer: A mixer/loader/applicator study was performed by the Outdoor

Residential Exposure Task Force (ORETF) using "Dacthal" as a surrogate compound to determine "generic" exposures to individuals applying a pesticide to turf with a low-pressure "nozzle gun" or "handgun" sprayer. Dermal and inhalation exposures were estimated using whole-body passive dosimeters and breathing-zone air samples on OVS tubes. Inhalation exposure was calculated using an assumed respiratory rate of 17 liters per minute for light work (NAFTA,1999), the actual sampling time for each individual, and the pump flow rate. All results were normalized for pounds active ingredient handled. A total of 90 replicates were monitored using 17 different subjects.

Four different formulations of dacthal [75% wettable powder (packaged in 4 and 24 pound bags), 75% wettable powder in water soluble bags (3 pound bag), 75% water dispersable granules (2 pound bag) and 55% liquid flowable (2.5 gallon container)] were applied by five different LCOs to actual residential lawns at each site in three different locations (Ohio, Maryland, and Georgia) for a total of fifteen replicates per formulation. An additional ten replicates at each site were monitored while they performed spray application only using the 75 percent wettable powder formulation. A target application rate of 2 pounds active ingredient was used for all replicates (actual rate achieved was about 2.2 pounds active ingredient per acre).

Each replicate treated a varying number of actual client lawns to attain a representative target of 2.5 acres (1 hectare) of turf. The exposure periods averaged five hours twenty-one minutes, five hours thirty-nine minutes, and six hours twenty-four minutes, in Ohio, Maryland and Georgia, respectively. Average time spent spraying at all sites was about two hours. All mixing, loading, application, adjusting, calibrating, and spill clean up procedures were monitored, except for typical end-of-day clean-up activities, e.g. rinsing of spray tank, etc.

In general, concurrent lab spikes produced mean recoveries in the range of 78-120 percent, with the exception of OVS sorbent tube sections which produced mean recoveries as low as 65.8 percent. Adjustment for recoveries from field fortifications were performed on each dosimeter section or sample matrix for each study participant, using the mean recovery for the closest field spike level for each matrix and correcting the value to 100 percent. The unit exposures are presented in Table 4. [Note the data were found to be lognormally distributed. As a result, all exposures are geometric means.]

Table 4: Unit Exposures Obtained From ORETF LCO Handgun Studies (MRID 449722-01)

Application Method	Total Dermal Unit Exposure (mg/lb ai)			Inhalation Unit Exposure (µg/lb ai) [1]
	Single Layer, No Gloves	Single Layer, Gloves	Double Layer, Gloves [2]	
LCO Handgun Spray Mixer/Loader/Applicator Liquid Flowable[3]	No Data	0.45	0.245	1.8
LCO Handgun Spray Mixer/Loader/Applicator Wettable Powder [3]	No Data	0.80	0.43	64
LCO Handgun Spray Mixer/Loader/Applicator Wettable Powder in Water Soluble Bags [3]	No Data	0.64	0.37	7.2

[1]Air concentration (mg/m^3/lb ai) calculated using NAFTA '99 standard breathing rate of 17 lpm (1 m^3/hr)
[2]Exposure calculated using OPP/HED 50% protection factor (PF) for cotton coveralls on torso, arms, legs.
[3]All commercial handlers wore long pants, long-sleeved shirt, nitrile gloves and shoes.

Homeowner Hose End Sprayer: A mixer/loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using Diazinon as a surrogate compound to determine "generic" exposures to individuals applying a pesticide to turf with a dial type hose end sprayer. Dermal and inhalation exposures were estimated using whole-body passive dosimeters and breathing-zone air samples on OVS tubes. Inhalation exposure was calculated using an assumed respiratory rate of 17 liters per minute for light work (NAFTA,1999), the actual sampling time for each individual, and the pump flow rate. All results were normalized for pounds active ingredient handled. A total of 30 replicates were monitored throughout the study.

Diazinon (25% emulsifiable concentrate) was applied by homeowners to actual residential lawns at a site in Maryland. A target application rate of 4 pounds active ingredient was used for all replicates. Each replicate monitored the test subject treating 5,000 ft^2 of turf and handling a total of 0.5 lb ai/replicate. The exposure periods (mixing/loading/applying) averaged seventy-five minutes. Dermal exposure was measured using inner and outer whole body dosimeters, hand washes, face/neck washes, and personal air monitoring devices. In general, concurrent lab spikes produced mean recoveries in the range of 87-103 percent. Adjustment for recoveries from field fortifications (79-104 %) were performed on each dosimeter section or sample matrix for each study participant, using the mean recovery for the closest field spike level for each matrix and correcting the value to 100 percent. The unit exposures are presented below. [Note the data were found to be lognormally distributed. As a result, all exposures are geometric means.]

Table 5: Unit Exposures Obtained From ORETF Hose End Sprayer Studies (MRID 449722-01)		
Type	Dermal: Long Pants, Long Sleeves (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Hose-end (Mix-your-own)	5.6	0.017
All unit exposures are geometric means.		

ORETF Handler Studies (MRID 445185-01): A report was submitted by the ORETF (Outdoor Residential Exposure Task Force) that presented data in which the application of various products used on fruit trees and ornamentals by homeowners was monitored. All of the data submitted in this report were completed in a series of studies. The study that monitored homeowner exposure scenarios using a low pressure handwand (ORETF Study OMA005) is summarized below.

Homeowner Hand-held Sprayer: Applications of Sevin Liquid® Carbaryl insecticide [RP-2 liquid (21%)] were made by volunteers to two young citrus trees and two shrubs in each replicate that was monitored in the study. The test field was located only in Florida. Twenty (20) replicates were monitored using hand held pump sprayers (low pressure handwands).

Each replicate opened the end-use product, added it to the hand held pump and then applied it to the trees and shrubs. After application to two trees and two shrubs dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of carbaryl from inner and outer 100 percent cotton dosimeters. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso. No gloves were worn therefore hand exposure was assessed with 400 mL handwash with 0.01 percent Aerosol OT-75 sodium dioctyl sulfosuccinate (OTS). One hundred percent cotton handkerchiefs wetted with 25 mL OTS were used to wipe face and neck to determine exposure.

Field fortification recoveries for passive dosimeters averaged 88.3 percent for inner and 76.2 percent for outer dosimeters. Face and neck wipe fortifications average 82.5 percent. Handwash and inhalation OVS tube field fortification averaged >90 percent. Inner and outer dosimeter and face and neck wipe residues were adjusted for field fortification results. Handwash and inhalation residues were not adjusted.

Laboratory method validation for each matrix fell within the acceptable range of 70 to 120 percent. The limit of quantitation (LOQ) was 1.0 µg/sample for all media except the inhalation monitors where the LOQ was 0.01 µg/sample. The limit of detection (LOD) was 0.5 µg/sample for all media except the inhalation monitors where the LOQ was 0.005 µg/sample.

For use in reregistration documents, the dermal exposure was calculated by adding the values from the hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the

inner dosimeter front and rear torso, upper legs and upper arms. This accounts for the residential handler wearing short-sleeved shirt and short pants. The results for the low pressure handwand are summarized in Table 6 below.

Table 6: Unit Exposures Obtained From ORETF Homeowner Low Pressure Handwand Studies (MRID 445185-01)

Type	Dermal: Long Pants, Long Sleeves (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Low Pressure Handwand	30.0	0.0038
All unit exposures are geometric means.		

ORETF Handler Studies (MRID 444598-01): A report was submitted by the ORETF (Outdoor Residential Exposure Task Force) that presented data in which the application of various products used on vegetable gardens by homeowners was monitored. All of the data submitted in this report were completed in a series of studies. The study that monitored homeowner exposure scenarios using a duster (ORETF Study OMA007) is summarized below.

Homeowner Duster: The data collected reflect the dermal and respiratory exposure of homeowners mixing, loading and applying Sevin® 10 Dust, a carbaryl end-use product. Applications were made by volunteers to two 18 foot rows of tomatoes and one 18 foot row of cucumber. The only test field was located in Florida. Exposure for each was monitored using 20 replicates which consisted of loading the dusters and applying the dust without gloves.

Each replicate opened the end-use product, added it to the application implement, adjusted the setting and applied it to the vegetable rows. After application to the vegetable rows, dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of carbaryl from inner and outer 100 percent cotton dosimeters, face/neck wipes, and glove and hand washes. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso.

Field fortification recoveries for passive dosimeters averaged 84.3 percent for inner and 77.7 percent for outer dosimeters. Face and neck wipe fortifications average 84.8 percent. Handwash and Inhalation OVS tube field fortification averaged >90 percent. Inner and outer dosimeter and face and neck wipe residues were adjusted for field fortification results. Handwash and inhalation residues were not adjusted.

Laboratory method validation for each matrix fell within the acceptable range of 70 to 120 percent. The limit of quantitation (LOQ) was 1.0 µg/sample for all media except the inhalation monitors where the LOQ was 0.01 µg/sample. The limit of detection (LOD) was 0.5 µg/sample for all media except the inhalation monitors where the LOQ was 0.005 µg/sample.

Dermal exposure was determined by adding the values from the bare hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants. Unit exposures for this scenario are presented below in Table 7. [Note: The geometric means were used for risk assessment purposes.]

Table 7: Unit Exposures Obtained From ORETF Homeowner Duster Studies (MRID 444598-01)

Type	Dermal: Long Pants, Long Sleeves (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Duster	76	620
All unit exposures are geometric means.		

Chemical Manufacturers Association (CMA) Antimicrobial Exposure Assessment Study (December 1992): The CMA exposure study was a response to March 4, 1987 data call-in notice by EPA. CMA is a generic biocide exposure assessment protocol used to assess potential dermal and/or inhalation exposure from the application of antimicrobial pesticide products in multiple settings using various application methods. The study examined nine separate antimicrobial pesticides and variety of application methods for a total number of 88 replicates. Dermal exposure was measured with the use of pads attached to the inside and the outside of the applicators clothing. Inhalation exposure was monitored continuously by chemical specific collection media using a personal sampling pump.

The CMA exposure study assessed exposures to individuals who used wipes to apply antimicrobial pesticides. There were six wipe replicates (no gloves) in the study. Unit exposures for this scenario are presented below in Table 8. While the wipe data from CMA provide the best available information on handler exposures for the wipe and sponge scenarios, it should be noted that some aspects of the study are issues such as: good labor practices were not closely followed, extraction efficiencies were below the minimum level suggested in the guidelines, calibration of the air monitoring equipment resulted in much of the data being less than detection, and the limited number of replicates (the guidelines recommend 15 replicates).

Table 8: Unit Exposures Obtained From CMA Exposure Assessment Study

Type	Dermal: No gloves (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Wipe	2870	27700
All unit exposures are arithmetic means.		

Proprietary Studies

Two proprietary studies were used to obtain unit exposures for handlers applying ready-to-use liquid formulations via trigger pump sprayer and handlers applying shampoos to dogs. The studies are summarized below:

EPA MRID 410547-01 (Propoxur trigger sprayer study): A total of 15 applicator events during residential applications using a hand-operated trigger pump sprayer, attached with an 18 inch hose to half gallon cans containing 0.95 percent propoxur, were completed in this study. The study was completed between October 26 and November 1, 1988 in the Kansas City Missouri metro area. Each person monitored in the study was a Bayer (the sponsor corporation) employee. Three employees were used to complete all replicates. In each replicate, "each applicator used a separate one-half gallon can of Raid for each house. The cap was removed from the top of the can and the hose sprayer was attached by inserting the dip tube into the can and tightening the screw cap. The sprayer was primed by pumping the trigger. The applicator treated the outside of the home in areas where pests were likely to be found, such as screens, door and window frames, foundation walls, patios, porches, stoops, and decks. When the application was completed, the hose sprayer was secured under the handle of the can." The data included in the study indicate that exposure durations ranged from 9 to 21 minutes per replicate and the amount of active ingredient handled ranged from 0.16 to 0.4 oz (i.e., 0.01 to 0.025 lb ai). Dermal (nonhand) exposure monitoring during each replicate was completed using gauze sponges held in "aluminized paper holders" with an open sampling surface area of 24.6 cm^2 while hand exposures were quantified with the handwash technique (2 - 200 mL aliquots of ethanol per hand for a total volume of 800 mL per person). Inhalation exposures were monitored using standard personal sampling pumps operating a 1 liter per minute with quartz microfiber filters. Samples were collected in this study to represent exposures when a person was wearing normal work clothing (i.e., long pants and long-sleeved shirts) and chemical-resistant gloves.

Analysis of propoxur residues was completed with high performance liquid chromatography, post-column derivatization, and fluorescence detection. The limits of quantification (LOQ) were 10 µg per sample for the handwash solutions, 0.1 µg/sample for the inhalation filters, and 0.03 µg/cm^2 for the dermal patch samples. Field and laboratory recovery data were generated for all media. This study was reviewed in September 1989 under EPA contract 68-02-4254 by Versar. The values used for regulatory purposes have been excerpted from that review (including recovery results). Average laboratory recovery for all media ranged from 99.2 to 109 percent while the coefficients of variation for each media were generally less than 5 (i.e., for the patches, the CV = 16.5). Patches and filters were fortified at 1 µg/sample while hand rinses were fortified at either 200 or 1000 µg/sample. Average field recovery results ranged from 90.3 to 102.2 percent while coefficients of variation also were generally less than 5 (i.e., inside patch CV= 6.9). Patches were fortified at levels from 1 to 50 µg/sample, hand rinses were fortified at 200 µg/sample, and filters were fortified at 0.2 µg/sample. Unit exposures for this scenario in each are presented in Table 9.

Table 9: Unit Exposures Obtained From Propoxur Trigger Pump Sprayer Study (MRID 410547-01)		
Type	Dermal (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Trigger Pump Sprayer	13.5	123

MRID 446584-01 (carbaryl-specific dog groomer data): The data collected reflect the dermal and respiratory exposure of commercial pet groomers applying the end use product, Adams® Carbaryl Flea and Tick Shampoo containing 0.50 percent carbaryl. These data meet most of the criteria specified in Series 875 Occupational and Residential Exposure Test Guidelines. In this study, applications of Adams® Carbaryl Flea and Tick Shampoo were made by professional pet groomers to 8 dogs at 2 sites in Georgia. A total of 16 replicates were monitored for dermal and inhalation exposure. Eight dogs of various sizes and hair lengths were shampooed during each replicate. Dermal exposure was monitored with face and neck swabs, 100 percent cotton union suit dosimeter worn underneath a short-sleeved t-shirt, long pants and a 65/35 polyester cotton long-sleeved smock (i.e., represents a short-sleeved shirt under a long-sleeved coat/smock). Hand exposure was quantified using handwash rinses (no protective gloves were worn). Inhalation exposure was monitored using personal air pumps with XAD2 resin tubes.

Between 373.3 to 3719.95 mg carbaryl (average use was 1360 mg ai) was used to shampoo 8 dogs. According to label directions, the application rate is a subjective determination by the individual groomers based on amount needed to create the desired lather. The dogs were wetted, shampooed to a lather (lather remained on dogs for 5 minutes) and rinsed. It is not clear how many or which of the dogs got further post-shampoo attention such as grooming or drying.

After completing 8 dog shampoos the dosimeters were collected. Face/neck swabs and 2 hand rinses were performed along with collection of the 100 percent cotton union suit. Only whole-body dosimeter values were adjusted for field recovery (87 percent). No other samples were corrected for recovery as the field and laboratory recoveries generally were >90 percent. Dermal exposures ranged between 0.88 mg and 17 mg ai and inhalation exposures range between 0.05 µg (non-detect) and 1.96 µg ai. The limit of detection (LOD) was 0.010 µg/ml. The limit of quantitation (LOQ) was 1 µg per whole body dosimeter, 0.10 µg/ml for 50 ml hand wash aliquot, 0.10 µg per facial wipe, 0.10 µg per resin tube, and 0.10 µg for glass fiber filter/su
The geometric mean of the normalized numbers was used in reregistration calculations because it is a measure of central tendency.

Even though the study protocol was approved prior to completion of the field work, the following factors should be considered when interpreting these results. In this task, direct contact of the dipping solution with the hands represents a major potential source of exposure. Therefore, obtaining accurate hand exposure estimates is critical in defining the risks for this use. The study measured the amount of carbaryl left on the hands after 8 shampoos and rinses using an aqueous handwash method. Shampoo was applied, a lather was created and rinsed off with a large degree of hand contact with the shampoo and water stream. Carbaryl repeatedly contacted

the hand for the duration of the grooming and some was removed during the rinsing of each dog. Because of this potential flux of residues off and on the groomer's hands and the presence of surfactants which may impact dermal absorption levels, the handwash method may underestimate exposures. This study should not be used for residential exposure assessments because protective clothing (i.e., smock and long pants) were worn over the whole-body dosimeters and adjusting the data using negative protection factors which is generally not considered appropriate. The data for this study is provided in Table 10.

Table 10: Unit Exposure Values Obtained From Professional Dog Groomer Study (MRID 446584-01)

Unit	Dermal (geometric mean)	Inhalation (geometric mean)
mg ai / lb ai handled	1800	12
mg ai / lb of dog treated	0.13	0.011

2.1.2 Permethrin Handler Exposure Scenarios

Exposure to pesticide handlers is likely during the occupational use of permethrin based on the types of equipment and techniques that can potentially be used. The quantitative exposure/risk assessment developed for occupational handlers is based on the following scenarios. The scenario numbers correspond to the tables of risk calculations included in the occupational risk calculation aspects of the appendices. Permethrin dermal and inhalation exposure was estimated using PHED, ORETF, CMA, and proprietary data. [**Note:** Scenarios denoted with a "*" could not be evaluated quantitatively because applicable unit exposure data are not available.]

Mixer/Loaders:
(1a) Liquids for Aerial Applications;
(1b) Liquids for Groundboom Applications;
(1c) Liquids for Airblast Applications;
(1d) Liquids for Truck Mounted ULV Applications;
(1e) Liquids for Dip Applications*;
(2a) Wettable Powder for Aerial Applications;
(2b) Wettable Powder for Groundboom Applications;
(2c) Wettable Powder for Airblast Applications;
(2d) Dusts for Mechanical Duster Applications (using PHED WP mixer/loader data);
(2e) Dusts for Dust Bag Applications (using PHED WP mixer/loader data);
(3a) Granulars for Aerial Applications;
(3b) Granulars for Tractor Drawn Spreader Applications;

Applicators:
(4) Aerial Applications (Sprays);
(5) Groundboom Applications;
(6) Airblast Applications;

(7) Truck Mounted ULV Applications;
(8) Dip Applications*;
(9) Aerial Applications (Granulars)
(10) Tractor Drawn Spreader Applications (Granulars);
(11) Mechanical Duster Applications*;
(12) Dust Bag Applications*;

Flaggers:
(13) Flagging for Aerial- Sprays;
(14) Flagging for Aerial-Granulars;

Mixer/Loader/Applicators:
(15) Liquid: Low Pressure Handwand Sprayer;
(16) Liquid: Handgun Sprayer;
(17) Liquid: High Pressure Handwand Sprayer;
(18) Liquid: Termiticide Injector;
(19) Liquid: Foam Applicator Equipment (using ORETF low pressure handwand data);
(20) Liquid: Watering Can (using ORETF residential hose end sprayer data);
(21) Liquid: Backpack ULV Sprayer (using ORETF low pressure handwand data);
(22) Liquid: Paint Brush;
(23) Wettable Powder: Low Pressure Handwand Sprayer;
(24) Wettable Powder: Handgun Sprayer;
(25) Wettable Powder: High Pressure Handwand Sprayer*;
(26) Water Soluble Bag: Handgun Sprayer;
(27) Dusts: Shaker Can;
(28) Microencapsulated Liquid: Fogger/Mist Generator*;
(29) RTU Liquid: Pour On Applications (using PHED mixing/loading liquid data);
(30) RTU Ear Tag Applications*;
(31) RTU: Hand Applications (Shampoos);
(32) RTU: Wipe Applications;
(33) RTU: Trigger Pump Sprayer Applications;
(34) RTU: Aerosol Cans;
(35) RTU: Fogger (using PHED aerosol can data);
(36) RTU Protective Flanges*;
(37) RTU Vapor Recovery System Tubes*.

2.1.3 Non-cancer Permethrin Handler Exposure and Assessment

The occupational handler exposure and non-cancer risk calculations are presented in this section.

2.1.3.1 Non-cancer Permethrin Handler Exposure and Risk Calculations

Non-cancer risks were calculated using the Margin of Exposure (MOE) which is a ratio of the daily dose to the toxicological endpoint of concern. Daily dose values are calculated by first calculating exposures by considering application parameters (i.e., rate and area treated) along with unit exposures. Exposures are then normalized by body weight and adjusted for absorption factors as appropriate to calculate dose levels.

Daily Exposure: The daily exposure and daily dose to handlers were calculated as described below. The first step was to calculate daily exposure (dermal or inhalation) using the following formula:

$$Daily\ Exposure\left(\frac{mg\ ai}{day}\right) = Unit\ Exposure\left(\frac{mg\ ai}{lb\ ai\ handled}\right) \times Application\ Rate\left(\frac{lbs\ ai}{area}\right) \times Daily\ Area\ Treated\left(\frac{area}{day}\right)$$

Where:

Daily Exposure	=	Amount (mg ai/day) deposited on the surface of the skin that is available for dermal absorption or amount inhaled that is available for inhalation absorption;
Unit Exposure	=	Unit exposures (mg ai/lb ai) derived from August 1998 PHED data, from ORETF data, from CMA data, or from Proprietary data;
Application Rate	=	Normalized application rate based on a logical unit treatment, such as acres, square feet, gallons, or cubic feet. Maximum values are generally used (lb ai/A, lb ai/sq ft, lb ai/gal, lb ai/cu ft); and
Daily Area Treated	=	Normalized application area based on a logical unit treatment such as acres (A/day), square feet (sq ft/day), gallons per day (gal/day), or cubic feet (cu ft/day).

Daily Dose: Daily dose (inhalation or dermal) was calculated by normalizing the daily dermal or inhalation exposure value by body weight and accounting for dermal or inhalation absorption. For adult handlers using permethrin, an average body weight of 70 kilograms was used for all exposure scenarios. Since the dermal toxicological endpoints of concern are based on oral studies, a dermal absorption rate is used to estimate the amount of permethrin likely to be absorbed through the skin following dermal exposures. A dermal absorption factor of 30 percent was used for all duration dermal calculations based on permethrin dermal absorption studies in rats. Since the inhalation toxicological endpoint of concern is based on an inhalation study, no absorption factor is needed for inhalation dose calculations. Daily dose was calculated using the following formula:

$$Average\ Daily\ Dose\_mg\ /kg\ /day = Daily\ Exposure\left(\frac{mg\ ai}{day}\right) \times \left(\frac{Absorption\ Factor\ (\%\ /100)}{Body\ Weight\ (kg)}\right)$$

Where:

Average Daily Dose	=	Absorbed dose received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day);

Daily Exposure	=	Amount (mg ai/day) deposited on the surface of the skin that is available for dermal absorption or amount inhaled that is available for inhalation absorption;
Absorption Factor	=	A measure of the amount of chemical that crosses a biological boundary such as the skin or lungs (% of the total available absorbed); and
Body Weight	=	Body weight determined to represent the population of interest in a risk assessment (kg).

Margins of Exposure: Finally, the calculations of daily dermal dose and daily inhalation dose received by handlers were then compared to the appropriate endpoint (i.e., NOAEL) to assess the total risk to handlers for each exposure route within the scenarios. All MOE values were calculated separately for dermal and inhalation exposure levels using the formula below:

$$MOE = \frac{NOAEL\_mg/kg/day}{Average\ Daily\ Dose\_mg/kg/day}$$

Where:

MOE	=	Margin of exposure, value used by HED to represent risk or how close a chemical exposure is to being a concern (unitless);
ADD	=	(Average Daily Dose) or the amount as absorbed dose received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day); and
NOAEL	=	Dose level in a toxicity study, where no observed adverse effects occurred (NOAEL) in the study

It is important to present risk estimates for each route of exposure (i.e., dermal or inhalation) in each scenario because it makes determining appropriate risk mitigation measures easier. For example, if overall risks are driven by dermal exposures and not inhalation, it is inadvisable to require respirators even though they may marginally reduce overall risks.

A total MOE was calculated for permethrin because common toxicity endpoints (neurotoxicity) were used to calculate dermal and inhalation risks for each exposure duration. The dermal and inhalation MOEs were combined using the formula below:

$$MOE_{TOTAL} = \frac{1}{(1/Dermal\ MOE) + (1/Inhalation\ MOE)}$$

2.1.3.2 Permethrin Non-cancer Risk Summary (using PHED, ORETF, CMA, and Proprietary Data)

All of the non-cancer risk unit exposures used in the calculations for occupational permethrin handlers completed in this assessment are included in Appendix A. A summary of the short- and intermediate-term risks for each exposure scenario are presented in Table 10.

Short- and Intermediate-term Dermal Risks

For most scenarios, risks do not exceed HED's level of concern (i.e., the MOEs are greater than 100) at some level of risk mitigation. The following occupational scenarios have short- and intermediate-term risks that exceed HED's level of concern (i.e., the MOEs are less than 100) for handlers at all levels of risk mitigation:

Scenario 17: Mixing/Loading/Applying Liquids via High Pressure Handwand (PHED data)

- mushroom houses at 1000 gallons per day (0.267 lb ai/gallon)

Scenario 27: Loading/Applying Dusts via Shaker Can (ORETF data)

- poultry at 4,000 animals per day (0.0025 lb ai/animal)

Scenario 31: Applying Ready-to-Use Shampoo Formulations via Hands (using EPA MRID 446584-01)

- dogs at 8 animals per day (0.00621 lb ai/animal)

Scenario 32: Applying Ready-to-Use Formulations via Wipe (using CMA)

- dogs and horses at 8 animals per day (0.00621 lb ai/animal)

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Combined MOEs [c]							
				Baseline	G - NR	PPE-G, DL - NR	G - 80% R	G - 90% R	G,DL - 80% R	G,DL - 90% R	Eng Cont
Mixer/Loader											
Mixing/Loading Emulsifiable Concentrates for Aerial Applications (1a)	pine seed orchard	1.2 lb ai/acre	100 acres	17	**1500**	1900	2000	2100	2700	2800	5300
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	14	**1300**	1600	1800	1800	2300	2400	4500
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	19	**1700**	2100	2300	2400	3100	3200	6100
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	6.7	**610**	750	820	830	1100	1100	2100
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	23	**2100**	2600	2800	2800	3700	3800	7300
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	8.4	**760**	930	1000	1000	1400	1400	2600
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	29	**2600**	3200	3500	3600	4700	4800	9000
	conifers (field grown)	0.2 lb ai/acre	100 acres	**100**	9100	11000	12000	12000	16000	17000	32000
	rose: field grown	0.2 lb ai/acre	60 acres	**170**	15000	19000	20000	21000	27000	28000	53000
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	57	**5200**	6400	7000	7100	9400	9600	18000
Mixing/Loading Emulsifiable Concentrates for Groundboom Applications (1b)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	84	**7600**	9300	10000	10000	14000	14000	26000
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	40	**3600**	4500	4900	5000	6600	6700	13000
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	**100**	9100	11000	12000	12000	16000	17000	32000
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	50	**4500**	5600	6100	6200	8200	8400	16000
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	**130**	11000	14000	15000	16000	20000	21000	39000
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	**250**	23000	28000	31000	31000	41000	42000	79000
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	**250**	23000	28000	31000	31000	41000	42000	79000
Mixing/Loading Emulsifiable Concentrates for Airblast Applications (1c)	pine seed orchard	1.2 lb ai/acre	20 acres	84	**7600**	9300	10000	10000	14000	14000	26000
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	**130**	11000	14000	15000	16000	20000	21000	39000
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	**170**	15000	19000	20000	21000	27000	28000	53000
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	**250**	23000	28000	31000	31000	41000	42000	79000
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	**500**	45000	56000	61000	62000	82000	84000	160000
Mixing/Loading Emulsifiable Concentrates with Truck Mounted ULV Sprayer (using PHED airblast data) (1d)	outdoor spaces	0.05 lb ai/acre	3000 acres	13	**1200**	1500	1600	1700	2200	2200	4200

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Mixing/Loading Emulsifiable Concentrates via Dip (1e)	animal: livestock (beef and dairy cattle), horses, swine	0.0023 lb ai/animal	400 animals	**2200**	200000	240000	270000	270000	360000	360000	690000
	animal: dogs	0.005 lb ai/gal	10 gallons	**40000**	3600000	4500000	4900000	5000000	6600000	6700000	13000000
Mixing/Loading Wettable Powders for Aerial Applications (2a)	pine seed orchard	1.2 lb ai/acre	100 acres	12	98	**110**	240	260	310	340	ND
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	10	84	91	**210**	230	260	290	ND
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	14	**110**	120	280	300	350	380	ND
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	4.8	39	43	98	**110**	120	130	ND
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	17	**130**	150	340	360	420	460	ND
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	6	49	53	**120**	130	150	170	ND
	cabbage, Chinese cabbage, corn (pop, seed, sweet) cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	21	**170**	180	420	450	530	580	ND
	conifers (field grown)	0.2 lb ai/acre	100 acres	72	**590**	640	1500	1600	1800	2000	ND
	rose: field grown	0.2 lb ai/acre	60 acres	**120**	980	1100	2400	2600	3100	3400	ND
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	41	**340**	370	840	900	1100	1200	ND
Mixing/Loading Wettable Powders for Groundboom Applications (2b)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	60	**490**	530	1200	1300	1500	1700	ND
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	29	**240**	260	590	630	740	810	ND
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	72	**590**	640	1500	1600	1800	2000	ND
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	36	**290**	320	730	790	920	1000	ND
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	91	**740**	800	1800	2000	2300	2500	ND
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	**180**	1500	1600	3700	4000	4600	5100	ND
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	**180**	1500	1600	3700	4000	4600	5100	ND
Mixing/Loading Wettable Powders for Airblast Applications (2c)	pine seed orchard	1.2 lb ai/acre	20 acres	60	**490**	530	1200	1300	1500	1700	ND
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	91	**740**	800	1800	2000	2300	2500	ND
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	**120**	980	1100	2400	2600	3100	3400	ND
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	**180**	1500	1600	3700	4000	4600	5100	ND
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	**360**	2900	3200	7300	7900	9200	10000	ND

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Combined MOEs [c]							
				Baseline	G - NR	PPE-G, DL - NR	G - 80% R	G - 90% R	G,DL - 80% R	G,DL - 90% R	Eng Cont
Loading Dusts via Mechanical Duster (using PHED wettable powders data) (2d)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	**120000**	950000	1000000	2400000	2600000	3000000	3300000	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	5.8	47	51	**120**	130	150	160	ND
	animal: swine	0.00016 lb ai/animal	400 animals	**23000**	180000	200000	460000	490000	570000	630000	ND
Loading Dusts via Dust Bag (using PHED wettable powders data) (2e)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	**120000**	950000	1000000	2400000	2600000	3000000	3300000	ND
	animal: swine	0.00016 lb ai/animal	400 animals	**23000**	180000	200000	460000	490000	570000	630000	ND
Loading Granulars for Aerial Applications (3a)	almonds, pistachios	0.4 lb ai/acre	350 acres	**2000**	2100	2600	5200	5600	9200	11000	98000
	alfalfa; corn: field, sweet-fresh & processed; corn: field-preplant	0.2 lb ai/acre	1200 acres	**1100**	1200	1500	3000	3300	5400	6100	56000
	corn: sweet-fresh & processed	0.2 lb ai/acre	350 acres	**3900**	4200	5100	10000	11000	18000	21000	190000
Loading Granulars for Tractor Drawn Spreader Applications (3b)	almonds, pistachios	0.4 lb ai/acre	80 acres	**8600**	9200	11000	23000	24000	40000	46000	430000
	corn: sweet (fresh & processed)	0.2 lb ai/acre	80 acres	**17000**	18000	22000	45000	49000	80000	92000	840000
	alfalfa, corn (field, sweet-fresh & processed), corn: field (preplant)	0.2 lb ai/acre	200 acres	**6900**	7400	9000	18000	20000	32000	37000	340000
Applicator											
Applying Liquid Sprays via Aerial Equipment (4)	pine seed orchard	1.2 lb ai/acre	100 acres	ND	ND	ND	ND	ND	ND	ND	**8800**
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**7500**
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**10000**
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	**3500**
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**12000**
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	**4400**
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**15000**
	conifers (field grown)	0.2 lb ai/acre	100 acres	ND	ND	ND	ND	ND	ND	ND	**53000**
	rose: field grown	0.2 lb ai/acre	60 acres	ND	ND	ND	ND	ND	ND	ND	**88000**
	broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**30000**

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Applying Liquid Sprays via Groundboom Equipment (5)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	**12000**	12000	15000	17000	17000	21000	22000	46000
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	**6000**	6000	7000	8000	8200	10000	10000	22000
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	**15000**	15000	18000	20000	20000	25000	26000	54000
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	**7400**	7400	8800	10000	10000	13000	13000	27000
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	**19000**	19000	22000	25000	26000	32000	32000	68000
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	**37000**	37000	44000	50000	51000	63000	65000	140000
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	**37000**	37000	44000	50000	51000	63000	65000	140000
Applying Liquid Sprays via Airblast Equipment (6)	pine seed orchard	1.2 lb ai/acre	20 acres	**620**	890	960	1000	1000	1100	1100	11000
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	**930**	1300	1400	1500	1500	1600	1600	16000
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	**1200**	1800	1900	2000	2000	2200	2200	22000
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	**1900**	2700	2900	3000	3000	3300	3300	32000
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	**3700**	5300	5700	6000	6000	6500	6600	65000
Applying Liquid Sprays with Truck Mounted ULV Sprayer (using PHED airblast data) (7)	outdoor spaces	0.05 lb ai/acre	3000 acres	99	**140**	150	160	160	170	180	1700
Applying Emulsifiable Concentrates via Dip (8)	animal: livestock (beef and dairy cattle), horses, swine	0.0023 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: dogs	0.005 lb ai/gal	10 gallons	ND	ND	ND	ND	ND	ND	ND	ND
	military battle dress	0.00000011 lb ai/cm2 of fabric		ND	ND	ND	ND	ND	ND	ND	ND
Applying Granulars via Aerial Equipment (9)	almonds, pistachios,	0.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**3600**
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	**2100**
	corn: sweet (fresh & processed)	0.2 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	**7200**
Applying Granulars via Tractor Drawn Spreader (10)	almonds, pistachios,	0.4 lb ai/acre	80 acres	**9600**	11000	14000	23000	24000	36000	40000	49000
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	200 acres	**7700**	9000	11000	18000	19000	29000	32000	39000
	corn: sweet (fresh & processed)	0.2 lb ai/acre	80 acres	**19000**	22000	27000	46000	48000	73000	79000	96000
Applying Dusts via Mechanical Duster (11)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: swine	0.00016 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Applying Dusts via Dust Bag (12)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: swine	0.00016 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
Flagger											
Flagging for Liquid Sprays via Aerial Equipment (13)	pine seed orchard	1.2 lb ai/acre	100 acres	**3600**	ND	3800	ND	ND	4800	4800	89000
	almonds, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	**3100**	ND	3300	ND	ND	4100	4100	77000
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	**4100**	ND	4400	ND	ND	5400	5500	100000
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	**4900**	ND	5300	ND	ND	6500	6600	120000
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans, cabbage, Chinese cabbage, cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	**6100**	ND	6600	ND	ND	8100	8200	150000
	conifers (field grown)	0.2 lb ai/acre	100 acres	**21000**	ND	23000	ND	ND	29000	29000	530000
	rose: field grown	0.2 lb ai/acre	60 acres	**36000**	ND	38000	ND	ND	48000	48000	890000
	broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	**12000**	ND	13000	ND	ND	16000	16000	310000
Flagging for Granulars via Aerial Equipment (14)	almonds, pistachios,	0.4 lb ai/acre	350 acres	**11000**	ND	15000	ND	ND	25000	25000	24000
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	350 acres	**21000**	ND	30000	ND	ND	49000	51000	48000

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Mixer/Loader/Applicator											
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (15)	mushroom houses	0.267 lb ai/gallon	40 gallons	5.4	**410**	430	1100	1200	1200	1300	NF
	conifers (field grown)	0.2 lb ai/acre	40 gallons	7.3	**540**	570	1400	1600	1600	1800	NF
	indoor surfaces, perimeter treatments	0.08 lb ai/gallon	40 gallons	18	**1400**	1400	3600	3900	4100	4400	NF
	ornamentals: outdoor	0.046 lb ai/gallon	40 gallons	32	**2400**	2500	6200	6700	7000	7700	NF
	animal premises, outdoor surfaces, wood, ants & fire ants	0.04 lb ai/gallon	40 gallons	36	**2700**	2900	7100	7800	8100	8900	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	73	**5400**	5700	14000	16000	16000	18000	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	**140**	10000	11000	27000	30000	31000	34000	NF
	agricultural premises	0.0085 lb ai/gallon	40 gallons	**170**	13000	13000	34000	37000	38000	42000	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	**290**	22000	23000	57000	62000	65000	71000	NF
	almond, filbert, pear, pistachio (trees at residential sites)	0.004 lb ai/gallon	40 gallons	**360**	27000	29000	71000	7820	81000	89000	NF
	peach (trees at residential sites)	0.003 lb ai/gallon	40 gallons	**480**	36000	38000	95000	1000000	110000	120000	NF
	apple & cherry trees at residential sites, ornamentals: greenhouse & other indoor, rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	**720**	54000	57000	140000	160000	160000	1800000	NF
	termites	33.2 lb ai/1000 linear feet	1000 linear feet	1.8	**130**	140	340	3900	390	430	NF
	animal: livestock (beef and dairy cattle), goats, horses, sheep, swine	0.0023 lb ai/animal	400 animals	63	**4700**	5000	12000	14000	14000	15000	NF

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Combined MOEs [c]							
				Baseline	G - NR	PPE-G, DL - NR	G - 80% R	G - 90% R	G,DL - 80% R	G,DL - 90% R	Eng Cont
Mixing/Loading/Applying Emulsifiable Concentrates with a Handgun Sprayer (ORETF data) (16)	turf	0.87 lb ai/acre	5 acres	ND	**2900**	5100	3000	3000	5300	5400	NF
	conifers (field grown)	0.2 lb ai/gallon	1000 gallons	ND	63	**110**	65	65	120	120	NF
	perimeter treatment	0.08 lb ai/gallon	1000 gallons	ND	**160**	280	160	160	290	290	NF
	ornamentals: outdoor	0.046 lb ai/gallon	1000 gallons	ND	**270**	480	280	280	500	510	NF
	outdoor surfaces, ants, and fire ants	0.04 lb ai/gallon	1000 gallons	ND	**310**	550	320	320	580	580	NF
	rose: field grown	0.02 lb ai/gallon	1000 gallons	ND	**630**	1100	650	650	1200	1200	NF
	pine seed orchard	0.0105 lb ai/gallon	1000 gallons	ND	**1200**	2100	1200	1200	2200	2200	NF
	agricultural premises	0.0085 lb ai/gallon	1000 gallons	ND	**1500**	2600	1500	1500	2700	2700	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	ND	**2500**	4400	2600	2600	4600	4700	NF
	almond, filbert, pear, pistachio (trees at residential sites)	0.004 lb ai/gallon	1000 gallons	ND	**3100**	5500	3200	3200	5800	5800	NF
	peach (trees at residential sites)	0.003 lb ai/gallon	1000 gallons	ND	**4200**	7400	4300	4300	7700	7800	NF
	apple & cherry trees at residential sites; roses: greenhouse, ornamental nursery stock (non-bearing); ornamentals: greenhouse	0.002 lb ai/gallon	1000 gallons	ND	**6300**	11000	6500	6500	12000	12000	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a High Pressure Handwand (only study in PHED is for greenhouse use) (17)	mushroom houses	0.267 lb ai/gallon	1000 gallons	ND	6.4	8.7	8.5	8.6	13	13	NF
	rose: field grown	0.02 lb ai/gallon	1000 gallons	ND	86	**120**	110	110	170	180	NF
	animal premises	0.012 lb ai/gallon	1000 gallons	ND	**140**	190	190	190	290	300	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	ND	**340**	460	450	460	690	710	NF
	rose: greenhouse	0.002 lb ai/gallon	1000 gallons	ND	**860**	1200	1100	1100	1700	1800	NF
	animal: poultry	0.00027 lb ai/animal	4000 animals	ND	**1600**	2200	2100	2100	3200	3300	NF
Mixing/Loading/Applying Emulsifiable Concentrate with an Injector (18)	termites	0.08 lb ai/gallon	2000 gallons (Carbaryl)	ND	97	**140**	100	100	140	150	NF

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Mixing/Loading/Applying Emulsifiable Concentrates via Foam Applicator Equipment (using ORETF low-pressure handwand) (19)	termites	4.25 lb ai/1000 sq ft	1000 sq ft	14	**2100**	2300	3100	3100	3500	3600	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (20)	fire ant mounds	0.04 lb ai/gallon	10 gallons	**2500**	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack ULV Sprayer (using PHED backpack data) (21)	outdoor spaces	0.1 lb ai/acre	5 acres	ND	**4300**	6400	4600	4600	7200	7200	NF
	outdoor spaces: barrier spray	0.1 lb ai/acre	5 acres	ND	**4300**	6400	4600	4600	7200	7200	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (22)	indoor surfaces	0.08 lb ai/gallon	5 gallons	80	**560**	600	600	610	660	660	NF
	wood, outdoor surfaces	0.04 lb ai/gallon	5 gallons	**160**	1100	1200	1200	1200	1300	1300	NF
Mixing/Loading/Applying Wettable Powders with Low Pressure Handwand (23)	conifers (field grown)	0.2 lb ai/gallon	40 gallons	ND	43	50	78	81	**110**	110	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	ND	**430**	500	780	810	1100	1100	NF
	indoor surfaces	0.0117 lb ai/gallon	40 gallons	ND	**740**	860	1300	1400	1800	1900	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	ND	**820**	960	1500	1500	2000	2100	NF
	mushroom houses, agricultural premises	0.0085 lb ai/gallon	40 gallons	ND	**1000**	1200	1800	1900	2500	2600	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	ND	**1700**	2000	3100	3300	4200	4400	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	ND	**4300**	5000	7800	8100	11000	11000	NF
Mixing/Loading/Applying Wettable Powders with a Handgun Sprayer (ORETF data) (24)	conifers (field grown)	0.2 lb ai/gallon	40 gallons	ND	23	32	35	36	62	65	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	ND	**230**	320	350	360	620	650	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	ND	**430**	610	660	680	1200	1200	NF
	agricultural premises	0.0085 lb ai/gallon	40 gallons	ND	**530**	750	810	840	1500	1500	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	ND	**910**	1300	1400	1400	2500	2600	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	ND	**2300**	3200	3500	3600	6200	6500	NF

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Mixing/Loading/Applying Wettable Powders with a High Pressure Handwand (25)	rose: field grown	0.02 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	mushroom houses	0.0085 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	rose: greenhouse	0.002 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Bags with Handgun Sprayer (ORETF data) (26)	conifers (field grown)	0.2 lb ai/gallon	40 gallons	ND	42	69	45	78	45	78	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	ND	**420**	690	450	780	450	780	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	ND	**800**	1300	860	1500	860	1500	NF
	animal premises	0.0085 lb ai/gallon	40 gallons	ND	**990**	1600	1100	1800	1100	1800	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	ND	**1700**	2700	1800	3100	1800	3100	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	ND	**4200**	6900	4500	7800	4500	7800	NF
Applying Dusts via Shaker Can (MRID 444598-01) (27)	animal: poultry	0.0025 lb ai/animal	4000 animals	7.2	ND	ND	ND	ND	ND	ND	NF
	animal: swine	0.00016 lb ai/animal	400 animals	**1100**	ND	ND	ND	ND	ND	ND	NF
	animal: dogs, cats	0.00016 lb ai/animal	8 animals	**56000**	ND	ND	ND	ND	ND	ND	NF
	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	**5800**	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Microencapsulated Liquids via Fogger/Mist Generator (28)	animal premises	0.012 lb ai/1000 sq ft	1000 sq ft	ND	ND	ND	ND	ND	ND	ND	NF
	indoor spaces	0.00036 lb ai/1000 cu ft	1000 cu ft	ND	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations via Pour-on (using PHED mix/load liquid) (29)	animal: horses	0.005lb ai/animal	400 animals	**1000**	91000	110000	120000	120000	160000	170000	NF
	animal: dairy and beef cattle, calves, sheep	0.0034 lb ai/animal	400 animals	**1500**	130000	160000	180000	180000	240000	250000	NF
	animal: swine	0.002 lb ai/animal	400 animals	**2500**	230000	280000	310000	310000	410000	420000	NF
	clothing: personal	0.002 lb ai/6 oz container	1 container	**1000000**	91000000	110000000	120000000	120000000	160000000	170000000	NF
	deer (ticks)	0.0092 lb ai/per post (240 lbs corn consumed per week)	40 posts (per treatment device)	**5400**	490000	610000	670000	680000	890000	910000	NF
Applying Ready to Use Formulations via RTU Ear-Tag (30)	animal	0.0044 lb ai/2 ear tags	400 cattle (2 tags/cattle)	ND	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Shampoo Formulations via Hands (MRID 446584-01) (31)	animal: dogs	0.0062 lb ai/animal	8 animals	65	ND	ND	ND	ND	ND	ND	NF

Table 10: Summary of Short- and Intermediate-Term Permethrin Occupational Handler Non-cancer Risk Estimates											
Exposure Scenario	**Crop or Target**	**Application Rate [a]**	**Area Treated Daily [b]**	**Combined MOEs [c]**							
				Baseline	**G - NR**	**PPE-G, DL - NR**	**G - 80% R**	**G - 90% R**	**G,DL - 80% R**	**G,DL - 90% R**	**Eng Cont**
Applying Ready to Use Formulations via RTU Wipe (32)	animal: dogs, horses	0.0062 lb ai/animal	8 animals	38	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur Trigger Pump study) (33)	animal: horses, foals	0.61 lb ai/gallon	2 gallons	**330**	ND	ND	ND	ND	ND	ND	NF
	indoor surfaces; animal: cattle, goats, sheep, swine	0.043 lb ai/gallon	2 gallons	**4700**	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations with Aerosol Cans (34)	outdoor surfaces	0.00438 lb ai/16 oz can	2 sixteen-ounce aerosol cans	**3300**	7300	9000	8100	8200	10000	10000	NF
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (35)	indoor spaces	0.0016 lb ai/6 oz fogger	4 six ounce fogger treats 6000 cubic feet	**4600**	10000	12000	11000	11000	14000	14000	NF
Applying Ready to Use Protective Flanges (36)	ants			ND	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Vapor Recovery System Tubes (37)	engines	0.000189 lb ai/tube		ND	ND	ND	ND	ND	ND	ND	NF

Footnotes

* MOEs shown in bold indicate the lowest risk mitigation level that does not exceed HED's level of concern.

