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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Chemical Code: 012801
DP Barcode: 325337

MEMORANDUM **DATE: 2/26/2007**

SUBJECT: EFED risk assessment for the registration of the new chemical Tembotrione

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EFED has completed the screening level risk assessment for the registration of the new chemical Tembotrione. The risk assessment has been conducted in accordance with Agency guidance on ecological risk assessment and the OPP ecological risk assessment Overview document.

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I. EXECUTIVE SUMMARY

A. Nature of Chemical Stressor

Tembotrione (2-[2-chloro-4-(methylsulfonyl)-3-[(2,2,2-trifluoroethoxy) methyl] benzoyl]-1,3-cyclohexanedione) is a new systemic herbicide proposed for use on field corn, silage corn, popcorn, sweet corn, and corn grown for seed in the U.S. It belongs to the triketone chemical class of herbicides and provides broadleaf and grass control. Tembotrione acts by binding to and inhibiting hydroxylphenyl pyruvate dioxygenase (HPPD), leading to inhibition of carotene pigment synthesis. The proposed use recommendation is for an application rate of 0.082 lbs a.i./acre (0.092 kg a.i./ha) followed 14 days later by a second treatment at the same application rate, if needed. Applications should take place between crop emergence to the V8 (more than 8 visible leaves) developmental stage of corn. Tembotrione is broadcast applied using flat-fan nozzles that provide medium to coarse spray droplets. Tembotrione is formulated as a suspension concentrate that requires the use of an external adjuvant (methylated or ethylated seed oil) to enhance herbicidal activity and a nitrogen source such as urea ammonium nitrate. The formulation also contains the safener isoxadifen-ethyl to protect corn from injury.

B. Potential Risks to Non-Target Organisms

For the aquatic assessment, estimated environmental concentrations (EECs) in surface water were calculated using the Tier II PRZM/EXAMS models and employing maximum proposed application rates for tembotrione usage on corn crops. Eleven PRZM scenarios were used to simulate tembotrione use in different types of regions with various types soil, weather patterns, and crop cultural practices (CA corn; FL sweet corn; IL corn; MS corn; NC (east) corn; ND corn; OH corn; OR sweet corn; PA corn; TX corn). The following scenarios were developed for organophosphates specificially but were included for completeness in this assessment: Ca, FL, ND, OR, TX.

Results of this screening-level assessment indicate that LOCs are exceeded for non-listed aquatic vascular plants in high runoff environments as modeled in the Florida corn scenario. Other regions in the continental U.S. that have similar, sub-tropical climates and, therefore risk concerns for aquatic non-listed vascular plants, are eastern Texas, Louisiana, most of Arkansa, Mississippi, Tennessee, Kentucky, Alabama, North and South Carolina, and Georgia. LOCs are exceeded in most modeled scenarios for listed (threatened and endangered) aquatic vascular plants except the California scenario (less rainfall), Oregon, Pennsylvania, and North Carolina scenarios. Impacts to aquatic plants were expected since Tembotrione is an herbicide. This screening level assessment determined that the use of tembotrione does not exceed any LOCs for non-listed aquatic non-vascular plants. Presently, there are no listed aquatic non-vascular aquatic plants that would be affected by this Federal action. Predicted risk for non-listed and listed freshwater fish, freshwater invertebrates, and estuarine/marine fish is consistent across all regions, and no *acute* or *chronic* risk quotients exceed Agency Level of Concern. The Federal action is not expected to have direct effects on freshwater animals and estuarine/marine fish. The use of tembotrione leads to *acute* LOC exceedances for non-listed and listed estuarine/marine invertebrates for the Florida corn scenario. Currently, there are no listed estuarine/marine species in Florida that could be impacted by this Federal action. *Chronic* risk to non-listed and listed estuarine/marine invertebrates is qualitatively assessed by comparing modeled estimated environmental concentrations to the lowest concentration tested in the life-cycle study for aquatic invertebrates and indicates concern in the Florida, North Carolina, Mississippi, and Texas scenarios. EECs exceed lowest test concentration, indicating a concern for chronic risk to non-listed and listed estuarine/marine invertebrates. Currently, the only listed estuarine/marine species (white abalone) is in California, which is not expected to be affected by this Federal action; the California scenario did not result in an LOC exceedance for estuarine/marine invertebrates. At this time, there is concern for chronic exposure only to non-listed invertebrates in coastal regions.

For terrestrial animals, the Tier I terrestrial model T-REX was used to assess risks of the proposed use on corn using maximum applications. Risks to terrestrial and semi-aquatic plants were assessed using the Tier I model TERRPLANT for a single application at the one time maximum application rate.