ND No Data

NF Not Feasible

a Application rates are the maximum application rates determined from EPA registered labels for permethrin.

b Amounts handled per day are HED estimates of acres, square feet, or cubic feet treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry sources, and HED estimates.

c
- Baseline: Long-sleeve shirt, long pants, no gloves, and no respirator.
- PPE-G-NR: Baseline plus chemical-resistant gloves, and no respirator.
- PPE-G,DL-NR: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and no respirator.
- PPE-G-80% R: Baseline plus chemical-resistant gloves and an 80% PF (quarter-face dust/mist) respirator.
- PPE-G,DL-80% R: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and an 80% PF (quarter-face dust/mist) respirator.
- PPE-G-90% R: Baseline plus chemical-resistant gloves and a 90% PF (half-face dust/mist) respirator.
- PPE-G,DL-90% R: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and a 90% PF (half-face dust/mist) respirator.
- Eng Controls: Closed mixing/loading system, enclosed cab, or enclosed cockpit.

2.1.4 Cancer Permethrin Handler Exposure and Risk Assessment

This section presents the occupational handler exposure and cancer risk assessment from permethrin.

2.1.4.1 Cancer Permethrin Handler Exposure and Risk Calculations

Cancer risk estimates resulting from exposures to permethrin were calculated using a linear low-dose extrapolation approach in which a *Lifetime Average Daily Dose* (LADD) is first calculated and then compared with a Q_1^* that has been calculated for permethrin based on dose response data ($Q_1^* = 9.567 \times 10^{-3}$ (mg/kg/day)$^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Section 2.1.3.1 describes how the ADD values were first calculated for the non-cancer MOEs. These values also serve as the basis for the cancer risk estimates. Dermal and inhalation ADD values were first added together to obtain combined ADD values. LADD values were then calculated and multiplied by the Q_1^* to obtain cancer risk estimates.

Lifetime Average Daily Dose: To estimate the carcinogenic risk from absorbed average daily dose, the values must be amortized over the working lifetime of occupational handlers. Current use patterns indicate that application can occur numerous times during a year. In a memo dated March 24, 2004 (Brassard), BEAD provided HED information on the number of days permethrin is applied annually by applicators. The information in this memo showed that for most crops and use-patterns, applicators apply permethrin less than ten days per year. As a result, HED considered one handler population (small, medium, and large scale growers as well as commercial applicators) for the cancer risk assessment. It was estimated that all handlers (small, medium, and large scale growers as well as commercial applicators) would handle permethrin approximately 10 days per year. Finally, a 35 year career and a 70 year lifespan were used to complete the calculations. LADD values were calculated using the following equation:

$$LADD = ADD \times \frac{Exposure\ Frequency}{365\ Days\ per\ Year} \times \frac{Exposure\ Duration}{Lifetime}$$

Where:

Lifetime Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario over a lifetime (mg/kg/day, also referred to as LADD);
Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario on a daily basis (mg/kg/day, also referred to as ADD);
Exposure Frequency	=	The annual frequency of exposure to an individual (days/year);
Exposure Duration	=	The amount of a lifetime that an individual is exposed (35 years for occupational); and
Lifetime	=	The average life expectancy of an individual (70 years).

Cancer risk estimates : Finally, estimated cancer risk calculations were completed by multiplying the LADD values to the Q_1^* for permethrin (Q_1^* = 9.567 x 10^{-3} $(mg/kg/day)^{-1}$). Cancer risk estimates were calculated using the following equation:

$$Estimated\ Cancer\ Risk = LADD \times Q1^*$$

Where:

Estimated Cancer Risk	=	Probability of excess cancer cases over a lifetime (unitless);
Lifetime Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario over a lifetime (mg//kg/day); and
Q_1^*	=	Quantitative dose response factor used for linear, low-dose response cancer risk calculations $(mg/kg/day)^{-1}$.

HED has defined a level of concern range for cancer risk estimates based on a policy memorandum issued in 1996 by then Office of Pesticide Programs (OPP) director, Mr. Dan Barolo. This memo refers to a predetermined quantified "level of concern" for occupational carcinogenic risk. In summary, this policy memo indicates occupational carcinogenic risks that are 1 x 10^{-6} or lower require no risk management action. For those chemicals subject to reregistration, HED is to carefully examine uses with estimated risks in the 10^{-6} to 10^{-4} range to seek ways of cost-effectively reducing risks. If estimated cancer risks are in this range for occupational handlers, increased levels of personal protection would be warranted as is commonly applied with non-cancer risk estimates (e.g., additional PPE or engineering controls). Cancer risk estimates that remain above 1.0 x 10^{-4} at the highest level of mitigation appropriate for that scenario remain a concern.

2.1.4.2 Permethrin Cancer Risk Summary

Estimated permethrin cancer risks for handlers are summarized below in Table 11. All the cancer risk calculations for occupational handlers exposed to permethrin completed in this assessment are included in the appendices.

In most scenarios, estimated cancer risks are below OPP's target level of concern (i.e., risks are below 1 x 10^{-6}) at some level of risk mitigation. For the most part, cancer risk estimates are below OPP's level of concern for cancer risks (i.e., risks are below 1 x 10^{-4}) with the single layer clothing, gloves, and no respirator level of personal protection. Cancer risk estimates for handlers are greater than OPP's level of concern for cancer risks (i.e., risks are at or above **1.0 x 10^{-4}**) at maximum feasible mitigation for the following handler scenario:

Scenario 17: Mixing/Loading/Applying Liquids via High Pressure Handwand (PHED data)

- mushroom houses at 1000 gallons per day (0.267 lb ai/gallon)

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixer/Loader											
Mixing/Loading Emulsifiable Concentrates for Aerial Applications (1a)	pine seed orchard	1.2 lb ai/acre	100 acres	2.0E-04	1.8E-06	1.4e-06	1.6E-06	1.2E-06	1.6E-06	1.2E-06	6.0E-07
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	2.3E-04	2.1E-06	1.7e-06	1.9E-06	1.4E-06	1.8E-06	1.4E-06	7.0E-07
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	1.7E-04	1.6E-06	1.2e-06	1.4E-06	1.0E-06	1.4E-06	1.0E-06	5.2E-07
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	4.9E-04	4.5E-06	3.5e-06	4.0E-06	3.0E-06	3.9E-06	2.9E-06	1.5E-06
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	1.4E-04	1.3E-06	1.0e-06	1.2E-06	8.7E-07	1.2E-06	8.6E-07	4.4E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	3.9E-04	3.6E-06	2.8e-06	3.2E-06	2.4E-06	3.2E-06	2.3E-06	1.2E-06
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	1.1E-04	1.1E-06	8.3e-07	9.4E-07	7.0E-07	9.2E-07	6.8E-07	3.5E-07
	conifers (field grown)	0.2 lb ai/acre	100 acres	3.3E-05	3.0E-07	2.4e-07	2.7E-07	2.0E-07	2.6E-07	2.0E-07	1.0E-07
	rose: field grown	0.2 lb ai/acre	60 acres	2.0E-05	1.8E-07	1.4e-07	1.6E-07	1.2E-07	1.6E-07	1.2E-07	6.0E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	5.7E-05	5.3E-07	4.1e-07	4.7E-07	3.5E-07	4.6E-07	3.4E-07	1.7E-07
Mixing/Loading Emulsifiable Concentrates for Groundboom Applications (1b)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	3.9E-05	3.6E-07	2.8e-07	3.2E-07	2.4E-07	3.2E-07	2.3E-07	1.2E-07
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	8.2E-05	7.6E-07	5.9e-07	6.7E-07	5.0E-07	6.6E-07	4.9E-07	2.5E-07
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	3.3E-05	3.0E-07	2.4e-07	2.7E-07	2.0E-07	2.6E-07	2.0E-07	1.0E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	6.5E-05	6.1E-07	4.7e-07	5.3E-07	4.0E-07	5.3E-07	3.9E-07	2.0E-07
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	2.6E-05	2.4E-07	1.9e-07	2.1E-07	1.6E-07	2.1E-07	1.6E-07	8.0E-08
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	1.3E-05	1.2E-07	9.4e-08	1.1E-07	8.0E-08	1.1E-07	7.8E-08	4.0E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	1.3E-05	1.2E-07	9.4e-08	1.1E-07	8.0E-08	1.1E-07	7.8E-08	4.0E-08
Mixing/Loading Emulsifiable Concentrates for Airblast Applications (1c)	pine seed orchard	1.2 lb ai/acre	20 acres	3.9E-05	3.6E-07	2.8e-07	3.2E-07	2.4E-07	3.2E-07	2.3E-07	1.2E-07
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	2.6E-05	2.4E-07	1.9e-07	2.1E-07	1.6E-07	2.1E-07	1.6E-07	8.0E-08
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	2.0E-05	1.8E-07	1.4e-07	1.6E-07	1.2E-07	1.6E-07	1.2E-07	6.0E-08
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	1.3E-05	1.2E-07	9.4e-08	1.1E-07	8.0E-08	1.1E-07	7.8E-08	4.0E-08
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	6.5E-06	6.1E-08	4.7e-08	5.3E-08	4.0E-08	5.3E-08	3.9E-08	2.0E-08

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixing/Loading Emulsifiable Concentrates with Truck Mounted ULV Sprayer (using PHED airblast data) (1d)	outdoor spaces	0.05 lb ai/acre	3000 acres	2.4E-04	2.3E-06	1.8e-06	2.0E-06	1.5E-06	2.0E-06	1.5E-06	7.5E-07
Mixing/Loading Emulsifiable Concentrates via Dip (1e)	animal: livestock (beef and dairy cattle), horses, swine	0.0023 lb ai/animal	400 animals	1.5E-06	1.4E-08	1.1e-08	1.2E-08	9.2E-09	1.2E-08	9.0E-09	4.6E-09
	animal: dogs	0.005 lb ai/gal	10 gallons	8.2E-08	7.6E-10	5.9e-10	6.7E-10	5.0E-10	6.6E-10	4.9E-10	2.5E-10
Mixing/Loading Wettable Powders for Aerial Applications (2a)	pine seed orchard	1.2 lb ai/acre	100 acres	2.6E-04	2.1E-05	1.8e-05	1.3E-05	1.1E-05	1.2E-05	9.7E-06	7.1E-07
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	3.0E-04	2.5E-05	2.1e-05	1.6E-05	1.2E-05	1.4E-05	1.1E-05	8.3E-07
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	2.3E-04	1.8E-05	1.6e-05	1.2E-05	9.4E-06	1.1E-05	8.5E-06	6.3E-07
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	6.5E-04	5.3E-05	4.6e-05	3.3E-05	2.7E-05	3.1E-05	2.4E-05	1.8E-06
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	1.9E-04	1.5E-05	1.3e-05	9.8E-06	7.8E-06	9.1E-06	7.1E-06	5.2E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	5.2E-04	4.2E-05	3.7e-05	2.7E-05	2.1E-05	2.5E-05	1.9E-05	1.4E-06
	cabbage, Chinese cabbage, corn (pop, seed, sweet) cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	1.5E-04	1.2E-05	1.1e-05	7.8E-06	6.2E-06	7.2E-06	5.7E-06	4.2E-07
	conifers (field grown)	0.2 lb ai/acre	100 acres	4.3E-05	3.5E-06	3.1e-06	2.2E-06	1.8E-06	2.1E-06	1.6E-06	1.2E-07
	rose: field grown	0.2 lb ai/acre	60 acres	2.6E-05	2.1E-06	1.8e-06	1.3E-06	1.1E-06	1.2E-06	9.7E-07	7.1E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	7.6E-05	6.2E-06	5.4e-06	3.9E-06	3.1E-06	3.6E-06	2.8E-06	2.1E-07
Mixing/Loading Wettable Powders for Groundboom Applications (2b)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	5.2E-05	4.2E-06	3.7e-06	2.7E-06	2.1E-06	2.5E-06	1.9E-06	1.4E-07
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	1.1E-04	8.8E-06	7.7e-06	5.6E-06	4.5E-06	5.2E-06	4.1E-06	3.0E-07
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	4.3E-05	3.5E-06	3.1e-06	2.2E-06	1.8E-06	2.1E-06	1.6E-06	1.2E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	8.6E-05	7.0E-06	6.1e-06	4.5E-06	3.6E-06	4.1E-06	3.2E-06	2.4E-07
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	3.5E-05	2.8E-06	2.5e-06	1.8E-06	1.4E-06	1.7E-06	1.3E-06	9.5E-08
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	1.7E-05	1.4E-06	1.2e-06	8.9E-07	7.1E-07	8.3E-07	6.5E-07	4.8E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	1.7E-05	1.4E-06	1.2e-06	8.9E-07	7.1E-07	8.3E-07	6.5E-07	4.8E-08

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixing/Loading Wettable Powders for Airblast Applications (2c)	pine seed orchard	1.2 lb ai/acre	20 acres	5.2E-05	4.2E-06	3.7e-06	2.7E-06	2.1E-06	2.5E-06	1.9E-06	1.4E-07
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	3.5E-05	2.8E-06	2.5e-06	1.8E-06	1.4E-06	1.7E-06	1.3E-06	9.5E-08
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	2.6E-05	2.1E-06	1.8e-06	1.3E-06	1.1E-06	1.2E-06	9.7E-07	7.1E-08
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	1.7E-05	1.4E-06	1.2e-06	8.9E-07	7.1E-07	8.3E-07	6.5E-07	4.8E-08
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	8.6E-06	7.0E-07	6.1e-07	4.5E-07	3.6E-07	4.1E-07	3.2E-07	2.4E-08
Loading Dusts via Mechanical Duster (using PHED wettable powders data) (2d)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	2.7E-08	2.2E-09	1.9e-09	1.4E-09	1.1E-09	1.3E-09	1.0E-09	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	5.4E-04	4.4E-05	3.8e-05	2.8E-05	2.2E-05	2.6E-05	2.0E-05	ND
	animal: swine	0.00016 lb ai/animal	400 animals	1.4E-07	1.1E-08	9.8e-09	7.1E-09	5.7E-09	6.6E-09	5.2E-09	ND
Loading Dusts via Dust Bag (using PHED wettable powders data) (2e)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	2.7E-08	2.2E-09	1.9e-09	1.4E-09	1.1E-09	1.3E-09	1.0E-09	ND
	animal: swine	0.00016 lb ai/animal	400 animals	1.4E-07	1.1E-08	9.8e-09	7.1E-09	5.7E-09	6.6E-09	5.2E-09	ND
Loading Granulars for Aerial Applications (3a)	almonds, pistachios	0.4 lb ai/acre	350 acres	1.1E-06	9.9E-07	7.1e-07	6.3E-07	3.6E-07	5.9E-07	3.1E-07	2.2E-08
	alfalfa; corn: field, sweet-fresh & processed; corn: field-preplant	0.2 lb ai/acre	1200 acres	1.9E-06	1.7E-06	1.2e-06	1.1E-06	6.1E-07	1.0E-06	5.3E-07	3.8E-08
	corn: sweet-fresh & processed	0.2 lb ai/acre	350 acres	5.5E-07	4.9E-07	3.6e-07	3.2E-07	1.8E-07	2.9E-07	1.6E-07	1.1E-08
Loading Granulars for Tractor Drawn Spreader Applications (3b)	almonds, pistachios	0.4 lb ai/acre	80 acres	2.5E-07	2.3E-07	1.6e-07	1.4E-07	8.1E-08	1.3E-07	7.1E-08	5.1E-09
	corn: sweet (fresh & processed)	0.2 lb ai/acre	80 acres	1.3E-07	1.1E-07	8.1e-08	7.2E-08	4.1E-08	6.7E-08	3.6E-08	2.5E-09
	alfalfa, corn (field, sweet-fresh & processed), corn: field (preplant)	0.2 lb ai/acre	200 acres	3.2E-07	2.8E-07	2.0e-07	1.8E-07	1.0E-07	1.7E-07	8.9E-08	6.4E-09

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Applicator											
Applying Liquid Sprays via Aerial Equipment (4)	pine seed orchard	1.2 lb ai/acre	100 acres	ND	ND	ND	ND	ND	ND	ND	3.5E-07
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	4.1E-07
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	3.1E-07
	corn: sweet (FL only)	0.25 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	8.8E-07
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	2.6E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	7.0E-07
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	2.1E-07
	conifers (field grown)	0.2 lb ai/acre	100 acres	ND	ND	ND	ND	ND	ND	ND	5.9E-08
	rose: field grown	0.2 lb ai/acre	60 acres	ND	ND	ND	ND	ND	ND	ND	3.5E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	1.0E-07
Applying Liquid Sprays via Groundboom Equipment (5)	artichokes, garlic, onions: dry bulb	0.3 lb ai/acre	80 acres	2.2E-07	2.2E-07	1.8e-07	2.0E-07	1.5E-07	1.9E-07	1.5E-07	6.9E-08
	corn: sweet (FL only)	0.25 lb ai/acre	200 acres	4.6E-07	4.6E-07	3.8e-07	4.1E-07	3.2E-07	4.0E-07	3.2E-07	1.4E-07
	corn: sweet (FL only)	0.25 lb ai/acre	80 acres	1.8E-07	1.8E-07	1.5e-07	1.6E-07	1.3E-07	1.6E-07	1.3E-07	5.8E-08
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans	0.2 lb ai/acre	200 acres	3.7E-07	3.7E-07	3.0e-07	3.3E-07	2.6E-07	3.2E-07	2.5E-07	1.2E-07
	cabbage, Chinese cabbage, corn (pop, seed, sweet), cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	80 acres	1.5E-07	1.5E-07	1.2e-07	1.3E-07	1.0E-07	1.3E-07	1.0E-07	4.6E-08
	chrysanthemum, roses: field grown	0.2 lb ai/acre	40 acres	7.4E-08	7.4E-08	6.1e-08	6.5E-08	5.2E-08	6.4E-08	5.1E-08	2.3E-08
	asparagus, broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards, turnips	0.1 lb ai/acre	80 acres	7.4E-08	7.4E-08	6.1e-08	6.5E-08	5.2E-08	6.4E-08	5.1E-08	2.3E-08
Applying Liquid Sprays via Airblast Equipment (6)	pine seed orchard	1.2 lb ai/acre	40 acres	5.1E-06	3.4E-06	3.2e-06	3.3E-06	3.0E-06	3.3E-06	3.0E-06	1.9E-06
	almonds, apples, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	40 acres	3.4E-06	2.3E-06	2.1e-06	2.2E-06	2.0E-06	2.2E-06	2.0E-06	1.3E-06
	cherries: sweet and sour, nectarines, peaches	0.3 lb ai/acre	40 acres	2.5E-06	1.7E-06	1.6e-06	1.6E-06	1.5E-06	1.6E-06	1.5E-06	9.5E-07
	avocados, papayas, conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	40 acres	1.7E-06	1.1E-06	1.1e-06	1.1E-06	1.0E-06	1.1E-06	1.0E-06	6.4E-07
	conifers (field grown), ornamental nursery stock	0.2 lb ai/acre	20 acres	8.4E-07	5.7E-07	5.3e-07	5.5E-07	5.0E-07	5.4E-07	5.0E-07	3.2E-07

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Applying Liquid Sprays with Truck Mounted ULV Sprayer (using PHED Airblast data) (7)	outdoor spaces	0.05 lb ai/acre	3000 acres	3.2E-05	2.1E-05	2.0e-05	2.0E-05	1.9E-05	2.0E-05	1.9E-05	1.2E-05
Applying Emulsifiable Concentrates via Dip (8)	animal: livestock (beef and dairy cattle), horses, swine	0.0023 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: dogs	0.005 lb ai/gal	10 gallons	ND	ND	ND	ND	ND	ND	ND	ND
	military battle dress	0.00000011 lb ai/cm2 of fabric		ND	ND	ND	ND	ND	ND	ND	ND
Applying Granulars via Aerial Equipment (9)	almonds, pistachios,	0.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	4.7E-07
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	1200 acres	ND	ND	ND	ND	ND	ND	ND	8.1E-07
	corn: sweet (fresh & processed)	0.2 lb ai/acre	350 acres	ND	ND	ND	ND	ND	ND	ND	2.4E-07
Applying Granulars via Tractor Drawn Spreader (10)	almonds, pistachios,	0.4 lb ai/acre	80 acres	2.5E-07	2.0E-07	1.5e-07	1.4E-07	9.0E-08	1.4E-07	8.3E-08	5.1E-08
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	200 acres	3.1E-07	2.5E-07	1.8e-07	1.8E-07	1.1E-07	1.7E-07	1.0E-07	6.4E-08
	corn: sweet (fresh & processed)	0.2 lb ai/acre	80 acres	1.2E-07	1.0E-07	7.4e-08	7.2E-08	4.5E-08	6.8E-08	4.1E-08	2.5E-08
Applying Dusts via Mechanical Duster (11)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: swine	0.00016 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
Applying Dusts via Dust Bag (12)	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: poultry	0.0025 lb ai/animal	100000 animals	ND	ND	ND	ND	ND	ND	ND	ND
	animal: swine	0.00016 lb ai/animal	400 animals	ND	ND	ND	ND	ND	ND	ND	ND

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Flagger											
Flagging for Liquid Sprays via Aerial Equipment (13)	pine seed orchard	1.2 lb ai/acre	100 acres	8.2E-07	ND	7.5e-07	ND	6.9E-07	ND	6.8E-07	3.5E-07
	almonds, filberts, pears (dormant & prebloom combo), pistachios, walnuts	0.4 lb ai/acre	350 acres	9.6E-07	ND	8.8e-07	ND	8.0E-07	ND	8.0E-07	4.0E-07
	artichokes, garlic, nectarines, onions: dry bulb, peaches	0.3 lb ai/acre	350 acres	7.2E-07	ND	6.6e-07	ND	6.0E-07	ND	6.0E-07	3.0E-07
	corn: sweet (FL only)	0.25 lb ai/acre	350 acres	6.0E-07	ND	5.5e-07	ND	5.0E-07	ND	5.0E-07	2.5E-07
	alfalfa, corn (field, pop, seed, sweet), corn: field (preplant), range grasses, soybeans, cabbage, Chinese cabbage, cucurbits, eggplant, leafy vegetables, peppers: bell, potatoes, tomatoes, tomatillos	0.2 lb ai/acre	350 acres	4.8E-07	ND	4.4e-07	ND	4.0E-07	ND	4.0E-07	2.0E-07
	conifers (field grown)	0.2 lb ai/acre	100 acres	1.4E-07	ND	1.3e-07	ND	1.1E-07	ND	1.1E-07	5.8E-08
	rose: field grown	0.2 lb ai/acre	60 acres	8.2E-08	ND	7.5e-08	ND	6.9E-08	ND	6.8E-08	3.5E-08
	broccoli, Brussel sprouts, cauliflower, Chinese broccoli, collards	0.1 lb ai/acre	350 acres	2.4E-07	ND	2.2e-07	ND	2.0E-07	ND	2.0E-07	1.0E-07
Flagging for Granulars via Aerial Equipment (14)	almonds, pistachios,	0.4 lb ai/acre	350 acres	2.6E-07	ND	1.7e-07	ND	1.3E-07	ND	1.3E-07	2.2E-07
	alfalfa, corn: field, corn: sweet (fresh & processed), corn: field (preplant)	0.2 lb ai/acre	350 acres	1.3E-07	ND	8.3e-08	ND	6.7E-08	ND	6.5E-08	1.1E-07

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixer/Loader/Applicator											
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (15)	mushroom houses	0.267 lb ai/gallon	40 gallons	6.0E-04	3.2E-06	2.8e-06	2.7E-06	2.3E-06	2.6E-06	2.3E-06	NF
	conifers (field grown)	0.2 lb ai/acre	40 gallons	4.5E-04	2.4E-06	2.1e-06	2.0E-06	1.8E-06	2.0E-06	1.7E-06	NF
	indoor surfaces, perimeter treatments	0.08 lb ai/gallon	40 gallons	1.8E-04	9.5E-07	8.4e-07	8.1E-07	7.0E-07	7.9E-07	6.8E-07	NF
	ornamentals: outdoor	0.046 lb ai/gallon	40 gallons	1.0E-04	5.5E-07	4.9e-07	4.7E-07	4.0E-07	4.5E-07	3.9E-07	NF
	animal premises, outdoor surfaces, wood, ants & fire ants	0.04 lb ai/gallon	40 gallons	9.0E-05	4.8E-07	4.2e-07	4.0E-07	3.5E-07	4.0E-07	3.4E-07	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	4.5E-05	2.4E-07	2.1e-07	2.0E-07	1.8E-07	2.0E-07	1.7E-07	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	2.4E-05	1.3E-07	1.1e-07	1.1E-07	9.2E-08	1.0E-07	9.0E-08	NF
	agricultural premises	0.0085 lb ai/gallon	40 gallons	1.9E-05	1.0E-07	9.0e-08	8.6E-08	7.4E-08	8.4E-08	7.3E-08	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	1.1E-05	6.0E-08	5.3e-08	5.1E-08	4.4E-08	4.9E-08	4.3E-08	NF
	almond, filbert, pear, pistachio (trees at residential sites)	0.004 lb ai/gallon	40 gallons	9.0E-06	4.8E-08	4.2e-08	4.0E-08	3.5E-08	4.0E-08	3.4E-08	NF
	peach (trees at residential sites)	0.003 lb ai/gallon	40 gallons	6.7E-06	3.6E-08	3.2e-08	3.0E-08	2.6E-08	3.0E-08	2.6E-08	NF
	apple & cherry trees at residential sites, ornamentals: greenhouse & other indoor, rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	4.5E-06	2.4E-08	2.1e-08	2.0E-08	1.8E-08	2.0E-08	1.7E-08	NF
	termites	33.2 lb ai/1000 linear feet	1000 linear feet	1.9E-03	9.9E-06	8.8e-06	8.4E-06	7.3E-06	8.2E-06	7.1E-06	NF
	animal: livestock (beef and dairy cattle), goats, horses, sheep, swine	0.0023 lb ai/animal	400 animals	5.2E-05	2.7E-07	2.4e-07	2.3E-07	2.0E-07	2.3E-07	2.0E-07	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Handgun Sprayer (ORETF data) (16)	turf	0.87 lb ai/acre	5 acres	1.7e-06	1.2e-06	6.2e-07	1.2e-06	6.1e-07	1.2e-06	6.1e-07	NF
	conifers (field grown)	0.2 lb ai/gallon	1000 gallons	7.8e-05	5.4e-05	2.9e-05	5.4e-05	2.8e-05	5.4e-05	2.8e-05	NF
	perimeter treatment	0.08 lb ai/gallon	1000 gallons	3.1e-05	2.2e-05	1.1e-05	2.2e-05	1.1e-05	2.2e-05	1.1e-05	NF
	ornamentals: outdoor	0.046 lb ai/gallon	1000 gallons	1.8e-05	1.3e-05	6.6e-06	1.2e-05	6.5e-06	1.2e-05	6.5e-06	NF
	outdoor surfaces, ants, and fire ants	0.04 lb ai/gallon	1000 gallons	1.6e-05	1.1e-05	5.7e-06	1.1e-05	5.6e-06	1.1e-05	5.6e-06	NF
	rose: field grown	0.02 lb ai/gallon	1000 gallons	7.8e-06	5.4e-06	2.9e-06	5.4e-06	2.8e-06	5.4e-06	2.8e-06	NF
	pine seed orchard	0.0105 lb ai/gallon	1000 gallons	4.1e-06	2.9e-06	1.5e-06	2.8e-06	1.5e-06	2.8e-06	1.5e-06	NF
	agricultural premises	0.0085 lb ai/gallon	1000 gallons	3.3e-06	2.3e-06	1.2e-06	2.3e-06	1.2e-06	2.3e-06	1.2e-06	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	2.0e-06	1.4e-06	7.2e-07	1.4e-06	7.0e-07	1.3e-06	7.0e-07	NF
	almond, filbert, pear, pistachio (trees at residential sites)	0.004 lb ai/gallon	1000 gallons	1.6e-06	1.1e-06	5.7e-07	1.1e-06	5.6e-07	1.1e-06	5.6e-07	NF
	peach (trees at residential sites)	0.003 lb ai/gallon	1000 gallons	1.2e-06	8.2e-07	4.3e-07	8.1e-07	4.2e-07	8.1e-07	4.2e-07	NF
	apple & cherry trees at residential sites; roses: greenhouse, ornamental nursery stock (non-bearing); ornamentals: greenhouse	0.002 lb ai/gallon	1000 gallons	7.8e-07	5.4e-07	2.9e-07	5.4e-07	2.8e-07	5.4e-07	2.8e-07	NF

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixing/Loading/Applying Emulsifiable Concentrates with a High Pressure Handwand (only study in PHED is for greenhouse use) (17)	mushroom houses	0.267 lb ai/gallon	1000 gallons	ND	4.3E-04	3.0e-04	3.9E-04	2.5E-04	3.8E-04	2.5E-04	NF
	rose: field grown	0.02 lb ai/gallon	1000 gallons	ND	3.3E-05	2.2e-05	2.9E-05	1.9E-05	2.9E-05	1.8E-05	NF
	animal premises	0.012 lb ai/gallon	1000 gallons	ND	2.0E-05	1.3e-05	1.7E-05	1.1E-05	1.7E-05	1.1E-05	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	ND	8.1E-06	5.6e-06	7.2E-06	4.7E-06	7.1E-06	4.6E-06	NF
	rose: greenhouse	0.002 lb ai/gallon	1000 gallons	ND	3.3E-06	2.2e-06	2.9E-06	1.9E-06	2.9E-06	1.8E-06	NF
	animal: poultry	0.00027 lb ai/animal	4000 animals	ND	4.4E-05	3.0e-05	3.9E-05	2.5E-05	3.9E-05	2.5E-05	NF
Mixing/Loading/Applying Emulsifiable Concentrate with an Injector (18)	termites	0.08 lb ai/gallon	2000 gallons (Carbaryl)	ND	3.3E-05	2.3e-05	3.2E-05	2.3E-05	3.2E-05	2.3E-05	NF
Mixing/Loading/Applying Emulsifiable Concentrates via Foam Applicator Equipment (using PHED low-pressure handwand) (19)	termites	4.25 lb ai/1000 sq ft	1000 sq ft	2.4E-04	1.3E-06	1.1e-06	1.1E-06	9.3E-07	1.1E-06	9.1E-07	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (20)	fire ant mounds	0.04 lb ai/gallon	10 gallons	2.5E-06	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack ULV Sprayer (using PHED backpack data) (21)	outdoor spaces	0.1 lb ai/acre	5 acres	ND	7.3E-07	4.8e-07	7.1E-07	4.5E-07	7.0E-07	4.5E-07	NF
	outdoor spaces: barrier spray	0.1 lb ai/acre	5 acres	ND	7.3E-07	4.8e-07	7.1E-07	4.5E-07	7.0E-07	4.5E-07	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (22)	indoor surfaces	0.08 lb ai/gallon	5 gallons	4.1E-05	5.6E-06	5.2e-06	5.4E-06	5.0E-06	5.4E-06	5.0E-06	NF
	wood, outdoor surfaces	0.04 lb ai/gallon	5 gallons	2.0E-05	2.8E-06	2.6e-06	2.7E-06	2.5E-06	2.7E-06	2.5E-06	NF
Mixing/Loading/Applying Wettable Powders with Low Pressure Handwand (23)	conifers (field grown)	0.2 lb ai/gallon	40 gallons	ND	5.5E-05	4.4e-05	4.2E-05	3.1E-05	4.0E-05	3.0E-05	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	ND	5.5E-06	4.4e-06	4.2E-06	3.1E-06	4.0E-06	3.0E-06	NF
	indoor surfaces	0.0117 lb ai/gallon	40 gallons	ND	3.2E-06	2.6e-06	2.5E-06	1.8E-06	2.4E-06	1.7E-06	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	ND	2.9E-06	2.3e-06	2.2E-06	1.6E-06	2.1E-06	1.5E-06	NF
	mushroom houses, agricultural premises	0.0085 lb ai/gallon	40 gallons	ND	2.3E-06	1.9e-06	1.8E-06	1.3E-06	1.7E-06	1.3E-06	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	ND	1.4E-06	1.1e-06	1.0E-06	7.8E-07	1.0E-06	7.4E-07	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	ND	5.5E-07	4.4e-07	4.2E-07	3.1E-07	4.0E-07	3.0E-07	NF

Table 11: Summary of Permethrin Occupational Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Mixing/Loading/Applying Wettable Powders with a Handgun Sprayer (ORETF data) (24)	conifers (field grown)	0.2 lb ai/gallon	40 gallons	1.3E-04	1.0E-04	6.6e-05	8.6E-05	4.7E-05	8.3E-05	4.5E-05	NF
	rose: field grown	0.02 lb ai/gallon	40 gallons	1.3E-05	1.0E-05	6.6e-06	8.6E-06	4.7E-06	8.3E-06	4.5E-06	NF
	pine seed orchard	0.0105 lb ai/gallon	40 gallons	7.1E-06	5.5E-06	3.5e-06	4.5E-06	2.5E-06	4.4E-06	2.4E-06	NF
	agricultural premises	0.0085 lb ai/gallon	40 gallons	5.7E-06	4.4E-06	2.8e-06	3.6E-06	2.0E-06	3.5E-06	1.9E-06	NF
	chrysanthemum	0.005 lb ai/gallon	40 gallons	3.4E-06	2.6E-06	1.6e-06	2.1E-06	1.2E-06	2.1E-06	1.1E-06	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	40 gallons	1.3E-06	1.0E-06	6.6e-07	8.6E-07	4.7E-07	8.3E-07	4.5E-07	NF
Mixing/Loading/Applying Wettable Powders with a High Pressure Handwand (25)	rose: field grown	0.02 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	mushroom houses	0.0085 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
	rose: greenhouse	0.002 lb ai/gallon	1000 gallons	ND	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Bags with Handgun Sprayer (ORETF data) (26)	conifers (field grown)	0.2 lb ai/gallon	1000 gallons	4.7E-06	3.3E-06	1.8e-06	3.2E-06	1.7E-06	3.2E-06	1.7E-06	NF
	rose: field grown	0.02 lb ai/gallon	1000 gallons	2.8E-06	2.0E-06	1.1e-06	1.9E-06	1.0E-06	1.9E-06	9.9E-07	NF
	pine seed orchard	0.0105 lb ai/gallon	1000 gallons	5.8E-06	4.1E-06	2.2e-06	4.0E-06	2.1E-06	4.0E-06	2.1E-06	NF
	animal premises	0.0085 lb ai/gallon	1000 gallons	1.1E-06	7.8E-07	4.2e-07	7.6E-07	4.0E-07	7.6E-07	4.0E-07	NF
	chrysanthemum	0.005 lb ai/gallon	1000 gallons	1.1E-05	7.8E-06	4.2e-06	7.6E-06	4.0E-06	7.6E-06	4.0E-06	NF
	rose: greenhouse, ornamental nursery stock (non-bearing)	0.002 lb ai/gallon	1000 gallons	1.1E-04	7.8E-05	4.2e-05	7.6E-05	4.0E-05	7.6E-05	4.0E-05	NF
Applying Dusts via Shaker Can (MRID 444598-01) (27)	animal: poultry	0.0025 lb ai/animal	4000 animals	8.5E-04	ND	ND	ND	ND	ND	ND	NF
	animal: swine	0.00016 lb ai/animal	400 animals	5.4E-06	ND	ND	ND	ND	ND	ND	NF
	animal: dogs, cats	0.00016 lb ai/animal	8 animals	1.1E-07	ND	ND	ND	ND	ND	ND	NF
	animal: dairy and beef cattle, horses	0.000031 lb ai/animal	400 animals	1.1E-06	ND	ND	ND	ND	ND	ND	NF
Mixing/Loading/Applying Microencapsulated Liquids via Fogger/Mist Generator (28)	animal premises	0.012 lb ai/1000 sq ft	1000 sq ft	ND	ND	ND	ND	ND	ND	ND	NF
	indoor spaces	0.00036 lb ai/1000 cu ft	1000 cu ft	ND	ND	ND	ND	ND	ND	ND	NF

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Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Cancer Risk Estimates							
				Baseline	PPE-G-NR	PPE-G, DL-NR	PPE-G-80% R	PPE-G, DL- 80% R	PPE-G- 90% R	PPE-G, DL- 90% R	Eng Control
Applying Ready to Use Formulations via Pour-on (using PHED mix/load liquid) (29)	animal: horses	0.005lb ai/animal	400 animals	3.3E-06	3.0E-08	2.4e-08	2.7E-08	2.0E-08	2.6E-08	2.0E-08	NF
	animal: dairy and beef cattle, calves, sheep	0.0034 lb ai/animal	400 animals	2.2E-06	2.1E-08	1.6e-08	1.8E-08	1.4E-08	1.8E-08	1.3E-08	NF
	animal: swine	0.002 lb ai/animal	400 animals	1.3E-06	1.2E-08	9.4e-09	1.1E-08	8.0E-09	1.1E-08	7.8E-09	NF
	clothing: personal	0.002 lb ai/6 oz container	1 container	3.3E-09	3.0E-11	2.4e-11	2.7E-11	2.0E-11	2.6E-11	2.0E-11	NF
	deer: ticks	40	posts (per treatment device)	6.0E-07	5.6E-09	4.3e-09	4.9E-09	3.7E-09	4.8E-09	3.6E-09	NF
Applying Ready to Use Formulations via RTU Ear-Tag (30)	animal	0.0044 lb ai/2 ear tags	400 cattle (2 tags/cattle)	ND	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations via Hands (MRID 446584-01) (31)	animal: dogs	0.0062 lb ai/animal	8 animals	5.0E-05	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations via RTU Wipe (32)	animal: dogs, horses	0.0062 lb ai/animal	8 animals	8.3E-05	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur Trigger Pump study) (33)	animal: horses, foals	0.61 lb ai/gallon	2 gallons	9.5E-06	ND	ND	ND	ND	ND	ND	NF
	indoor surfaces; animals cattle, goats, sheep, swine	0.043 lb ai/gallon	2 gallons	6.7E-07	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Formulations with Aerosol Cans (34)	outdoor surfaces	0.00438 lb ai/16 oz can	2 sixteen-ounce aerosol cans	9.6E-07	4.2E-07	3.4e-07	4.0E-07	3.2E-07	4.0E-07	3.2E-07	N
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (35)	indoor spaces	0.0016 lb ai/6 oz fogger	4 six ounce fogger treats 6000 cubic feet	7.0E-07	3.1E-07	2.5e-07	2.9E-07	2.3E-07	2.9E-07	2.3E-07	NF
Applying Ready to Use Protective Flanges (36)	ants			ND	ND	ND	ND	ND	ND	ND	NF
Applying Ready to Use Vapor Recovery System Tubes (37)	engines	0.000189 lb ai/tube		ND	ND	ND	ND	ND	ND	ND	NF

Footnotes

– Handler exposure was considered to be 10 days per year for 35 years over a 70 year lifetime.

ND No Data

NF Not Feasible

a Application rates are the maximum application rates provided by for permethrin in all cases. Typical rates provided by BEAD differed very little from the maximum rates.

b Amount handled per day values are HED estimates of acreage treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.

Baseline:	Long-sleeve shirt, long pants, no gloves, and no respirator.
PPE-G-NR:	Baseline plus chemical-resistant gloves, and no respirator.
PPE-G,DL-NR:	Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and no respirator.
PPE-G-80% R:	Baseline plus chemical-resistant gloves and an 80%PF (quarter-face dust/mist) respirator.
PPE-G,DL-80% R:	Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and an 80%PF (quarter-face dust/mist) respirator.
PPE-G-90% R:	Baseline plus chemical-resistant gloves and a 90% PF (half-face dust/mist) respirator.
PPE-G,DL-90% R:	Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, and a 90% PF (half-face dust/mist) respirator.
Eng Controls:	Closed mixing/loading system, enclosed cab, or enclosed cockpit.

2.1.5 Summary of Risk Concerns and Data Gaps for Occupational Handlers

There are only a few occupational handler scenarios for permethrin that have risks associated with them that exceed HED's level of concern for non-cancer and cancer risk assessments. However, there are several occupational handler scenarios for permethrin that have data gaps.

2.1.5.1 Summary of Risk Concerns

The short- and intermediate-term handler risk assessment for permethrin indicates that a few handler scenarios have risks that exceed HED's level of concern at maximum risk mitigation. All of these scenarios are mixer/loader/applicator scenarios that have relatively high application rates or relatively high amounts treated daily relative to the rest of the uses in those particular scenarios. These scenarios include:

- mixing/loading/applying liquids in mushroom houses with a high pressure handwand (0.267 lb ai/gallon at 1,000 gallons/day);
- loading/applying dusts to poultry with a shaker can (0.0025 lb ai/animal at 4,000 animals/day);
- applying ready-to-use formulations to horses via wipe (0.00621 lb ai/animal at 400 animals/day);
- applying ready-to-use formulations to dogs via wipe (0.00621 lb ai/animal at 8 animals/day); and
- applying ready-to-use formulations to horses and foals with a trigger pump sprayer (0.016 lb ai/animal at 400 animals/day).

Cancer risk estimates exceed HED's level of concern for one scenario:

- mixing/loading/applying liquids in mushroom houses with a high pressure handwand (0.267 lb ai/gallon at 1,000 gallons/day);

2.1.5.2 Summary of Data Gaps

Several data gaps were identified for permethrin in many different use areas that include:

- dip treatments to animals and clothing;
- dust treatments via mechanical duster or dust bags on animals in agriculture;
- wettable powder treatments using backpack and high-pressure handwand sprayers; and
- microencapsulated liquids using fogger/mist generator equipment.

There are also several data gaps that were identified for permethrin such as the various specialized uses (i.e., ear tags, protective flanges, and vapor recovery system tubes), however, HED believes that the other assessed scenarios are protective of these specialized uses.

2.1.6 Recommendations For Refining Occupational Handler Risk Assessment

In order to refine this occupational risk assessment, data on actual use patterns including rates, timing, and areas treated would better characterize permethrin risks. Exposure studies for many equipment types that lack data or that are not well represented in PHED (e.g., because of low replicate numbers or data quality) should also be considered based on the data gaps identified above and based on a review of the quality of the data used in this assessment.

2.2 Occupational Postapplication Exposures and Risks

HED uses the term "postapplication" to describe exposures to individuals that occur as a result of being in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). HED believes that there are distinct job functions or tasks related to the kinds of activities that occur in previously treated areas. Job requirements (e.g., the kinds of jobs to cultivate a crop), the nature of the crop or target that was treated, and the how chemical residues degrade in the environment can cause exposure levels to differ over time. Each factor has been considered in this assessment.

2.2.1 Occupational Postapplication Exposure Scenarios

Permethrin use is extremely varied as it can be used on agricultural crops (food, feed, fiber, ornamental, and turf), on agricultural animals (poultry and livestock), in impregnated clothing, and in a variety of other indoor and outdoor occupational settings. As a result, a wide array of individuals can potentially be exposed by working in areas that have been previously treated. HED is concerned about these kinds of exposures one could receive in the workplace.

2.2.1.1 Agricultural Scenarios

When assessing postapplication exposures to agricultural crops, HED uses a concept known as the *transfer coefficient* to numerically represent the post-application exposures one would receive (i.e., generally presented as cm^2/hour). The transfer coefficient concept has been established in the scientific literature and through various exposure monitoring guidelines published by the U.S. EPA and international organizations such as Health Canada and OECD (Organization For Economic Cooperation and Development). The establishment of transfer coefficients also forms the basis of the work of the Agricultural Reentry Task Force. The transfer coefficient is essentially a measure of the contact with a treated surface one would have while doing a task or activity. These values are defined by calculating the ratio of an exposure for a given task or activity to the amount of pesticide on leaves (or other surfaces) that can rub off on the skin resulting in an exposure. For postapplication exposures, the amounts that can rub off on the skin are measured using techniques that specifically determine the amount of residues on treated leaves or other surfaces (referred to as transferable residues or dislodgeable foliar residues) rather than the total residues contained both on the surface and absorbed into treated leaves. HED has developed a series of standard *transfer coefficients* that are unique for variety of job tasks or activities that are used in lieu of chemical- and scenario-specific data.

As with the handler risk assessment process, the first step in the post-application risk assessment process is to identify the kinds of individuals that are likely to be exposed to permethrin after application. In order to do this in a consistent manner, HED has developed a series of general descriptions for tasks that are associated with post-application exposures. HED also considers whether or not individuals are exposed to pesticides as part of their employment (referred to as occupational risk assessments). Common examples include: agricultural harvesters, scouting activities in agriculture, crop maintenance tasks (e.g., irrigating, hoeing and weeding), and turf maintenance (golf course mowing).

The next step in the risk assessment process is to define how and when pesticides are applied in order to determine the level of transferable residues to which individuals could be exposed over time. Wherever available, use and usage data are included in this process to define values such as application rates and application frequency. HED always completes risk assessments using maximum application rates for each scenario because what is possible under the label (the legal means of controlling pesticide use) must be evaluated, for complete stewardship, in order to ensure HED has no concern for the specific use. Additionally, whenever HED has additional information, such as typical or average application rates or frequency data, it uses the information to further evaluate the overall risks associated with the use of the chemical. In order to define the amount of transferable residues to which individuals can be exposed, HED relies on chemical- and crop-specific studies as described in HED guidelines for exposure data collection (*Series 875, Occupational and Residential Exposure Test Guidelines: Group B - Postapplication Exposure Monitoring Test Guidelines*). HED has also developed a standard modeling approach that can also be used to predict transferable residues over time in lieu of chemical- and scenario-specific data (best described in HED's *SOPs For Residential Exposure Assessment*). All agricultural scenarios were evaluated using permethrin-specific DFR dissipation data.

Next, assessors must understand how exposures to permethrin occur (i.e., frequency and duration) and how the patterns of these occurrences can alter the effects of the chemical in the population after being exposed (referred to as dose response). This is supported by the fact that several areas within a work environment may be treated at different times. For example, parts of agricultural fields in a localized area might be treated over several weeks because of an infestation with a concurrent need for hand labor activities. Therefore, individuals working in those fields might be exposed from contact with treated foliage over an extended period of time that could be categorized as an intermediate-term exposure as they work on different sections of fields. Two different types of non-cancer risk calculations were required for each exposure duration considered. The durations of exposure that were considered for non-cancer toxicity were short-term (≤30 days) and intermediate-term (30 days up to several months). A complete array of calculations was completed for all identified exposure scenarios using the short- and intermediate-term endpoint, because HED believes that permethrin uses fit the criteria for both of these durations. Long-term exposures were considered for non-cancer assessments for persons wearing or working with permethrin-impregnated fabric. Cancer risk estimates were also calculated using a linear, low-dose extrapolation model (i.e., Q_1^*). It was assumed that agricultural workers would be exposed to permethrin from postapplication agricultural activities

approximately 10 or 30 days per year. These assumptions were selected based on best professional judgement and due to the fact that postapplication exposures can vary depending on the activity and type of worker (i.e., migrant farm workers vs. the farmers/growers themselves). Inhalation exposures are thought to be negligible in outdoor postapplication scenarios because of the low vapor pressure and due to the infinite dilution expected outdoors. As such, inhalation postapplication exposures are not considered in this assessment.

The use of personal protective equipment or other types of equipment to reduce exposures for post-application workers is not considered a viable alternative for the regulatory process. This is described in some detail in EPA's Worker Protection Standard (40CFR170). As such, an administrative approach is used by HED to reduce the risks and is referred to as the *Restricted Entry Interval* or REI. The REI is time period follow a pesticide application during which entry into the treated area is restricted. At this time, the REI on the permethrin labels is 12 hours set by the acute toxicity category of the active ingredient (i.e., dermal toxicity, eye irritation potential, or skin irritation potential). Postapplication risk levels are generally calculated in the risk assessment process on a chemical-, crop-, and activity-specific basis. To establish REIs, considers postapplication risks on varying days after application.

HED has used the basic approach described above since the mid 1980s for calculating postapplication risks to pesticides. From that time to the present, several revisions and modifications were made to HED policies as data which warranted such changes became available. In 1995, HED issued a Data Call-In for postapplication agricultural data that prompted the formation of the Agricultural Reentry Task Force (ARTF). This task force has generated a number of exposure studies and associated documents that are currently under review by . The work of the ARTF is not yet complete, however, sufficient data were available from the group that warranted a significant interim change in HED policy related to the data which were already available as the efforts of the ARTF paralleled push for tolerance reassessment stipulated by the timelines established by FQPA. As a result of the need for the revision and using the latest data, HED developed a revised policy on August 7, 2000 entitled *Policy 003.1 Science Advisory Council For Exposure Policy Regarding Agricultural Transfer Coefficients*. The revision to this policy entailed linking worker activities to more specific crop/agronomic groupings and making better use of the available occupational post-application exposure data. In the new policy, transfer coefficients were selected to represent the activities associated with 18 distinct crop/agronomic groupings based on different types of vegetables, trees, berries, vine/trellis crops, turf, field crops, and bunch/bundle crops (e.g., tobacco). In this new scheme which HED uses to develop scenarios for occupational postapplication exposures, permethrin uses were identified in the following crop groupings from the policy:

- Field/row crops, low/medium (e.g., alfalfa, soybeans);
- Field/row crops, tall (e.g., corn);
- Cut flowers (e.g., floriculture crops);
- Trees/fruit, deciduous (e.g., apples, apricots, cherries, peaches, pears);
- Trees/fruit, evergreen (e.g., avocados, Christmas trees);

- Trees/nut (e.g., almonds, filberts, pistachios, walnuts);
- Turf/sod (e.g., golf courses, sod farms);
- Vegetable/root (e.g., garlic, onions, potatoes, turnips);
- Vegetable/cucurbit (e.g., cantaloupe, cucumber, squash, watermelon);
- Vegetable/fruiting (e.g., eggplant, pepper, tomato);
- Vegetable/head and stem brassica (e.g., broccoli, cauliflower, Brussel sprouts);
- Vegetables/leafy (e.g., Chinese cabbage, collard greens, lettuce, parsley, spinach);
- Vegetables/stem and stalk (e.g., artichoke, asparagus); and
- Nursery crops (e.g., container and balled and burlapped ornamentals).

Within each agronomic group, a variety of cultural practices are required to maintain the included crops. These practices are varied and typically involve light to heavy contact with immature plants as well as with more mature plants. HED selected transfer coefficient values in its revision of Policy 003 to represent this range of exposures within each agronomic group. In the policy, transfer coefficients were placed in 1 of 5 generic categories based on the exposures relative to that group. These 5 categories include: very low exposure, low exposure, medium exposure, high exposure, and very high exposure. Numerical values were not necessarily assigned to each category for each crop group. Selections depended upon the actual agronomic practices that were identified by for each group (i.e., some groups had 2 assigned transfer coefficients while others had 5). The transfer coefficient values which have been used are excerpted directly from HED policy 003. The nursery crop group data have not yet been formally included in EPA Policy 3. However, the studies in this area submitted by ARTF have been reviewed and used since they will be integrated into Policy 3.

2.2.1.2 Impregnated Clothing Scenarios

Assessors must understand how exposures to permethrin-impregnated clothing occur (i.e., frequency, duration, and degree of contact). HED believes there are two different types of occupational postapplication exposures possible:

- military personnel who *wear* battle dress impregnated with permethrin on a daily basis (i.e., approximately 250 days/year) and
- factory workers who work with fabric or clothing after impregnation during making of garments or packaging of clothing on a work-day basis (i.e., 250 days per year).

Since both postapplication occupational exposures are more than 180 days per year, the duration of exposure considered for this noncancer assessment is long-term. Cancer risk estimates were also calculated using a linear, low-dose extrapolation model (i.e., Q_1^*). The cancer assessment also assumed that these populations would be exposed to permethrin from postapplication activities involving impregnated clothing 250 days per year. These assumptions were selected based on best professional judgement. Inhalation exposures are thought to be negligible for postapplication scenarios involving exposure to permethrin-impregnated clothing because of the low vapor pressure. As such, inhalation postapplication exposures are not considered in this

assessment.

When assessing postapplication exposures to impregnated clothing, HED used the latest EPA Antimicrobial Division (AD) approaches to estimate the postapplication exposures. The data required for estimating postapplication potential doses via AD's methods include the clothing residue concentration (assumed to be equivalent to the application rate on a mass per area basis, as determined from the label), surface area of the skin that is in contact with the fabric, the transfer factor, and the body weight.

2.2.2 Data/Assumptions for Postapplication Exposure Scenarios

2.2.2.1 Agricultural Scenarios

A series of assumptions and exposure factors served as the basis for completing the occupational postapplication worker risk assessments for agricultural scenarios. Each assumption and factor is detailed below on an individual basis. In addition to these values, transfer coefficient values were used to calculate risk estimates. Several chemical-specific residue dissipation studies were also submitted which were used in the development of the risk values . The transfer coefficients were taken from HED's revised policy entitled *Policy 003.1 Science Advisory Council For Exposure Policy Regarding Agricultural Transfer Coefficients* (August 7, 2000). The assumptions and factors used in the risk calculations are presented below:

- There are many factors that are common to handler and postapplication risk assessments such as body weights, duration, and ranges of application rates. Please refer to the assumptions and factors in Section 2.1.1.1 for further information concerning these values which are common to both handler and postapplication risk assessments. In the postapplication risk assessment, generally only maximum application rates were considered because of the complexity of the calculations (i.e., short- and intermediate-term and cancer endpoints for each of the agronomic groups contained in Policy 003).

- **Levels of Concern:** HED has established the following levels of concern (LOC) for occupational postapplication risks:
  - margin of exposure of less than 100 for occupational non-cancer risks;
  - cancer risk estimates greater than 1×10^{-4} (and reasonable mitigation to reach 1×10^{-6}) for occupational cancer assessments.

- The transfer coefficient in Policy 003 for tree fruit thinning has been reduced since the issuance of the policy from 8000 cm^2/hour to 3000 cm^2/hour based on a re-evaluation of the data from the cited study (i.e., the change is based on an altered analytical recovery correction factor that was erroneously used in the initial study report). This modification has been made in the tree fruit group and any other scenarios which have used this value.

- The tree fruit harvester transfer coefficient used in this assessment of 1500 cm^2/hr was reduced in this assessment from a value of 3000 cm^2/hr. This modification was discussed at HED's Science Advisory Council For Exposure (i.e., EXPOSAC) and has been permanently incorporated into its Policy 003 for agricultural transfer coefficients. This modification was made by considering the results of six different tree harvester studies conducted/owned by the Agricultural Reentry Task Force. A range of crops was represented in these data including pome fruit (apples), stone fruit (peaches), and citrus.

- The available dislodgeable foliar residue and turf transferable residue data for permethrin were used to complete all postapplication risk assessments involving agricultural crops and turfgrass. The chemical-specific residue data are described in detail below and summarized in Appendix B.

- Exposure calculations reflect chemical-specific residue dissipation rates over time coupled with surrogate transfer coefficients as outlined in HED's revised policy. Permethrin is used on numerous agriculture crops but only three residue studies were submitted that meet current HED guidelines for sampling techniques and data quality. The three studies (two dislodgeable foliar residue [DFR] and one turf transferable residue [TTR]) were used as the residue source term for each of these groups. These data were extrapolated to other groups based on the nature of the crop and application method. A more complete description of how the data have been used is provided below.

- A pseudo-first order kinetics analysis was used to analyze permethrin residue dissipation over time as outlined in EPA's draft *Series 875 Postapplication Exposure Monitoring Guidelines*. A more sophisticated curve-fitting approach was not warranted because any sophistication gained with a curve fitting technique would be lost in an extrapolation to another crop).

- When extrapolating the available DFR data to other crops, HED adjusted the data for differences in application rate using a simple proportional approach. This approach seems to be the most appropriate given the data which are available. This approach is commonly used in HED postapplication risk assessments.

- In postapplication cancer risk assessments, HED uses a tiered approach. In this case LADD (Lifetime Average Daily Dose) levels were calculated by amortizing the average of single day exposures of varying intervals (e.g., (DAT 1-7 and DAT 2-28) from the short-term assessment over a lifetime using the 10 and 30 days per year frequency values. This may introduce a level of conservatism into the assessment. However, it does not appear that cancer risk estimates would drive decisions for postapplication exposure scenarios because of the concerns for reentry workers from non-cancer risks. Therefore, the analysis was not refined further.

Postapplication Studies: A total of three studies are described in this section. These studies

quantified residue dissipation and exposure for cotton, peaches, and turf. The DFR component of those studies has been extracted for chemical-specific use in this risk assessment. The transfer coefficients used in this assessment are from an interim transfer coefficient policy developed by HED's Science Advisory Council for Exposure using proprietary data from the Agricultural Re-entry Task Force (ARTF) database (policy # 3.1). Each study can be identified with the following information. The studies which have been used in this assessment are identified below followed by a brief summary of each:

- **"Dislodgeable Insecticide Residues on Cotton Foliage: Fenvalerate, Permethrin, Sulprofos, Chloryrifos, Methyl Parathion, EPN, Oxamyl, and Profenofos"** MRID 455705-25; Report dated 1980. Authors N.A. Buck, B.J. Estesen, and G.W. Ware; Submitted by Dow Chemical Company U.S.A.

- **"Dissipation of Dislodgeable Foliar Residues of Permethrin Applied to Orchards (Peaches)"** EPA MRID 437557-01; Report dated July 20, 1995; Authors; Tami Belcher, Larissa Schuster; Sponsor: Zeneca Ag Products, Inc.: C/O permethrin Task Force; Performing Laboratories: Analytical - ABC Laboratories, Pan-Ag Division.

- **"Transferable Turf Residue Study: Permethrin Residues in Turf Following Application of Dragnet SFR Insecticide"** EPA MRID 449555-01; Report dated October 1, 1999; Author; Jill C. Holihan; Sponsor: FMC Corporation: Agricultural Products Group; Performing Laboratories: Analytical - FMC Corporation and Maxim Technologies, Inc.

MRID 455705-25 (cotton DFR data): This DFR study is summarized below for use in the permethrin risk assessment. The field phase of this study was conducted one site located in Marana, Arizona. The field phase of the study was conducted during the period from July to August 1978. At each site, a manually drawn groundboom sprayer was used to make one application of Pounce 3.2EC, an emulsifiable concentrate formulation ,of permethrin at an application rate of 0.196 lb ai/A at the first test plot and 0.152 lb ai/A at the second test plot. Spray volume was approximately 13.5 gallons of water per acre. No significant precipitation was observed in this study during the sampling period.

Triplicate DFR samples were collected out to 96 hours after the last application using a 2.5 centimeter diameter Birkestrand leaf punch with a total number of 100 punches per sample. There were still measurable residues 96 hours after application. The percent transferability of the 0 day sample averaged 34 percent of the application rate for the two trials. There are no field fortification recoveries provided in this study. [**Note:** When this study was performed (late 1970s), it was common practice to present the leaf punch data as single-sided (one surface only). This has been corrected to reflect today's standard of examining double sided residues.] The results of the study are presented in detail in Tables 1 and 2 as well as Figures 1 and 2 of Appendix B. The results of the pseudo-first order statistical analysis of the data are summarized below in Table 12.

Table 12: Cotton DFR Dissipation Data (No MRID, University of Arizona Study)							
Location	App. Rate (lb ai/acre)	App. Method	Corr. Coeff.	Slope (Ln TTR vs. t)	$[T_0]$ ($\mu g/cm^2$)	$T_{1/2}$ (days)	Day 0 (% trans.)
AZ	0.196	Groundboom	0.886	-0.472	0.22	1.5	9.9
AZ	0.152		0.945	-0.152	0.16	4.6	9.4

MRID 437557-01 (peach DFR data): This DFR study is summarized below for use in the permethrin risk assessment. The field phase of this study was conducted at three sites. The locations were California, Georgia, and Washington. The field phase of the study was conducted during the period from July to August 1994. At each site, a tractor mounted airblast sprayer was used to make 5 applications of Ambush 25W, a 25% wettable powder formulation, 7 days apart at an application rate of 0.4 lb ai/acre. Additionally, at one of the two California sites, Pounce 3.2EC, an emulsifiable concentrate formulation was applied using the same application parameters. Spray volume was approximately 50 gallons of water per acre. No significant precipitation was observed in this study at the California and Washington sites but there were to major rainfall events at the Georgia site with one occurring 2 days after the first application and another occurring on the day of the fourth application.

Triplicate DFR samples were collected out to 28 days after the last application using a 2.5 centimeter diameter Birkestrand leaf punch for a total leaf surface area sampled of 400 cm2/sample (40 punches per sample). The *Limit of Quantitation (LOQ)* in this study was 1 µg/sample or 0.005 $\mu g/cm^2$. There were still measurable residues 28 days after application. The percent transferability of the 0 day sample averaged 22 percent of the application rate for the three wettable powder settings. Average field fortification recoveries ranged from 51.3 to 102. The results of the study for the California (two separate sites), Georgia, and Washington sites, respectively, are presented in detail in Tables 3-6 as well as Figures 3-6 of Appendix B. The results of the pseudo-first order statistical analysis of the data are summarized below in Table 13.

Table 13: Peach DFR Dissipation Data (MRID 437557-01)							
Location	App. Rate (lb ai/acre)	App. Method	Corr. Coeff.	Slope (Ln TTR vs. t)	$[T_0]$ ($\mu g/cm^2$)	$T_{1/2}$ (days)	Day 0 (% trans.)
CA (Ambush 25W)	0.4	Airblast	0.295	-0.025	0.641	27.8	14.3
CA (Pounce 3.2)			0.472	-0.028	0.427	24.9	9.5
GA (Ambush 25W)			0.848	-0.060	0.709	11.6	15.8
WA (Ambush 25W)			0.725	-0.048	1.71	14.5	38.1

MRID 451143-01 (turf transferable residue data): A TTR study was conducted at individual sites in three states using the Modified California Roller Technique. The locations were in California, Georgia, and Pennsylvania. Tall fescue was the variety in California, Kentucky bluegrass was the variety in Pennsylvania, and Bermudagrass was the variety in Georgia. Applications were made and samples were collected essentially in the fall of 1998 in California and Georgia while the Pennsylvania study was completed the spring of 1999. Three applications were made 21 days apart at each site. All applications in this study were completed at a rate of

0.87 lb ai/acre. At all sites, applications were made with typical groundboom sprayers using approximately 25 to 20 gallons of water per acre. All applications were made using Dragnet SFR Insecticide which is a emulsifiable concentrate formulation that contains permethrin at a nominal concentration of 36.8 percent by weight.

There was no reported rainfall in the month of October for the Georgia site but there was a total of 1.81 inches in the month of November. Irrigation and rainfall totals were provided for the California site for all three months the study was ongoing. There was a total of 4.17, 2.80, and 0.5 inches of water on the turf for the months of October, November, and December, respectively. According to the study report, irrigation was avoided for a minimum of 3 days following each application. Irrigation and rainfall totals were also provided for the Pennsylvania site for all three months the study was ongoing. There was a total of 1.03, 2.46, and 1.53 inches of water on the turf for the months of May, June, and July, respectively. The timing of rainfall events was not provided for any site. Mowing (with mulching mowers) was performed throughout the study period at each site.

Triplicate TTR samples were collected at 11 intervals out to 28 days after the last application. The *Limit of Quantitation (LOQ)* for permethrin residues was 0.005 $\mu g/cm^2$. Correction of turf transferable residues was not necessary because overall field fortification recovery values from each site was greater than 90 percent. The results of the study for the California, Georgia, and Pennsylvania sites, respectively, are presented in Tables 7- 9 and Figures 7-9 of Appendix B. The data and the results of the pseudo-first order statistical analysis of the data are summarized below in Table 14.

Table 14: TTR Dissipation Data (MRID 451143-01)

Location	App. Rate (lb ai/acre)	App. Method	Corr. Coeff.	Slope (Ln TTR vs. t)	$[T_0]$ ($\mu g/cm^2$)	$T_{1/2}$ (days)	Day 0 (% trans.)
CA	0.87	Groundboom	0.879	-0.147	0.083	4.7	0.85
GA			0.560	-0.063	0.062	11.1	0.64
PA			0.964	-0.232	0.059	3.0	0.53

2.2.2.2 Impregnated Clothing Scenarios

A series of assumptions and exposure factors served as the basis for completing the occupational postapplication worker risk assessments for impregnated clothing scenarios. Each assumption and factor is detailed below on an individual basis.

- **Levels of Concern:** HED has established the following levels of concern (LOC) for occupational postapplication risks:
  - margin of exposure of less than 100 for occupational non-cancer risks;
  - cancer risk estimates greater than 1×10^{-4} (and reasonable mitigation to reach 1×10^{-6}) for occupational cancer assessments.

- Dermal exposures to military personnel are based on the clothing contact surface area of adults exposed to permethrin-impregnated clothing (0.85 m^2). This number is based on the assumption that military personnel wear briefs and undershirts underneath the battle dress and therefore the surface area of arms and legs (but not the torso) for an adult are used.

- Dermal exposures to garment workers are based on the contact surface area of adults exposed to permethrin impregnated clothing in a factory after the impregnation process (0.22 m^2). This number is based on the hands and forearms of an adult garment worker.

- Results from a leaching study (Snodgrass 1992) showed that fabric treated with 0.125 mg/cm2 (the maximum application rate) of permethrin lost the substance to a rabbits skin surface at an average rate of 0.49% per day.

2.2.3 Occupational Postapplication Exposure and Non-cancer Risks

The occupational postapplication estimated exposure and non-cancer risk estimates are presented in this section. Non-cancer risk estimates were calculated using the Margin of Exposure (MOE) which is a ratio of the daily dose to the toxicological endpoint of concern. Daily dose values are calculated by first calculating exposures by considering application parameters (i.e., rate and area treated) along with unit exposures. Exposures were calculated by multiplying these factors by an 8 hour work day. Exposures are then normalized by body weight and adjusted for dermal absorption to calculate absorbed dose. MOEs were then calculated. Postapplication risks diminish over time because permethrin residues eventually dissipate in the environment. As a result risk estimates were calculated over time based on changing residue levels.

2.2.3.1 Agricultural Scenarios

Dissipation Kinetics: The first step in the postapplication risk assessment was to complete an analysis of the available dislodgeable foliar and turf transferable residue (DFR and TTR) data. As discussed in Section 2.2.2 above, data from the two DFR studies and on TTR study were used to calculate risks for all agronomic crop groups. Best fit DFR levels were calculated based on empirical data using the equation D2-16 from *Series 875-Occupational and Residential Test Guidelines: Group B-Postapplication Exposure Monitoring Test Guidelines*. The summary of the available chemical-specific DFR and TTR data were developed based on a semilog regression of the empirical dissipation data using a commercial spreadsheet linear regression function. Half-lives were calculated using the algorithm ($T_{1/2}$ = -Ln 2/slope). The results of the regression analyses were used to calculate best fit concentrations over time using the following pseudo-first order equation:

$$C_{envir(t)} = C_{envir(0)} e^{PAI_{(t)} * M}$$

Where:

$\mathbf{C_{envir(t)}}$ = dislodgeable foliar or turf transferable residue concentration ($\mu g/cm^2$) that represents the amount of residue on the surface of a contacted leaf surface that is available for dermal exposure at time (t);
$\mathbf{C_{envir(0)}}$ = dislodgeable foliar or turf transferable residue concentration ($\mu g/cm^2$) that represents the amount of residue on the surface of a contacted leaf surface that is available for dermal exposure at time (0);
e =natural logarithms base function;
$\mathbf{PAI_t}$ = postapplication interval or dissipation time (e.g., days after treatment or DAT); and
M = slope of line generated during linear regression of data [$\ln(C_{envir})$ versus postapplication interval (PAI)].

In cases where no chemical-specific residue dissipation data are available, HED typically uses a generic dissipation model to complete risk calculations. In this case, HED determined that it is more appropriate, however, to extrapolate using permethrin-specific dissipation data in the risk assessment for other currently labeled crops than it is to use the generic dissipation model. This approach is consistent with current HED policies for generating transferable/dislodgeable residue data. The existing residue data were extrapolated to the currently labeled crops as follows:

- **Cotton DFR Data:** These data have been used to complete all assessments for them following agronomic crop groups defined in HED's revised transfer coefficient policy 003:
  - low/medium field/row crop,
  - tall field/row crop,
  - cucurbit vegetable,
  - fruiting vegetable,
  - head and stem vegetable,
  - leafy vegetable,
  - root vegetable,
  - stem and stalk vegetable, and
  - cut flower.

This extrapolation was completed because of similarities in application methods between the study and selected crop groups, the crop canopy, and application rates (i.e., between the study and current labels).

- **Peach DFR Data:** These data have been used to complete all assessments for the following agronomic crop groups defined in HED's revised transfer coefficient policy 003:
  - tree fruit (deciduous and evergreen),
  - nut crop, and
  - ornamentals.

This extrapolation was completed because of similarities in application methods between the study and selected crop groups, the crop canopy, and application rates (i.e., between the study and current labels).

- **Turf TTR Data:** These data have been used to complete all assessments for the crop/activity combinations for the turf agronomic crop group defined in HED's revised transfer coefficient policy 003. No extrapolation was required in this assessment.

Daily Exposure: The next step in the risk assessment process was to calculate dermal exposures on each day after application using the following equation (see equation D2-20 from *Series 875-Occupational and Residential Test Guidelines: Group B-Postapplication Exposure Monitoring Test Guidelines* and *Residential SOP 3.2: Postapplication Dermal Potential Doses From Pesticide Residues On Gardens*):

$$DE_{(t)}\ (mg/day) = (TR_{(t)}\ (\mu g/cm^2) \times TC\ (cm^2/hr) \times Hr/Day)/1000\ (\mu g/mg)$$

Where:

DE(t)	=	Daily exposure or amount deposited on the surface of the skin at time (t) attributable for activity in a previously treated area, also referred to as potential dose (mg ai/day);
TR(t)	=	Transferable residues that can either be dislodgeable foliar or turf transferable residue at time (t) where the longest duration is dictated by the decay time observed in the studies ($\mu g/cm^2$);
TC	=	Transfer Coefficient (cm^2/hour); and
Hr/day	=	Exposure duration meant to represent a typical workday (hours).

Note that the ($TR_{(t)}$) input may represent levels on a single day after application in the case of short-term risk calculations.

Daily Dose and Margins of Exposure: Once daily exposures are calculated, the calculation of daily absorbed dose and the resulting Margin of Exposures use the same algorithms that are described above for the handler exposures (See Section 2.1.3). These calculations are completed for each day or appropriate block of time after application.

Non-cancer Risk Summary: For all, but a few, agricultural postapplication exposure scenarios in some crop groupings, postapplication occupational risks are below HED's level of concern (i.e., the MOEs are greater than 100) on day 0 – approximately 12 hours following application. In a few cases, postapplication occupational risks from certain high exposure activities do not fall below HED's level of concern for 1 to 4 days following application. Risks from corn detasseling – the highest exposure activity – did not fall below HED's level of concern until 9 days following application. All of the non-cancer risk calculations for occupational permethrin handlers completed in this assessment are included in Appendix B/Table B10. A summary of the results for each crop/activity combination considered for each time-frame is also provided in Table 15.

Table 15: Summary of Permethrin Non-cancer Postapplication Worker Risk Estimates from Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate (lb ai/A)	DAT (days)	DFR ug/cm^2 normalized	Short/ Intermediate-Term MOE
Occupational Postapplication Non-cancer Risks Calculated with Peach DFR Study (MRID # 437557-01)						
conifer seed orchard	seed cone harvesting	3000	1.2	1	2.44	**100**
apples, pears	thinning	3000	0.4	0	0.85	**290**
	hand-harvesting, hand-pruning, propping, training	1500	0.4	0	0.85	**570**
	hand-weeding, irrigating, scouting	1000	0.4	0	0.85	**860**
almonds, filberts, pistachios, walnuts	hand-harvesting, hand-pruning	2500	0.4	0	0.85	**340**
	irrigating, scouting, thinning	500	0.4	0	0.85	**1,700**
cherries: sweet and sour, nectarines, peaches	thinning	3000	0.3	0	0.64	**380**
	hand-harvesting, hand-pruning	1500	0.3	0	0.64	**760**
	hand-weeding, irrigating, scouting	1000	0.3	0	0.64	**1,100**
avocados, conifer (field grown-Christmas trees), papayas	thinning	3000	0.2	0	0.43	**570**
	hand-pruning	1500	0.2	0	0.43	**1,100**
	hand-weeding, scouting	1000	0.2	0	0.43	**1,700**
ornamentals	hand-pruning	400	0.2	0	0.43	**4,300**
	hand-pinching	175	0.2	0	0.43	**9,800**
	hand-harvesting	110	0.2	0	0.43	**16,000**
Occupational Postapplication Non-cancer Risks Calculated with Cotton DFR Study (MRID # 455705-25)						
alfalfa, soybeans	hand-harvesting	2500	0.20	1	0.13	**160**
	irrigating, scouting (full development)	1500	0.20	0	0.22	**160**
	irrigating, scouting (min development)	100	0.20	0	0.22	**2,400**
corn	detasseling, hand-harvesting	17000	0.20	9	0.028	**110**
	irrigating, scouting (full development)	1000	0.20	0	0.22	**240**
	scouting (min development)	400	0.20	0	0.22	**590**
cucurbits	hand-harvesting, hand-pruning	2500	0.20	1	0.13	**160**
	irrigating, scouting	1500	0.20	0	0.22	**160**
	thinning	500	0.20	0	0.22	**470**
onions: dry bulb, garlic	hand-harvesting	2500	0.30	1	0.19	**110**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.30	0	0.32	**100**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.30	0	0.32	**520**
potatoes	hand harvesting	2500	0.20	1	0.13	**160**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.20	0	0.22	**160**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.20	0	0.22	**790**
turnips	hand-harvesting	2500	0.10	0	0.11	**190**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.10	0	0.11	**310**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.10	0	0.11	**1,600**
eggplant, peppers: bell, tomatoes	hand-harvesting, hand-pruning	1000	0.20	0	0.22	**240**
	irrigating, scouting	700	0.20	0	0.22	**340**
	hand-weeding, thinning	500	0.20	0	0.22	**470**

Table 15: Summary of Permethrin Non-cancer Postapplication Worker Risk Estimates from Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate (lb ai/A)	DAT (days)	DFR ug/cm^2 normalized	Short/ Intermediate-Term MOE
cabbage	hand-harvesting, hand-pruning, irrigating	5000	0.20	3	0.08	**120**
	scouting	4000	0.20	3	0.08	**150**
	hand-weeding	2000	0.20	0	0.22	**120**
broccoli, Brussel sprouts, cauliflower, Chinese broccoli	hand-harvesting, hand-pruning, irrigating	5000	0.10	1	0.06	**160**
	scouting	4000	0.10	0	0.11	**120**
	hand-weeding	2000	0.10	0	0.11	**240**
collards	hand-harvesting	2500	0.10	0	0.11	**190**
	irrigating, scouting (all at medium development)	1500	0.10	0	0.11	**310**
	irrigating, scouting, thinning (all at min development)	500	0.10	0	0.11	**940**
Chinese cabbage, leafy vegetables	hand-harvesting	2500	0.20	1	0.13	**160**
	irrigating, scouting (all at medium development)	1500	0.20	0	0.22	**160**
	irrigating, scouting, thinning (all at min development)	500	0.20	0	0.22	**470**
artichokes	hand-harvesting, hand-pruning	1000	0.30	0	0.32	**160**
	irrigating, scouting (all at medium development)	500	0.30	0	0.32	**310**
	irrigating, scouting, thinning (all at min development), hand weeding	300	0.30	0	0.32	**520**
cut flowers	Old Brouwer data - for comparative purposes only	7000	0.30	6	0.073	**100**
	cut roses	2600	0.30	1	0.19	**100**
	all other cut flowers	500	0.30	0	0.32	**310**
Occupational Postapplication Non-cancer Risks Calculated with Turf TTR Study MRID# 449555-01						
turf	mowing	500	0.87	0	0.06	**1,400**

It should be noted that there were several scenarios for which no appropriate exposure data are known to exist or ongoing transfer coefficient studies have not yet been submitted (e.g., ARTF nursery and ornamental data). The scope of HED's revised policy 003 for transfer coefficients should also be considered as it only quantitatively addresses risks where the transfer coefficient model is appropriate (i.e., where foliar contact is known to exist). There are many kinds of potential exposure pathways that involve foliar contact that have not been addressed in this risk assessment (as defined in policy 003, refer to that document for a complete list). The scenarios include:

- Transplanting many crops including in the ornamental and forestry industry;
- Some partially mechanized operations that also involve human contact (e.g., cotton harvesting where module builders and trampers are used, see below);

- Various operations with Christmas trees such as pruning or balling; and
- Various operations with nut production such as sweeping for harvest.

[Note: Additional DFR data on different crops could refine exposure and risk estimates.]

2.2.3.2 Impregnated Clothing Scenarios

When assessing postapplication exposures to impregnated clothing, HED used the latest EPA Antimicrobial Division (AD) approaches to estimate the post-application exposures one would receive. The approach used to calculate the dermal exposures that are attributable to exposure from contacting impregnated clothing is:

$$\mathbf{PDR = (CR * CF1 * SA * TF) / BW}$$

Where:

PDR	=	potential dose rate (mg ai/kg/day);
CR	=	clothing residue concentration (mg ai/cm^2), assumed to be equivalent to the application rate on a mass per area basis (0.125 mg ai/cm^2);
CF1	=	conversion factor to convert m^2 to cm^2 (10,000 cm^2/m^2);
SA	=	surface area of the portion of the body that will touch the clothing (cm^2/day);
TF	=	transfer factor (unitless); and
BW	=	body weight (kg).

Margins of Exposure: Once the potential dose rate is calculated, the Margin of Exposure is determined by comparing the long-term dermal endpoint of concern with the potential dose rate.

Non-cancer Risk Summary: All postapplication exposure scenarios for permethrin-impregnated clothing are below HED's level of concern (i.e., the MOEs are greater than 100). A summary of the results for each population considered is provided in Table 16.

Table 16: Summary of Permethrin Long-Term Non-cancer Postapplication Worker Risk Estimates from Impregnated Clothing Scenarios

Population	Clothing residue (mg ai/cm2)	Surface area (m2/day)	Transfer factor (%/day)	PDR (mg ai/kg/day)	Long-Term MOE
Military adults	0.125	0.85	0.49%	0.022	**1,100**
Garment workers	0.125	0.221	0.49%	0.006	**4,300**

2.2.4 Occupational Postapplication Exposure and Risk Estimates for Cancer

The occupational exposure and cancer risk calculations for postapplication workers are presented in this section. Cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a *Lifetime Average Daily Dose* (LADD) is first calculated and then multiplied by Q_1* that has been calculated for permethrin based on dose response data in the appropriate

toxicology study (Q_1^* =9.567 x 10^{-3} (mg/kg/day)$^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Section 2.1.3 above describes how the ADD values were first calculated for the non-cancer MOE calculations. These values also serve as the basis for the cancer risk estimates. Dermal ADD values were then used to calculate the LADD values which were multiplied Q_1^* to obtain cancer risk estimates.

LADD and Cancer Risk Calculations: The use of dissipation data and the manner in which daily postapplication dermal exposures were calculated are inherently different than with handler exposures. However, once daily exposures are calculated, the calculation of LADD (Lifetime Average Daily Dose) and the resulting cancer risk estimates use the same algorithms that are described above for the handler exposures (See Section 2.1.4).

To reiterate, estimated occupational carcinogenic risks that are 1 x 10^{-6} or lower require no risk management action based on the 1996 Barolo memo. For those chemicals subject to reregistration, is to carefully examine uses with estimated risks in the 10^{-6} to 10^{-4} range to seek ways of cost-effectively reducing risks. If carcinogenic risks are in this range for postapplication workers, an increase in time after application prior to allowing a reentry activity would be warranted as is commonly applied to non-cancer risks.

Cancer Risk Summary: All of the cancer risk calculations for permethrin postapplication workers are included in Appendix B/Table B11.

2.2.3.1 Agricultural Scenarios

Cancer risk estimates for different crop groups are described above and summarized in Table 17 below. Two different occupational postapplication exposure scenarios were assessed – individuals employed solely by one establishment (i.e., "hired hands") were assumed to be exposed 10 days per year and individuals employed by multiple establishments (i.e., commercial or migratory farmworkers) were assumed to be exposed 30 days per year. Within each crop group, differing transfer coefficients were used to represent various types of cultural practices. Data from the permethrin specific studies discussed above were used along with the transfer coefficients to calculate the LADDs. Averages (of DFRs) were taken from the permethrin-specific data for specific crop groupings depending on the treatment interval listed on the labels. These averages were calculated beginning the day after the postapplication non-cancer risk exceeded the required MOE of 100 all the way through to the day when it was possible to retreat the crop. For example, conifer seed orchards can be treated every 30 days and the non-cancer postapplication risk for conifer seed orchards exceeded the required MOE of 100 on Day 1. Thus, an average of the permethrin specific data from day 2 through day 28 (the last day of the study) was taken and this average was used as the DFR value in the postapplication cancer calculations. All of the postapplication cancer risk estimates for both "hired hands" and commercial/migratory farmworkers are less than 1 x 10^{-4} and most are in the 10^{-6} to 10^{-7} range.