LOCs are exceeded for non-listed and listed terrestrial plants (emergence and vegetative vigor) and plants growing in semi-aquatic areas (emergence). Terrestrial dicots are also at risk from drift, but risk is driven mostly by runoff rather than spray drift. Direct effects are expected to listed terrestrial plants (dicots) and terrestrial plants in semi-aquatic areas (monocots and dicots) from the tembotrione Federal action. Because there are direct effects to listed terrestrial plants, any listed species depending on these taxa may be experiencing indirect effects from this Federal action in areas where tembotrione is actually used. This screening level risk assessment determined that use of tembotrione exceeds LOCs for chronic risk to mammals based on body weight gain and corneal opacity data. No adverse reproductive effects were observed. The level of severity for decrease in body weight gain and corneal opacity are low and occurred under continuous exposure (for decrease in parental body weight gain effects became visible after day 28), which is an unlikely scenario in the field due to the chemical's propensity to degrade quickly, the number of applications per season, and the proposed interval between applications. Therefore, under the conditions of actual use, this screening level assessment concludes that the tembotrione Federal action is not expected to result in direct effects to listed mammals. Acute and chronic RQs for birds do not exceed LOCs. The tembotrione Federal action is not expected to result in direct effects to listed avian species. Toxicity studies on the effects of tembotrione to honey bees indicate that beneficial terrestrial insects are not at risk from the tembotrione Federal action.

A summary of the potential for direct and indirect effects to listed species, summarized by taxonomic group, is provided in **Table 1**.

Table 1. Listed Species Risks Associated with Direct or Indirect Effects Due to Applications of Tembotrione for Use on Corn		
Listed Taxonomy	**Direct Effects**	**Indirect Effects**
Semi-aquatic plants – monocots	Yes (semi-aquatic only)	None
Terrestrial and semi-aquatic plants – dicots	Yes	None
Terrestrial invertebrates *	None	Yes [e]
Birds	None [a]	Yes [e]
Terrestrial phase amphibians	None [a,d]	Yes [e]
Reptiles	None[a,d]	Yes [e]
Mammals	None [c]	Yes [e]
Aquatic vascular plants	Yes	None
Aquatic non-vascular plants	None[h]	None
Freshwater fish	None	Yes[e,f]
Aquatic phase amphibians	None [d]	Yes[f]
Freshwater invertebrates	None	Yes[f]
Mollusks	No Data	Yes[f]
Marine/estuarine fish	None	Yes[b]
Marine/estuarine invertebrates	Acute[i] and Chronic[g]	None

[i] no listed estuarine/marine invertebrates are present in states where modeling scenario indicated exceedance of LOCs.

[a] Trigger of chronic LOC for birds may be exceeded. NOAEC in study not established. Lowest concentration tested did not lead to exceedance of trigger; but reproductive effects were observed at this treatment level.

[b] Acute endangered risk LOC exceeded for marine/estuarine invertebrates. Presently, only 1 species (white abalone) is listed in California out of the entire U.S. As estuarine/marine species become threatened or endangered, risk to these organisms becomes of concern and indirect effects to estuarine/marine fish must be evaluated.

[c] While chronic LOCs are exceeded for mammals based on decrease of body weight gain (5-6% and 11-12% in females and males, respectively, and corneal opacity (low degree of severity), actual adverse effects in the field are not expected due to short exposure window.

[d] Terrestrial phase amphibians and reptiles estimated using birds as surrogates. Aquatic amphibians estimated using freshwater fish as surrogates.

[e] LOC exceedances for terrestrial and semi-aquatic plants.

[f] LOC exceedance for aquatic vascular plants

[g] no listed estuarine/marine invertebrates are present in states where modeling scenario indicated LOC exceedance

[h] no non-vascular plants are presently listed

C. Conclusions – Exposure Characterization

Aquatic and terrestrial species may be exposed to tembotrione through its proposed agricultural uses. Tembotrione is not persistent in the environment except when present in loamy sands, degrading primarily through biodegradation in soil and water. Tembotrione appears to be stable to hydrolysis at environmental pH (pH range 5–9) but may be susceptible to photolysis in soil and water. Due to its vapor pressure and Henry's Law constant, volatilization from water and soil is not expected to be an important environmental fate process. Tembotrione has a high mobility in soil and the potential to leach into ground water. The stressor of concern is the parent chemical, tembotrione. Its less toxic and short lived degradates are not of concern and not evaluated in this assessment, however, a description is included for completeness.