Table 17: Summary of Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate	DAT (days)	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
						LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
Occupational Postapplication Cancer Risk Estimates Calculated with Peach DFR Study (MRID # 437557-01)									

Table 17: Summary of Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate	DAT (days)	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
						LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
conifer seed orchard	seed cone harvesting	3000	1.2	AVG DAT 2-28	1.44	2.0e-03	1.9e-05	6.1E-03	5.8e-05
apples, pears	thinning	3000	0.4	AVG DAT 1-7	0.71	1.0e-03	9.6e-06	3.0E-03	2.9e-05
	hand-harvesting, hand-pruning, propping, training	1500	0.4	AVG DAT 1-7	0.71	5.0e-04	4.8e-06	1.5E-03	1.4e-05
	hand-weeding, irrigating, scouting	1000	0.4	AVG DAT 1-7	0.71	3.3e-04	3.2e-06	1.0E-03	9.6e-06
almonds, filberts, pistachios, walnuts	hand-harvesting, hand-pruning	2500	0.4	AVG DAT 1-7	0.71	8.3e-04	8.0e-06	2.5E-03	2.4e-05
	irrigating, scouting, thinning	500	0.4	AVG DAT 1-7	0.71	1.7e-04	1.6e-06	5.0E-04	4.8e-06
cherries: sweet and sour, nectarines, peaches	thinning	3000	0.3	AVG DAT 1-7	0.53	7.5e-04	7.2e-06	2.2E-03	2.2e-05
	hand-harvesting, hand-pruning	1500	0.3	AVG DAT 1-7	0.53	3.7e-04	3.6e-06	1.1E-03	1.1e-05
	hand-weeding, irrigating, scouting	1000	0.3	AVG DAT 1-7	0.53	2.5e-04	2.4e-06	7.5E-04	7.2e-06
avocados, conifer (field grown-Christmas trees), papayas	thinning	3000	0.2	AVG DAT 1-7	0.35	5.0e-04	4.8e-06	1.5E-03	1.4e-05
	hand-pruning	1500	0.2	AVG DAT 1-7	0.35	2.5e-04	2.4e-06	7.5E-04	7.2e-06
	hand-weeding, scouting	1000	0.2	AVG DAT 1-7	0.35	1.7e-04	1.6e-06	5.0E-04	4.8e-06
ornamentals	hand-pruning	400	0.2	AVG DAT 1-7	0.35	6.7e-05	6.4e-07	2.0E-04	1.9e-06
	hand-pinching	175	0.2	AVG DAT 1-7	0.35	2.9e-05	2.8e-07	8.7E-05	8.4e-07
	hand-harvesting	110	0.2	AVG DAT 1-7	0.35	1.8e-05	1.8e-07	5.5E-05	5.3e-07
Occupational Postapplication Cancer Risk Estimates Calculated with Cotton DFR Study (MRID # 455705-25)									
alfalfa, soybeans	hand-harvesting	2500	0.20	DAT AVG 2-7	0.07	8.2e-05	7.9e-07	2.5e-04	2.4e-06
	irrigating, scouting (full development)	1500	0.20	DAT AVG 1-7	0.08	5.7e-05	5.4e-07	1.7E-04	1.6e-06
corn	detasseling, hand-harvesting	17000	0.20	DAT AVG 5-14	0.03	2.4e-04	2.3e-06	7.3e-04	7.0e-06
	irrigating, scouting (full development)	1000	0.20	DAT AVG 1-7	0.08	3.8e-05	3.6e-07	1.1E-04	1.1e-06
cucurbits	hand-harvesting, hand-pruning	2500	0.20	DAT AVG 2-7	0.07	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	irrigating, scouting	1500	0.20	DAT AVG 1-7	0.08	5.7e-05	5.4e-07	1.7e-04	1.6e-06
	thinning	500	0.20	DAT AVG 1-7	0.08	1.9e-05	1.8e-07	5.7E-05	5.4e-07
onions: dry bulb, garlic	hand-harvesting	2500	0.30	DAT AVG 2-7	0.11	1.2e-04	1.2e-06	3.7E-04	3.5e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.30	DAT AVG 1-7	0.12	8.5e-05	8.2e-07	2.6E-04	2.4e-06

Table 17: Summary of Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate	DAT (days)	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
						LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
potatoes	hand-harvesting	2500	0.20	DAT AVG 2-7	0.13	1.5e-04	1.5e-06	4.6E-04	4.4e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.20	DAT AVG 1-7	0.08	5.7e-05	5.4e-07	1.7E-04	1.6e-06
turnips	hand-harvesting	2500	0.10	DAT AVG 1-7	0.04	4.7e-05	4.5e-07	1.4E-04	1.4e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.10	DAT AVG 1-7	0.04	2.8e-05	2.7e-07	8.5E-05	8.1e-07
eggplant, peppers: bell, tomatoes	hand-harvesting, hand-pruning	1000	0.20	DAT AVG 1-7	0.08	3.8e-05	3.6e-07	1.1E-04	1.1e-06
	irrigating, scouting	700	0.20	DAT AVG 1-7	0.08	2.7e-05	2.5e-07	8.0E-05	7.6e-07
	hand-weeding, thinning	500	0.20	DAT AVG 1-7	0.08	1.9e-05	1.8e-07	5.7E-05	5.4e-07
cabbage	hand-harvesting, hand-pruning, irrigating	5000	0.20	DAT AVG 4-7	0.05	1.3e-04	1.2e-06	3.9E-04	3.7e-06
	scouting	4000	0.20	DAT AVG 4-7	0.05	1.0e-04	9.9e-07	3.1E-04	3.0e-06
	hand-weeding	2000	0.20	DAT AVG 1-7	0.08	7.6e-05	7.2e-07	2.3E-04	2.2e-06
broccoli, Brussel sprouts, cauliflower, Chinese broccoli	hand-harvesting, hand-pruning, irrigating	5000	0.10	DAT AVG 2-7	0.04	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	scouting	4000	0.10	DAT AVG 1-7	0.04	7.6e-05	7.2e-07	2.3E-04	2.2e-06
	hand-weeding	2000	0.10	DAT AVG 1-7	0.04	3.8e-05	3.6e-07	1.1E-04	1.1e-06
collards	hand-harvesting	2500	0.10	DAT AVG 1-7	0.04	4.7e-05	4.5e-07	1.4E-04	1.4e-06
	irrigating, scouting, thinning (all at medium development)	1500	0.10	DAT AVG 1-7	0.04	2.8e-05	2.7e-07	8.5E-05	8.1e-07
Chinese cabbage, leafy vegetables	hand-harvesting	2500	0.20	DAT AVG 2-7	0.07	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	irrigating, scouting, thinning (all at medium development)	1500	0.20	DAT AVG 1-7	0.08	5.7e-05	5.4e-07	1.7e-04	1.6e-06
artichokes	hand-harvesting, hand-pruning	1000	0.30	DAT AVG 1-7	0.12	5.7e-05	5.4e-07	1.7E-04	1.6e-06
	irrigating, scouting, thinning (all at medium development)	500	0.30	DAT AVG 1-7	0.12	2.8e-05	2.7e-07	8.5E-05	8.1e-07
cut flowers	Old Brouwer data - for comparative purposes only	7000	0.30	DAT AVG 5-7	0.07	2.4e-04	2.3e-06	7.3E-04	7.0e-06
	cut roses	2600	0.30	DAT AVG 2-7	0.11	1.3e-04	1.2e-06	3.8E-04	3.7e-06
	all flowers	500	0.30	DAT AVG 1-7	0.12	2.8e-05	2.7e-07	8.5E-05	8.1e-07
Occupational Postapplication Cancer Risks Calculated with Turf TTR Study (MRID # 449555-01)									
turf	mowing	500	0.87	DAT AVG 1-14	0.03	6.3e-06	6.1e-08	1.9e-05	1.8e-07

2.2.3.2 Impregnated Clothing Scenarios

Impregnated Clothing Scenarios – Cancer risk estimates for different activities are summarized in Table 18 below. HED believes there are two different types of occupational postapplication exposures possible:

- military personnel who *wear* battle dress impregnated with permethrin on a daily basis (i.e., approximately 250 days/year) and
- factory workers who work with fabric or clothing after impregnation during making of garments or packaging of clothing on a work-day basis (i.e., 250 days per year).

Dermal exposures to military personnel are based on the clothing contact surface area of adults exposed to permethrin-impregnated clothing (0.85 m^2). This number is based on the assumption that military personnel wear briefs and undershirts underneath the battle dress and therefore the surface area of arms and legs (but not the torso) for an adult are used. Dermal exposures to garment workers are based on the contact surface area of adults exposed to permethrin impregnated clothing in a factory after the impregnation process (0.22 m^2). This number is based on the hands and forearms of an adult garment worker. All of the postapplication cancer risk estimates for both populations are less than 1 x 10^{-4}, but greater than 1 x 10^{-6}.

Table 18: Summary of Permethrin Cancer Postapplication Worker Risk Estimates for Impregnated Clothing Scenarios

Population	Clothing residue (mg ai/cm2)	Surface area (m2/day)	Transfer factor (%/day)	Exposure duration (years)	Exposure Frequency (days/year)	Averaging time (years)	LADD (mg ai/kg/day)	Cancer Risk
Military personnel	0.125	0.85	0.49%	10	250	70	0.0022	2.09E-05
Garment workers	0.125	0.221	0.49%	35	250	70	0.002	1.90E-05

2.2.5 Summary of Occupational Postapplication Risk Concerns and Data Gaps

For all, but a few, exposure scenarios in some crop groupings, short-and intermediate-term risks are below HED's level of concern (i.e., the MOEs are greater than 100) at day 0, approximately 12 hours following application. In a few cases, postapplication occupational risks from certain high exposure activities do not fall below HED's level of concern for 1 to 4 days following application. Risks from corn detasseling – the highest exposure activity – did not fall below HED's level of concern until 9 days following application. All postapplication long-term exposure scenarios for permethrin-impregnated clothing are below HED's level of concern (i.e., the MOEs are greater than 100).

Cancer risks were estimated for hired hands (i.e., 10 exposures/year) and commercial/migratory farmworkers (i.e., 30 exposures/year) with the only difference being the annual frequency of exposure days. All of the estimated postapplication cancer risk estimates for both types of farmworkers are less than 1 x 10^{-4} and most are in the 10^{-6} to 10^{-7} range. Cancer risks were also estimated for exposure to impregnated clothing. All of the estimated postapplication cancer risk estimates for military personnel and garment workers exposed to permethrin impregnated clothing are less than 1 x 10^{-6}, but greater than 1 x 10^{-4}.

HED has used the latest information to complete this postapplication risk assessment for

permethrin. Several data gaps exist such as a lack of postapplication studies in different crop groupings (e.g., cole crops, tall field crops) and lack of exposure data on mechanized or partially mechanized cultural practices where there is a potential for exposure. Additionally, because of the number and breadth of permethrin uses, there may be many exposure pathways where the transfer coefficient is not an appropriate model (e.g., working with treated animals or wearing treated clothing such as military uniforms) that have not been quantitatively addressed due to a lack of data.

2.2.6 Recommendations For Refining Occupational Postapplication Risk assessment

To refine this occupational risk assessment, data on actual use patterns including rates, timing, and the kinds of tasks that are required to produce agricultural commodities and other products would better characterize permethrin risks. Exposure studies for many cultural practices that lack data or that are not well represented in the revised transfer coefficient policy should also be considered based on the data gaps identified above.

3.0 Residential and Other Non-Occupational Exposures and Risks

It has been determined there is a potential for exposure in residential settings during the application process for homeowners who use products containing permethrin. There is also a potential for exposure from entering permethrin-treated areas, such as lawns or home gardens that could lead to exposures to adults and children. Risk assessments have been completed for both residential handler and postapplication scenarios.

In addition to homeowner uses in residential settings, permethrin is labeled for mosquito adulticide use, which is applied by occupational applicators, but may result in postapplication exposures in residential settings. These potential postapplication exposures to homeowners also have been considered in this assessment.

3.1 Residential Handler Exposures and Risks

HED uses the term "handlers" to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct tasks related to applications and that exposures can vary depending on the specifics of each task as was described above for occupational handlers. Residential handlers are addressed somewhat differently by HED as homeowners are assumed to complete all elements of an application without use of any protective equipment.

3.1.1 Handler Exposure Scenarios

Scenarios are used to define risks based on the *U.S. EPA Guidelines For Exposure Assessment* (U.S. EPA; Federal Register Volume 57, Number 104; May 29, 1992). Assessing exposures and

risks resulting from residential uses is very similar to assessing occupational exposures and risks, with the following exceptions:

- Residential handler exposure scenarios are considered to be short-term only due to the infrequent uses associated with homeowner products;

- A tiered approach for personal protection using increasing levels of PPE is not used in residential handler risk assessments. Homeowner handler assessments are based on the assumption that individuals are wearing shorts, short-sleeved shirts, socks, and shoes;

- Homeowner handlers are expected to complete all tasks associated with the use of a pesticide product including mixing/loading if needed as well as the application;

- Label use-rates and use-information specific to residential products serve as the basis for the risk calculations; and

- Area/volumes of spray or chemical used in the risk assessment are based on HED's guidance specific to residential use-patterns.

It has been determined that exposure to pesticide handlers is likely during the residential use of permethrin in a variety of indoor and outdoor environments including on lawns, gardens, ornamentals, indoor surfaces and spaces, and pets. The anticipated use patterns and current labeling indicate 23 major residential exposure scenarios based on the types of equipment and techniques that can potentially be used to make permethrin applications. The quantitative exposure/risk assessment developed for residential handlers is based on these scenarios. [Note: The scenario numbers for these residential handler scenarios correspond to the tables of risk calculations included in the residential risk calculation aspects of the appendices.]

Mixer/Loader/Applicators:
(1) Liquid: Low Pressure Handwand;
(2) Liquid: Backpack Sprayer;
(3) Liquid: Hose-End Sprayer;
(4) Liquid: Watering Can;
(5) Liquid: Paint Brush;
(6) Liquid: Sponge;
(7) Granulars: Push Type Spreader;
(8) Granulars: Belly Grinder;
(9) Granulars: Spoon or Cup;
(10) Dusts: Spoon or Cup;
(11) Dusts: Shaker Can;
(12) Dusts: Rotary Duster/Dust Gun*;
(13) Dusts: FPO Puffer Can*;
(14) RTU Liquids: Pour-on (using PHED liquid mixing/loading data);

(15) RTU Cream: Applicator Tube*;
(16) RTU Shampoos: Hands;
(17) RTU Wipe Applications (using CMA data);
(18) RTU: Trigger Pump Sprayer Applications;
(19) RTU: Aerosol Cans;
(20) RTU: Fogger (using PHED aerosol can data);
(21) RTU Tubes (for use on lawns)*;
(22) RTU Chair and Table Coasters*;
(23) RTU Protective Flanges*.

3.1.2 Data and Assumptions For Handler Exposure Scenarios

A series of assumptions and exposure factors served as the basis for completing the residential handler risk assessments. Each assumption and factor is detailed below. In addition to these factors, unit exposures were used to calculate risk estimates. Mostly, these unit exposures were taken from the Pesticide Handlers Exposure Database (PHED) and the Outdoor Residential Exposure Task Force (ORETF) studies. In addition, data was used from proprietary studies and the Non-Dietary Exposure Task Force (NDETF) studies. Both PHED and the individual studies are presented below. [Note: Several of the assumptions and factors used for the assessment are similar to those used in the occupational assessment presented above. As such, only factors that are unique to the residential scenarios are presented below.]

Assumptions and Factors: The assumptions and factors used in the risk calculations include:

- Permethrin is one of the most widely used pesticide active ingredients. It has an extraordinary number of use patterns that would be difficult to completely capture in this document. As such, HED has developed this risk assessment on a series of representative scenarios that are believed to represent the vast majority of permethrin uses. Refinements to the assessment will be made as more detailed information about permethrin use-patterns become available.

- Exposure factors used to calculate daily exposures to handlers were based on applicable data if available. When appropriate data are unavailable, values from a scenario deemed similar might be used. As an example, mixer/loader/applicator data for hose-end sprayers were used to assess sprinkler can applications. These application methods are believed to be similar enough to bridge the data. There were other instances where HED bridged specific data to represent other scenarios. See Appendix C/Table C1 for more details.

- The exposure durations (i.e., years per lifetime) used by HED in the cancer risk assessment were consistent with those used for other chemicals (i.e., 50 years to potentially handle the active ingredient and 70-year lifetime).

- HED always considers the maximum application rates allowed by labels in its risk

assessments. If additional information such as average or typical rates are available, these values also may be used to allow risk managers to make a more informed risk management decision. Average/ typical application rates were not available for residential scenarios.

- Residential risk assessments are based on estimates of what homeowners would typically treat, such as the size of a lawn, or the size of a garden. The factors used for the permethrin assessment were from the Health Effects Division Science Advisory Committee *Policy 12: Recommended Revisions To The Standard Operating Procedures For Residential Exposure Assessment* which was completed on February 22, 2001 and on best professional judgement. The daily volumes handled and area treated, used in each residential scenario, include:

    - 1 container of ready-to-use non-pet products including garden dusts, trigger-pump sprayers and aerosol cans;
    - ½ container of ready-to-use pet products, including dusts and liquid shampoos;
    - 100 gallons of finished spray output for hose-end sprayers, except for uses on lawns, where ½ acre was assumed;
    - 2 six ounce ready-to-use foggers;
    - 5 gallons when mixing/loading/applying liquids with a low-pressure handwand sprayers, except for animal (dog and cat) uses where 2 animals were assumed;
    - 5 gallons when mixing/loading/applying liquids with a sprinkling can;
    - 1 gallon of paint-on solution for outdoor wood surfaces;
    - ½ acre for broadcast applications to lawns;
    - 1000 square feet spot applications in lawns, and broadcast applications to gardens, and ornamentals (this value used as appropriate when application rates were based on a square foot basis for spot-type treatments); and
    - 5 mounds per day treated for fire ant applications.

Residential Handler Exposure Studies: The unit exposures that were used in this assessment were based on the Outdoor Residential Exposure Task Force studies, the Pesticide Handler Exposure Database (PHED, Version 1.1 August 1998), the Chemical Manufacturers Association (CMA) Antimicrobial Exposure Assessment Study, the Non-Dietary Exposure Task Force (NDETF) studies, and three proprietary studies using surrogate chemicals. [Note: PHED, some ORETF studies, the CMA study, and the propoxur trigger pump proprietary study are all described above.]

EPA MRID 449722-01 (ORETF Handler Studies):
A report was submitted by the ORETF (Outdoor Residential Exposure Task Force[4]) that presented data in which the application of various products used on turf by homeowners and lawncare operators (LCOs) was monitored. All of the data submitted in this report were completed in a series of studies.

Homeowner Push-Type Spreader (OMA003): A mixer/loader/applicator study was performed by the ORETF using Dacthal (active ingredient DCPA, dimethyl tetrachloroterephthalate) as a surrogate compound to determine "generic" exposures of individuals applying a granular pesticide formulation to residential lawns. A total of 30 volunteers were monitored using passive dosimetry (inner and outer whole body dosimeters, hand washes, face/neck wipes, and personal inhalation monitors). Each volunteer carried, loaded, and applied two 25-lb bags of fertilizer and pesticide granules (0.89% active ingredient) with a rotary type spreader to a lawn covering 10,000 ft^2. The target application rate was 2 lb ai/acre (actual rate achieved was about 1.9 lbs ai/acre). The average application time was 22 minutes, including loading the rotary push spreader and disposing of the empty bags. Each replicate handled approximately 0.45 lbs ai. The study results are normalized to kg ai handled. The US EPA HED typically assumes that residential applicators wear short pants and short-sleeved shirts, as described in the Residential SOPs (1997). Therefore, the table reports the dermal exposures for the short pants and short-sleeve shirt clothing scenario only.

Table 19: Unit Exposures Obtained From ORETF Study MRID 449722-01

Type	Dermal (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Push-Type Spreader	0.67	0.88

Non-Dietary Exposure Task Force (NDETF) Studies

Primary assumptions for assessing post-application exposure to use of foggers and aerosols in indoor residential settings were based on data provided by the Non-Dietary Exposure Task Force (NDETF). the NDETF was formed in 1996 from members of the Pyrethrin Joint Venture (PJV) and the Piperonyl Butoxide Task Force II (PBOTFII), task forces that were set up in 1980s by producers, formulators, and marketers of the active ingredients to respond to reregistration needs. NDETF includes: Bayer CropSciences; Botanical Resources Australia; Endura S.P.A.; McLaughlin Gormley King Company; Pyrethrum Board of Kenya Prentiss Inc.; S.C. Johnson and Son, Inc.; and Valent BioSciences Corporation.

The NDETF conducted studies to examine the deposition of residues from total release foggers. The studies conducted with formulations of pyrethrin/piperonyl butoxide and permethrin/piperonyl butoxide were submitted to EPA in January 2004. The studies simulated the use of a fogger and aerosol products indoors to provide data on air dispersion and deposition on surfaces. Carpet and vinyl were selected as the flooring surfaces of interest because they represent a significant amount of the floor coverings used in homes in North America. The studies used hand presses, rollers, and drag sleds to assess the residue transferability of the pesticides from the carpet and vinyl.

Roller and drag sled transfer data were averaged together for use in this assessment as there was little difference between the datasets. Transfer of permethrin to roller/drag sled from fogger

treated carpet was assumed to be 4.4% of deposition based on data from Volume 25 of the NDETF studies. Transfer of permethrin to roller/drag sled from fogger treated carpet was assumed to be 1.8% of deposition based on data from Volumes 5 and 25 of the NDETF studies. This data was used to assess the adult and toddler dermal exposure from indoor surfaces scenarios.

Hand transfer data used in this assessment comes from the bare wetted hand scenarios that were performed in some of the NDETF studies. Transfer of permethrin to bare hands from fogger treated carpet was assumed to be13% of deposition based on data from Volume 29 of the NDETF studies. Transfer of permethrin to bare hands from fogger treated carpet was assumed to be 6.6% of deposition based on data from Volume2 9 of the NDETF studies. This data was used to assess the toddler incidental oral ingestion hand-to-mouth from indoor surfaces scenario. The data are presented in Table 20 below.

Table: 20 Percent Transfer of Residues from Carpet and Vinyl Flooring Treated with Fogger

Roller/Drag Sled Technique	
Study ID - Procedure	Permethrin
Carpet Flooring	
Project ID 01-017-PY01 (Volume 25) - Roller Technique	4.4
Vinyl Flooring	
Project ID 98-031-PY01 (Volume 5) - Drag Sled Technique	2.0
Project ID 01-017-PY01 (Volume 25) - Roller Technique	1.5
AVERAGE	1.8
Using Wetted Bare Hand Technique	
Carpet Flooring	
Project ID 01-031-PY01 (Volume 29)	13
Vinyl Flooring	
Project ID 01-031-PY01 (Volume 29)	6.6

Proprietary Studies

Two proprietary studies were used to obtain unit exposures for handlers applying dusts to dogs and granulars via spoon and cup. These studies are summarized below:

MRID 44439901 (Carbaryl homeowner dog dusting study): The objective of the study was to measure homeowner dermal and respiratory exposure to permethrin while dusting 3 dogs for fleas using Sevin® 5 Dust. The dogs were from a local facility and varied in size and fur length. The product was supplied to the handlers in 1 pound Ortho Sevin® 5 Dust canisters. The handlers opened the can, shook the product onto the dogs coat and rubbed the dust into the fur. The first replicate consisted of each applicator applying dust to 3 dogs of varying size with chemical- resistant gloves. The second replicate was the same handler applying Ortho®Sevin® 5 Dust without gloves on 3 dogs. A total of 40 replicates were collected, 20 replicates with

gloves and 20 replicates without gloves.

Each participant wore inner and outer dosimeters to simulate skin and clothing respectively. The cloth dosimeter parts (inner and outer), handwashes, face/neck wipes, and air monitoring devices were frozen, sent to a laboratory, and analyzed for permethrin after the replicates were performed. The amount of product used to dust 3 dogs averaged 65.3 grams of product or 3.51 grams active ingredient. It took an average of 7 minutes to dust 3 dogs.

Field fortification recoveries for passive dosimeters averaged >90 percent for all media except face and neck wipe fortifications (average = 87.6%). Field fortification results that were >90 percent were not adjusted, therefore only the face and neck wipe data were adjusted for field recovery. Storage stability tests were done and acceptable.

Unit exposures were calculated using the data from the study. The study reported the total dermal exposure to carbaryl as the residues on the inner dosimeter. However, since this is a residential product, residues on the inner dosimeter upper arms, upper legs, front torso, and back torso were combined with the residues on the outer dosimeter lower arms and lower legs to represent a residential handler wearing a short-sleeved shirt, short pants, and no gloves. The exposures were normalized by the amount of chemical used by the individual applicators. The geometric mean of the data are presented in Table 21 below.

Table 21: Unit Exposures Obtained From Permethrin Homeowner Dog Dusting Study (MRID 444399-01)

Type	Dermal (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Dust (dogs)	3300	25

Worker Exposure Study During Application of Regent 20GR In Banana Plantation, EPA MRID 452507-02 (Fipronil Study): Handler exposure data from a proprietary granular mixer/loader/applicator study (MRID 452507-02) in bananas using fipronil (Regent 20GR) were used in place of PHED data for the "loading/applying granulars using a spoon, measuring scoop, shaker can or by hand" scenario. This fipronil study is considered to be an appropriate source of surrogate handler exposure data for permethrin because formulation types are similar (granular) and application methods are similar (applying granulars with a spoon). The study is considered to be of sufficient quality for use in risk assessment. Data compensation for these data should be determined.

Several factors should be considered when using fipronil data in the permethrin exposure assessment. Protection factors used to calculate permethrin dermal unit exposures, based on the fipronil unit exposures, include a standard 50% protection factor for the torso, a 10% protection factor for legs, based on shorts, and a 10% protection factor for arms, based on a short-sleeved shirt. These protection factors represent the typical attire assumed to be worn by a homeowner during pesticide application (shorts and short-sleeved shirt). The 10% protection factor for shorts and the 10% protection factor for a short-sleeved shirt are not standard protection factors used by

HED; rather, these values are based on the best professional judgement of HED scientists and are appropriate for calculating range-finding estimates only.

Some other issues and limitations to be considered when using the fipronil study include the following:

- HED guidelines require that 15 replicates be completed in exposure studies in three different locations. In the fipronil study, only ten replicates were completed using spoons, and at only one location. However, the events that were monitored seemed to be reasonable representations of actual agricultural practices, so it is unlikely that additional replicates would significantly alter the final unit exposure results. Additionally, it is unlikely that cultural practices would significantly vary if the study was completed at different locations.

- The individual amounts of chemical applied were not recorded in this study. Instead, the investigators determined how much product was applied by the application teams used. Using this information, the investigators calculated the amount used for each individual by assuming that each was equally productive (i.e., dividing the total amount used per team by the number of team members).

- One applicator using the spoons had a spoon with no handle. The results for this individual were included with the other spoon applicators as it is a plausible variation of that application method.

Table 22 Unit Exposures Obtained From Fipronil Study MRID 452507-02

Type	Dermal (mg ai/lb handled)	Inhalation (µg ai/lb handled)
Spoon Applications	3.5	45.0

3.1.3 Residential Handler Exposure and Non-Cancer Risk Estimates

The residential handler exposure and non-cancer risk estimations are presented in this section. Noncancer risks were estimated using the Margin of Exposure (MOE) as described above. Assessing exposures and risks resulting from residential uses is very similar to assessing occupational exposures and risks, except as described above in Section 3.1.1. The other major difference with residential risk assessments is that the uncertainty factor which defines the level of risk concern has the additional FQPA safety factor applied. The overall uncertainty factor applied to permethrin for residential handler risk assessments is 100 which is based on the FQPA safety factor of 1x along with the 10x for inter-species extrapolation and 10x for intra-species sensitivity (see Section 1.3.1 for more information).

Noncancer Risk Summary: All of the noncancer risk estimations for residential permethrin

handlers completed in this assessment are included in Appendix C/Table C2. A brief summary of the results for each exposure scenario is also provided below.

The data submitted by the registrants accompanied by the other data used by HED have provided a basic broad overview of the uses of permethrin around a residential environment (i.e., the database is fairly complete). As indicated above, however, it is likely that permethrin can be used in a myriad of ways that have not specifically been identified in this assessment. HED believes that the scenarios assessed in this document represent worse-case exposures and risks resulting from use of permethrin in residential environments. It should also be noted that there were many other scenarios where medium to low quality PHED data were used to complete the assessment. Data quality should be considered in the interpretation of the uncertainties associated with each risk presented.

Short-term risks for residential handlers (intermediate-term exposures are not likely, because of the sporadic nature of applications by homeowners) are presented in Table 23. For all scenarios, risks are below HED's level of concern (i.e., MOEs are greater than 100) assuming handlers are wearing short-sleeve shirt, short pants, shoes, and socks.

Table 23: Summary of Short-Term Permethrin Residential Handler Noncancer Risk Estimates						
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Baseline MOEs		
				Dermal	Inhalation	Combined
Mixer/Loader/Applicator						
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (1)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	450	880000	**450**
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	480	940000	**480**
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	520	1000000	**520**
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	1000	2000000	**1000**
	turf	0.005 lb ai/gallon	5 gallons	4200	8100000	**4200**
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	5200	10000000	**5200**
	apples, peaches	0.0033 lb ai/gallon	5 gallons	6300	12000000	**6300**
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	10000	20000000	**10000**
	asparagus, broccoli, Brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	17000	34000000	**17000**
	fire ant mounds	0.1 lb ai/mound	5 mounds	210	410000	**210**
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	69000	140000000	**69000**
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack Sprayer (2)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	5000	110000	**4800**
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	5300	120000	**5100**
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	5700	130000	**5500**
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	11000	260000	**11000**
	turf	0.005 lb ai/gallon	5 gallons	46000	1000000	**44000**
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	57000	1300000	**55000**
	apples, peaches	0.0033 lb ai/gallon	5 gallons	69000	1600000	**66000**
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	110000	2600000	**110000**
	asparagus, broccoli, Brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	190000	4300000	**180000**
	fire ant mounds	0.1 lb ai/mound	5 mounds	2300	51000	**2200**
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	760000	17000000	**730000**
Mixing/Loading/Applying Emulsifiable Concentrates with Hose-End Sprayer (ORETF data) (3)	turf	0.087 lb ai/acre	0.5 acres	12000	1000000	**12000**
	ornamentals: outdoor trees	0.043 lb ai/gallon	100 gallons	120	11000	**120**
	stored lumber, wood piles	0.04 lb ai/gallon	100 gallons	130	11000	**130**
	ornamentals: outdoor	0.02 lb ai/gallon	100 gallons	270	23000	**260**
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	100 gallons	1300	110000	**1300**
	apples, peaches	0.003 lb ai/gallon	100 gallons	1800	150000	**1700**
	cherries; ornamentals: outdoor herbaceous/ woody plants & shrubs	0.002 lb ai/gallon	100 gallons	2700	230000	**2600**
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (4)	fire ant mounds	0.1 lb ai/mound	5 mounds	1100	91000	**1000**
	stored lumber, wood piles	0.04 lb ai/gallon	5 gallons	2700	230000	**2600**
	ornamentals: indoor	0.0017 lb ai/gallon	5 gallons	62000	5300000	**62000**
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (5)	outdoor wood surfaces; outdoor surfaces	0.04 lb ai/gallon	1 gallon	630	68000	**630**
Mixing/Loading/Applying Emulsifiable Concentrates via Sponge (CMA data) (6)	horses	0.005 lb ai/animal	2 animals	200	2800	**190**
Loading/Applying Granulars via Push Type Spreader (ORETF data) (7)	turf	0.65 lb ai/acre	0.5 acres	26000	2600000	**26000**
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	110000	11000000	**110000**

Table 23: Summary of Short-Term Permethrin Residential Handler Noncancer Risk Estimates						
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Baseline MOEs		
				Dermal	Inhalation	Combined
Loading/Applying Granulars via Belly Grinder (8)	turf	0.65 lb ai/acre	0.5 acres	160	38000	**160**
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	660	160000	**660**
Loading/Applying Granulars via Spoon or Cup (MRID 452507-01) (9)	fire ant mounds	0.00125 lb ai/mound	5 mounds	470000	2700000	**400000**
	ant mounds	0.000078 lb ai/mound	5 mounds	7600000	44000000	**6500000**
Loading/Applying Dusts via Spoon or Cup (MRID 444598-01) (10)	fire ant mounds	0.00156 lb ai/mound	5 mounds	5100	110000	**4800**
Mixing/Loading/Applying Dusts via Shaker Can (MRID 444598-01) (11)	indoor surfaces	0.05 lb ai/1000 sq ft	1000 sq ft	790	18000	**750**
	apples, asparagus, broccoli, Brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	16000	350000	**15000**
	animal premises: dogs and cats	0.0025 lb ai/1lb container	1/10th of a 1 lb container	160000	3500000	**150000**
	animal: dogs, cats	0.00016 lb ai/animal	2 animals	5500	96000	**5200**
Mixing/Loading/Applying Dusts via Rotary Duster/Dust Gun (12)	apples, asparagus, broccoli, Brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	No Data		
Mixing/Loading/Applying Dusts via FPO Puffer Can (13)	garden vegetables, ornamentals	0.00125 lb ai/1lb container	1 lb container	No Data		
Applying Ready to Use Formulations via Pour-on (using PHED liquid mixer/loader data) (14)	animal: horses	0.005 lb ai/animal	2 animals	200000	64000000	**200000**
	clothing: personal	0.002 lb ai/gallon	1 container	1000000	320000000	**1000000**
Applying Ready to Use Cream Formulations via Applicator Tube (15)	animal: dogs	0.003 lb ai/animal	2 animals	No Data		
Applying Ready to Use Formulations via Hands (16)	animal: dogs, cats	0.0014 lb ai/animal	2 animals	No Data		
Applying Ready to Use Formulations via RTU Wipe (CMA data) (17)	animal: dogs & horses	0.0062 lb ai/animal	2 animals	160	2200	**150**
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur study) (18)	ornamentals: outdoors; indoor surfaces	0.043 lb ai/gallon	1 gallon	10000	150000	**9400**
	animal: dogs	0.00034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	160000	2300000	**150000**
	animal: cats	0.000034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	1600000	23000000	**1500000**
	animal: horses, foals	0.016 lb ai/animal	2 animals	14000	200000	**13000**
Applying Ready to Use Formulations with Aerosol Cans (19)	outdoor & indoor surfaces	0.00438 lb ai/16 oz can	1 sixteen-ounce aerosol can	6100	73000	**5600**

Table 23: Summary of Short-Term Permethrin Residential Handler Noncancer Risk Estimates						
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Baseline MOEs		
				Dermal	Inhalation	Combined
	animal: dogs & cats; animal premises: dogs and cats	0.000538 lb ai/16 oz can	0.5 sixteen-ounce aerosol cans	99000	1200000	**91000**
	ornamentals: indoor & outdoor	0.002 lb ai/16 oz can	1 sixteen-ounce aerosol cans	12000	150000	**11000**
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (20)	indoor spaces	0.002 lb ai/6 oz fogger	2 animals	5800	70000	**5300**
Applying Ready to Use Tubes (21)	outdoor surfaces	No Data				
Applying Ready to Use Coasters (22)	ants	No Data				
Applying Ready to Use Protective Flanges (23)	ants	No Data				

Footnotes

a Application rates are the maximum application rates provided by for permethrin in all cases.

b Amount handled per day values are HED estimates of area treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.

3.1.4 Residential Handler Exposure and Risk Estimates for Cancer

The residential handler exposure and cancer risk calculations are presented in this section. Cancer risk estimates were calculated using a linear, low-dose extrapolation approach (Q_1*) using the same formula as described above in Section 2.1.4. In addition to the cancer risk estimates for an annual frequency of 1 time per year, the number of days of exposure per year required to get a $1x10^{-6}$ cancer risk have been calculated. In this calculation, the $1x10^{-6}$ cancer risk limit was divided by the estimated cancer risks for each scenario for a single day of exposure. Assessing exposures and risks resulting from residential uses is very similar to assessing occupational exposures and risks, except as described above in Section 3.1.1. The major difference with residential cancer risk assessments is that the annual frequency of use is lower for homeowners.

Cancer Risk Summary All of the cancer risk estimations for residential permethrin handlers completed in this assessment are included in Appendix C/Table C3.

Table 21 presents the quantitative cancer risk estimates associated with each scenario considered in the assessment. For all but eight scenarios, cancer risk estimates are less than $1x10^{-6}$ (most are in the 10^{-7} to 10^{-9} range) when a single application per year is evaluated. This table also includes the allowable number of days exposure per year and risks remain below $1x10^{-6}$. There are 24 scenarios where 5 days or less of exposure per year are allowable. The eight scenarios

where cancer risk estimates are more than $1x10^{-6}$ include:

- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor surfaces (0.046 lb ai/gallon),
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor trees (0.043 lb ai/gallon),
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to outdoor wood surfaces and for perimeter treatments (0.04 lb ai/gallon),
- mixing/loading/applying emulsifiable concentrates with low pressure handwand to fire ant mounds (0.01 lb ai/mound),
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to outdoor trees (0.043 lb ai/acre),
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to stored lumber and wood piles (0.04 lb ai/gallon)
- mixing/loading/applying emulsifiable concentrates with hose-end sprayer to ornamentals outdoors (0.02 lb ai/gallon),
- applying to dogs or horses using a ready-to-use wipe (0.0062 lb ai/wipe)

Table 24: Summary of Permethrin Residential Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Residential Applicator Baseline Cancer Risk [c]	Days per Year
Mixer/Loader/Applicator					
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (1)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	1.8E-06	<1
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	1.7E-06	<1
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	1.6E-06	<1
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	8.0E-07	1
	turf	0.005 lb ai/gallon	5 gallons	2.0E-07	4
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	1.6E-07	6
	apples, peaches	0.0033 lb ai/gallon	5 gallons	1.3E-07	7
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	8.0E-08	12
	asparagus, broccoli, Brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	4.8E-08	20
	fire ant mounds	0.1 lb ai/mound	5 mounds	4.0E-06	<1
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	1.2E-08	83
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack Sprayer (2)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	9.6E-08	10
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	9.0E-08	11
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	8.3E-08	11
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	4.2E-08	23
	turf	0.005 lb ai/gallon	5 gallons	1.0E-08	95
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	8.3E-09	119
	apples, peaches	0.0033 lb ai/gallon	5 gallons	6.9E-09	145
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	4.2E-09	239
	asparagus, broccoli, Brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	2.5E-09	365
	fire ant mounds	0.1 lb ai/mound	5 mounds	2.1E-07	4
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	6.3E-10	365
Mixing/Loading/Applying Emulsifiable Concentrates with Hose-End Sprayer (ORETF data) (3)	turf	0.087 lb ai/acre	0.5 acres	3.9E-08	25
	ornamentals: outdoor trees	0.043 lb ai/gallon	100 gallons	3.8E-06	<1
	stored lumber, wood piles	0.04 lb ai/gallon	100 gallons	3.5E-06	<1
	ornamentals: outdoor	0.02 lb ai/gallon	100 gallons	1.8E-06	<1
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	100 gallons	3.5E-07	2
	apples, peaches	0.003 lb ai/gallon	100 gallons	2.7E-07	3
	cherries; ornamentals: outdoor herbaceous/ woody plants & shrubs	0.002 lb ai/gallon	100 gallons	1.8E-07	5

Table 24: Summary of Permethrin Residential Handler Cancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Residential Applicator Baseline Cancer Risk [c]	Days per Year
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (4)	fire ant mounds	0.1 lb ai/mound	5 mounds	4.4E-07	2
	stored lumber, wood piles	0.04 lb ai/gallon	5 gallons	1.8E-07	5
	ornamentals: indoor	0.0017 lb ai/gallon	5 gallons	7.5E-09	132
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (5)	outdoor wood surfaces; outdoor surfaces	0.04 lb ai/gallon	1 gallon	7.4E-07	1
Mixing/Loading/Applying Emulsifiable Concentrates via Sponge (CMA data) (6)	horses	0.005 lb ai/gallon	2 animals	2.4E-06	2
Loading/Applying Granulars via Push Type Spreader (ORETF data) (7)	turf	0.65 lb ai/acre	0.5 acres	1.8E-08	56
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	4.4E-09	228
Loading/Applying Granulars via Belly Grinder (8)	turf	0.65 lb ai/acre	0.5 acres	2.9E-06	2
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	7.1E-07	2
Loading/Applying Granulars via Spoon or Cup (MRID 452507-01) (9)	fire ant mounds	0.00125 lb ai/mound	5 mounds	1.1E-09	365
	ant mounds	0.000078 lb ai/mound	5 mounds	6.7E-11	365
Loading/Applying Dusts via Spoon or Cup (MRID 444598-01) (10)	fire ant mounds	0.00156 lb ai/mound	5 mounds	9.4E-08	10
Mixing/Loading/Applying Dusts via Shaker Can (MRID 444598-01) (11)	indoor surfaces	0.05 lb ai/1000 sq ft	1000 sq ft	6.1E-07	1
	apples, asparagus, broccoli, Brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	3.0E-08	33
	animal premises: dogs and cats	0.0025 lb ai/1lb container	1/10th of a 1 lb container	3.0E-09	330
	animal: dogs, cats	0.00016 lb ai/animal	2 animals	3.9E-09	258
Mixing/Loading/Applying Dusts via Rotary Duster or Dust Gun (12)	apples, asparagus, broccoli, Brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	No Data	
Mixing/Loading/Applying Dusts via FPO Puffer Can (13)	garden vegetables, ornamentals	0.00125 lb ai/1lb container	1 lb container	No Data	

Table 24: Summary of Permethrin Residential Handler Cancer Risk Estimates					
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Residential Applicator Baseline Cancer Risk [c]	Days per Year
Applying Ready to Use Formulations via Pour-on (using PHED liquid mixer/loader data) (14)	animal: horses	0.005 lb ai/animal	2 animals	2.3E-09	365
	clothing: personal	0.002 lb ai/gallon	1 container	4.7E-10	365
Applying Ready to Use Cream Formulations via Applicator Tube (15)	animal: dogs	0.003 lb ai/animal	2 animals	No Data	
Applying Ready to Use Formulations via Hands (16)	animal: dogs, cats	0.0014 lb ai/animal	2 animals	No Data	
Applying Ready to Use Formulations via RTU Wipe (CMA data) (17)	animal: dogs & horses	0.0062 lb ai/animal	2 animals	2.9E-06	<1
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur study) (18)	ornamentals: outdoors; indoor surfaces	0.043 lb ai/gallon	1 gallon	4.8E-08	20
	animal: dogs	0.00034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	3.0E-09	329
	animal: cats	0.000034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	3.0E-10	365
	animal: horses, foals	0.016 lb ai/animal	2 animals	3.6E-08	27
Applying Ready to Use Formulations with Aerosol Cans (19)	outdoor & indoor surfaces	0.00438 lb ai/16 oz can	1 sixteen-ounce aerosol can	8.0E-08	12
	animal: dogs & cats; animal premises: dogs and cats	0.000538 lb ai/16 oz can	0.5 sixteen-ounce aerosol cans	4.9E-09	203
	ornamentals: indoor & outdoor	0.002 lb ai/16 oz can	1 sixteen-ounce aerosol cans	3.9E-08	25
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (20)	indoor spaces	0.002 lb ai/6 oz fogger	2 animals	8.4E-08	11
Applying Ready to Use Tubes (21)	outdoor surfaces	No Data			
Applying Ready to Use Coasters (22)	ants	No Data			
Applying Ready to Use Protective Flanges (23)	ants	No Data			

Footnotes

a Application rates are the maximum application rates provided by for permethrin in all cases.

b Amount handled per day values are HED estimates of area treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.

c Cancer risk estimates were calculated for an annual frequency of 1 time per year.

3.1.5 Summary of Risk Concerns and Data Gaps for Handlers

Noncancer risks are below HED's level of concern (i.e., the MOEs are less than 100) for all residential handler scenarios. Cancer risk estimates for most scenarios are in the 10^{-7} to 10^{-9} range, although there are eight residential handler scenarios where the risks are more than $1x10^{-6}$.

No key data gaps have been identified by HED at this time for residential handlers. However, there were some scenarios that remain unaddressed by HED at this time due to a lack of data or other information (i.e., rotary duster/dust gun applications, puffer-can applications, and the use of RTU furniture coasters and protective flanges). HED believes that the shaker can scenario is representative of the rotary duster/dust gun scenario and thus it can be considered not of concern.

3.1.6 Recommendations For Refining Residential Handler Risk Assessment

In order to refine this residential risk assessment, more data on actual use patterns including rates, timing, and areas treated would better characterize permethrin risks. Exposure studies for many equipment types that lack data or that are not well represented in PHED (e.g., because of low replicate numbers or data quality) should also be considered based on the data gaps identified above and based on a review of the quality of the data used in this assessment.

3.2 Residential Postapplication Exposures and Risks

HED uses the term "postapplication" to describe exposures to individuals that occur as a result of being in an environment that has been previously treated with a pesticide. Permethrin can be used in many areas that can be frequented by the general population including residential areas (e.g., home lawns and gardens). As a result, individuals can be exposed by entering these areas if they have been previously treated. Permethrin can also be used on companion animals, which can lead to exposures by contact with the treated animals. It can also be impregnated in clothing which can lead to exposures during use of the clothing.. Finally, permethrin can also be used as a mosquito adulticide which can result in postapplication exposures to the general population, because it involves wide area, ultra-low volume spraying in residential areas. HED generically refers to these exposures as "residential" in nature.

3.2.1 Residential Postapplication Exposure Scenarios

A wide array of individuals of varying ages can potentially be exposed to permethrin when they do activities in areas that have been previously treated, wear permethrin-impregnated clothing, or have contact with treated companion animals. Postapplication exposure scenarios were developed for each residential setting where permethrin can be used. Assessing postapplication exposures and risks resulting from residential uses is very similar to assessing occupational postapplication exposures and risks, except in residential assessments:

- exposures were calculated for children of differing ages as well as adults;

- non-dietary ingestion exposures to toddlers were calculated (i.e., soil ingestion, hand-/object-to-mouth);
- a dermal "hug" approach has been used instead of transfer coefficients to calculate exposures to pesticide residues on companion animals; and
- cancer risks were not calculated for children per HED policy.

HED relies on a standardized approach for completing residential risk assessments that is based on current permethrin labels and guidance contained in the following five documents. In addition, when assessing postapplication exposures to impregnated clothing, HED used the latest EPA Antimicrobial Division (AD) approaches to estimate the postapplication exposures.