D. Conclusions – Effects Characterization

Technical tembotrione is practically non-toxic to freshwater fish (96-hr LC_{50} >100 mg a.i./L) and estuarine fish (96-hr LC_{50} >100 mg a.i./L), slightly toxic to freshwater invertebrates (48-hr EC_{50} = 48.9 mg a.i./L), and highly toxic to estuarine/marine invertebrates (96-hr LC_{50} = 0.1 mg a.i./L). Chronic effects were observed in a fish early-life stage study that resulted in a 34-d NOAEC of

0.604 mg a.i./L for survival. Chronic effects were observed for freshwater invertebrates that resulted in a 21-d NOAEC of 5.1 mg a.i./L for growth. Chronic risk to estuarine marine fish was estimated using the Acute –Chronic Ratio method; estimated NOAECs of 0.604 mg a.i./L and 10.1 mg a.i./L were used to bracket chronic risk to estuarine/marine fish. Chronic effects were observed in a 28-d mysid life-cycle study at the lowest concentration tested (1.6 µg a.i./L). No NOAEC was established; thus the study was used only to qualitatively describe risk. Acute risk due to technical tembotrione is very highly toxic to vascular aquatic plants and highly toxic to non-vascular aquatic plants. A duckweed study resulted in an 14-d EC_{50} of 5.2 µg a.i./L and NOAEC of 2.84 µg a.i./L for reduced frond number. An algal study resulted in a 96-hr EC_{50} of 0.31 mg a.i./L for cell density and NOAEC of 0.070 mg a.i./L for biomass.

Technical tembotrione is practically non-toxic to birds (LD_{50} > 2250 mg a.i./kg-bw) and mammals (LD_{50} >2000 mg a.i./kg-bw). Sublethal chronic effects were observed in a 21-week, one generation reproductive study for birds (upland bird) that resulted in a NOAEC of 65.3 mg a.i./kg for reduced body weight gain in adults. A 20-week, one generation reproductive study in birds (waterfowl) observed reproductive effects (ratios of number hatched to eggs laid and eggs set and the ratio of survivors to eggs set) at 1000 mg ai/kg diet with a NOAEC of 250 mg a.i./kg). Sublethal chronic effects in mammals resulted in a NOAEC of <20 mg a.i./kg for corneal opacity and a NOAEC of 20 mg a.i./kg for reduced body weight gain.

Tembotrione formulation is very highly toxic to terrestrial dicots and slightly less toxic to terrestrial monocots. A seedling emergence study resulted in a dicot (lettuce) EC_{25} of 0.00039 lbs a.i./L and NOAEC of 0.00018 lbs a.i./L for dry weight; the monocot (onion) EC_{25} and NOAEC of 0.028 lbs a.i./L and 0.011 lbs a.i./L were used, respectively. A vegetative vigor study resulted in a dicot (tomato) EC_{25} of 0.00039 lb ai/L and NOAEC of 0.00033 lb ai/L for dry weight; the monocot (onion) EC_{25} and NOAEC of 0.005 lb ai/L and 0.0026 lb ai/L were used, respectively.

E. Uncertainties and Data Gaps

- 72-4(b) life cycle estuarine/marine invertebrate requirement is a data gap. A NOAEC for technical grade tembotrione was not established in the chronic toxicity studies submitted for estuarine/marine shrimp. Qualitative assessment of chronic risk shows that LOCs would exceed if lowest treatment level concentrations are considered. Obtaining new chronic data with an actual NOAEC will allow characterizing chronic risk to estuarine/marine invertebrates. Although there is presently only one listed estuarine/marine invertebrate, this information is important to obtain. For one, there is a vast discrepancy in response to tembotrione exposure between freshwater and estuarine/marine invertebrates, which needs to be quantified. Second, as estuarine/marine species become listed, this information will be essential.

- Chronic toxicity data on technical grade tembotrione were not submitted for estuarine/marine fish. A chronic NOAEC was estimated with the acute-to-chronic ratio method using freshwater fish data.

- Acute and chronic toxicity data on technical grade tembotrione were not submitted for estuarine/marine mollusks.

- No studies on technical grade tembotrione were submitted for marine algae.

- Since tembotrione is a newly developed herbicide, no monitoring data are available for comparison with estimated exposure levels derived from the models.

- No foliar dissipation studies exist for tembotrione. The foliar dissipation default half-life of 35 days was used for calculating risk from plant materials to terrestrial wildlife. Based on other available fate characteristics of tembotrione, the 35days half-life assumption is expected to be conservative.