- ***Series 875, Residential and Residential Exposure Test Guidelines: Group B - Postapplication Exposure Monitoring Test Guidelines (V 5.4, Feb. 1998)*** This document provides general risk assessment guidance and criteria for analysis of residue dissipation data.

- ***Standard Operating Procedures For Residential Exposure Assessment (Dec. 1997)*** This document provides the overarching guidance for developing residential risk assessments including scenario development, algorithms, and values for inputs.

- ***Science Advisory Council For Exposure Policy 003.1 (Aug. 2000): Agricultural Transfer Coefficients*** This document provides transfer coefficients which have been used to assess exposures in home gardens.

- ***Science Advisory Council For Exposure Policy 12 (Feb. 2001): Recommended Revisions To The Standard Operating Procedures (SOPs) For Residential Exposure Assessment*** This document provides additional, revised guidance for completing residential exposure assessments.

- Overview of Issues Related To The Standard Operating Procedures For Residential Exposure Assessment (August 1999 Presentation To The FIFRA SAP). This document provides rationale for HED changes in SOPs. Companion animal approach included in document used for risk assessment.

When the guidance in current labels and these documents is considered, it is clear that HED should consider children of differing ages as well as adults in its assessments. It is also clear that different age groups should be considered in different situations. The populations that were considered in the assessment include:

- **Residential Adults:** these individuals are members of the general population that are exposed to chemicals by engaging in activities at their residences (e.g., in their lawns or gardens) and also in areas not limited to their residence (e.g., golf courses or parks) previously treated with a pesticide. These kinds of exposures are attributable to a variety

of activities and usually addressed by HED in risk assessments by considering a representative activity as the basis for the exposure calculation.

- **Residential Children:** children are members of the general population that can also be exposed in their residences (e.g., on lawns, in gardens, or from contact with treated pets) as well as other areas previously treated with a pesticide (e.g., parks). These kinds of exposures are attributable to a variety of activities such as playing outside, home gardening, or playing with a companion animal. Toddlers have been selected as a sentinel (or representative) population for turf and companion animal assessments. Youth-aged children (ages 10 to 12) are considered the sentinel population for a fruit harvesting assessment because it is likely that children of this age would help with garden maintenance. They are usually addressed by HED in risk assessments by considering a representative activities for each age group in an exposure calculation.

The *SOPs For Residential Exposure Assessment* define several scenarios that apply to uses specified in current labels. These scenarios served as the basis for the residential postapplication assessment along with the modifications to them and the additional data and approaches described above. HED used this guidance to define the exposure scenarios that essentially include dermal and nondietary ingestion exposure to toddlers on treated lawns, dermal exposure to youths in treated gardens, dermal exposure to children from treated companion animals, and dermal exposure to adults in treated gardens and on treated lawns. The SOPs and the associated scenarios are presented below:

- ***Dose from dermal exposure on treated turf:*** Postapplication dermal dose calculations for toddlers from playing on treated turf;

- ***Dose from ingestion of permethrin granules from treated turf:*** Postapplication dose calculations for toddlers from episodic nondietary ingestion of pesticide granules picked up from treated turf (i.e., those residues that are swallowed when toddlers pick up granules from treated turf and put the granules in their mouth);

- ***Dose from hand-to-mouth activity from treated turf:*** Postapplication dose calculations for toddlers from incidental nondietary ingestion of pesticide residues on treated turf from hand-to-mouth transfer (i.e., those residues that are swallowed when toddlers get pesticide residues on their hands from touching treated turf and then put their hands in their mouth);

- ***Dose from object-to-mouth activity from treated turf:*** Postapplication dose calculations for toddlers from incidental nondietary ingestion of pesticide residues on treated turf from object-to-mouth transfer (i.e., those residues that swallowed when toddlers put treated turf in their mouths);

- ***Dose from soil ingestion activity from treated turf:*** Postapplication dose calculations for

toddlers from incidental nondietary ingestion of pesticide residues from ingesting soil in a treated turf area (i.e., those soil residues are swallowed when toddlers get pesticide residues on their hands from touching treated soil and then put their hands in their mouth);

- ***Dose from dermal exposure while working in treated gardens or with various trees (nut, fruit, and ornamentals):*** Postapplication dermal dose calculations for adults and youth-aged children (ages 10 to 12) while gardening [Note: These series of SOPs also call for addressing nondietary ingestion, these types of exposures have been included in the turf/toddler calculations.];

- ***Dose from dermal contact with treated pets:*** Postapplication potential dose calculations for toddlers from dermal contact with a treated pet;

- ***Dose from hand-to-mouth activity :*** Postapplication potential dose calculations for toddlers from nondietary ingestion of pesticide residues on treated pets from hand-to-mouth transfer (i.e., those residues are swallowed when toddlers get pesticide residues on their hands from touching a pet and then put their hands in their mouth);

- ***Dose from inhalation exposure while outdoors during mosquito ULV ground treatments:*** Postapplication inhalation dose calculations for adults and toddlers who are outdoors during truck-mounted ULV mosquito applications.

- ***Dose from dermal exposure on indoor surfaces:*** Postapplication dermal dose calculations for toddlers from playing on treated indoor surfaces;

- ***Dose from hand-to-mouth activity from treated indoor surfaces:*** Postapplication potential dose calculations for toddlers from nondietary ingestion of pesticide residues on treated indoor surfaces from hand-to-mouth transfer (i.e., those residues are swallowed when toddlers get pesticide residues on their hands from touching a treated indoor surfaces and then put their hands in their mouth);

- ***Dose from dermal exposure to impregnated clothing:*** Postapplication dermal dose calculations for toddlers, youths, and adults from wearing pesticide impregnated clothing; and

- ***Dose from object-to-mouth activity on impregnated clothing:*** Postapplication dose calculations for toddlers from incidental nondietary ingestion of pesticide residues on impregnated clothing from object-to-mouth transfer (i.e., those residues that swallowed when toddlers put treated clothing in their mouths.)

The detailed residential postapplication calculations are presented in Appendix D of this document.

3.2.2 Data and Assumptions for Residential Postapplication Exposure Scenarios

A series of assumptions and exposure factors served as the basis for completing the residential postapplication risk assessments. The assumptions and factors used in the risk calculations are consistent with current HED policy for completing residential exposure assessments (i.e., *SOPs For Residential Exposure Assessment*). The values used in this assessment include:

- There are many factors that are common to the occupational and residential postapplication risk assessments, such as body weights for adults, analysis of residue dissipation data, and transfer coefficients used for the garden exposure scenarios. Please refer to the assumptions and factors in Section 2.1.1 for further information concerning these common values.

- Exposure frequencies used in cancer risk assessments for adults are the same as those used for residential handlers (1 time per year). HED believes that individuals may reenter treated home gardens and lawns more than one time per year. However, exact information linking the timing of applications and the frequency of reentry is not available. To refine these results, HED has also calculated the number of exposure-days allowed per year to achieve a $1x10^{-6}$ cancer risk level of concern.

- HED combines risks resulting from exposures to individual chemicals when it is likely they can occur simultaneously based on the use pattern and the behavior associated with the exposed population. Within a residential assessment, this can take two forms. The first approach is to add together risks for individual exposure scenarios from all likely sources of exposure such as after an application to turf or use on a pet. For permethrin, HED has combined risks (i.e., MOEs) for different kinds of exposures for the turf scenarios (i.e., dermal, hand-to-mouth, object-to-mouth, and soil ingestion), pet scenarios (i.e., dermal and hand-to-mouth), and impregnated clothing scenarios (i.e., dermal and object-to-mouth). These represent the standard set of exposures that are typically combined when chemicals are used on turf, on pets and in impregnated clothing, because it is logical they can co-occur.

- Exposures to adults and children on treated turf have been addressed using the latest HED standard operating procedures for this scenario including:
  - the TTR at day zero from the permethrin-specific turf transferable residue study (MRID # 449555-01) was used in each scenario;
  - 5 percent of the application rate has been used to calculate the day-zero residue levels used for assessing risks from hand-to-mouth behaviors;
  - 20 percent of the application rate has been used to calculate the day-zero residue levels used for assessing risks from object-to-mouth behaviors (a higher percent transfer has been used for object-to-mouth behaviors, because it involves a teething action believed to be more analogous to DFR/leaf wash sample collection

where 20 percent is also used);
- the measured TTR levels quantified in MRID 451143-01 have been used to complete the dermal exposure calculations as the day-zero transferability was less than 1 percent of the application rate for the short-term data sources (studies where transferability is less than 1 percent are not used for risk assessment purposes, because the transfer coefficients used by HED for defining exposures are based on Jazzercize studies in which TTR values were measured by techniques where transferability is generally in the 1 to 5 percent range other than the ORETF roller method where transferability tends to be lower);
- the transfer coefficients used are those presented at the 1999 Agency presentation before the FIFRA Science Advisory Panel that have been adopted in routine practice by HED;
- 3 year old toddlers are expected to weigh 15 kg (average of 1 to 6 year olds);
- hand-to-mouth exposures are based on a frequency of 20 events/hour and a surface area per event of 20 cm^2 representing the palmar surfaces of three fingers;
- saliva extraction efficiency is 50 percent meaning that every time the hand goes in the mouth approximately ½ of the residues on the hand are removed;
- object-to-mouth exposures are based on a 25 cm^2 surface area;
- exposure durations are expected to be 2 hours based on information in HED's *Exposure Factors Handbook*;
- soil residues are contained in the top centimeter and soil density is 0.67 mL/gram; and
- dermal, hand- and object-to-mouth, and soil ingestion are combined to represent an overall risk from exposure to turf while granular ingestion is considered to be a much more episodic behavior and is considered separately by HED.

- Exposures to children and adults working in home gardens have been addressed using the latest HED approaches for this scenario including:
  - youth-aged children are considered along with adults;
  - 12 year old youth are expected to weigh 39.1 kg;
  - exposure durations are expected to be 40 minutes for adults and 20 minutes for the children;
  - transfer coefficients for youth were calculated by adjusting the appropriate adult transfer coefficients by a 50% factor as specified the *SOPs For Residential Exposure Assessment*;
  - the updated transfer coefficients specified in HED's *Science Advisory Council For Exposure Policy 003.1 (Aug. 2000): Agricultural Transfer Coefficients* have been used rather than those currently specified in the SOPs, because they represent more refined estimates of exposure for the fruiting vegetable and deciduous tree crop groups;
  - the combination of adjusting transfer coefficients for youth-aged children and using appropriate body weights for the age group results in dose levels that are slightly lower than that of adults in the same activity (the transfer coefficient

reduction and body weight reduction is essentially a 1:1 ratio); and
- the DFR data used for the assessments are the same as those used in the occupational risk assessment for the selected crop groups.

- Exposures to children after contact with treated pets have been addressed using the latest HED approaches for this scenario including:
  - only toddlers are considered because they are thought to be the highest exposed population (i.e., they are considered the sentinel population by HED);
  - a equilibrium approach based on a single child "hug" of the treated animal is used to assess dermal exposure as described in the 1999 Agency SAP Overview document (i.e., the skin loads after a single contact with the treated animal and additional contacts don't proportionally add exposures), the surface area of the dermal hug is based on a toddler skin surface area and typical clothing;
  - residue dissipation is 5 percent per day for the shampoo and dust products (based on data from J. Chambers at Mississippi State University on other pet use products);
  - HED default for transferability of residues from fur is 20 percent; and
  - risks are based on an even loading of residues across the entire surface of a 30 lb dog (chosen as a representative animal), the animal surface area was calculated using (12.3 * Body Weight (g) $^{0.65}$) from HED's 1993 Wildlife Exposure Factors Handbook (i.e., dog surface area of 5986 cm^2).

- Exposures to adults and children after contact with impregnated clothing have been addressed using the latest Antimicrobial Division (AD) approaches for this scenario including:
  - adults, toddlers, and youths are all considered;
  - dermal exposures are based on the clothing contact surface area of adults, youths, and toddlers exposed to permethrin impregnated clothing (1.5, 0.86, and 0.46 m^2, respectively);
  - the permethrin migration factor (from fabric to skin) was 0.49% per day (Snodgrass, 1992);
  - object-to-mouth exposures are based on a 25 cm^2 surface area; and
  - dermal and object-to-mouth are combined to represent an overall risk from exposure to permethrin impregnated clothing.

- Inhalation exposures to children and adults during truck-mounted mosquito fogger treatments have been addressed using the latest HED approaches for this scenario including:
  - both toddlers and adults are considered;
  - exposure durations are expected to be 20 minutes;
  - an airborne concentration dilution factor of 1 to 100 (i.e., 1%) of the product released is available for inhalation exposure; and
  - NAFTA breathing rate values were utilized (adult breathing rate for light activity

is 1.0 m^3/hour and toddler breathing rate for light activity is 0.8 m^3/hour).

- Postapplication residential risks are based on maximum application rates or values specified in the *SOPs For Residential Exposure Assessment.*

- The Jazzercize approach is the basis for the dermal transfer coefficients as described in HED's Series 875 guidelines, *SOPs For Residential Exposure Assessment*, and the 1999 FIFRA SAP Overview document.

3.2.3 Residential Postapplication Exposure and Noncancer Risk Estimates

Noncancer risks were calculated using the Margin of Exposure (MOE) approach, which is a ratio of the body burden to the toxicological endpoint of concern. Exposures were calculated by considering the potential sources of exposure (i.e., DFRs on garden plants, TTRs on lawns, and transferable residues on treated pets and impregnated clothing), then calculating dermal and nondietary ingestion exposures. Inhalation exposures were calculated following truck-mounted mosquito fogger treatments. The major difference with residential risk assessments is that the uncertainty factor which defines the level of risk concern also has to consider application of the additional FQPA safety factor. In the case of permethrin, the FQPA factor is 1X. Therefore, the overall uncertainty factor applied to permethrin for residential postapplication risk assessments is 100 which is based on the FQPA safety factor of 1X along with the 100 applied for inter-species extrapolation (10x) and intra-species sensitivity (10x).

Dermal exposures and risks from lawn and garden uses were calculated in the same manner as described above in Section 2.2.2. Dermal exposures from treated pets were calculated using a slightly different approach where a "hug" contact is expected to lead to an equilibrium concentration on the skin of the affected individual. Along with calculating these dermal exposures, other aspects of the turf, and treated pet exposure scenarios involved calculating dose from non-dietary ingestion. Dermal and incidental oral exposures from impregnated clothing were based on the approach used by the Antimicrobial Division (AD) in their risk assessments. The algorithms used for each type of calculation which have not been previously addressed in Section 2.2.3 are presented below.

Nondietary Ingestion Exposure From Treated Turf: Nondietary ingestion exposure from treated turf were calculated using the following equations. These values were then used to calculate MOEs.

Dermal Exposure from Treated Lawns (adult and toddler)

The approach used to calculate the dermal exposures that are attributable to exposure from contacting treated lawns is:

$$\mathbf{ADD = (TTR_0 * ET * TC * DA * CF1) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
TTR_t	=	turf transferable residue on day "0" (μg/cm^2);
ET	=	exposure time (2 hr/day);
TC	=	transfer coefficient (14,500 cm^2/hr for adults and 5,200 cm^2/hr for toddlers);
DA	=	dermal absorption factor (30%);
CF1	=	weight unit conversion factor to convert μg units to mg for the daily exposure (0.001 mg/μg); and
BW	=	body weight (70 kg for adults and 15 kg for toddlers).

Hand-to-mouth Transfer of Pesticide Residues on Lawns (toddler)

The approach used to calculate the nondietary ingestion exposures that are attributable to hand-to-mouth behavior on treated turf is:

$$\mathbf{ADD = (TTR_0 * SA * FQ * ET * SE * CF1) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
TTR_t	=	turf transferable residue on day "0" (μg/cm^2);
SA	=	surface area of the hands (20 cm^2/event);
FQ	=	frequency of hand-to-mouth activity (20 events/hr);
ET	=	exposure time (2 hr/day);
SE	=	extraction by saliva (50%);
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg); and
BW	=	body weight (15 kg).

Object-to-mouth Transfer of Pesticide Residues on Lawns (toddler)

The approach used to calculate exposures that are attributable to object-to-mouth behavior on treated turf that is represented by a child mouthing on a handful of turf is:

$$\mathbf{ADD = (TTR_0 * IgR * CF1) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
TTR_t	=	turf transferable residue on day "0" (μg/cm^2);
IgR	=	ingestion rate of grass (25 cm^2/day);
CF1	=	weight unit conversion factor to convert the μg of residues on the grass to mg to provide units of mg/day (1E-3 mg/μg); and
BW	=	body weight (15 kg).

Incidental Ingestion of Soil from Pesticide-Treated Residential Areas (toddler)

The approach used to calculate exposures that are attributable to soil ingestion is:

$$\mathbf{ADD = (SR_0 * IgR * CF1) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
SR_{0t}	=	soil residue on day "0" (0.0022 µg/g);
IgR	=	ingestion rate of soil (100 mg/day);
CF1	=	weight unit conversion factor to convert the µg of residues on the soil to grams to provide units of mg/day (1E-6 g/µg); and
BW	=	body weight (15 kg).

and

$$\mathbf{SR_t = TTR_t * F * CF2}$$

Where:

TTR_t	=	turf transferable residue on day "0" (µg/cm^2);
F	=	fraction of ai available in uppermost cm of soil (1 fraction/cm); and
CF2	=	volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (U.S. EPA, 1992) (0.67 cm^3/g soil).

Incidental Ingestion of Granules from Pesticide-Treated Residential Areas (toddler)

The approach used to calculate exposures that are attributable to granule ingestion is:

$$\mathbf{ADD = (IgR * F * CF1)/BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
IgR	=	ingestion rate of soil (0.3 g/day);
F	=	fraction of ai in dry formulation (unitless);
CF1	=	weight unit conversion factor to convert the g units in the ingestion rate value to mg for the daily exposure (1000 mg/g); and
BW	=	body weight (15 kg).

Dermal Exposure from Treated Gardens (adult and youth)

The approach used to calculate the dermal exposures that are attributable to exposure from contacting treated gardens is:

$$\mathbf{ADD = (DFR_0 * ET * TC * CF1) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
DFR_t	=	dislodgeable foliar residue on day "0" (µg/cm^2);
ET	=	exposure time (0.67 hr/day for adults and 0.33 hr/day for youths);
TC	=	transfer coefficient (1,500 cm^2/hr for adults and 750 cm^2/hr for toddlers);
CF1	=	weight unit conversion factor to convert µg units to mg for the daily exposure (0.001 mg/µg)
BW	=	body weight (70 kg for adults and 39 kg for youths).

Dermal Exposure From Treated Pets:

The approach used to calculate dermal exposure from contacting treated pets is:

$$\mathbf{D = \{((AR*F_{AR})/SA_{pet}) * (1\text{-}DR)^t * SA_{hug} * DA\}/BW}$$

Where:

ADD	=	average daily dose via dermal pet contact (mg/kg/day);
AR	=	application rate or amount applied to animal in a single treatment (mg ai/animal);
F_{AR}	=	fraction of the application rate available for dermal contact as transferable residue (20%);
SA_{pet}	=	surface area of a treated 30 lb dog (5,986cm^2/animal);
t	=	time after application (days);
DR	=	fractional dissipation rate per day (5% per day);
SA_{hug}	=	surface area of a child hug (1,875cm^2 contact/hug);
DA	=	dermal absorption factor (30%); and
BW	=	body weight (15 kg).

Hand-to-mouth Transfer of Pesticide Residues From Treated Pets:

The approach used to calculate nondietary exposure that are attributable to hand-to-mouth behavior on pets is:

$$\mathbf{D = \{((AR*F_{AR})/SA_{pet}) * (1\text{-}DR)^t * SE *SA_{hands} * FQ * ET * DA\}/BW}$$

where:

D	=	nondietary ingestion dose from with treated pets (mg/day);
AR	=	application rate or amount applied to animal in a single treatment (mg ai/animal);
F_{AR}	=	fraction of the application rate available for dermal contact as transferable residue (20%/100);
SA_{pet}	=	surface area of a treated dog (5,986 cm^2/animal);
t	=	time after application (days);
DR	=	fractional dissipation rate per day (5% per day/100);
SE	=	saliva extraction factor (50% extractability);
SA_{hands}	=	surface area of the hands (20 cm^2);
FQ	=	frequency of hand-to-mouth activity (20 events/hr);
ET	=	exposure time (2 hr/day);
DA	=	dermal absorption factor (30%); and
BW	=	body weight (15 kg).

Dermal Exposure from Indoor Surfaces (adult and toddler)

The approach used to calculate the dermal exposures that are attributable to exposure from contacting indoor surfaces is:

$$\mathbf{ADD = (AR * TR * ET * TC * CF1 * CF2) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
AR	=	application rate;

TR	=	transferable residue available (4.4% for carpets/1.3% for vinyl flooring, calculated from NDETF studies);
ET	=	exposure time (8 hr/day for carpets and 4 hr/day for vinyl flooring);
TC	=	transfer coefficient (16,700 cm^2/hr for adults and 6,000 cm^2/hr for toddlers);
CF1	=	weight unit conversion factor to convert lb units to mg for the daily exposure (4.54E5 mg/lb)
CF2	=	area unit conversion factor to convert ft^2 units to cm^2 for the daily exposure (1.08E-3 ft^2/cm^2) mg/μg); and
BW	=	body weight (70 kg for adults and 15 kg for toddlers).

Hand-to-mouth Transfer of Pesticide Residues on Indoor Surfaces (toddler)

The approach used to calculate the nondietary exposures that are attributable to hand-to-mouth behavior on indoor surfaces is:

$$\mathbf{ADD = (AR * \%D * SA * FQ * ET * SE * CF1 * CF2) / BW}$$

Where:

ADD	=	average daily dose (mg/kg/day);
AR	=	application rate;
%D	=	percent active ingredient dislodgeable (13% for carpets/6.6% for vinyl flooring, calculated from NDETF studies);
SA	=	surface area of the hands (20 cm^2/event);
FQ	=	frequency of hand-to-mouth activity (20 events/hr);
ET	=	exposure time (2 hr/day);
SE	=	extraction by saliva (50%);
CF1	=	weight unit conversion factor to convert lb units to mg for the daily exposure (4.54E5 mg/lb)
CF2	=	area unit conversion factor to convert ft^2 units to cm^2 for the daily exposure (1.08E-3 ft^2/cm^2); and
BW	=	body weight (15 kg).

Dermal Exposure from Impregnated Clothing (adult, youth, and toddler)

The approach used to calculate the dermal exposures that are attributable to exposure from wearing impregnated clothing is:

$$\mathbf{PDR = (CR * CF1 * SA * TF) / BW}$$

Where:

PDR	=	potential dose rate (mg ai/kg/day);
CR	=	clothing residue concentration (mg ai/cm^2), assumed to be equivalent to the application rate on a mass per area basis (0.125 mg ai/cm^2);
CF1	=	conversion factor to convert m^2 to cm^2 (10,000 cm^2/m^2);
SA	=	surface area of the portion of the body that will touch the clothing (cm^2/day);
TF	=	transfer factor (unitless); and
BW	=	body weight (kg).

Object-to-mouth Transfer of Pesticide Residues on Impregnated Clothing (toddler)

The approach used to calculate exposures that are attributable to object-to-mouth behavior on impregnated clothing that is represented by a child mouthing on impregnated clothing is:

$$\mathbf{PDR = (CR * SAC * TF) / BW}$$

Where:

PDR	=	potential dose rate (mg ai/kg/day);
CR	=	clothing residue concentration (mg ai/cm^2), assumed to be equivalent to the application rate on a mass per area basis (0.125 mg ai/cm^2);
SAC	=	surface area of cloth mouthed (25 cm^2/day);
TF	=	transfer factor (unitless); and
BW	=	body weight (15 kg).

Mosquito Control Applications:

Postapplication exposures from mosquito control and other wide-area pesticide uses (e.g., black fly treatments) have been previously addressed using a methodology that involves defining how much material is deposited on the ground in impacted areas and then using the same methodology that is used for a residential lawn risk assessment. However, in the case of permethrin, the turf application rate is significantly higher than the mosquito application rate (0.87 lb ai/acre versus 0.1 lb ai/acre) and thus HED believes that it is not necessary to separately analyze the postapplication dermal and incidental oral exposure risks resulting from mosquito applications.

Inhalation exposure usually does not factor significantly into postapplication risk. However, due to the use of permethrin in truck-mounted ULV fogger applications to control mosquitos, a risk assessment has been developed for residential postapplication inhalation exposure from truck-mounted ULV fogger applications. The approach is based on the one described in the SOPs for inhalation exposure to outdoor residential short-term pest control.

$$\mathbf{ADD = (AC * BR * DF * ET)/BW}$$

Where:

ADD	=	average daily dose (mg/kg/day)
AC	=	airborne concentration of pesticide (lbs ai/ft^3)
BR	=	breathing rate (adults = 1.0 m^3/hour and toddler = 0.8 m^3/hour);
DF	=	dilution factor (0.01);
ET	=	exposure time (0.33 hr/day); and
BW	=	body weight (15 kg).

3.2.4 Residential Postapplication Noncancer Risk Summary

All of the noncancer risk calculations for the various residential permethrin assessments are included in Appendix D.

HED has addressed residential postapplication exposures to permethrin using the standard set of scenarios that are prescribed in current guidance. There are many issues associated with the development of these scenarios and, in general, residential exposure methods. Readers should refer to the guidance documents that are presented above for further information concerning the development of scenarios for residential exposure assessment purposes. The uncertainty factors are similar to those applied to the residential handler assessments described above (i.e., 100 for short- and intermediate-term exposures).

Adult short-term postapplication risks from high contact activities following indoor sprays to carpet exceed HED's level of concern (i.e., the MOE is less than 100) on the day of application. For all other scenarios, short-term MOEs do not exceed HED's level of concern (MOEs > 100) on the day of application. Table 25 presents the postapplication MOEs for adults after lawn and home garden applications of permethrin.

Table 25: Adult Residential Risk Estimates for Postapplication Exposure to Permethrin

Exposure Scenario	Route of Exposure	Application Rate[a]	MOE at Day 0
Outdoors			
Residential Turf (High Contact Activities)	Dermal	0.87 lb ai/acre	3,300
Residential Turf (Mowing)	Dermal	0.87 lb ai/acre	96,000
Home Garden (Fruit and Nut Tree)	Dermal	0.4 lb ai/acre	1,000
Home Garden (Vegetables)	Dermal	0.23 lb ai/acre	3,500
Mosquitos (ULV Truck Fogger)	Inhalation	0.1 lb ai/acre	6,300
Indoors			
Indoor Surfaces (High Contact Activities) - Spray (Carpet)	Dermal	0.0001 lb ai/sq ft	20
Indoor Surfaces (High Contact Activities) - Spray (Vinyl)	Dermal	0.0001 lb ai/sq ft	130
Indoor Surfaces (High Contact Activities) - Fogger (Carpet)	Dermal	0.0023 lb ai/6 oz fogger	230
Indoor Surfaces (High Contact Activities) - Fogger (Vinyl)	Dermal	0.0023 lb ai/6 oz fogger	1,100
Clothing			
Impregnated Clothing	Dermal	0.125 mg ai/cm^2	640

Youth-aged children (10 to 12 years old) short-term postapplication risks are below HED's level of concern (i.e., the MOEs are greater than 100) for all scenarios. Table 26 below summarizes the postapplication MOEs for youth home garden applications of permethrin.

Table 26: Youth Residential Risk Estimates for Postapplication Exposure to Permethrin

Exposure Scenario	Route of Exposure	Application Rate	MOE at Day 0
Outdoors			
Home Garden (Fruit and Nut Tree)	Dermal	0.4 lb ai/acre	2,300
Home Garden (Vegetables)	Dermal	0.23 lb ai/acre	7,900

Clothing			
Impregnated Clothing	Dermal	0.125 mg ai/cm^2	620

Toddler (3 year old) short-term postapplication risks were calculated following the lawncare, indoor, and pet uses of permethrin as well as for exposure to clothing impregnated with permethrin. Table 27 presents a summary of the MOE estimates for toddlers. Short-term MOEs from dermal and incidental oral exposures to treated turf (in products labeled for direct application to turf) and inhalation exposures to ULV truck fogger mosquito treatments are below HED's level of concern (i.e., the MOEs are greater than 100).

Ingestion of permethrin granules is also a potential source of exposure, because children can eat them if they are found in treated lawns or gardens. This scenario is considered an episodic scenario by HED (i.e., acute dietary endpoints are used). The concentration of permethrin in granular products is 0.5 percent. The acute MOE resulting from incidental ingestion of granules is below HED's level of concern (i.e., the MOE is greater than 100).

The assessments for indoor and pet uses considered dermal and nondietary ingestion exposures. Several of the short-term postapplication risks from dermal and incidental oral exposures to treated indoor surfaces and pets exceed HED's level of concern (i.e., the MOEs are less than 100).

The assessments for exposure to permethrin impregnated clothing considered dermal and nondietary ingestion exposures. The short-term risks for postapplication risks from exposure to permethrin impregnated clothing are below HED's level of concern (i.e., the MOEs are greater than 100).

Table 27: Toddler Residential Risk Estimates for Postapplication Exposure to Permethrin

Exposure Scenario	Route of Exposure	Application Rate	MOE at Day 0
Outdoors			
Hand to Mouth Activity on Turf	Oral	0.87 lb ai/acre	15,000
Object to Mouth Activity on Turf	Oral	0.87 lb ai/acre	250,000
Incidental Soil Ingestion	Oral	0.87 lb ai/acre	570,000
Incidental Ingestion of Granules	Oral	0.65 lb ai/acre	250
Residential Turf (High Contact Activities)	Dermal	0.87 lb ai/acre	2,000
Mosquitos (ULV Truck Fogger)	Inhalation	0.1 lb ai/acre	1700
Indoors			
Hand to Mouth Activity on Indoor Surfaces (Carpet)	Oral	0.0001 lb ai/sq ft	68
Hand to Mouth Activity on Indoor Surfaces (Vinyl)	Oral	0.0001 lb ai/sq ft	270
Indoor Surfaces (High Contact Activities) - Spray (Carpet)	Dermal	0.0001 lb ai/sq ft	12
Indoor Surfaces (High Contact Activities) - Spray (Vinyl)	Dermal	0.0001 lb ai/sq ft	79

Indoor Surfaces (High Contact Activities) - Fogger (Carpet)	Dermal	0.0023 lb ai/6 oz fogger	130
Indoor Surfaces (High Contact Activities) - Fogger (Vinyl)	Dermal	0.0023 lb ai/6 oz fogger	680
Pets			
Hand to Mouth Activity on Pets - Dusts	Oral	0.00016 lb ai/animal	1,300
Hand to Mouth Activity on Pets - Liquid	Oral	0.0014 lb ai/animal	150
Pet Contact Activities - Dusts	Dermal	0.00016 lb ai/animal	270
Pet Contact Activities - Liquid	Dermal	0.0014 lb ai/animal	31
Clothing			
Impregnated Clothing	Dermal	0.125 mg ai/cm^2	440
Object to Mouth Activity on Impregnated Clothing	Oral	0.125 mg ai/cm^2	24,000

Combined Risk Assessment for Residential Scenarios

HED combines risk values resulting from separate postapplication exposure scenarios when it is likely they can occur simultaneously based on the use-pattern and the behavior associated with the exposed population. Table 28 presents a summary of the combined MOE estimates.

The combined risk assessment was calculated as follows:

$$\text{Combined MOE} = \text{NOAEL}/(\text{ADD}_{\text{hand-to-mouth}} + \text{ADD}_{\text{object-to-mouth}} + \text{ADD}_{\text{incidental soil ingestion}})$$

The combined risks for the turf spray scenario, the pet-dust scenario, and the impregnated clothing scenario are 1700, 160, and 430, respectively and are below HED's level of concern. The combined risks exceed HED's level of concern for the pet-shampoo scenario (MOE = 18).

Table 28: Permethrin Residential Scenarios for Combined Risk Estimates

Postapplication Exposure Scenario			Margins of Exposure (MOEs) (UF=100)	
			Short-Term Oral (Non-Dietary)	Total Non-Dietary Risk
Toddler	Turf - sprays (0.87 lb ai/acre)	Dermal	2,000	1,700
		Hand to Mouth	15,000	
		Object to Mouth	250,000	
		Incidental Soil Ingestion	570,000	
Toddler	Pet - shampoo	Hand to Mouth	150	26
		Dermal	31	
Toddler	Pet - dusts	Hand to Mouth	1,300	220
		Dermal	270	
Toddler	Impregnated Clothing	Object to Mouth	24,000	430
		Dermal	440	

3.2.5 Residential Postapplication Exposure and Risk Estimates for Cancer

Residential cancer risks were calculated using a linear low-dose extrapolation approach in which a *Lifetime Average Daily Dose* (LADD) is first calculated and then multiplied by a Q_1* that has

been calculated for permethrin based on dose response data in the appropriate toxicology study ($Q_1^* = 9.576 \times 10^{-3}$ (mg/kg/day)$^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADDs. Section 2.1.3 describes how the ADD values were first calculated for the noncancer MOEs. These values also serve as the basis for the cancer risk estimates. LADDs were estimated and multiplied by the Q_1^* to obtain cancer risk estimates.

LADD and Cancer Risk Estimations: The use of dissipation data and the manner in which daily postapplication dermal exposures were calculated are different for postapplication exposures versus handler exposures. However, once daily exposures were determined, the calculation of LADD (Lifetime Average Daily Dose) and the resulting cancer risk estimates use the same algorithms that were described for the handler exposures (See Section 2.1.4).

HED has defined a range of cancer risks based on a policy issued in 1996. This memo refers to a predetermined quantified "level of concern" for residential carcinogenic risk. Residential carcinogenic risks that are 1×10^{-6} or lower require no risk management action. In addition to the postapplication cancer risk estimates for an annual frequency of one exposure per year, the number of days of exposure per year required to get reach a 1×10^{-6} cancer risk have been calculated.

3.2.6 Residential Postapplication Cancer Risk Summary

The postapplication cancer risk estimates indicate that:

- for all scenarios on turf, home gardening, and mosquitos, cancer risk estimates are in the 10^{-7} to 10^{-8} range or less when a single reentry event per year is evaluated and entry on the day of the application (i.e., day 0) is assumed.

- for all indoor scenarios, estimated risks are in the 10^{-5} to 10^{-6} range and exceed HED's level of concern when a single reentry event per year is evaluated and entry on the day of application (i.e., day 0) is assumed.

- for the pet scenarios, estimated risks are below HED's level of concern for postapplication dermal exposure to pets after dust applications when a single exposure event per year is evaluated and exposure on the day of application (i.e., day 0) is assumed. However, estimated risks are above HED's level of concern for postapplication dermal exposure to pets after spray applications when a single exposure event per year is evaluated and exposure on the day of application (i.e., day 0) is assumed.

- for the impregnated clothing scenarios, estimated cancer risks (in the 10^{-7} range) are below HED's level of concern when a single exposure event per year is evaluated. HED believes that individuals will wear permethrin impregnated clothing more than one time a year. If multiple exposure events per year are considered, then estimated cancer risks exceed HED's level of concern.

Table 29 below summarizes the postapplication risk estimates calculated for adults after applications of permethrin. It should be noted that these estimates represent one day of postapplication exposure per year and exposure on the day of application (i.e., day 0) for each year of a 50-year exposure period. HED lacks data to further refine postapplication cancer assessments in residential settings.

HED calculated the number of exposure-days (assuming exposure on the day of application (i.e., day 0) needed to reach a risk level of $1x10^{-6}$ for each scenario. The results indicate that the number of exposure-days range from 0 to 205 days per year, depending on the residential postapplication scenario.

Table 29: Summary of Permethrin Postapplication Residential Cancer Risks For Adults

Exposure Scenario	Route of Exposure	Application Rate	Cancer Risk at Day 0	Allowed Days/Year
Outdoors				
Residential Turf (High Contact Activities)	Dermal	0.87 lb ai/acre	1.4×10^{-7}	7
Residential Turf (Mowing)	Dermal	0.87 lb ai/acre	4.9×10^{-9}	205
Home Garden (Fruit and Nut Tree)	Dermal	0.4 lb ai/acre	3.6×10^{-8}	28
Home Garden (Vegetables)	Dermal	0.23 lb ai/acre	2.1×10^{-8}	48
Mosquitos (ULV Truck Fogger)	Dermal/ Inhalation	0.1 lb ai/acre	3.9×10^{-8}	25
Indoors				
Indoor Surfaces (High Contact Activities) - Spray	Dermal	0.0001 lb ai/sq ft	2.6×10^{-5}	0
Indoor Surfaces (High Contact Activities) - Fogger	Dermal	0.0023 lb ai/6 oz fogger	2.4×10^{-6}	0
Pets				
Pet Contact Activities - Dust	Dermal	0.00016 lb ai/animal	3.7×10^{-7}	2
Pet Contact Activities - Liquid	Dermal	0.0014 lb ai/animal	3.2×10^{-6}	0
Clothing				
Impregnated Clothing	Dermal	0.125 mg ai/cm^2	7.4×10^{-7}	1

3.2.7 Summary of Residential Postapplication Risk Concerns and Data Gaps

HED considered a number of exposure scenarios for products that can be used in the residential environment representing different segments of the population including toddlers, youth-aged children, and adults. Short-term noncancer MOEs were calculated for all scenarios. Additionally, cancer risk estimates were calculated for the exposure scenarios involving adults where methods are currently available. Cancer risks were not estimated for children per HED policy. In residential settings, HED does not use restricted-entry intervals or other mitigation approaches to limit postapplication exposures because they are viewed as impractical and not enforceable. As such, risk estimates on the day of application are the key concern.

Risks exceed HED's level of concern (i.e., the MOEs are less than 100) for exposures to adults contacting indoor surfaces, for hand to mouth and dermal postapplication exposures to toddlers from indoor pesticide treatments, and for toddlers that have contact with pets treated with dust or liquid products. Toddler risks from pet and turf uses and while wearing impregnated clothing represent total exposures from many pathways. For the pet uses, and wearing impregnated clothing, dermal and hand-to-mouth exposures essentially both equally contribute to the overall estimate. For the turf uses, dermal and hand-to-mouth exposures are also the key contributors to the overall estimates. When wearing impregnated clothing, dermal exposures are the key pathway.

Cancer postapplication risks were estimated for adults and most were found to be in the 10^{-7} to 10^{-9} range on the day of application (e.g., lawncare, golfing and gardening). Risks exceed HED's level of concern (1×10^{-6}) on the day of application for all indoor scenarios and the pet contact scenario (after a liquid spray). All postapplication cancer risks (except for the impregnated clothing scenario) were estimated based on an annual frequency of 1 exposure-day per year (assuming exposure on the day of application (i.e., day 0). It is likely that additional events could occur, but data linking postapplication activities and permethrin use patterns are not available. To address this issue, HED calculated the number of daily exposures that can occur and still remain below HED's risk level of concern of 1×10^{-6} and determined that from 0 exposure-days per year to 205 exposure-days per year could occur depending upon the scenario.

HED combines risks resulting from different routes of exposures to individuals when it is likely they can occur simultaneously based on the use pattern and the behavior associated with the exposed population. For permethrin, HED has combined risk values (i.e., MOEs) for different routes of exposures associated with the turf (dermal, hand-to-mouth, object-to-mouth, and soil ingestion), pet scenarios (dermal and hand-to-mouth), and impregnated clothing scenarios (dermal and object-to-mouth). These are typically added together when pesticides are used on turf or on pets, because it is logical they can co-occur. All of these combined risks are below HED's level of concern (i.e., the MOEs are greater than 100), except for the pet-spray combined risk (MOE = 26), which exceeds HED's level of concern.

In summary, the assessment for residential exposure presented in this section concludes that there are a number of risk concerns for permethrin as it is currently used in a residential environment.

3.2.8 Recommendations For Refining Residential Postapplication Risk Assessment

In order to refine this residential assessment, data on actual use patterns including rates, timing, and the kinds of tasks that are required to better characterize permethrin risks.

Appendix A: Occupational Handler Exposures

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
		Mixer/Loader Descriptors	
Mixing/Loading Liquid Formulations (1a through 1e)	PHED V1.1	**Aerial:** 1,200 acres for high acreage agricultural crops, 100 acres for conifer forests, 60 acres for field grown roses, and 350 acres for all other crops; **Groundboom:** 200 acres for high acreage agricultural crops, 40 acres for field grown roses, and 80 acres for all other crops; **Airblast:** 40 acres for agricultural crops **Truck ULV:** 3000 acres **Dip:** 400 animals for agricultural animals, and 10 gallons for dogs	**Baseline:** Dermal, hand, and inhalation = acceptable grades. Hands = 53 replicates; Dermal = 72 to 122 replicates; and Inhalation = 85 replicates. High confidence in hand, dermal, and inhalation data. No protection factor was needed to define the unit exposures. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = acceptable grades. Hands = 59 replicates. High confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Hands, dermal, and inhalation = acceptable grades. Hands = 31 replicates; Dermal = 16 to 22 replicates; and Inhalation = 27 replicates. High confidence in hand, dermal, and inhalation data. **Gloves were used coupled with engineering controls since empirical data without gloves were not available and back calculation of gloves to a no glove scenario is believed to give erroneously high estimates.**
Mixing/Loading Wettable Powder Formulations (2a through 2e)	PHED V1.1	**Aerial:** 1,200 acres for high acreage agricultural crops, 100 acres for conifer forests, 60 acres for field grown roses, and 350 acres for all other crops; **Groundboom:** 200 acres for high acreage agricultural crops, 40 acres for field grown roses, and 80 acres for all other crops; **Airblast:** 40 acres for agricultural crops	**Baseline:** Dermal, hand, and inhalation = ABC grades. Hands = 7 replicates; Dermal = 22 to 45 replicates, and Inhalation = 44 replicates. Low confidence in the dermal/hands data due to the low number of hand replicates. Medium confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** Hands = ABC grades. Hands = 24 replicates. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = ABC grades. Hands = 24 replicates. Medium confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls**: Dermal and hands = AB grades. Inhalation = all grades. Dermal = 6 to 15 replicates; Hands = 9 replicates; and Inhalation = 15 replicates. Low confidence in hand, dermal, and inhalation data. **Gloves were used coupled with engineering controls since empirical data without gloves were not available and back calculation of gloves to a no glove scenario is believed to give erroneously high estimates.**
Loading Granular Formulations (3a through 3b)	PHED V1.1	**Aerial:** 1,200 acres for high acreage agricultural crops, 350 acres for all other crops; **Tractor Drawn Spreader:** 200 acres for high acreage agricultural crops, 80 acres for all other crops	**Baseline:** Dermal = ABC grades; Hand = all grades; and Inhalation = AB grades. Dermal = 25 to 59 replicates; Hands = 10 replicates; and Inhalation = 58 replicates. Low confidence in the dermal/hands data due to the poor replicate quality of the hand replicates and low replicate number. High confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** Dermal = ABC grades and Hand = AB grades. Dermal = 33 to 78 replicates and Hands = 45 replicates. Medium confidence in the dermal/hands data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls**: The same data are used as for baseline coupled with a 98% protection factor to account for the use of an engineering control (e.g., closed mixing/loading system)).
		Applying Descriptors	
Applying Sprays via Fixed-wing Aircraft (4)	PHED V1.1	1,200 acres for high acreage agricultural crops, 100 acres for conifer forests, 60 acres for field grown roses, and 350 acres for all other crops	**Engineering Controls:** Dermal and hands = AB grade and Inhalation = ABC grade. Dermal = 20 to 28 replicates; Hands = 34 replicates; and Inhalation = 23 replicates. High confidence in dermal and hand data. Medium confidence in inhalation data. No protection factor was needed to define the unit exposure value. **EPA has no data for this scenario, other than enclosed cockpits – the engineering control.**

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Applying Sprays via Groundboom Sprayer (5)	PHED V1.1	200 acres for high acreage agricultural crops, 40 acres for field grown roses, and 80 acres for all other crops	**Baseline**: Dermal, hand, and inhalation = AB grades. Dermal = 23 to 42 replicates; Hands =29 replicates; and Inhalation = 22 replicates. High confidence in hand, dermal, and inhalation data. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = ABC grades. Hands = 21 replicates. Medium confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls**: Dermal and Hands = ABC grade. Inhalation = AB grades. Dermal = 20 to 31 replicates; Hands = 16 replicates; and inhalation = 16 replicates. Medium confidence in the hand and dermal data. High confidence in inhalation data. No protection factor needed to define the unit exposure value. Protective gloves not used.
Applying Sprays via Airblast Sprayer (6)	PHED V1.1	40 acres for agricultural crops	**Baseline:** Dermal, hand, and inhalation = AB grades. Dermal = 32 to 49 replicates; Hands = 22 replicates; and Inhalation = 47 replicates. High confidence in all data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = AB grades. Hands = 18 replicates. High confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Dermal and hands = AB grade, and inhalation = ABC grade. Dermal = 20 to 30 replicates; Hands= 20 replicates; and inhalation = 9 replicates. High confidence in hand and dermal data. Low confidence for inhalation data due to low replicate number. **Gloves were used coupled with engineering controls since empirical data without gloves were not available and back calculation of gloves to a no glove scenario is believed to give erroneously high (130µg/lb ai) estimates for a closed cab scenarios.**
Applying Sprays via Truck Mounted ULV Sprayer (7)	PHED V1.1	3000 acres	PHED exposure data for applying sprays via airblast sprayers (scenario 4) was used as a surrogate for applying sprays via truck mounted ULV sprayer.
Applying Sprays via Dip (8)	No Data	400 animals for agricultural animals and 10 gallons for dogs	There is no PHED general or chemical specific data for this scenario.
Applying Granulars via Fixed-wing Aircraft (9)	PHED V1.1	1,200 acres for high acreage agricultural crops, and 350 acres for all other crops	**Engineering Controls:** Dermal = C grade and Hands and Inhalation = all grades. Dermal = 9 to 13 replicates; Hands = 4 replicates; and Inhalation = 13 replicates. Low confidence in dermal, hand, and inhalation data due to inadequate replicate number and poor grade quality. No protection factor was needed to define the unit exposure value. **EPA has no data for this scenario, other than enclosed cockpits – the engineering control.**

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Applying Granulars via Tractor Drawn Spreader (10)	PHED V1.1	200 acres for high acreage agricultural crops, and 80 acres for all other crops	**Baseline**: Dermal, hand, and inhalation = AB grades. Dermal = 1 to 5 replicates; Hands = 5 replicates; and Inhalation = 5 replicates. Low confidence in hand, dermal, and inhalation data due to low replicates. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Dermal = AB grades. Low confidence in dermal data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Gloved hand replicates are unavailable for this scenario. The only way to estimate gloved hand exposure is to reduce the "no glove" hand value by 90%.** **Engineering Controls**: Dermal, hands, and inhalation = AB grade. Dermal = 2 to 27 replicates; Hands = 24 replicates; and Inhalation = 37 replicates. Low confidence in the dermal data due to inadequate replicate number. High confidence in hand and inhalation data. No protection factor needed to define the unit exposure value. Protective gloves not used.
Applying Dusts via Mechanical Duster (11)	No Data	400 animals for all agricultural animals except poultry which was 100,000 animals	There is no PHED general or chemical specific data for this scenario.
Applying Dusts via Dust Bag (12)	No Data	400 animals for all agricultural animals except poultry which was 100,000 animals	There is no PHED general or chemical specific data for this scenario.
Flagging Descriptors			
Flagging for Aerial Spray Applications (13)	PHED V1.1	1,200 acres for high acreage agricultural crops, 800 acres for conifer forests, 60 acres for field grown roses, and 350 acres for all other crops	**Baseline:** Dermal, hands, and inhalation = AB grades. Dermal = 18 to 28 replicates; Hands = 30 replicates; and Inhalation = 28 replicates. High confidence in dermal, hand, and inhalation data. No protection factor was required to calculate unit exposures. **PPE**: The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hand = AB grades. Hands = 6 replicates. Low confidence in hand data due to the small number of replicates. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls**: The same data are used as for baseline coupled with a 98% protection factor to account for the use of an engineering control (e.g., sitting in a vehicle).
Flagging for Aerial Granular Applications (14)	PHED V1.1	1,200 acres for high acreage agricultural crops, 350 acres for all other crops	**Baseline:** Dermal, hands, and inhalation = AB grades. Dermal = 18 to 28 replicates; Hands = 30 replicates; and Inhalation = 28 replicates. High confidence in dermal, hand, and inhalation data. No protection factor was required to calculate unit exposures. **PPE**: The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hand = AB grades. Hands = 6 replicates. Low confidence in hand data due to the small number of replicates. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls**: The same data are used as for baseline coupled with a 98% protection factor to account for the use of an engineering control (e.g., sitting in a vehicle).

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Mixing/Loading/Applying Descriptors			
Mixing/Loading/Applying Emulsifiable Concentrates via Low Pressure Handwand (15)	PHED V1.1	8 acres for turf, 400 animals for all agricultural animals,1000 linear feet for termite soil treatments, 40 gallons for all other sites	**Baseline:** Hands = all grades; dermal and inhalation = ABC grades. Dermal = 9 to 80 replicates; Hands = 70 replicates; and Inhalation = 80 replicates. Medium confidence in inhalation data. Low confidence in dermal and hand data. No protection factor was needed to define the unit exposure values. **PPE**: The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hand = 10 replicates. Hands= ABC grades Low confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Mixing/Loading/Applying Emulsifiable Concentrates via Handgun Sprayer (ORETF data) (16)	ORETF Chemical Handler Exposure Studies	5 acres for turf and 40 gallons for all other crops	**Baseline:** Dermal data = B grade and 15 replicates. **The only empirical data available are based on the use of chemical-resistant gloves.** It is generally not appropriate to back-calculate a non-glove hand exposure. Inhalation = B grade and 15 replicates. Moderate to high confidence in inhalation data. **PPE:**. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Gloved hand = 15 replicates. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Mixing/Loading/Applying Emulsifiable Concentrates via High Pressure Handwand (17)	PHED V1.1	4,000 animals for poultry, and 1,000 gallons for all other crops	**Baseline:** Inhalation = A grades. Inhalation = 13 replicates. Low confidence in inhalation data. **The only empirical hand data available are based on the use of chemical-resistant gloves.** It is generally not appropriate to back-calculate a non-glove hand exposure levels. **PPE**: The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands= C grades. Hand = 13 replicates. Low confidence in hand data due to inadequate replicate number. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Mixing/Loading/Applying Emulsifiable Concentrate with an Injector (18)	PHED V1.1	2000 gallons	**Baseline:** Dermal and inhalation = AB grades. Dermal = 17 replicates and inhalation = 17 replicates. **The only empirical data that are available are based on the use of chemical-resistant gloves.** It is generally not appropriate to back-calculate a non-glove hand exposure levels. High confidence in inhalation data. Low confidence in dermal data. **PPE**: Dermal and Hands= AB grades, 17 replicates and high confidence. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Mixing/Loading/Applying Emulsifiable Concentrates via Foam Applicator Equipment (19)	ORETF Chemical Handler Exposure Studies	1,000 square feet for termite treatments	**Baseline:** Dermal, inhalation, and hands = A grade. Dermal, inhalation, and hands = 20 replicates each. High confidence in all data. **PPE:** There is only baseline dermal data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF hose-end sprayer data) (20)	ORETF Chemical Handler Exposure Studies	10 gallons	**Baseline: The only empirical data that are available are based on the use of no protective clothing.** Dermal and inhalation = 60 replicates.
Mixing/Loading/Applying Emulsifiable Concentrates via Backpack ULV Sprayer (21)	PHED V1.1	5 acres	PHED exposure data for mixing/loading/applying emulsifiable concentrates via backpack sprayers was used as a surrogate for mixing/loading/applying emulsifiable concentrates via backpack ULV sprayers.
Applying Emulsifiable Concentrates with a Paint Brush (22)	PHED V1.1	5 gallons	**Baseline:** Hands = AB grades. Dermal and inhalation = C grades. Low confidence in dermal and hand data. Hand = 15 replicates. Dermal =14 to 15 replicates and inhalation = 15 replicates. Medium confidence in inhalation data. **PPE:** Dermal = C grades. Low confidence in dermal data. The same hand data are used as for baseline coupled with a 90% protection factor to account for a gloves. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Mixing/Loading/Applying Wettable Powders via Low Pressure Handwand (23)	PHED V1.1	40 gallons	**Baseline:** Inhalation = ABC grades. Inhalation = 16 replicates. Medium confidence in inhalation data. Low confidence in dermal and hand data due to lack of "no glove" hand data. **The only empirical hand data available are based on the use of chemical-resistant gloves.** It is generally not appropriate to back-calculate a non-glove hand exposure levels. **PPE**: The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hand = 15 replicates. Hands= AB grades. Medium confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Mixing/Loading/Applying Wettable Powders via Handgun Sprayer (ORETF data) (24)	ORETF Chemical Handler Exposure Studies	40 gallons	**Baseline:** Dermal data = B grade and 15 replicates. **The only empirical data available are based on the use of chemical-resistant gloves.** It is generally not appropriate to back-calculate a non-glove hand exposure levels, an extrapolation has been completed for this scenario (90 percent protection factor), however, because the empirical data indicate that hands are a minor contributor to overall exposure levels. Inhalation = B grade and 15 replicates. Moderate to high confidence in inhalation data. **PPE:**. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Gloved hand = 15 replicates. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** See Water Soluble Bag Scenario
Mixing/Loading/Applying Wettable Powders via High Pressure Handwand (25)	PHED V1.1	1,000 gallons	There is no PHED general or chemical specific data for this scenario.
Mixing/Loading/Applying Water Soluble Bags via Handgun Sprayer (ORETF data) (26)	ORETF Chemical Handler Exposure Studies	40 gallons	**Baseline:** N/A **PPE:** N/A **Engineering Controls:** Dermal data = B grade and 15 replicates. Inhalation = B grade and 15 replicates. Moderate to high confidence in inhalation data.
Loading/applying dusts via shaker can (27)	MRID 444598-01	16 animals for dogs and cats, 400 animals for all agricultural animals except poultry which was 100,000 animals	**Baseline: The only empirical data that are available are based on the use of no protective clothing.** A total of 20 replicates were monitored in this study. No individuals wore gloves. The clothing scenario represents short-sleeved shirt, short pants, and no gloves. The data are considered high quality by the Agency.
Mixing/Loading/Applying Microencapsulated Liquids via Fogger/Mist Generator (28)	PHED V1.1	1,000 sq ft	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Liquid Formulations via Open Pour (29)	PHED V1.1	400 animals for all agricultural animals, 1 container for clothing treatment	PHED exposure data for mixing/loading emulsifiable concentrates (scenario 1) was used as a surrogate for applying ready to use liquid formulations via open pour.
Applying Ready to Use Formulations via RTU Tag (30)	No Data	400 animals (cattle)	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Formulations via Hand (31)	PHED V1.1	16 animals for dogs and cats	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Formulations via Wipe (32)	PHED V1.1	16 animals for dogs and cats, 400 animals for horses	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Formulations via Trigger Pump Sprayer (33)	MRID 410547-01	400 animals for all agricultural animals, 2 gallons for indoor surfaces	**Baseline: The only empirical data that are available are based on the use of no protective clothing.**

Appendix A/Table A1: Sources of Exposure Data Used In The Occupational Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Applying Ready to Use Formulations with Aerosol Cans (34)	PHED V1.1	2 (16 oz) cans	**Baseline:** Dermal and inhalation = AB grade. Hands = A grade. Hands = 15 replicates; dermal = 15 replicates; and inhalation = 15 replicates. High confidence in all data. No protection factor was needed to define the unit exposure values. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = A grade. Hands = 15 replicates. High confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a quarter-face respirator (dust/mist filtering only). A respirator protection factor of 10 is applied to estimate the use of a half-face negative pressure respirator or a powered air purifying respirator (dust/mist filtering and/or organic vapor-removing). **Engineering Controls:** Not considered feasible for this exposure scenario.
Applying Ready to Use Formulations with Foggers (35)	PHED V1.1	4 foggers	PHED exposure data for aerosol can application (scenario 40) was used as a surrogate for fogger application.
Applying Ready to Use Protective Flanges (36)	No Data	No Data	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Vapor Recovery System Tubes (37)	No Data	No Data	There is no PHED general or chemical specific data for this scenario.

- All Standard Assumptions are based on an 8-hour work day as estimated by the Agency.
- All handler exposure assessments in this document are based on the "Best Available" data as defined by the HED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows:
  High = grades A and B and 15 or more replicates per body part
  Medium = grades A, B, and C and 15 or more replicates per body part
  Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates.
- **PHED grading criteria do not reflect overall quality of the reliability of the assessment. Sources of the exposure factors should also be considered in the risk**

Appendix A/Table A2: Unit Exposure Values Used In The Occupational Permethrin Handler Exposure And Risk Calculations									
Exposure Scenario	Baseline Dermal Unit Exposure (mg/lb ai)	Baseline Inhalation Unit Exposure (ug/lb ai)	PPE-G Dermal Unit Exposure (mg/lb ai)	PPE-G,DL Dermal Unit Exposure (mg/lb ai)	PPE-G,HG,DL Dermal Unit Exposure (mg/lb ai)	80% PPE-R Inhalation Unit Exposure (ug/lb ai)	90% PPE-R Inhalation Unit Exposure (ug/lb ai)	Eng Con Dermal Unit Exposure (mg/lb ai)	Eng Con Inhalation Unit Exposure (ug/lb ai)
Mixer/Loader									
Mixing/Loading Emulsifiable Concentrates for Aerial Applications	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Mixing/Loading Emulsifiable Concentrates for Groundboom Applications	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Mixing/Loading Emulsifiable Concentrates for Airblast Applications	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Mixing/Loading Emulsifiable Concentrates with Truck Mounted ULV Sprayer (using PHED airblast data)	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Mixing/Loading Emulsifiable Concentrates via Dip	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Mixing/Loading Wettable Powders for Aerial Applications	3.7	43	0.17	0.13	NA	8.6	4.3	0.0098	0.24
Mixing/Loading Wettable Powders for Groundboom Applications	3.7	43	0.17	0.13	NA	8.6	4.3	0.0098	0.24
Mixing/Loading Wettable Powders for Airblast Applications	3.7	43	0.17	0.13	NA	8.6	4.3	0.0098	0.24
Loading Dusts via Mechanical Duster (using PHED wettable powders data)	3.7	43	0.17	0.13	NA	8.6	4.3	NF	NF
Loading Dusts via Dust Bag (using PHED wettable powders data)	3.7	43	0.17	0.13	NA	8.6	4.3	NF	NF
Loading Granulars for Aerial Applications	0.0084	1.7	0.0069	0.0034	NA	0.34	0.17	0.00017	0.034
Loading Granulars for Tractor Drawn Spreader Applications	0.0084	1.7	0.0069	0.0034	NA	0.34	0.17	0.00017	0.034
Applicator									
Applying Liquid Sprays via Aerial Equipment	ND	ND	ND	ND	NA	ND	ND	0.005	0.068

Appendix A/Table A2: Unit Exposure Values Used In The Occupational Permethrin Handler Exposure And Risk Calculations									
Exposure Scenario	Baseline Dermal Unit Exposure (mg/lb ai)	Baseline Inhalation Unit Exposure (ug/lb ai)	PPE-G Dermal Unit Exposure (mg/lb ai)	PPE-G,DL Dermal Unit Exposure (mg/lb ai)	PPE-G,HG,DL Dermal Unit Exposure (mg/lb ai)	80% PPE-R Inhalation Unit Exposure (ug/lb ai)	90% PPE-R Inhalation Unit Exposure (ug/lb ai)	Eng Con Dermal Unit Exposure (mg/lb ai)	Eng Con Inhalation Unit Exposure (ug/lb ai)
Applying Liquid Sprays via Groundboom Equipment	0.014	0.74	0.014	0.011	NA	0.148	0.074	0.005	0.043
Applying Liquid Sprays via Airblast Equipment	0.36	4.5	0.24	0.22	0.17	0.9	0.45	0.019	0.45
Applying Liquid Sprays with Truck Mounted ULV Sprayer (using PHED airblast data)	0.36	4.5	0.24	0.22	NA	0.9	0.45	0.019	0.45
Applying Emulsifiable Concentrates via Dip	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Granulars via Aerial Equipment	ND	ND	ND	ND	NA	ND	ND	0.0017	1.3
Applying Granulars via Tractor Drawn Spreader	0.0099	1.2	0.0072	0.0042	NA	0.24	0.12	0.0021	0.22
Applying Dusts via Mechanical Duster	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Dusts via Dust Bag	ND	ND	ND	ND	NA	ND	ND	ND	ND
Flagger									
Flagging for Liquid Sprays via Aerial Equipment	0.011	0.35	ND	0.01	NA	0.07	0.035	0.00022	0.043
Flagging for Granulars via Aerial Equipment	0.0028	0.15	ND	0.0016	NA	0.03	0.015	0.000056	0.22
Mixer/Loader/Applicator									
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (ORETF data)	100	120	0.43	0.37	NA	24	12	NF	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Handgun Sprayer (ORETF data)	ND see PPE	1.8	0.45	0.25	NA	0.36	0.18	NF	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a High Pressure Handwand (only study in PHED is for greenhouse use)	ND see PPE	120	2.5	1.6	NA	24	12	NF	NF

Appendix A/Table A2: Unit Exposure Values Used In The Occupational Permethrin Handler Exposure And Risk Calculations									
Exposure Scenario	Baseline Dermal Unit Exposure (mg/lb ai)	Baseline Inhalation Unit Exposure (ug/lb ai)	PPE-G Dermal Unit Exposure (mg/lb ai)	PPE-G,DL Dermal Unit Exposure (mg/lb ai)	PPE-G,HG,DL Dermal Unit Exposure (mg/lb ai)	80% PPE-R Inhalation Unit Exposure (ug/lb ai)	90% PPE-R Inhalation Unit Exposure (ug/lb ai)	Eng Con Dermal Unit Exposure (mg/lb ai)	Eng Con Inhalation Unit Exposure (ug/lb ai)
Mixing/Loading/Applying Emulsifiable Concentrates via Foam Applicator Equipment (using ORETF low-pressure handwand)	100	30	0.43	0.37	NA	6	3	NF	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data)	5.6	17	ND	ND	NA	ND	ND	NF	NF
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack ULV Sprayer (using PHED backpack data)	ND see PPE	30	2.5	1.6	NA	6	3	NF	NF
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush	180	280	24	22	NA	56	28	NF	NF
Mixing/Loading/Applying Wettable Powders with Low Pressure Handwand	ND see PPE	1100	8.6	6.2	NA	220	110	ND	ND
Mixing/Loading/Applying Wettable Powders with Backpack Sprayer	ND	ND	ND	ND	NA	ND	ND	ND	ND
Mixing/Loading/Applying Wettable Powders with a Handgun Sprayer (ORETF data)	ND see PPE	64	0.8	0.43	NA	12.8	6.4	NF	NF
Mixing/Loading/Applying Wettable Powders with a High Pressure Handwand	ND	ND	ND	ND	NA	ND	ND	ND	ND
Mixing/Loading/Applying Water Soluble Bags with Handgun Sprayer (ORETF data)	ND see PPE	7.2	0.64	0.37	NA	1.44	0.72	NF	NF
Applying Dusts via Shaker Can (MRID 444598-01)	76	620	ND	ND	NA	ND	ND	ND	ND

Appendix A/Table A2: Unit Exposure Values Used In The Occupational Permethrin Handler Exposure And Risk Calculations									
Exposure Scenario	Baseline Dermal Unit Exposure (mg/lb ai)	Baseline Inhalation Unit Exposure (ug/lb ai)	PPE-G Dermal Unit Exposure (mg/lb ai)	PPE-G,DL Dermal Unit Exposure (mg/lb ai)	PPE-G,HG,DL Dermal Unit Exposure (mg/lb ai)	80% PPE-R Inhalation Unit Exposure (ug/lb ai)	90% PPE-R Inhalation Unit Exposure (ug/lb ai)	Eng Con Dermal Unit Exposure (mg/lb ai)	Eng Con Inhalation Unit Exposure (ug/lb ai)
Mixing/Loading/Applying Microencapsulated Liquids via Fogger/Mist Generator	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Formulations via Pour-on (using PHED mix/load liquid)	2.9	1.2	0.023	0.017	NA	0.24	0.12	0.0086	0.083
Applying Ready to Use Formulations via RTU Ear-Tag	0.01	ND	ND	ND	NA	ND	ND	NF	NF
Applying Ready to Use Formulations via Hands	1800	0.00012	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Formulations via RTU Wipe	2870	27700	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur Trigger Pump study)	13.5	123	ND	ND	NA	ND	ND	NF	NF
Applying Ready to Use Formulations with Aerosol Cans	190	1300	81	64	NA	260	130	NF	NF
Applying Ready to Use Formulations with Foggers (using PHED aerosol data)	190	1300	81	64	NA	260	130	NF	NF
Applying Ready to Use Coasters	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Protective Flanges	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Vapor Recovery System Tubes	ND	ND	ND	ND	NA	ND	ND	ND	ND
Applying Ready to Use Mattress Liners	ND	ND	ND	ND	NA	ND	ND	ND	ND

NA = Not Applicable
NF= Not Feasible
ND = No Data

Appendix B: Occupational Postapplication Exposures

COTTON DFR STUDY DATA

Appendix B/Table B1: Regression Analysis Summary for Cotton Trial 1 (Arizona)

Regression Statistics	
Multiple R	0.941057
R Square	0.885588
Adjusted R^2	0.847451
Standard Error	0.309993
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	2.23144	2.23144	23.221085	0.017025694
Residual	3	0.288286	0.096095		
Total	4	2.519727			

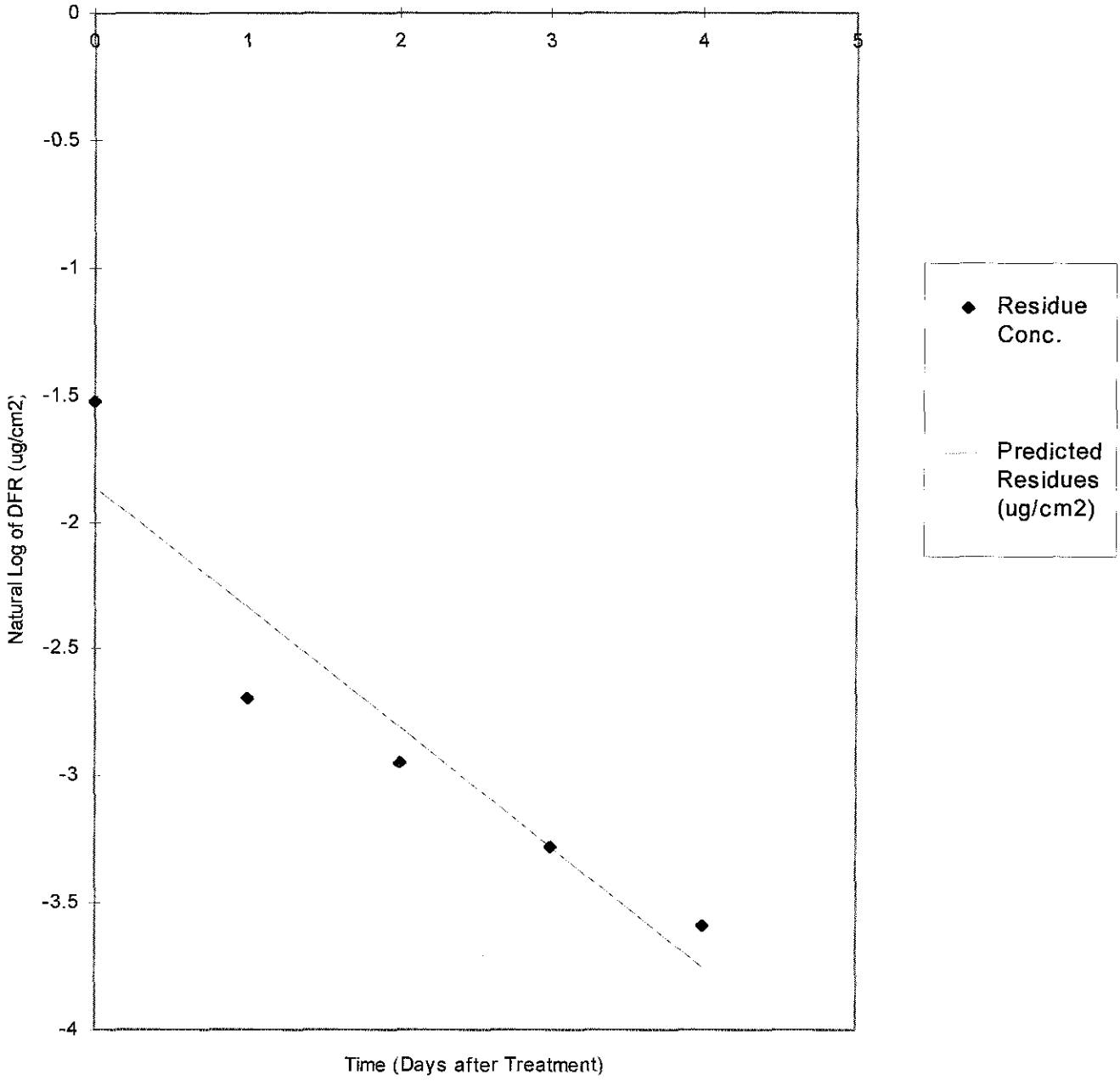
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.86426	0.240119	-7.76389	0.0044451	-2.628426881	-1.100092112
Slope	-0.47238	0.098028	-4.81883	0.0170257	-0.784351264	-0.160411207

Half Life =	1.467347Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.155011	21	7.624E-06
1	0.096652	22	4.753E-06
2	0.060264	23	2.964E-06
3	0.037575	24	1.848E-06
4	0.023429	25	1.152E-06
5	0.014608	26	7.184E-07
6	0.009109	27	4.48E-07
7	0.005679	28	2.793E-07
8	0.003541	29	1.742E-07
9	0.002208	30	1.086E-07
10	0.001377	31	6.771E-08
11	0.000858	32	4.222E-08
12	0.000535	33	2.632E-08
13	0.000334	34	1.641E-08
14	0.000208	35	1.023E-08
15	0.00013		
16	8.09E-05		
17	5.04E-05		
18	3.14E-05		
19	1.96E-05		
20	1.22E-05		

Appendix B/Figure B1: Log of Dislodgeable Foliar Residue vs. Time for Cotton Trial 1 (Arizona)



Appendix B/Table B2: Regression Analysis Summary for Cotton Trial 2 (Arizona)

Regression Statistics	
Multiple R	0.971886
R Square	0.944562
Adjusted R^2	0.926083
Standard Error	0.067333
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	0.231737	0.231737	51.114603	0.005634837
Residual	3	0.013601	0.004534		
Total	4	0.245338			

	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.79086	0.052156	-34.3369	5.431E-05	-1.956847063	-1.624881879
Slope	-0.15223	0.021292	-7.14945	0.0056348	-0.219991294	-0.084467075

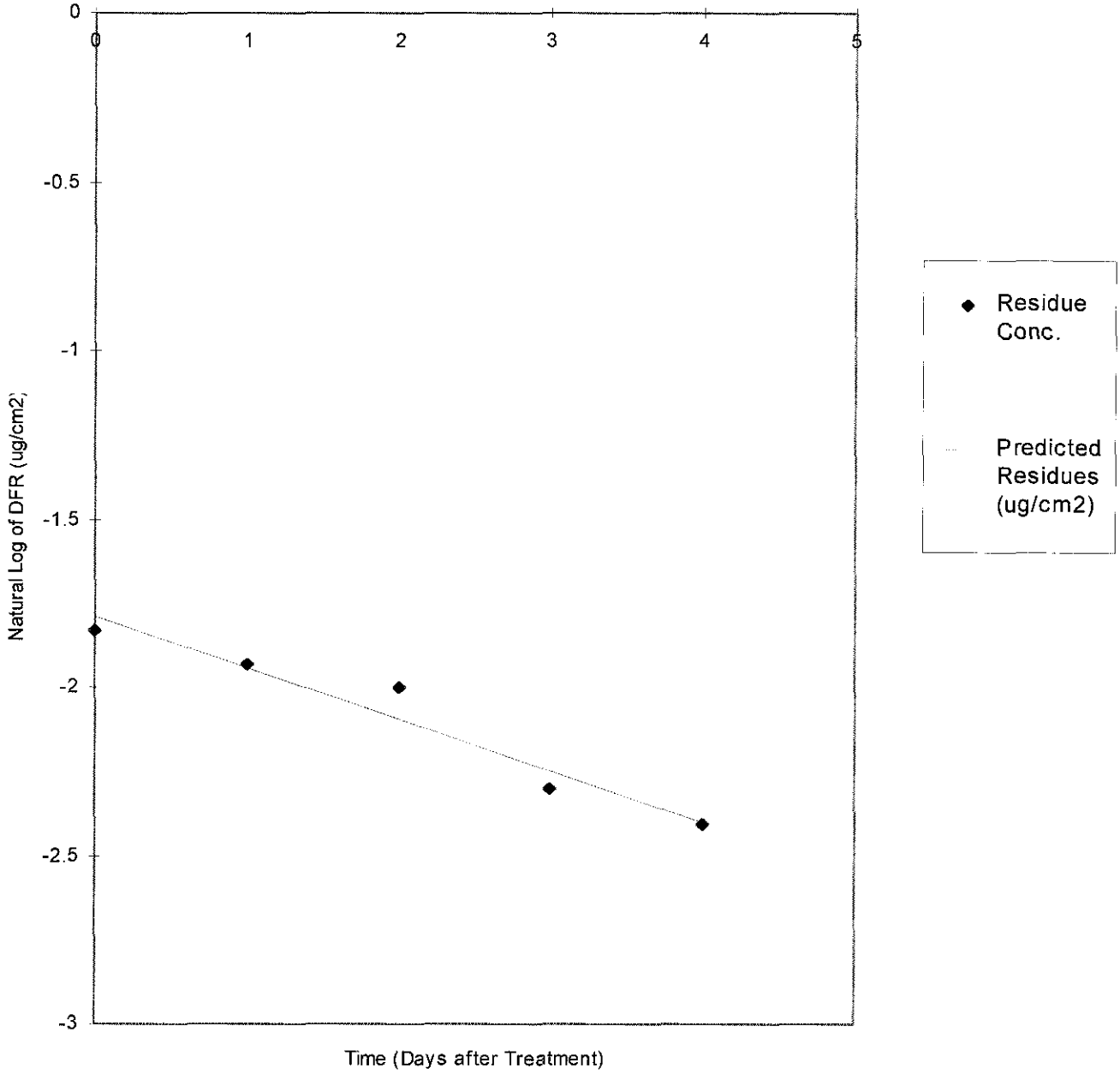
Half Life =	4.553313Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)
0	0.166816
1	0.14326
2	0.123031
3	0.105658
4	0.090738
5	0.077925
6	0.066921
7	0.057471
8	0.049356
9	0.042386
10	0.036401
11	0.031261
12	0.026847
13	0.023056
14	0.0198
15	0.017004
16	0.014603
17	0.012541
18	0.01077
19	0.009249
20	0.007943

Time (Days)	Residue (ug/cm2)
21	0.0068215
22	0.0058582
23	0.005031
24	0.0043206
25	0.0037105
26	0.0031865
27	0.0027366
28	0.0023501
29	0.0020183
30	0.0017333
31	0.0014885
32	0.0012783
33	0.0010978
34	0.0009428
35	0.0008097

Appendix B/FigureB2: Log of Dislodgeable Foliar Residue vs. Time for Cotton Trial 2 (Arizona)



PEACH DFR STUDY DATA

Appendix B/Table B3: Regression Analysis Summary for Peach Trial Treated with Ambush W (California)

Regression Statistics	
Multiple R	0.542743
R Square	0.29457
Adjusted R^2	0.275504
Standard Error	0.323648
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	1.618382	1.618382	15.450254	0.000357376
Residual	37	3.875673	0.104748		
Total	38	5.494055			

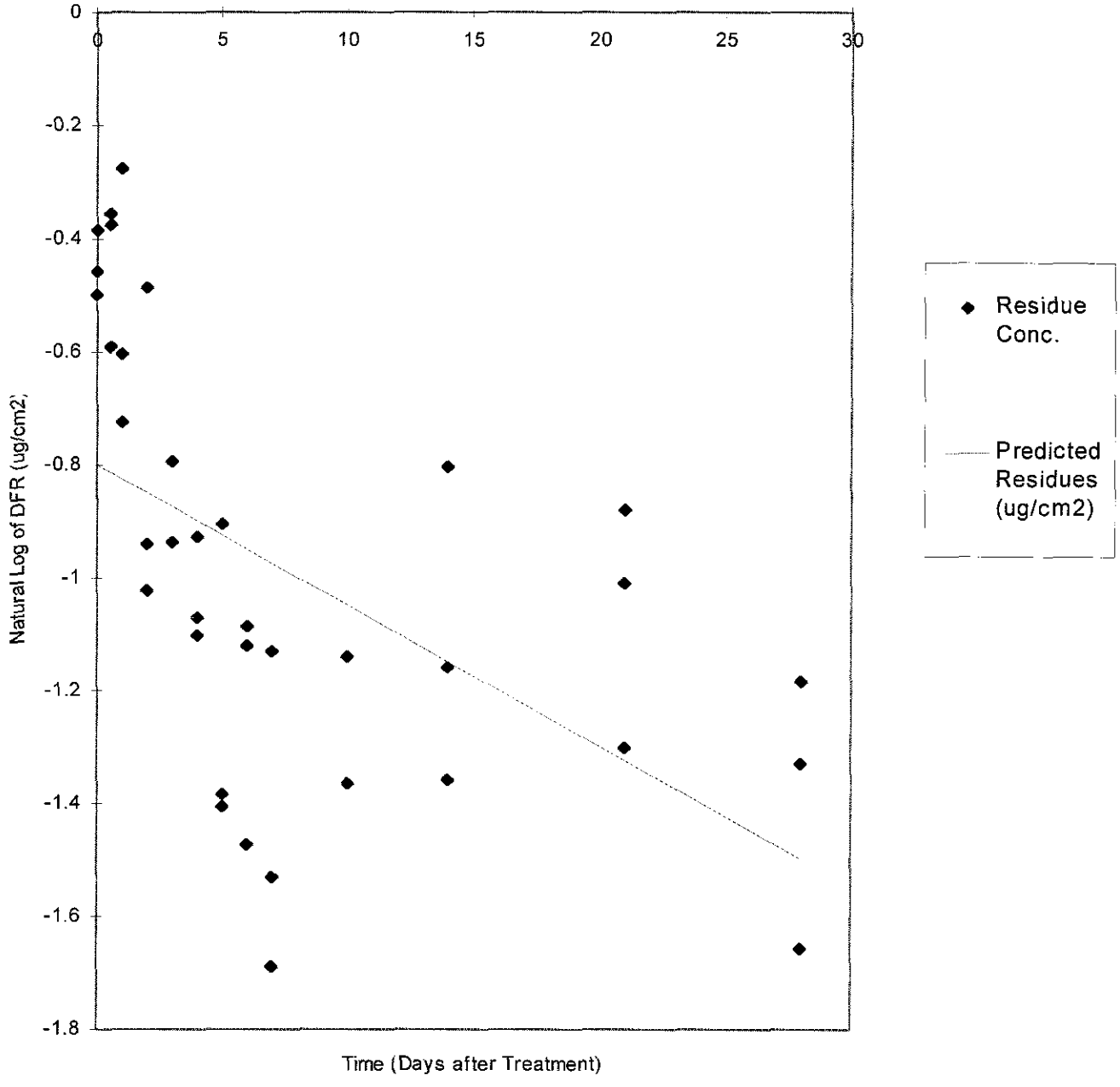
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.79926	0.071665	-11.1527	2.161E-13	-0.944462807	-0.654049882
Slope	-0.02492	0.00634	-3.93068	0.0003574	-0.037764009	-0.012073653

Half Life =	27.8162Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.449663	21	0.2664545
1	0.438597	22	0.2598968
2	0.427802	23	0.2535005
3	0.417274	24	0.2472616
4	0.407004	25	0.2411763
5	0.396987	26	0.2352407
6	0.387217	27	0.2294512
7	0.377687	28	0.2238042
8	0.368392	29	0.2182962
9	0.359326	30	0.2129237
10	0.350482	31	0.2076835
11	0.341857	32	0.2025722
12	0.333443	33	0.1975867
13	0.325237	34	0.1927239
14	0.317233	35	0.1879808
15	0.309425		
16	0.30181		
17	0.294382		
18	0.287137		
19	0.28007		
20	0.273178		

Appendix B/Figure B3: Log of Dislodgeable Foliar Residue vs. Time for CA Ambush W



Appendix B/Table B3: Regression Analysis Summary for Peach Trial Treated with Pounce EC(California)

Regression Statistics	
Multiple R	0.6869
R Square	0.471832
Adjusted R^2	0.456298
Standard Error	0.257033
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	2.006654	2.006654	30.373462	3.72053E-06
Residual	34	2.246245	0.066066		
Total	35	4.2529			

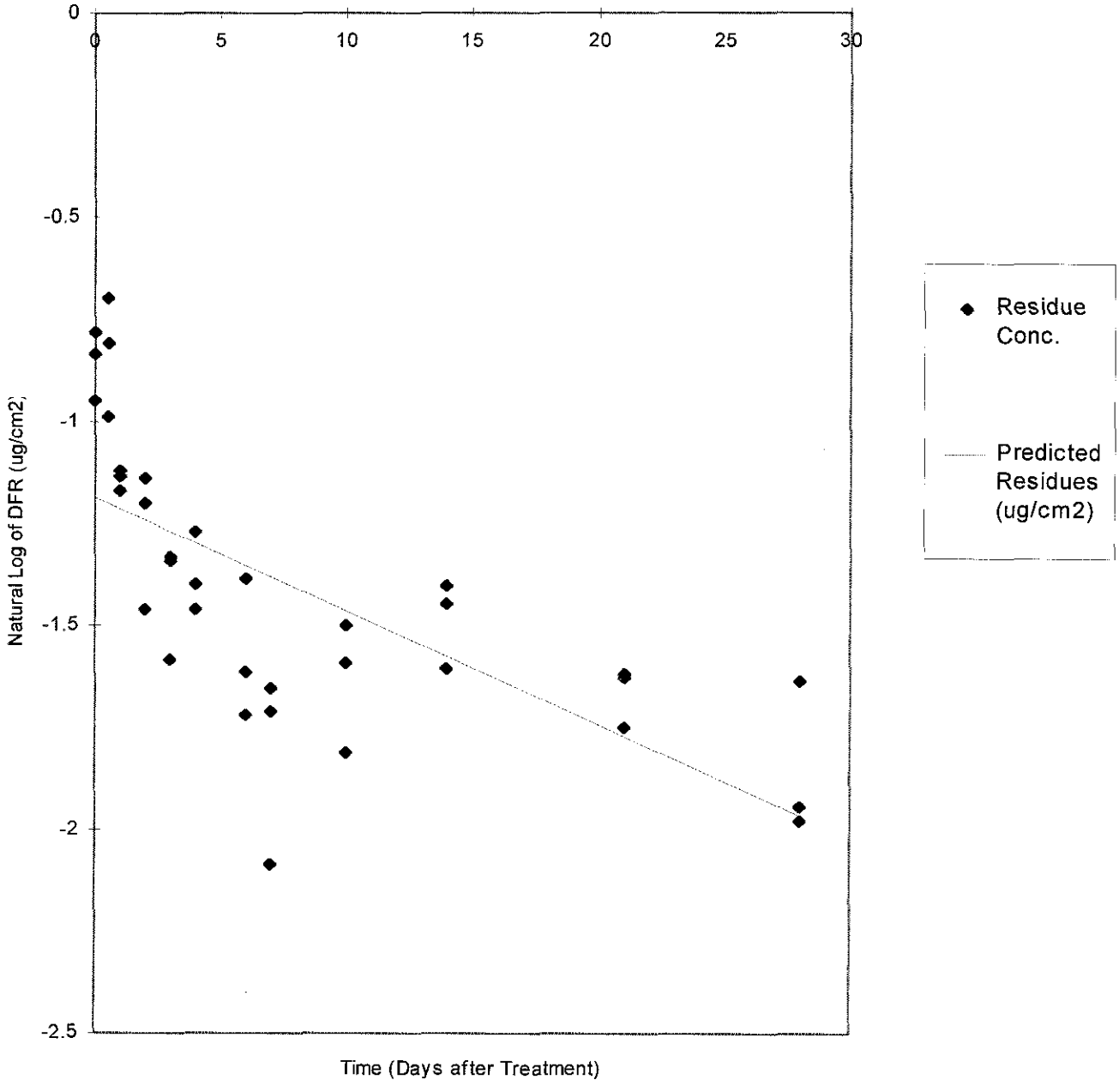
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.18504	0.059082	-20.0575	2.034E-20	-1.305107803	-1.064969569
Slope	-0.02788	0.00506	-5.51121	3.721E-06	-0.038167329	-0.017602405

Half Life =	24.85747Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.305734	21	0.1702273
1	0.297327	22	0.1655461
2	0.28915	23	0.1609936
3	0.281199	24	0.1565663
4	0.273466	25	0.1522608
5	0.265946	26	0.1480737
6	0.258632	27	0.1440017
7	0.25152	28	0.1400417
8	0.244603	29	0.1361906
9	0.237877	30	0.1324454
10	0.231335	31	0.1288032
11	0.224974	32	0.1252612
12	0.218787	33	0.1218165
13	0.21277	34	0.1184666
14	0.206919	35	0.1152088
15	0.201229		
16	0.195695		
17	0.190314		
18	0.18508		
19	0.179991		
20	0.175041		

Appendix B/Figure B4: Log of Dislodgeable Foliar Residue vs. Time for CA Pounce EC



Appendix B/Table B5: Regression Analysis Summary for Peach Trial Treated with Ambush W (Georgia)

Regression Statistics	
Multiple R	0.920633
R Square	0.847564
Adjusted R^2	0.843445
Standard Error	0.213458
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	9.373762	9.373762	205.72547	1.08626E-16
Residual	37	1.685884	0.045564		
Total	38	11.05965			

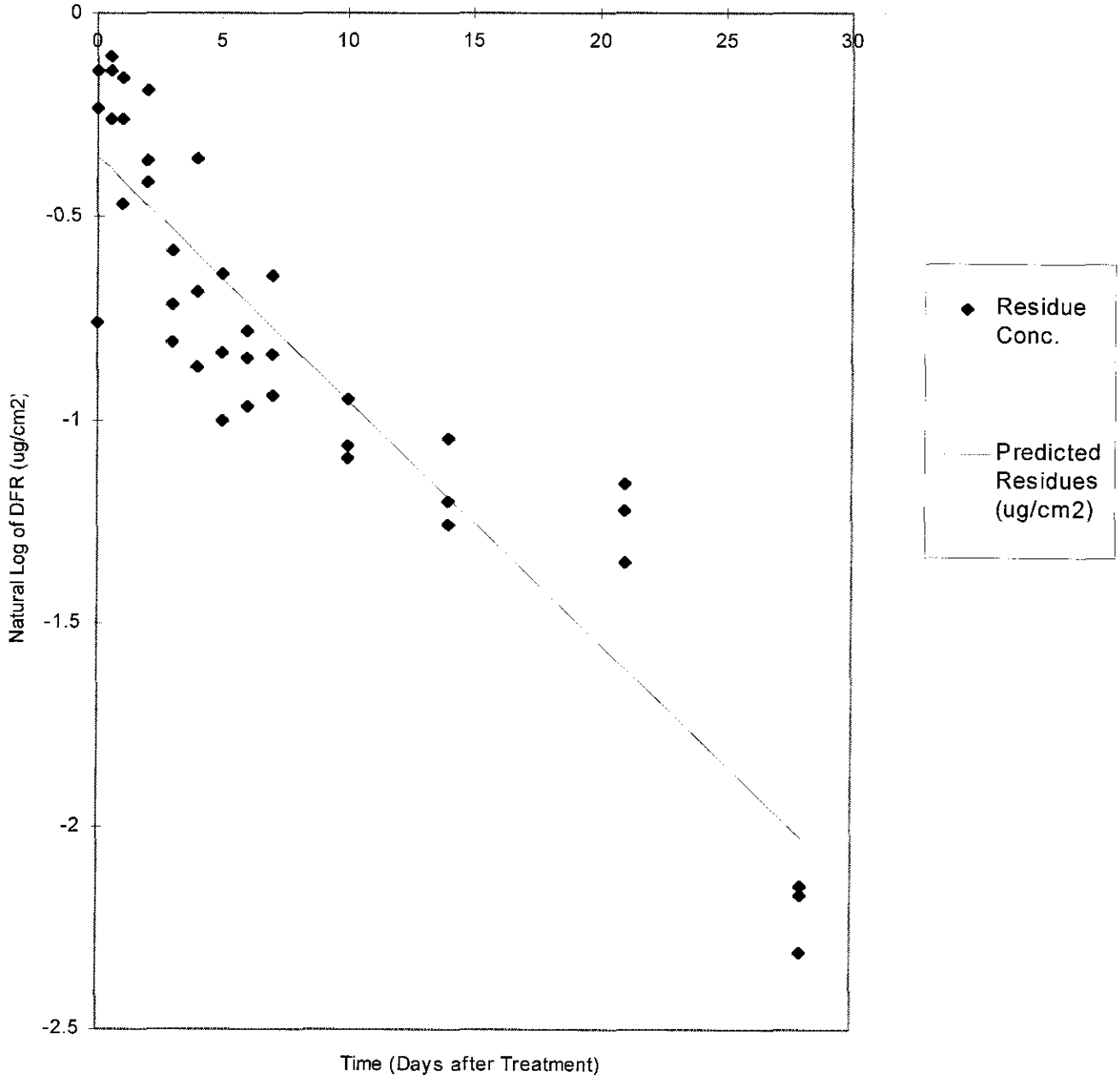
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.35093	0.047266	-7.42465	7.761E-09	-0.446700424	-0.255161878
Slope	-0.05997	0.004181	-14.3431	1.086E-16	-0.068443283	-0.0514995

Half Life =	11.55796Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.704032	21	0.1998216
1	0.663052	22	0.1881903
2	0.624456	23	0.177236
3	0.588108	24	0.1669193
4	0.553875	25	0.1572032
5	0.521635	26	0.1480526
6	0.491271	27	0.1394347
7	0.462675	28	0.1313184
8	0.435743	29	0.1236746
9	0.410379	30	0.1164757
10	0.386492	31	0.1096958
11	0.363995	32	0.1033106
12	0.342807	33	0.097297
13	0.322853	34	0.0916335
14	0.30406	35	0.0862996
15	0.286361		
16	0.269692		
17	0.253994		
18	0.239209		
19	0.225285		
20	0.212172		

Appendix B/Figure B5: Log of Dislodgeable Foliar Residue vs. Time for GA Ambush W



Appendix B/Table B6: Regression Analysis Summary for Peach Trial Treated with Ambush W (Washington)

Regression Statistics	
Multiple R	0.85128
R Square	0.724677
Adjusted R^2	0.717236
Standard Error	0.246884
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	5.935942	5.935942	97.387813	6.57308E-12
Residual	37	2.255209	0.060952		
Total	38	8.191151			

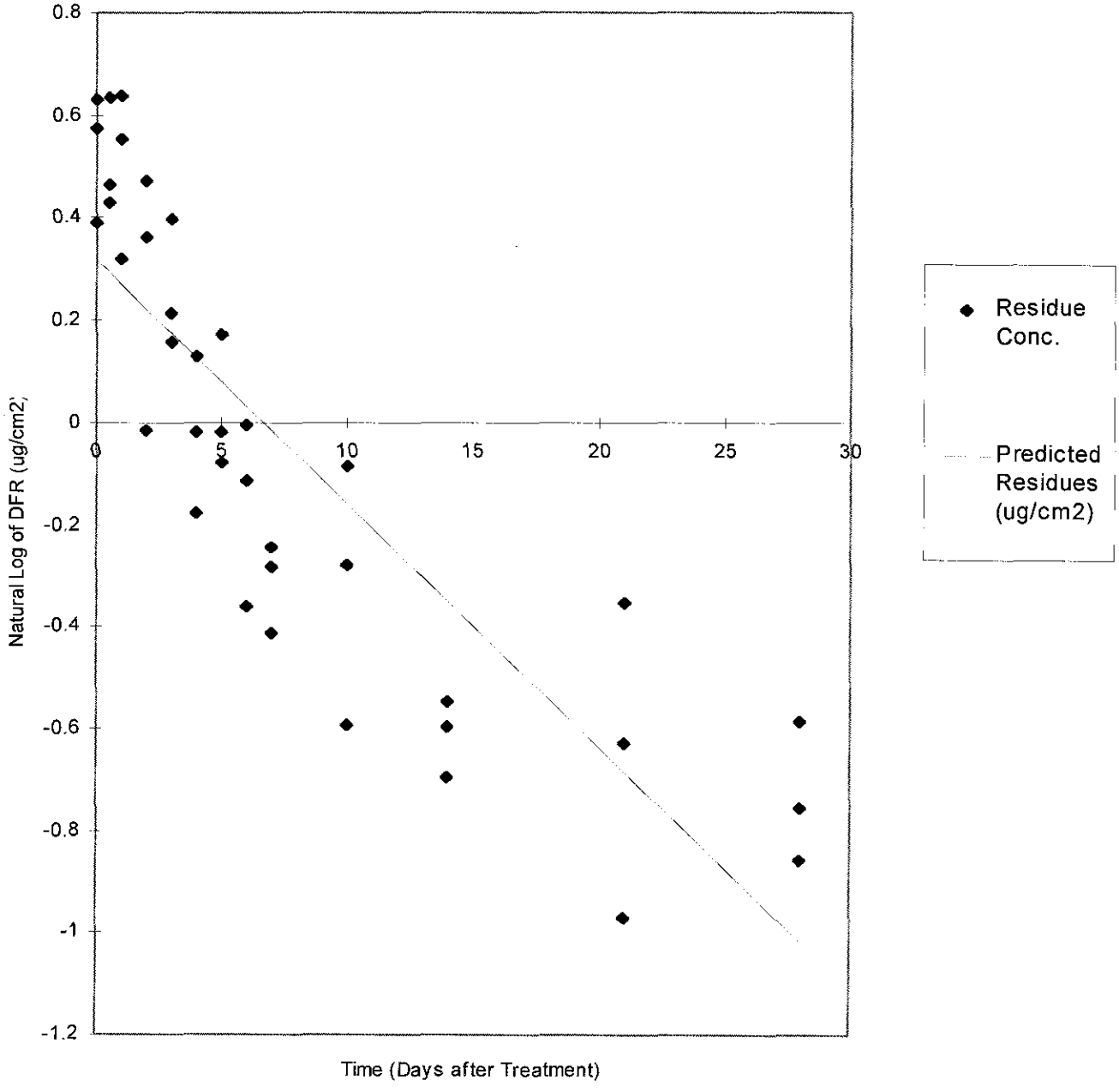
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.318077	0.054667	5.818436	1.106E-06	0.207310788	0.428842426
Slope	-0.04772	0.004836	-9.86853	6.573E-12	-0.057521974	-0.037924958

Half Life =	14.52424Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	1.374482	21	0.504536
1	1.310427	22	0.4810233
2	1.249358	23	0.4586063
3	1.191134	24	0.4372341
4	1.135625	25	0.4168578
5	1.082701	26	0.3974312
6	1.032245	27	0.3789098
7	0.984139	28	0.3612517
8	0.938276	29	0.3444164
9	0.89455	30	0.3283657
10	0.852862	31	0.313063
11	0.813116	32	0.2984734
12	0.775223	33	0.2845638
13	0.739095	34	0.2713024
14	0.704652	35	0.258659
15	0.671813		
16	0.640505		
17	0.610655		
18	0.582197		
19	0.555065		
20	0.529198		

Appendix B/Figure B6: Log of Dislodgeable Foliar Residue vs. Time for WA Ambush W



TURF TTR STUDY DATA

Appendix B/Table B7: Regression Analysis Summary for Turf Trial Treated with Permethrin (California)

Regression Statistics	
Multiple R	0.937623
R Square	0.879137
Adjusted R^2	0.874661
Standard Error	0.383972
Observations	29

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	28.95521	28.95521	196.394	6.59353E-14
Residual	27	3.980726	0.147434		
Total	28	32.93594			

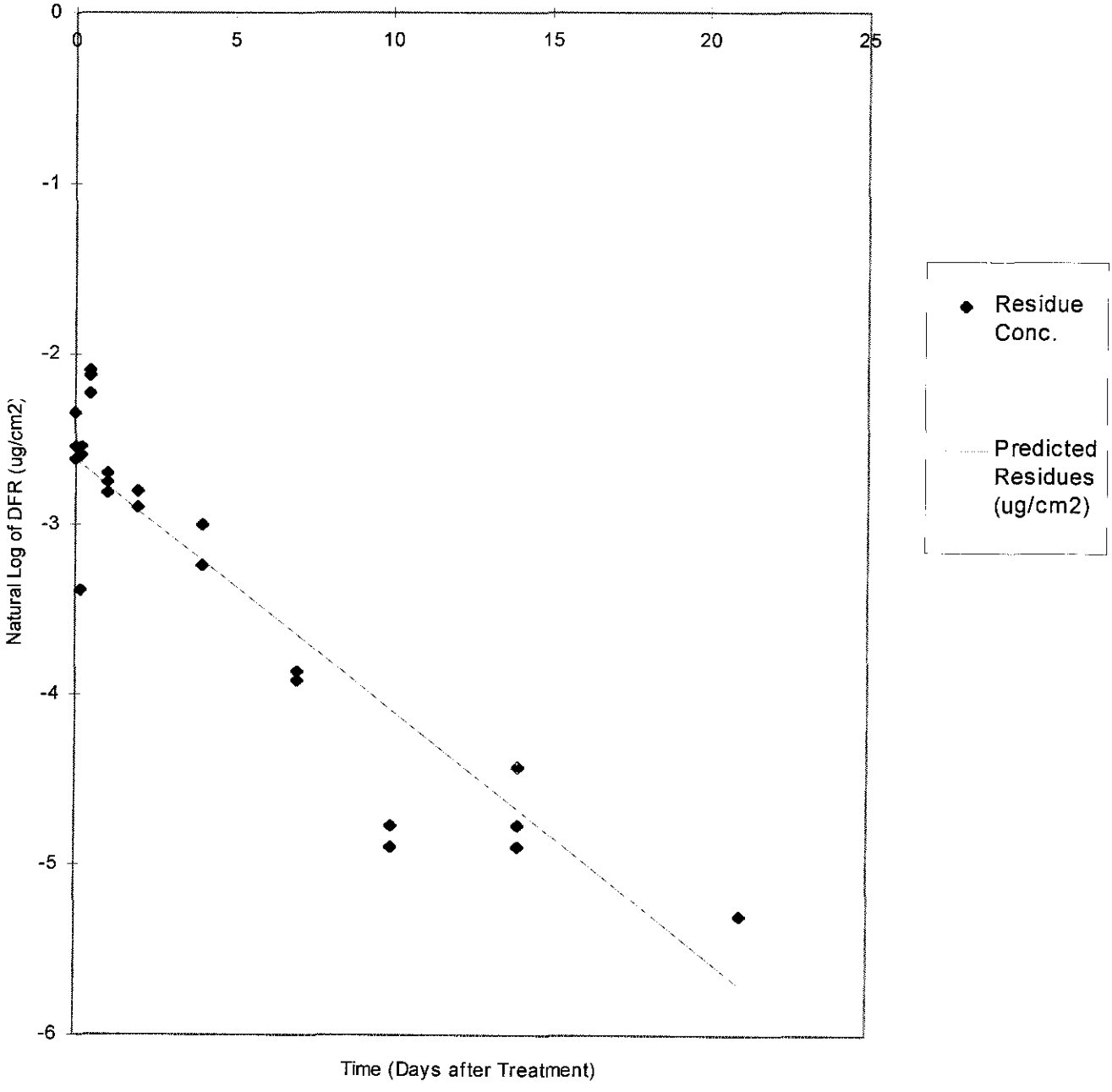
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.61882	0.09587	-27.3164	3.319E-21	-2.815526988	-2.422109557
Slope	-0.14714	0.010499	-14.0141	6.594E-14	-0.16868358	-0.125597289

Half Life =	4.710787Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.072889	21	0.0033168
1	0.062916	22	0.0028629
2	0.054307	23	0.0024712
3	0.046876	24	0.0021331
4	0.040462	25	0.0018412
5	0.034926	26	0.0015893
6	0.030147	27	0.0013718
7	0.026022	28	0.0011841
8	0.022462	29	0.0010221
9	0.019388	30	0.0008823
10	0.016736	31	0.0007615
11	0.014446	32	0.0006573
12	0.012469	33	0.0005674
13	0.010763	34	0.0004898
14	0.00929	35	0.0004227
15	0.008019		
16	0.006922		
17	0.005975		
18	0.005157		
19	0.004452		
20	0.003843		

Appendix B/Figure B7: Log of Dislodgeable Foliage Residue vs. Time for Permethrin / California



Appendix B/Table B8: Regression Analysis Summary for Turf Trial Treated with Permethrin (Georgia)

Regression Statistics	
Multiple R	0.748278
R Square	0.559919
Adjusted R^2	0.546976
Standard Error	0.651628
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	18.36841	18.36841	43.25856	1.54866E-07
Residual	34	14.43705	0.424619		
Total	35	32.80545			

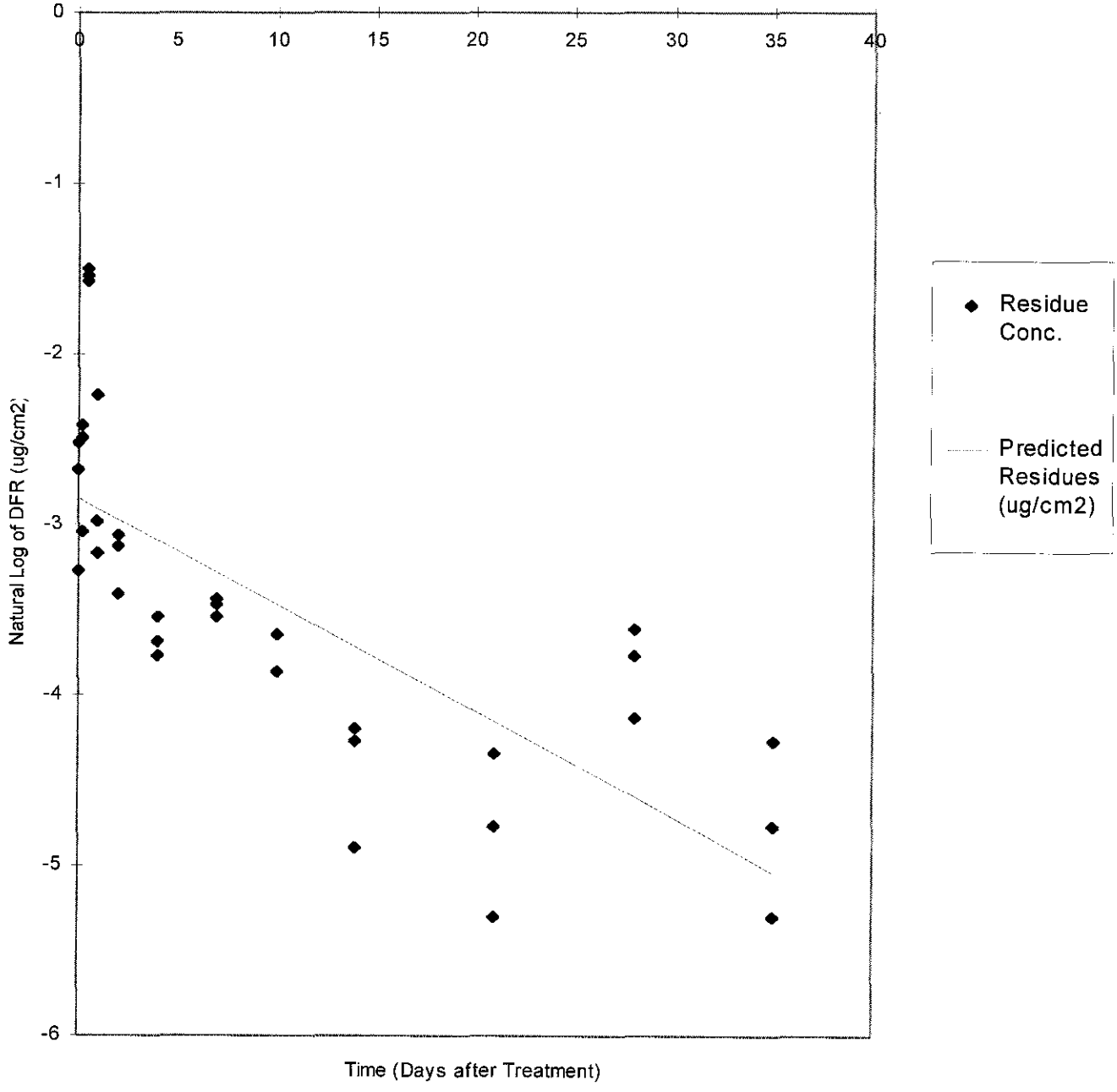
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.84551	0.145816	-19.5143	4.811E-20	-3.141840133	-2.549171607
Slope	-0.0626	0.009518	-6.57712	1.549E-07	-0.081946464	-0.043259499

Half Life =	11.07211Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.058105	21	0.0156049
1	0.054579	22	0.014658
2	0.051267	23	0.0137685
3	0.048156	24	0.0129329
4	0.045233	25	0.0121481
5	0.042489	26	0.0114109
6	0.03991	27	0.0107185
7	0.037488	28	0.010068
8	0.035213	29	0.0094571
9	0.033076	30	0.0088832
10	0.031069	31	0.0083441
11	0.029184	32	0.0078378
12	0.027413	33	0.0073621
13	0.025749	34	0.0069154
14	0.024187	35	0.0064957
15	0.022719		
16	0.02134		
17	0.020045		
18	0.018829		
19	0.017686		
20	0.016613		

Appendix B/Figure B8: Log of Dislodgeable Foliage Residue vs. Time for Permethrin / Georgia



Appendix B/Table B9: Regression Analysis Summary for Turf Trial Treated with Permethrin (Pennsylvania)

Regression Statistics	
Multiple R	0.982023
R Square	0.964369
Adjusted R^2	0.96275
Standard Error	0.159683
Observations	24

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	1	15.1831	15.1831	595.44493	2.00945E-17
Residual	22	0.560972	0.025499		
Total	23	15.74407			

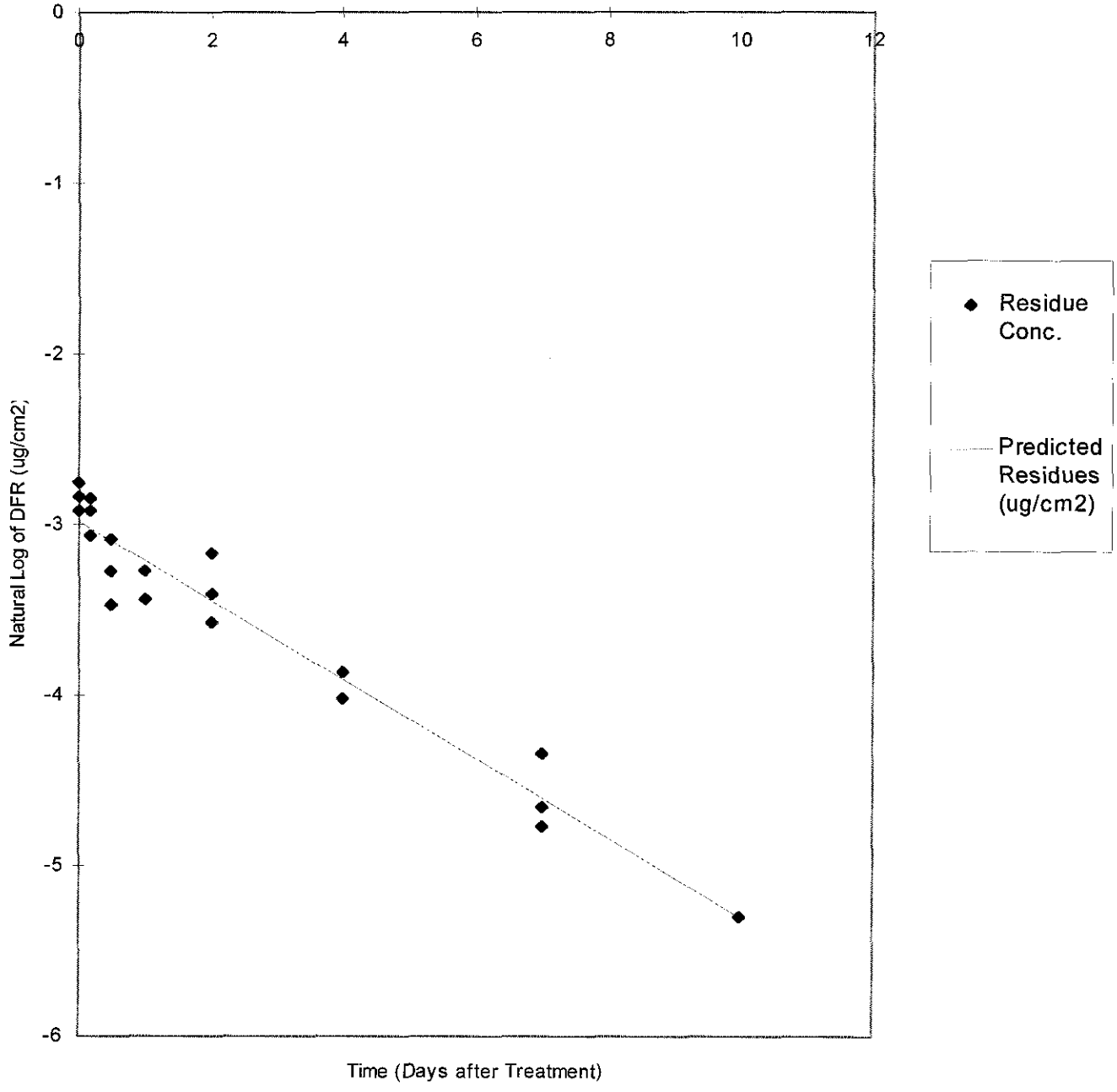
	Coeff.	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.98063	0.043823	-68.0151	4.502E-27	-3.071512801	-2.889745837
Slope	-0.23179	0.009499	-24.4017	2.009E-17	-0.251485507	-0.212087022

Half Life =	2.990458Days

Predicted DFR Levels

Time (Days)	Residue (ug/cm2)	Time (Days)	Residue (ug/cm2)
0	0.050761	21	0.0003905
1	0.040259	22	0.0003097
2	0.03193	23	0.0002456
3	0.025324	24	0.0001948
4	0.020085	25	0.0001545
5	0.01593	26	0.0001225
6	0.012634	27	9.719E-05
7	0.01002	28	7.708E-05
8	0.007947	29	6.113E-05
9	0.006303	30	4.849E-05
10	0.004999	31	3.846E-05
11	0.003965	32	3.05E-05
12	0.003145	33	2.419E-05
13	0.002494	34	1.919E-05
14	0.001978	35	1.522E-05
15	0.001569		
16	0.001244		
17	0.000987		
18	0.000783		
19	0.000621		
20	0.000492		

Appendix B/Figure B9: Log of Dislodgeable Foliage Residue vs. Time for Permethrin / Pennsylvania



Appendix B/Table B10: Permethrin Non-cancer Postapplication Worker Risk Estimates from Agricultural Scenarios										
Crop	**Activity**	**TC cm^2/hr**	**Maximum Application Rate**	**Hours of Exposure**	**Dermal Absorption**	**DAT (days)**	**DFR ug/cm^2 from study**	**DFR ug/cm^2 normalized**	**Short-Intermediate-term Dose (mg/kg/day)**	**Short-Intermediate-term MOE**
Short/Intermediate-Term Postapplication Risks (Calculated with Peach DFR Study MRID# 437557-01)										
alfalfa, soybeans	hand-harvesting	2500	0.20	8	0.30	0	0.21	0.22	0.019	94
		2500	0.20	8	0.30	1	0.13	0.13	0.011	**160**
	irrigating, scouting (full development)	1500	0.20	8	0.30	0	0.21	0.22	0.011	**160**
	irrigating, scouting (min development)	100	0.20	8	0.30	0	0.21	0.22	0.001	**2,400**
corn	detasseling, hand-harvesting	17000	0.20	8	0.30	0	0.21	0.22	0.126	14
		17000	0.20	8	0.30	7	0.04	0.04	0.024	74
	irrigating, scouting (full development)	1000	0.20	8	0.30	0	0.21	0.22	0.007	**240**
	scouting (min development)	400	0.20	8	0.30	0	0.21	0.22	0.003	**590**
cucurbits	hand-harvesting, hand-pruning	2500	0.20	8	0.30	0	0.21	0.22	0.019	94
		2500	0.20	8	0.30	1	0.13	0.13	0.011	**160**
	irrigating, scouting	1500	0.20	8	0.30	0	0.21	0.22	0.011	**160**
	thinning	500	0.20	8	0.30	0	0.21	0.22	0.004	**470**
onions: dry bulb, garlic	hand-harvesting	2500	0.30	8	0.30	0	0.21	0.32	0.028	63
		2500	0.30	8	0.30	1	0.13	0.19	0.017	**110**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.30	8	0.30	0	0.21	0.32	0.017	**100**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.30	8	0.30	0	0.21	0.32	0.003	**520**
potatoes	hand-harvesting	2500	0.20	8	0.30	0	0.21	0.22	0.019	94
		2500	0.20	8	0.30	1	0.13	0.13	0.011	**160**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.20	8	0.30	0	0.21	0.22	0.011	**160**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.20	8	0.30	0	0.21	0.22	0.002	**790**
turnips	hand-harvesting	2500	0.10	8	0.30	0	0.21	0.11	0.009	**190**
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.10	8	0.30	0	0.21	0.11	0.006	**310**
	hand-weeding, irrigating, scouting, thinning (min development)	300	0.10	8	0.30	0	0.21	0.11	0.001	**1,600**
eggplant, peppers: bell, tomatoes	hand-harvesting, hand-pruning	1000	0.20	8	0.30	0	0.21	0.22	0.007	**240**
	irrigating, scouting	700	0.20	8	0.30	0	0.21	0.22	0.005	**340**
	hand-weeding, thinning	500	0.20	8	0.30	0	0.21	0.22	0.004	**470**

Appendix B/Table B10: Permethrin Non-cancer Postapplication Worker Risk Estimates from Agricultural Scenarios										
Crop	**Activity**	**TC cm^2/hr**	**Maximum Application Rate**	**Hours of Exposure**	**Dermal Absorption**	**DAT (days)**	**DFR ug/cm^2 from study**	**DFR ug/cm^2 normalized**	**Short-Intermediate-term Dose (mg/kg/day)**	**Short-Intermediate-term MOE**
cabbage	hand-harvesting, hand-pruning, irrigating	5000	0.20	8	0.30	0	0.21	0.22	0.037	47
		5000	0.20	8	0.30	3	0.08	0.08	0.015	**120**
	scouting	4000	0.20	8	0.30	0	0.21	0.22	0.030	59
		4000	0.20	8	0.30	3	0.08	0.08	0.012	**150**
	hand-weeding	2000	0.20	8	0.30	0	0.21	0.22	0.015	**120**
broccoli, brussel sprouts, cauliflower, chinese broccoli	hand-harvesting, hand-pruning, irrigating	5000	0.10	8	0.30	0	0.21	0.11	0.019	94
		5000	0.10	8	0.30	1	0.13	0.06	0.011	**160**
	scouting	4000	0.10	8	0.30	0	0.21	0.11	0.015	**120**
	hand-weeding	2000	0.10	8	0.30	0	0.21	0.11	0.007	**240**
collards	hand-harvesting	2500	0.10	8	0.30	0	0.21	0.11	0.009	**190**
	irrigating, scouting (all at medium development)	1500	0.10	8	0.30	0	0.21	0.11	0.006	**310**
	irrigating, scouting, thinning (all at min development)	500	0.10	8	0.30	0	0.21	0.11	0.002	**940**
chinese cabbage, leafy vegetables	hand-harvesting	2500	0.20	8	0.30	0	0.21	0.22	0.019	94
		2500	0.20	8	0.30	1	0.13	0.13	0.011	**160**
	irrigating, scouting (all at medium development)	1500	0.20	8	0.30	0	0.21	0.22	0.011	**160**
	irrigating, scouting, thinning (all at min development)	500	0.20	8	0.30	0	0.21	0.22	0.004	**470**
artichokes	hand-harvesting, hand-pruning	1000	0.30	8	0.30	0	0.21	0.32	0.011	**160**
	irrigating, scouting (all at medium development)	500	0.30	8	0.30	0	0.21	0.32	0.006	**310**
	irrigating, scouting, thinning (all at min development), hand weeding	300	0.30	8	0.30	0	0.21	0.32	0.003	**520**
cut flowers	Old Brouwer data - for comparative purposes only	7000	0.30	8	0.30	0	0.21	0.32	0.078	22
		7000	0.30	8	0.30	6	0.05	0.07	0.018	100
	cut roses	2600	0.30	8	0.30	0	0.21	0.32	0.029	60
		2600	0.30	8	0.30	1	0.13	0.19	0.017	**100**
	all flowers	500	0.30	8	0.30	0	0.21	0.32	0.006	**310**

Appendix B/Table B10: Permethrin Non-cancer Postapplication Worker Risk Estimates from Agricultural Scenarios										
Crop	**Activity**	**TC cm^2/hr**	**Maximum Application Rate**	**Hours of Exposure**	**Dermal Absorption**	**DAT (days)**	**DFR ug/cm^2 from study**	**DFR ug/cm^2 normalized**	**Short-Intermediate-term Dose (mg/kg/day)**	**Short-Intermediate-term MOE**
Short/Intermediate-Term Postapplication Risks (Calculated with Cotton DFR Study No MRID)										
conifer seed orchard	seed cone harvesting	3000	1.2	8	0.30	0	0.852	2.56	0.263	95
		3000	1.2	8	0.30	1	0.813	2.44	0.251	**100**
apples, pears	thinning	3000	0.4	8	0.30	0	0.852	0.85	0.088	**290**
	hand-harvesting, hand-pruning, propping, training	1500	0.4	8	0.30	0	0.852	0.85	0.044	**570**
	hand-weeding, irrigating, scouting	1000	0.4	8	0.30	0	0.852	0.85	0.029	**860**
almonds, filberts, pistachios, walnuts	hand-harvesting, hand-pruning	2500	0.4	8	0.30	0	0.852	0.85	0.073	**340**
cherries: sweet and sour, nectarines, peaches	thinning	3000	0.3	8	0.30	0	0.852	0.64	0.066	**380**
	hand-harvesting, hand-pruning	1500	0.3	8	0.30	0	0.852	0.64	0.033	**760**
	hand-weeding, irrigating, scouting	1000	0.3	8	0.30	0	0.852	0.64	0.022	**1,100**
avocados, conifer (field grown -christmas trees), papayas	hand-pruning	1500	0.2	8	0.30	0	0.852	0.43	0.022	**1,100**
	hand-weeding, scouting	1000	0.2	8	0.30	0	0.852	0.43	0.015	**1,700**
ornamentals	hand-pruning	400	0.2	8	0.30	0	0.852	0.43	0.006	**4,300**
	hand-pinching	175	0.2	8	0.30	0	0.852	0.43	0.003	**9,800**
	hand-harvesting	110	0.2	8	0.30	0	0.852	0.43	0.002	**16,000**
Short/Intermediate-Term Postapplication Risks (Calculated with Turf TTR Study MRID# 449555-01)										
turf	mowing	500	0.87	8	0.30	0	0.06	0.06	0.001	**1,400**

Appendix B/Table B11: Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate	Hours of Exposure	Dermal Absorption	DAT (days)	DFR ug/cm^2 from study	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
									LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
Occupational Postapplication Cancer Risk Estimates Calculated with Cotton DFR Study (MRID # 455705-25)												
alfalfa, soybeans	hand-harvesting	2500	0.20	8	0.30	DAT AVG 2-7	0.07	0.07	8.2e-05	7.9e-07	2.5e-04	2.4e-06
	irrigating, scouting (full development)	1500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	5.7e-05	5.4e-07	1.7E-04	1.6e-06
corn	detasseling, hand-harvesting	17000	0.20	8	0.30	DAT AVG 5-14	0.05	0.03	2.4e-04	2.3e-06	7.3e-04	7.0e-06
	irrigating, scouting (full development)	1000	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	3.8e-05	3.6e-07	1.1E-04	1.1e-06
cucurbits	hand-harvesting, hand-pruning	2500	0.20	8	0.30	DAT AVG 2-7	0.07	0.07	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	irrigating, scouting	1500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	5.7e-05	5.4e-07	1.7e-04	1.6e-06
	thinning	500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	1.9e-05	1.8e-07	5.7E-05	5.4e-07
onions: dry bulb, garlic	hand-harvesting	2500	0.30	8	0.30	DAT AVG 2-7	0.07	0.11	1.2e-04	1.2e-06	3.7E-04	3.5e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.30	8	0.30	DAT AVG 1-7	0.08	0.12	8.5e-05	8.2e-07	2.6E-04	2.4e-06
potatoes	hand-harvesting	2500	0.20	8	0.30	DAT AVG 2-7	0.13	0.13	1.5e-04	1.5e-06	4.6E-04	4.4e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	5.7e-05	5.4e-07	1.7E-04	1.6e-06
turnips	hand-harvesting	2500	0.10	8	0.30	DAT AVG 1-7	0.08	0.04	4.7e-05	4.5e-07	1.4E-04	1.4e-06
	hand-weeding, irrigating, scouting, thinning (full development)	1500	0.10	8	0.30	DAT AVG 1-7	0.08	0.04	2.8e-05	2.7e-07	8.5E-05	8.1e-07
eggplant, peppers: bell, tomatoes	hand-harvesting, hand-pruning	1000	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	3.8e-05	3.6e-07	1.1E-04	1.1e-06
	irrigating, scouting	700	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	2.7e-05	2.5e-07	8.0E-05	7.6e-07
	hand-weeding, thinning	500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	1.9e-05	1.8e-07	5.7E-05	5.4e-07

Appendix B/Table B11: Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios

Crop	Activity	TC cm^2/hr	Maximum Application Rate	Hours of Exposure	Dermal Absorption	DAT (days)	DFR ug/cm^2 from study	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
									LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
cabbage	hand-harvesting, hand-pruning, irrigating	5000	0.20	8	0.30	DAT AVG 4-7	0.05	0.05	1.3e-04	1.2e-06	3.9E-04	3.7e-06
	scouting	4000	0.20	8	0.30	DAT AVG 4-7	0.05	0.05	1.0e-04	9.9e-07	3.1E-04	3.0e-06
	hand-weeding	2000	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	7.6e-05	7.2e-07	2.3E-04	2.2e-06
broccoli, Brussel sprouts, cauliflower, Chinese broccoli	hand-harvesting, hand-pruning, irrigating	5000	0.10	8	0.30	DAT AVG 2-7	0.07	0.04	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	scouting	4000	0.10	8	0.30	DAT AVG 1-7	0.08	0.04	7.6e-05	7.2e-07	2.3E-04	2.2e-06
	hand-weeding	2000	0.10	8	0.30	DAT AVG 1-7	0.08	0.04	3.8e-05	3.6e-07	1.1E-04	1.1e-06
collards	hand-harvesting	2500	0.10	8	0.30	DAT AVG 1-7	0.08	0.04	4.7e-05	4.5e-07	1.4E-04	1.4e-06
	irrigating, scouting, thinning (all at medium development)	1500	0.10	80.30		DAT AVG 1-7	0.08	0.04	2.8e-05	2.7e-07	8.5E-05	8.1e-07
Chinese cabbage, leafy vegetables	hand-harvesting	2500	0.20	8	0.30	DAT AVG 2-7	0.07	0.07	8.2e-05	7.9e-07	2.5E-04	2.4e-06
	irrigating, scouting, thinning (all at medium development)	1500	0.20	8	0.30	DAT AVG 1-7	0.08	0.08	5.7e-05	5.4e-07	1.7e-04	1.6e-06
artichokes	hand-harvesting, hand-pruning	1000	0.30	8	0.30	DAT AVG 1-7	0.08	0.12	5.7e-05	5.4e-07	1.7E-04	1.6e-06
	irrigating, scouting, thinning (all at medium development)	500	0.30	8	0.30	DAT AVG 1-7	0.08	0.12	2.8e-05	2.7e-07	8.5E-05	8.1e-07
cut flowers	Old Brouwer data - for comparative purposes only	7000	0.30	8	0.30	DAT AVG 5-7	0.05	0.07	2.4e-04	2.3e-06	7.3E-04	7.0e-06
	cut roses	2600	0.30	8	0.30	DAT AVG 2-7	0.07	0.11	1.3e-04	1.2e-06	3.8E-04	3.7e-06
	all flowers	500	0.30	8	0.30	DAT AVG 1-7	0.08	0.12	2.8e-05	2.7e-07	8.5E-05	8.1e-07
Occupational Postapplication Cancer Risk Estimates Calculated with Peach DFR Study (MRID # 437557-01)												
conifer seed orchard	seed cone harvesting	3000	1.2	8	0.30	AVG DAT 2-28	0.479	1.44	2.0e-03	1.9e-05	6.1E-03	5.8e-05
apples, pears	thinning	3000	0.4	8	0.30	AVG DAT 1-7	0.709	0.71	1.0e-03	9.6e-06	3.0E-03	2.9e-05
	hand-harvesting, hand-pruning, propping, training	1500	0.4	8	0.30	AVG DAT 1-7	0.709	0.71	5.0e-04	4.8e-06	1.5E-03	1.4e-05
	hand-weeding, irrigating, scouting	1000	0.4	8	0.30	AVG DAT 1-7	0.709	0.71	3.3e-04	3.2e-06	1.0E-03	9.6e-06

Appendix B/Table B11: Permethrin Cancer Postapplication Worker Risk Estimates for Agricultural Scenarios												
Crop	Activity	TC cm^2/hr	Maximum Application Rate	Hours of Exposure	Dermal Absorption	DAT (days)	DFR ug/cm^2 from study	DFR ug/cm^2 normalized	10 Days per Year		30 Days per year	
									LADD (mg/kg/day)	Cancer risk	LADD (mg/kg/day)	Cancer risk
almonds, filberts, pistachios, walnuts	hand-harvesting, hand-pruning	2500	0.4	8	0.30	AVG DAT 1-7	0.709	0.71	8.3e-04	8.0e-06	2.5E-03	2.4e-05
	irrigating, scouting, thinning	500	0.4	8	0.30	AVG DAT 1-7	0.709	0.71	1.7e-04	1.6e-06	5.0E-04	4.8e-06
cherries: sweet and sour, nectarines, peaches	thinning	3000	0.3	8	0.30	AVG DAT 1-7	0.709	0.53	7.5e-04	7.2e-06	2.2E-03	2.2e-05
	hand-harvesting, hand-pruning	1500	0.3	8	0.30	AVG DAT 1-7	0.709	0.53	3.7e-04	3.6e-06	1.1E-03	1.1e-05
	hand-weeding, irrigating, scouting	1000	0.3	8	0.30	AVG DAT 1-7	0.709	0.53	2.5e-04	2.4e-06	7.5E-04	7.2e-06
avocados, conifer (field grown-Christmas trees), papayas	thinning	3000	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	5.0e-04	4.8e-06	1.5E-03	1.4e-05
	hand-pruning	1500	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	2.5e-04	2.4e-06	7.5E-04	7.2e-06
	hand-weeding, scouting	1000	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	1.7e-04	1.6e-06	5.0E-04	4.8e-06
ornamentals	hand-pruning	400	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	6.7e-05	6.4e-07	2.0E-04	1.9e-06
	hand-pinching	175	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	2.9e-05	2.8e-07	8.7E-05	8.4e-07
	hand-harvesting	110	0.2	8	0.30	AVG DAT 1-7	0.709	0.35	1.8e-05	1.8e-07	5.5E-05	5.3e-07
Occupational Postapplication Cancer Risks Calculated with Turf TTR Study (MRID # 449555-01)												
turf	mowing	500	0.87	8	0.30	DAT AVG 1-14	0.03	0.03	6.3e-06	6.1e-08	1.9e-05	1.8e-07

Appendix C: Residential Handler Exposures

Appendix C/Table C1: Sources of Exposure Data Used In The Residential Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Mixer/Loader/Applicator Descriptors			
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (1)	ORETF Chemical Handler Exposure Studies	2 animals for applications to dog and horses, 5 gallons for all other applications	**Baseline:** Dermal, inhalation, and hands = A grade. Dermal, inhalation, and hands = 20 replicates each. High confidence in all data. **PPE and Engineering Controls:** Not required for assessment.
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack Sprayer (2)	PHED V1.1	2 animals for applications to horses, 5 gallons for all other applications	**Baseline:** Dermal = AB grades; Hands = C grades; and Inhalation = A grades. Dermal = 9 to 11 replicates; Hands = 11 replicates; and Inhalation = 11 replicates. Low confidence in dermal, inhalation, and hand data due to inadequate replicate number. No protection factor was needed to define the unit exposure values.
Mixing/Loading/Applying Emulsifiable Concentrates with Hose-End Sprayer (ORETF data) (3)	ORETF Chemical Handler Exposure Studies	0.5 acres for turf, 100 gallons for all other applications	**Baseline:** Dermal, inhalation, and hands = A grade. Dermal, inhalation, and hands = 20 replicates each. High confidence in all data. **PPE and Engineering Controls:** Not required for assessment.
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF hose-end sprayer data) (4)	ORETF Chemical Handler Exposure Studies	5 gallons	ORETF exposure data for mixing/loading/applying liquids via hose-end sprayer (scenario 3) was used as a surrogate for mixing/loading/applying liquids with a watering can.
Loading/Applying Emulsifiable Concentrates with a Paint Brush (5)	PHED V1.1	1 gallon	**Baseline:** Dermal = C grades; Hands = B grades; and Inhalation = C grades. Dermal = 14 to 15 replicates; Hands = 15 replicates; and Inhalation = 15 replicates. Low to medium confidence in dermal and hand data due to inadequate replicate number. Medium confidence in inhalation data. No protection factor was needed to define the unit exposure values.
Mixing/Loading/Applying Emulsifiable Concentrates via Sponge (6)	CMA	2 gallons	
Loading/Applying Granular Formulations with Push Type Spreader (ORETF data) (7)	ORETF Chemical Handler Exposure Studies	0.5 acres for turf applications; and 1,000 sq ft for building perimeter applications	**Baseline: The only empirical data that are available are based on the use of no protective clothing.**
Loading/Applying Granular Formulations with a Belly Grinder (8)	PHED V1.1	0.5 acres for turf applications; and 1,000 sq ft for building perimeter applications	**Baseline:** Hands = ABC grades; dermal = ABC grades; and inhalation = AB grades. Dermal = 20 to 45 replicates; hands = 23 replicates; and inhalation = 40 replicates. Medium confidence in dermal and hand data. No protection factor was needed to define the unit exposure values.
Loading/applying granules using a spoon, measuring scoop, shaker can, or by hand (9)	Review of fipronil granular mixer/loader/applicator study as a source of surrogate data, MRID 452507-01. J. Dawson memo, D270065, 1/5/01.	5 mounds for ants and fire ants	**Baseline:** A 90% protection factor was applied to gloved hands data to back calculate "no glove" hand exposure. A standard 50% protection factor was used for the torso. A 10% protection factor was used to represent the protection afforded by shorts and a short-sleeved shirt.
Loading/Applying Dusts via Spoon or Cup (10)	MRID 444598-01	5 mounds for fire ants	**Baseline:** A total of 20 replicates were monitored in this study. No individuals wore gloves. The clothing scenario represents short-sleeved shirt, short pants, and no gloves. The data are considered high quality by the Agency.
Loading/Applying Dusts via Shaker Can (11)	MRID 444598-01	1/10th of a container for applications to animal premises; 2 animals for dogs and cats; 1 container for ornamental and garden ornamentals; and 1,000 sq ft for indoor surfaces	A total of 20 replicates were monitored in this study. No individuals wore gloves. The clothing scenario represents short-sleeved shirt, short pants, and no gloves. The data are considered high quality by the Agency.

Appendix C/Table C1: Sources of Exposure Data Used In The Residential Permethrin Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day) [a]	Comments[b, c]
Mixing/Loading/Applying Dusts via Rotary Duster/Dust Gun (12)	No Data	1 container for ornamental and garden ornamentals	There is no PHED general or chemical specific data for this scenario.
Mixing/Loading/Applying Dusts via FPO Puffer Can (13)	No Data	1 container for ornamental and garden ornamentals	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Liquid Formulations via Open Pour (14)	PHED V1.1	2 animals for horses, 1 container for clothing treatment	PHED exposure data for occupational mixing/loading emulsifiable concentrates was used as a surrogate for applying ready to use liquid formulations via open pour.
Applying Ready to Use Cream Formulations via Applicator Tube (15)	No Data	2 animals for dogs	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Formulations (Shampoos) via Hands (16)	No Data	2 animals for dogs and cats	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Formulations via RTU Wipe (17)	CMA	2 animals for dogs and horses	
Applying Ready to Use Formulations via Trigger Pump Sprayer (18)	MRID 410547-01	2 animals for horses; 1 gallon for indoor surfaces and outdoor ornamentals; ½ of a 16 ounce bottle for applications to dogs and cats	**Baseline: The only empirical data that are available are based on the use of no protective clothing.**
Applying Ready to Use Formulations with Aerosol Cans (19)	PHED V1.1	½ of a 16 oz can for applications to dogs and cats (including premises); 1 (16 oz) can for all other applications	**Baseline:** Dermal and inhalation = ABC grade. Hands = A grade. Dermal = 30 replicates; Hands = 15 replicates; and Inhalation = 30 replicates. Medium confidence in all data. No protection factor was needed to define the unit exposure values.
Applying Ready to Use Formulations with Foggers (20)	PHED V1.1	2 foggers	PHED exposure data for aerosol can application (scenario 21) was used as a surrogate for fogger applications.
Applying Ready to Use Tubes (21)	No Data	No Data	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Coasters (22)	No Data	No Data	There is no PHED general or chemical specific data for this scenario.
Applying Ready to Use Protective Flanges (23)	No Data	No Data	There is no PHED general or chemical specific data for this scenario.

PPE and Engineering Controls data are not required for this assessment.

a All *Standard Assumptions* are based on an 8-hour work day as estimated by HED. BEAD data were not available.

b All handler exposure assessments in this document are based on the "Best Available" data as defined by the PHED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows:

High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates.

c **PHED grading criteria do not reflect overall quality of the reliability of the assessment. Sources of the exposure factors should also be considered in the risk management decision.**

Appendix C/Table C2: Short-Term Baseline Permethrin Residential Handler Noncancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Dermal			Inhalation			Dermal + Inhalation MOE
						Exposure	Dose	MOE	Exposure	Dose	MOE	
Mixer/Loader/Applicator												
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (1)	outdoor surfaces	0.046 lb ai/gal	5 gals	56	3.8	13	0.055	450	0.00087	0.000012	880000	450
	ornamentals: outdoor trees	0.043 lb ai/gal	5 gals	56	3.8	12	0.052	480	0.00082	0.000012	940000	480
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gal	5 gals	56	3.8	11	0.048	520	0.00076	0.000011	1000000	520
	ornamentals: outdoor	0.02 lb ai/gal	5 gals	56	3.8	5.6	0.024	1000	0.00038	0.0000054	2000000	1000
	turf	0.005 lb ai/gal	5 gals	56	3.8	1.4	0.006	4200	0.000095	0.0000014	8100000	4200
	almonds, filberts, pears, pistachios	0.004 lb ai/gal	5 gals	56	3.8	1.1	0.0048	5200	0.000076	0.0000011	10000000	5200
	apples, peaches	0.0033 lb ai/gal	5 gals	56	3.8	0.92	0.004	6300	0.000063	0.0000009	12000000	6300
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gal	5 gals	56	3.8	0.56	0.0024	10000	0.000038	0.00000054	20000000	10000
	asparagus, broccoli, brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gal	5 gals	56	3.8	0.34	0.0014	17000	0.000023	0.00000033	34000000	17000
	fire ant mounds	0.1 lb ai/mound	5 gals	56	3.8	28	0.12	210	0.0019	0.000027	410000	210
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	56	3.8	0.084	0.00036	69000	5.7E-06	8.1E-08	140000000	69000
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack Sprayer (2)	outdoor surfaces	0.046 lb ai/gal	5 gals	5.1	30	1.2	0.005	5000	0.0069	0.000099	110000	4800
	ornamentals: outdoor trees	0.043 lb ai/gal	5 gals	5.1	30	1.1	0.0047	5300	0.0065	0.000092	120000	5100
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gal	5 gals	5.1	30	1	0.0044	5700	0.006	0.000086	130000	5500
	ornamentals: outdoor	0.02 lb ai/gal	5 gals	5.1	30	0.51	0.0022	11000	0.003	0.000043	260000	11000
	turf	0.005 lb ai/gal	5 gals	5.1	30	0.13	0.00055	46000	0.00075	0.000011	1000000	44000
	almonds, filberts, pears, pistachios	0.004 lb ai/gal	5 gals	5.1	30	0.1	0.00044	57000	0.0006	0.0000086	1300000	55000
	apples, peaches	0.0033 lb ai/gal	5 gals	5.1	30	0.084	0.00036	69000	0.0005	0.0000071	1600000	66000
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gal	5 gals	5.1	30	0.051	0.00022	110000	0.0003	0.0000043	2600000	110000
	asparagus, broccoli, brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gal	5 gals	5.1	30	0.031	0.00013	190000	0.00018	0.0000026	4300000	180000
	fire ant mounds	0.1 lb ai/mound	5 gals	5.1	30	2.6	0.011	2300	0.015	0.00021	51000	2200
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	5.1	30	0.0077	0.000033	760000	0.000045	0.00000064	17000000	730000

Appendix C/Table C2: Short-Term Baseline Permethrin Residential Handler Noncancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Dermal			Inhalation			Dermal + Inhalation MOE
						Exposure	Dose	MOE	Exposure	Dose	MOE	
Mixing/Loading/Applying Emulsifiable Concentrates with Hose-End Sprayer (ORETF data) (3)	turf	0.087 lb ai/acre	0.5 acres	11	17	0.48	0.0021	12000	0.00074	0.000011	1000000	12000
	ornamentals: outdoor trees	0.043 lb ai/gal	100 gals	11	17	47	0.2	120	0.073	0.001	11000	120
	stored lumber, wood piles	0.04 lb ai/gal	100 gals	11	17	44	0.19	130	0.068	0.00097	11000	130
	ornamentals: outdoor	0.02 lb ai/gal	100 gals	11	17	22	0.094	270	0.034	0.00049	23000	260
	almonds, filberts, pears, pistachios	0.004 lb ai/gal	100 gals	11	17	4.4	0.019	1300	0.0068	0.000097	110000	1300
	apples, peaches	0.003 lb ai/gal	100 gals	11	17	3.3	0.014	1800	0.0051	0.000073	150000	1700
	cherries; ornamentals: outdoor herbaceous/ woody plants & shrubs	0.002 lb ai/gal	100 gals	11	17	2.2	0.0094	2700	0.0034	0.000049	230000	2600
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (4)	fire ant mounds	0.1 lb ai/mound	5 gals	11	17	5.5	0.024	1100	0.0085	0.00012	91000	1000
	stored lumber, wood piles	0.04 lb ai/gal	5 gals	11	17	2.2	0.0094	2700	0.0034	0.000049	230000	2600
	ornamentals: indoor	0.0017 lb ai/gal	5 gals	11	17	0.094	0.0004	62000	0.00014	0.0000021	5300000	62000
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (5)	outdoor wood surfaces; outdoor surfaces	0.04 lb ai/gal	1 gal	230	284	9.2	0.039	630	0.011	0.00016	68000	630
Mixing/Loading/Applying Emulsifiable Concentrates via Sponge (CMA data) (6)	horses	0.005 lb ai/gal	2 gals	2870	27700	29	0.12	200	0.28	0.004	2800	190
Loading/Applying Granulars via Push Type Spreader (ORETF data) (7)	turf	0.65 lb ai/acre	0.5 acres	0.68	0.91	0.22	0.00095	26000	0.0003	0.0000042	2600000	26000
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	0.68	0.91	0.054	0.00023	110000	0.000073	0.000001	11000000	110000
Loading/Applying Granulars via Belly Grinder (8)	turf	0.65 lb ai/acre	0.5 acres	110	62	36	0.15	160	0.02	0.00029	38000	160
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	110	62	8.8	0.038	660	0.005	0.000071	160000	660
Loading/Applying Granulars via Spoon or Cup (MRID 452507-01) (9)	fire ant mounds	0.00125 lb ai/mound	5 mounds	1.978	45	0.012	0.000053	470000	0.00028	0.000004	2700000	400000
	ant mounds	0.000078 lb ai/mound	5 mounds	1.978	45	0.00077	0.0000033	7600000	0.000018	0.00000025	44000000	6500000
Loading/Applying Dusts via Spoon or Cup (MRID 444598-01) (10)	fire ant mounds	0.00156 lb ai/mound	5 mounds	148	870	1.2	0.0049	5100	0.0068	0.000097	110000	4800

Appendix C/Table C2: Short-Term Baseline Permethrin Residential Handler Noncancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Dermal			Inhalation			Dermal + Inhalation MOE
						Exposure	Dose	MOE	Exposure	Dose	MOE	
Mixing/Loading/Applying Dusts via Shaker Can (MRID 444598-01) (11)	indoor surfaces	0.05 lb ai/1000 sq ft	1000 sq ft	148	870	7.4	0.032	790	0.044	0.00062	18000	750
	apples, asparagus, broccoli, brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	148	870	0.37	0.0016	16000	0.0022	0.000031	350000	15000
	animal premises: dogs and cats	0.0025 lb ai/1lb container	0.1 lb container	148	870	0.037	0.00016	160000	0.00022	0.0000031	3500000	150000
	animal: dogs, cats	0.00016 lb ai/animal	2 animals	3300	25000	1.1	0.0045	5500	0.008	0.00011	96000	5200
Mixing/Loading/Applying Dusts via Rotary Duster/Dust Gun (12)	apples, asparagus, broccoli, brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb containers	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Mixing/Loading/Applying Dusts via FPO Puffer Can (13)	garden vegetables, ornamentals	0.00125 lb ai/1lb container	1 lb containers	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Formulations via Pour-on (using PHED liquid mixer/loader data) (14)	animal: horses	0.005 lb ai/animal	2 animals	2.9	1.2	0.029	0.00012	200000	0.000012	0.00000017	64000000	200000
	clothing: personal	0.002 lb ai/6 oz container	1 container	2.9	1.2	0.0058	0.000025	1000000	2.4E-06	3.4E-08	320000000	1000000
Applying Ready to Use Cream Formulations via Applicator Tube (MRID 446584-01) (15)	animal: dogs	0.003 lb ai/animal	2 animals	1800	0.00012	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Formulations via Hands (MRID 446584-01) (16)	animal: dogs, cats	0.0014 lb ai/animal	2 animals	1800	0.00012	5	0.022	1200	3.4E-10	4.8E-12	2.3E+12	1200
Applying Ready to Use Formulations via RTU Wipe (CMA data) (17)	animal: dogs & horses	0.0062 lb ai/animal	2 animals	2870	27700	36	0.15	160	0.34	0.0049	2200	150

Appendix C/Table C2: Short-Term Baseline Permethrin Residential Handler Noncancer Risk Estimates

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Dermal			Inhalation			Dermal + Inhalation MOE
						Exposure	Dose	MOE	Exposure	Dose	MOE	
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur study) (18)	ornamentals: outdoors; indoor surfaces	0.043 lb ai/gal	1 gal	13.5	123	0.58	0.0025	10000	0.0053	0.000076	150000	9400
	animal: dogs	0.00034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	13.5	123	0.037	0.00016	160000	0.00033	0.0000048	2300000	150000
	animal: cats	0.000034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	13.5	123	0.0037	0.000016	1600000	0.000033	0.00000048	23000000	1500000
	animal: horses, foals	0.016 lb ai/animal	2 animals	13.5	123	0.43	0.0019	14000	0.0039	0.000056	200000	13000
Applying Ready to Use Formulations with Aerosol Cans (19)	outdoor & indoor surfaces	0.00438 lb ai/16 oz can	1sixteen-ounce aerosol cans	220	2400	0.96	0.0041	6100	0.011	0.00015	73000	5600
	animal: dogs & cats; animal premises: dogs and cats	0.000538 lb ai/16 oz can	0.5 sixteen-ounce aerosol cans	220	2400	0.059	0.00025	99000	0.00065	0.0000092	1200000	91000
	ornamentals: indoor & outdoor	0.00213 lb ai/16 oz can	1sixteen-ounce aerosol cans	220	2400	0.47	0.002	12000	0.0051	0.000073	150000	11000
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (20)	indoor spaces	0.0023 lb ai/6 oz fogger	2six ounce fogger treats 6000 cubic feet	220	2400	1	0.0043	5800	0.011	0.00016	70000	5300
Applying Ready to Use Tubes (21)	outdoor surfaces	0.000733 lb ai/tube		No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Coasters (22)	ants			No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Protective Flanges (23)	ants			No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Footnotes

a Application rates are the maximum application rates provided by for permethrin in all cases.

b Amount handled per day values are HED estimates of area treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.

Appendix C/Table C3: **Permethrin Baseline Residential Handler Cancer Risk Estimates**

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Absorbed Daily Dermal Dose (mg/kg/day)	Daily Inhalation Dose (mg/kg/day)	Daily Total Dose (mg/kg/day)	Total LADD (mg/kg/day)	Cancer Risk [c]	Days/ Year to Reach LOC
Mixer/Loader/Applicator											
Mixing/Loading/Applying Emulsifiable Concentrates with Low Pressure Handwand (1)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	100	30	0.098571	9.9e-05	0.099	1.9E-04	1.8E-06	< 1
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	100	30	0.092143	9.2e-05	0.092	1.8E-04	1.7E-06	< 1
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	100	30	0.085714	8.6e-05	0.086	1.7E-04	1.6E-06	< 1
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	100	30	0.042857	4.3e-05	0.043	8.4E-05	8.0E-07	2
	turf	0.005 lb ai/gallon	5 gallons	100	30	0.010714	1.1e-05	0.011	2.1E-05	2.0E-07	4
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	100	30	0.008571	8.6e-06	0.0086	1.7E-05	1.6E-07	6
	apples, peaches	0.0033 lb ai/gallon	5 gallons	100	30	0.007071	7.1e-06	0.0071	1.4E-05	1.3E-07	7
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	100	30	0.004286	4.3e-06	0.0043	8.4E-06	8.0E-08	12
	asparagus, broccoli, brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	100	30	0.002571	2.6e-06	0.0026	5.0E-06	4.8E-08	20
	fire ant mounds	0.1 lb ai/mound	5 mounds	100	30	0.214286	2.1e-04	0.21	4.2E-04	4.0E-06	
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	100	30	0.000643	6.4e-07	0.00064	1.3E-06	1.2E-08	83
Mixing/Loading/Applying Emulsifiable Concentrates with Backpack Sprayer (2)	outdoor surfaces	0.046 lb ai/gallon	5 gallons	5.1	30	0.005027	9.9e-05	0.0051	1.0E-05	9.6E-08	10
	ornamentals: outdoor trees	0.043 lb ai/gallon	5 gallons	5.1	30	0.004699	9.2e-05	0.0048	9.4E-06	9.0E-08	11
	perimeter treatment, outdoor wood surfaces	0.04 lb ai/gallon	5 gallons	5.1	30	0.004371	8.6e-05	0.0045	8.7E-06	8.3E-08	11
	ornamentals: outdoor	0.02 lb ai/gallon	5 gallons	5.1	30	0.002186	4.3e-05	0.0022	4.4E-06	4.2E-08	23
	turf	0.005 lb ai/gallon	5 gallons	5.1	30	0.000546	1.1e-05	0.00056	1.1E-06	1.0E-08	95
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	5 gallons	5.1	30	0.000437	8.6e-06	0.00045	8.7E-07	8.3E-09	119
	apples, peaches	0.0033 lb ai/gallon	5 gallons	5.1	30	0.000361	7.1e-06	0.00037	7.2E-07	6.9E-09	145
	celery, cherries, eggplant, horseradish, head lettuce, ornamentals: indoor, ornamentals: outdoor (trees, shrubs, roses, flowers, woody plants), potatoes, peppers, sweet corn; animal premises: dogs	0.002 lb ai/gallon	5 gallons	5.1	30	0.000219	4.3e-06	0.00022	4.4E-07	4.2E-09	239
	asparagus, broccoli, brussel sprouts, cabbage, cauliflower, spinach	0.0012 lb ai/gallon	5 gallons	5.1	30	0.000131	2.6e-06	0.00013	2.6E-07	2.5E-09	365
	fire ant mounds	0.1 lb ai/mound	5 mounds	5.1	30	0.010929	2.1e-04	0.011	2.2E-05	2.1E-07	4
	animal: dogs, horses	0.00075 lb ai/animal	2 animals	5.1	30	3.28E-05	6.4e-07	0.000033	6.5E-08	6.3E-10	365
Mixing/Loading/Applying Emulsifiable Concentrates with Hose-End Sprayer (ORETF data) (3)	turf	0.087 lb ai/acre	0.5 acres	11	16	0.002051	9.9e-06	0.0021	4.0E-06	3.9E-08	25
	ornamentals: outdoor trees	0.043 lb ai/gallon	100 gallons	11	16	0.202714	9.8e-04	0.2	4.0E-04	3.8E-06	< 1
	stored lumber, wood piles	0.04 lb ai/gallon	100 gallons	11	16	0.188571	9.1e-04	0.19	3.7E-04	3.5E-06	< 1
	ornamentals: outdoor	0.02 lb ai/gallon	100 gallons	11	16	0.094286	4.6e-04	0.095	1.9E-04	1.8E-06	< 1
	almonds, filberts, pears, pistachios	0.004 lb ai/gallon	100 gallons	11	16	0.018857	9.1e-05	0.019	3.7E-05	3.5E-07	2
	apples, peaches	0.003 lb ai/gallon	100 gallons	11	16	0.014143	6.9e-05	0.014	2.8E-05	2.7E-07	3
	cherries; ornamentals: outdoor herbaceous/ woody plants & shrubs	0.002 lb ai/gallon	100 gallons	11	16	0.009429	4.6e-05	0.0095	1.9E-05	1.8E-07	5

Appendix C/Table C3: **Permethrin Baseline Residential Handler Cancer Risk Estimates**											
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Absorbed Daily Dermal Dose (mg/kg/day)	Daily Inhalation Dose (mg/kg/day)	Daily Total Dose (mg/kg/day)	Total LADD (mg/kg/day)	Cancer Risk [c]	Days/ Year to Reach LOC
Mixing/Loading/Applying Emulsifiable Concentrates with a Watering Can (using ORETF residential hose-end data) (4)	fire ant mounds	0.1 lb ai/mound	5 mounds	11	16	0.023571	1.1e-04	0.024	4.6E-05	4.4E-07	2
	stored lumber, wood piles	0.04 lb ai/gallon	5 gallons	11	16	0.009429	4.6e-05	0.0095	1.9E-05	1.8E-07	5
	ornamentals: indoor	0.0017 lb ai/gallon	5 gallons	11	16	0.000401	1.9e-06	0.0004	7.9E-07	7.5E-09	132
Mixing/Loading/Applying Emulsifiable Concentrates with a Paint Brush (5)	outdoor wood surfaces; outdoor surfaces	0.04 lb ai/gallon	1 gallon	230	284	0.039429	1.6e-04	0.04	7.7E-05	7.4E-07	2
Mixing/Loading/Applying Emulsifiable Concentrates via Sponge (CMA data) (6)	horses	0.005 lb ai/gallon	2 animals	2870	27700	0.123	4.0e-03	0.13	2.5E-04	2.4E-06	2
Loading/Applying Granulars via Push Type Spreader (ORETF data) (7)	turf	0.65 lb ai/acre	0.5 acres	0.68	0.91	0.000947	4.2e-06	0.00095	1.9E-06	1.8E-08	56
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	0.68	0.91	0.000233	1.0e-06	0.00023	4.6E-07	4.4E-09	228
Loading/Applying Granulars via Belly Grinder (8)	turf	0.65 lb ai/acre	0.5 acres	110	62	0.153214	2.9e-04	0.15	3.0E-04	2.9E-06	2
	perimeter treatment	0.08 lb ai/1000 sq ft	1000 sq ft	110	62	0.037714	7.1e-05	0.038	7.4E-05	7.1E-07	2
Loading/Applying Granulars via Spoon or Cup (MRID 452507-01) (9)	fire ant mounds	0.00125 lb ai/mound	5 mounds	1.978	45	5.3E-05	4.0e-06	0.000057	1.1E-07	1.1E-09	365
	ant mounds	0.000078 lb ai/mound	5 mounds	1.978	45	3.31E-06	2.5e-07	3.6E-06	7.0E-09	6.7E-11	365
Loading/Applying Dusts via Spoon or Cup (MRID 444598-01) (10)	fire ant mounds	0.00156 lb ai/mound	5 mounds	148	870	0.004947	9.7e-05	0.005	9.9E-06	9.4E-08	10
Mixing/Loading/Applying Dusts via Shaker Can (MRID 444598-01) (11)	indoor surfaces	0.05 lb ai/1000 sq ft	1000 sq ft	148	870	0.031714	6.2e-04	0.032	6.3E-05	6.1E-07	2
	apples, asparagus, broccoli, brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	148	870	0.001586	3.1e-05	0.0016	3.2E-06	3.0E-08	33
	animal premises: dogs and cats	0.0025 lb ai/1lb container	1/10th of a 1 lb container	148	870	0.000159	3.1e-06	0.00016	3.2E-07	3.0E-09	330
	animal: dogs, cats	0.00016 lb ai/animal	2 animals	148	870	0.000203	4.0e-06	0.00021	4.0E-07	3.9E-09	258

Appendix C/Table C3: **Permethrin Baseline Residential Handler Cancer Risk Estimates**

Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Absorbed Daily Dermal Dose (mg/kg/day)	Daily Inhalation Dose (mg/kg/day)	Daily Total Dose (mg/kg/day)	Total LADD (mg/kg/day)	Cancer Risk [c]	Days/ Year to Reach LOC
Mixing/Loading/Applying Dusts via Rotary Duster/Dust Gun (12)	apples, asparagus, broccoli, brussel sprouts, cauliflower, cabbage, celery, cucumber, eggplant, garlic, head & leaf lettuce, muskmelon, onion: dry bulb, parsley, peaches, pepper: bell, potato, pumpkin, rhubarb, spinach, squash, sweet corn, tomato, walnuts	0.0025 lb ai/1lb container	1 lb container	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Mixing/Loading/Applying Dusts via FPO Puffer Can (13)	garden vegetables, ornamentals	0.00125 lb ai/1lb container	1 lb container	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Formulations via Pour-on (using PHED liquid mixer/loader data) (14)	animal: horses	0.005 lb ai/animal	2 animals	2.9	1.2	0.000124	1.7e-07	0.00012	2.4E-07	2.3E-09	365
	clothing: personal	0.002 lb ai/gallon	1 container	2.9	1.2	2.49E-05	3.4e-08	0.000025	4.9E-08	4.7E-10	365
Applying Ready to Use Cream Formulations via Applicator Tube (15)	animal: dogs	0.003 lb ai/animal	2 animals	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Formulations via Hands (16)	animal: dogs, cats	0.0014 lb ai/animal	2 animals	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Formulations via RTU Wipe (CMA data) (17)	animal: dogs & horses	0.0062 lb ai/animal	2 animals	2870	27700	0.15252	4.9e-03	0.16	3.1E-04	2.9E-06	< 1
Applying Ready to Use Formulations via Trigger-Pump Sprayer (using Propoxur study) (18)	ornamentals: outdoors; indoor surfaces	0.043 lb ai/gallon	1 gallon	13.5	123	0.002488	7.6e-05	0.0026	5.0E-06	4.8E-08	20
	animal: dogs	0.00034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	13.5	123	0.000157	4.8e-06	0.00016	3.2E-07	3.0E-09	329
	animal: cats	0.000034 lb ai/ounce	8 ounces (assume ½ 16 oz bottle)	13.5	123	1.57E-05	4.8e-07	0.000016	3.2E-08	3.0E-10	365
	animal: horses, foals	0.016 lb ai/animal	2 animals	13.5	123	0.001851	5.6e-05	0.0019	3.7E-06	3.6E-08	27
Applying Ready to Use Formulations with Aerosol Cans (19)	outdoor & indoor surfaces	0.00438 lb ai/16 oz can	1 sixteen-ounce aerosol can	220	2400	0.00413	1.5e-04	0.0043	8.4E-06	8.0E-08	12
	animal: dogs & cats; animal premises: dogs and cats	0.000538 lb ai/16 oz can	0.5 sixteen-ounce aerosol cans	220	2400	0.000254	9.2e-06	0.00026	5.1E-07	4.9E-09	203
	ornamentals: indoor & outdoor	0.002 lb ai/16 oz can	1 sixteen-ounce aerosol cans	220	2400	0.002008	7.3e-05	0.0021	4.1E-06	3.9E-08	25
Applying Ready to Use Formulations with Foggers (using PHED aerosol data) (20)	indoor spaces	0.002 lb ai/6 oz fogger	2 animals	220	2400	0.004337	1.6e-04	0.0045	8.8E-06	8.4E-08	11

Appendix C/Table C3: **Permethrin Baseline Residential Handler Cancer Risk Estimates**											
Exposure Scenario	Crop or Target	Application Rate [a]	Area Treated Daily [b]	Dermal Unit Exposure (mg/lb ai)	Inhalation Unit Exposure (ug/lb ai)	Absorbed Daily Dermal Dose (mg/kg/day)	Daily Inhalation Dose (mg/kg/day)	Daily Total Dose (mg/kg/day)	Total LADD (mg/kg/day)	Cancer Risk [c]	Days/ Year to Reach LOC
Applying Ready to Use Tubes (21)	outdoor surfaces	0.000733	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Coasters (22)	ants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Applying Ready to Use Protective Flanges (23)	ants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Footnotes

a Application rates are the maximum application rates provided by for permethrin in all cases.

b Amount handled per day values are HED estimates of area treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.

c Cancer risk estimates were calculated for an annual frequency of 1 time per year.

Appendix D: Residential Postapplication Exposures

Appendix D/Table D7 - Oral Exposure from Hand-to-Mouth Activity on Permethrin Treated Turf										
Exposure Scenario	Application Rate (lb ai/acre)	TTR on DAT0 (ug/cm^2)	Normalized TTR on DAT0 (ug/cm^2)	Surface area (cm^2)	Hand to Mouth (events/hr)	Extraction by Saliva	Exposure Time	Body Weight (kg)	Average Daily Dose (mg/kg/day)	Oral MOE (Target = 100)
Hand to Mouth (turf)	0.87	0.0606	0.0606	20	20	50%	2	15	0.00162	15,000

$$ADD = \frac{(TTR_0 * SA * FQ * ET * SE * CF1)}{BW}$$

Where:

ADD = average daily dose (mg/kg/day);
TTR_t = turf transferable residue on day "0" ($\mu g/cm^2$);
SA = surface area of the hands (20 cm^2/event);
FQ = frequency of hand-to-mouth activity (20 events/hr);
ET = exposure time (2 hr/day);
SE = extraction by saliva (50%);
CF1 = weight unit conversion factor to convert µg units in the DFR value to mg for the daily exposure (0.001 mg/µg); and
BW = body weight (15 kg).

Appendix D/Table D2 - Oral Exposure from Mouthing Permethrin Treated Turf							
Exposure Scenario	Application Rate (lb ai/acre)	TTR on DAT0 (ug/cm^2)	Normalized TTR on DAT0 (ug/cm^2)	Surface area (cm^2)	Body Weight (kg)	Average Daily Dose (mg/kg/day)	Oral MOE (Target = 100)
Object to Mouth (turf)	0.87	0.0606	0.0606	25	15	0.00011	250,000

$$ADD = \frac{(TTR_0 * IgR * CF1)}{BW}$$

Where:

ADD = average daily dose (mg/kg/day);
TTR_t = turf transferable residue on day "0" ($\mu g/cm^2$);
IgR = ingestion rate of grass (25 cm^2/day);
CF1 = weight unit conversion factor to convert the µg of residues on the grass to mg to provide units of mg/day (1E-3 mg/µg); and
BW = body weight (15 kg).

Appendix D/Table D3 - Oral Exposure from Incidental Soil Ingestion						
Exposure Scenario	Application Rate (lb ai/acre)	% of rate in uppermost 1 cm of soil	Body Weight (kg)	Ingestion Rate (IgR) (mg/day)	Average Daily Dose mg/kg/day	Oral MOE (target = 100)
Soil Ingestion	0.87	100%	15	100	0.000044	570,000

$$ADD = \frac{AR\ (lb\ ai/A) \times F\ (1.0/cm) \times IgR(mg/day) \times CF1(4.54E\text{-}8 \mu g/lb) \times CF2\ (2.47E\text{-}8\ A/cm^2) \times CF3\ (0.67\ cm^3/g) \times CF4\ (1E\text{-}6\ g/\mu g)}{BW\ (kg)}$$

Where:

ADD = oral dose on day of application (mg/kg/day)
AR = application rate (lb ai/A)
F = fraction or residue retained on uppermost 1 cm of soil
IgR = ingestion rate of soil (mg/day)
CF1 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the soil residue value (4.54×10^8 µg/lb)
CF2 = area unit conversion factor to convert the surface area units (acres) in the application rate to cm^2 for the SR value (2.47×10^{-8} acre/cm^2)
CF3 = volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the soil residue value (0.67 cm^3/g soil)
CF4 = weight unit conversion factor to convert the µg of residues on the soil to grams to provide units of mg/day (1E-6 g/µg)
BW = body weight (kg)

Appendix D/Table D4 - Incidental Ingestion of Pellets						
Exposure Scenario	Application Rate (lb ai/acre)	% active ingredient	Body Weight (kg)	Ingestion Rate (IgR) (mg/day)	Average Daily Dose (mg/kg/day)	Oral MOE (target = 100)
Incidental Ingestion of Pellets	0.65	0.5%	15	300	0.10	250

$$ADD = \frac{(IgR * F * CF1)}{BW}$$

Where:

ADD = average daily dose (mg/kg/day);
IgR = ingestion rate of soil (0.3 g/day);
F = fraction of ai in dry formulation (unitless);
CF1 = weight unit conversion factor to convert the g units in the ingestion rate value to mg for the daily exposure (1000 mg/g); and
BW = body weight (15 kg).

Appendix D/Table D5 - Dermal Exposure from Permethrin Treated Turfgrass								
Exposure Scenario		Application Rate (lb ai/acre)	Hours of Exposure	Body Weight (kg)	DFR/TTR (μg/cm²) (normalized) DAT 0	Transfer Coefficient (cm²/hr)	Absorbed Dermal Dose (mg/kg/day)	Dermal MOE (target = 100)
High Contact Lawn Activities	Adult	0.87	2	70	0.061	14,500	0.0075	3,300
	Toddler	0.87	2	15	0.061	5,200	0.013	2,000
Mowing Turf	Adult	0.87	2	70	0.061	500	0.00026	96,000
Gardening	Adult	0.4 (fruits)	0.67	70	0.86	10,000	0.025	1,000
		0.23 (vegetables)			0.25		0.0071	3,500
	Youths (10-12 yrs)	0.4 (fruits)	0.33	39	0.86	5,000	0.011	2,300
		0.23 (vegetables)			0.25		0.0032	7,900

$$\text{Dermal Dose (mg/kg/day)} = \frac{\text{TTR } (\mu g/cm^2) \times 0.001 \text{ (mg/}\mu g) \times \text{TC } (cm^2/hr) \times \text{ET (hr/day)}}{\text{BW (kg)}}$$

Where:

Dose = Dermal exposure at on day of application attributable for activity in a previously treated area (mg/kg/day)
TTR = Turf Transferable Residue on day of application (μg/cm²)
TC = Transfer Coefficient; and
ET = Exposure Time (hours)
BW = Body Weight (kg)

Assumptions:

TC - The assumed transfer coefficients (TCs) for adults and children performing short-term high contact activities on treated turf are 14,500 and 5,200, respectively. The assumed transfer coefficients (TCs) for adults and children performing short-term high contact activities in treated gardens are 10,000 and 5,000, respectively. Golfing, mowing and other low contact activities were assumed to have a TC of 500 μg/cm².

ET - The exposure time for high and low contact activities on residential lawns is 2 hours. The exposure time for adults and children are 0.67 and 0.33 hours, respectively.

AppendixD/Table D6: Oral Exposure from Hand-to-Mouth Activity on Permethrin Treated Indoor Surfaces									
Exposure Scenario	Application Rate (lb ai/sq ft)	Percent Active Ingredient Dislodgeable	Surface Area (cm^2)	Hand to Mouth (events/hr)	Extraction by Saliva	Exposure Time (hours)	Body Weight (kg)	Average Daily Dose (mg/kg/day)	Oral MOE
Hand to Mouth Transfer from Indoor Surfaces – Spray/Carpet	0.0001	13%	20	20	50%	4	15	0.37	68
Hand to Mouth Transfer from Indoor Surfaces – Spray/Hard Surfaces	0.0001	6.6%	20	20	50%	2	15	0.093	270

$$\text{Oral Dose (mg/kg/day)} = \frac{\text{AR (lb ai/1000 sq ft)} \times \text{CF} \times \text{F} \times \text{SA (cm}^2\text{)} \times \text{EXT} \times \text{FQ (events/hr)} \times \text{ET (hrs/day)}}{\text{BW (kg)}}$$

Where:

Dose = oral dose on day of application (mg/kg/day)
AR = application rate (lb ai/1000 sq ft)
F = Fraction of residue dislodgeable from wet hands
CF = conversion factor to convert µg to mg (0.001)
SA = surface area of 1 to 3 fingers (cm^2)
EXT = extraction rate by saliva (unitless)
FQ = frequency of hand-to-mouth events (events/hour)
ET = exposure duration (hours/day)
BW = body weight (kg)

Assumptions:

F - The fraction of residue dislodgeable from wet hands is 5% for carpets and 10% for hard surfaces. For the fogger calculations, the percent dislodgeable was taken from studies conducted by the NDETF.
SA - The surface area of 1 to 3 fingers is 20 cm^2
EXT - The extraction rate by saliva is 50%
ET - The exposure duration is 4 hours/day for carpets and 2% for hard surfaces.

AppendixD/Table D7: Dermal Exposure from Permethrin Treated Indoor Surfaces (Spray)								
Exposure Scenario		Application Rate (lb ai/sq ft)	Transferable Residue	Hours of Exposure	Body Weight (kg)	Transfer Coefficient (cm^2/hr)	Absorbed Dermal Dose (mg/kg/day)	Dermal MOE
Indoor (Carpet) Surfaces – Spray	Adult	0.0001	4.6%	8	70	16,700	1.3	19
	Toddler	0.0001			15	6,000	2.2	12
Indoor (Hard) Surfaces – Spray	Adult	0.0001	1.3%	4	70	16,700	0.19	130
	Toddler	0.0001			15	6,000	0.32	79

$$\text{Dermal Dose (mg/kg/day)} = \frac{\text{AR (lb ai/1000 sq ft)} \times 0.001\ (\text{mg}/\mu\text{g}) \times \text{TR} \times \text{TC } (\text{cm}^2/\text{hr}) \times \text{ET (hr/day)}}{\text{BW (kg)}}$$

Where:

Dose	=	dermal exposure at on day of application attributable for activity in a previously treated area (mg/kg/day)
AR	=	application rate (lb ai/1000 sq ft)
TR	=	transferable residue available (4.6% for carpets and 1.3% for vinyl flooring, calculated from NDETF studies);
TC	=	transfer coefficient (cm^2/hr)
ET	=	Exposure Time (hours)
BW	=	Body Weight (kg)

Assumptions:

TC	-	The assumed transfer coefficients (TCs) for adults and children performing short/ intermediate-term high contact activities 16,700 $\mu g/cm^2$ and 6,000 $\mu g/cm^2$, respectively
ET	-	The exposure duration is 4 hours/day for hard surfaces and 8 hours/day for carpet

AppendixD/Table D8: Dermal Exposure from Permethrin Treated Indoor Surfaces (Fogger)								
Exposure Scenario		Deposition (ug/cm^2)	Transferable Residue	Hours of Exposure	Body Weight (kg)	Transfer Coefficient (cm^2/hr)	Absorbed Dermal Dose (mg/kg/day)	Dermal MOE
Indoor (Carpet) Surfaces – Fogger	Adult	4.4	4.6%	8	70	16,700	0.12	220
	Toddler	4.4			15	6,000	0.19	130
Indoor (Hard) Surfaces – Fogger	Adult	4.4	1.3%	4	70	16,700	0.022	1,100
	Toddler	4.4			15	6,000	0.037	680

Dermal Dose (mg/kg/day) = (D * TR * ET * TC * CF1 * CF2) / (BW * RS)

Where:

D = deposition (ug/cm^2);
TR = transferable residue available (4.6% for carpets and 1.3% for vinyl flooring, calculated from NDETF studies);
ET = exposure time (8 hr/day for carpets and 4 hr/day for vinyl flooring);
TC = transfer coefficient (16,700 cm^2/hr for adults and 6,000 cm^2/hr for toddlers)
CF1 = weight unit conversion factor to convert lb units to mg for the daily exposure (4.54E8 mg/lb)
CF2 = area unit conversion factor to convert ft^2 units to cm^2 for the daily exposure (1.08E-3 ft^2/cm^2); and
BW = body weight (70 kg for adults and 15 kg for toddlers).

AppendixD/Table D9: Hand-to-Mouth Exposure from Treated Pets (adult and children)													
Exposure Scenario		Application Rate	Body Weight	Fraction of App Rate Available	Surface Area of 30 lb Dog (cm^2/animal)	Time after Application (days)	Fractional Dissipation Rate per Day	Saliva Extraction Factor	Surface Area of Fingers (cm^2)	Event Frequency (events/ hour)	Hours per Day	Oral Dose (mg/kg/ day)	Oral MOE
Pet hand-to-mouth (Dust)	Toddler	0.00016 lb ai/animal	15	20%	5986	0	0.05	0.50	20	20	2	0.019	1,300
Pet hand-to-mouth (Liquid-Shampoo)		0.014 lb ai/animal	15			0						0.17	150

Oral Dose (mg/kg/day) = $\{((AR*F_{AR})/SA_{pet}) * (1-DR)^t * SE * SA_{hands} * FQ * ET * DA\}/BW$

where:

D = nondietary ingestion dose from with treated pets (mg/day);
AR = application rate or amount applied to animal in a single treatment (mg ai/animal);
F_{AR} = fraction of the application rate available for dermal contact as transferable residue (20%/100);
SA_{pet} = surface area of a treated dog (5,986 cm^2/animal);
t = time after application (days);
DR = fractional dissipation rate per day (5% per day/100);
SE = saliva extraction factor (50% extractability);
SA_{hands} = surface area of the hands (20 cm^2);
FQ = frequency of hand-to-mouth activity (20 events/hr);
ET = exposure time (2 hr/day);
DA = dermal absorption factor (30%); and
BW = body weight (15 kg).

AppendixD/Table D10: Dermal Exposure from Treated Pets (adult and children)										
Exposure Scenario		Application Rate	Body Weight	Fraction of App Rate Available	Surface Area of 30 lb Dog (cm^2/animal)	Time after Application (days)	Fractional Dissipation Rate per Day	Surface Area of child hug (cm^2 contact/hug)	Absorbed Dermal Dose (mg/kg/day)	Dermal MOE
Pet hug (Dust)	Toddler	0.00016 lb ai/animal	15	20%	5986	0	0.05	1,875	0.091	270
Pet hug (Liquid-Shampoo)	Toddler	0.014 lb ai/animal	15	20%	5986	0			0.8	31

Dermal Dose (mg/kg/day) = $\{((AR*F_{AR})/SA_{pet}) * (1\text{-}DR)^t * SA_{hug} * DA\}/BW$

Where:

ADD	=	average daily dose via dermal pet contact (mg/kg/day);
AR	=	application rate or amount applied to animal in a single treatment (mg ai/animal);
F_{AR}	=	fraction of the application rate available for dermal contact as transferable residue (20%);
SA_{pet}	=	surface area of a treated 30 lb dog (5,986cm^2/animal);
t	=	time after application (days);
DR	=	fractional dissipation rate per day (5% per day);
SA_{hug}	=	surface area of a child hug (1,875cm^2 contact/hug);
DA	=	dermal absorption factor (30%); and
BW	=	body weight (15 kg).

AppendixD/Table D11: Inhalation Exposure from Truck ULV Mosquito Treatments (adult and children)								
Exposure Scenario	Application Rate	Body Weight	Application Rate Expressed as an Airborne Concentration (mg/m^3)	Dilution Factor (1 to 100)	Breathing Rate;: Light Activity (m^3/hour)	Hours per Day	Absorbed Inhalation Dose Rounded (mg/kg/day)	Inhalation MOE (rounded)
Adult	0.1 lb ai/acre	70	36.8	0.01	1	0.33	0.002	6,300
Toddler	0.1 lb ai/acre	15	36.8	0.01	0.8	0.33	0.007	1,700

Inhalation Dose (mg/kg/day) = (AC * BR * DF * ET)/BW

Where:

ADD = average daily dose (mg/kg/day)
AC = airborne concentration of pesticide (lbs ai/ft^3)
BR = breathing rate (adults = 1.0 m^3/hour and toddler = 0.8 m^3/hour);
DF = dilution factor (0.01);
ET = exposure time (0.33 hr/day); and
BW = body weight (15 kg).

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Chemical:	**Permethrin**
PC Code:	**109701**
HED File Code	**12000 Exposure Reviews**
Memo Date:	**10/27/2004**
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