II. PROBLEM FORMULATION

A. Stressor Source and Distribution

1. Source and Intensity

AE 0172747 herbicide (proposed name tembotrione), a hydroxylphenyl pyruvate dioxygenase (HPPD) inhibitor, is intended for use on corn crops to control annual broadleaf and grass weeds. Tembotrione is not presently registered for agricultural use in the U.S. The chemical is a post-emergence herbicide to be applied via ground methods; it is not to be applied aerially. This assessment focuses on proposed uses of tembotrione on field corn, silage corn, popcorn, sweet corn, and corn grown for seed. Maps of potential application areas based on the geographic distribution of corn production are provided in Appendix J.

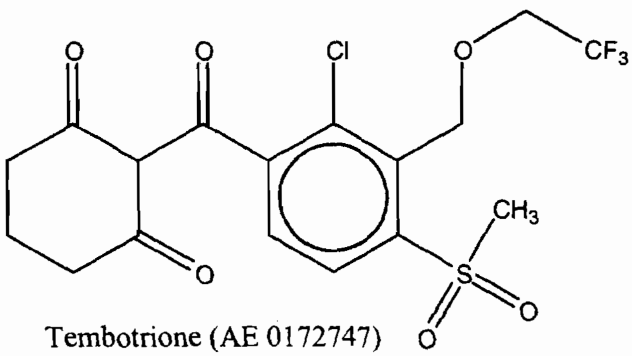
2. Physical/Chemical/Fate and Transport Properties

Tembotrione is not considered persistent in the environment. The major route of dissipation is biodegradation under aerobic conditions. Tembotrione and some of its metabolites possess high mobility in soils and have the potential to leach into ground water, although the rapid rate of degradation may attenuate this process. Tembotrione can reach surface waters via spray drift and rainfall events that cause runoff. The important physical and chemical properties for tembotrione are summarized in **Table 2** followed by its chemical structure (**Figure 1**).

Table 2. Chemical and Physical Properties for Tembotrione

CAS number	335104-84-2	
SMILES notation	O=C1CCCC(C1C(c2c(Cl)c(COCC(F)(F)F)c(S(=O)(C)=O)cc2)=O)=O	
Molecular weight	440.8	MRID 46695412
Molecular formula	$C_{17}H_{16}ClF_3O_6S$	MRID 46695412
Vapor pressure	8.2×10^{-11} mm Hg	MRID 46695412
Solubility in water (pH 7, 20 °C)	283,000 mg/L (pH 7 and 20 °C)	MRID 46695412
Henry's Law constant	1.69×10^{-15} atm-m^3/mol	Calculated from vapor pressure and solubility
Log K_{ow}	2.16 (pH 2) -1.09 (pH 7) -1.37 (pH 9)	MRID 46695412
pK_a	3.2	MRID 46695419 (the pK_a corresponds to the hydroxyl group of the enol form of AE 0172747)
Hydrolysis half-life (days) for pH 5, 7, and 9	Stable at pH 5, 7, and 9	MRID 46695410
Aquatic photolysis half-life	172 days	MRID 46695411 (values corrected to represent natural sunlight at 33.36 °N latitude; uncorrected laboratory half-life of 56 days – continuous irradiation; xenon lamp).

Table 2. Chemical and Physical Properties for Tembotrione		
Soil photolysis half-life	32 days 29 days	MRID 46695412 MRID 46695413 (values corrected to represent natural sunlight at 33.36 °N latitude; uncorrected laboratory half-lives were 9.2 and 7.7 days – continuous irradiation; xenon lamp).
Aerobic soil metabolism half-life	4.6 days (silt loam) 63 days (loamy sand) 14 days (sandy loam) 6 days (clay) 72.1 days (loamy sand) 6.9 days (silt loam)	MRID 46695414 MRID 46695415 MRID 46695415 MRID 46695415 MRID 46695416 MRID 46695416
Anaerobic soil metabolism half-life	231 days 257 days	MRID 46695419 MRID 46695420
K_{oc} (adsorption)	32 (silt loam) 27 (sandy loam) 131 (loamy sand) 20 (clay) 53 (silt loam) 130 (loamy sand) 379 (sandy loam – sediment)	MRID 46695404
Aerobic aquatic metabolism half-life	168 days 62 days	MRID 46695421 MRID 46695422
Anaerobic aquatic metabolism half-life	448 days 351 days	MRID 46695423 MRID 46695424



Tembotrione (AE 0172747)

Figure 1. Chemical Structure of Tembotrione.

3. Pesticide Type, Class, and Mode of Action

Tembotrione belongs to the triketone (benzoylcyclohaxanedione) chemical class of herbicides and provides broadleaf weed and grass control. It is a hydroxylphenyl pyruvate dioxygenase (HPPD) inhibitor that binds to the HPPD enzyme and inhibits the synthesis of plastoquinones and carotene pigments, resulting in bleaching of the cells with subsequent plant death.

4. Overview of Pesticide Usage

The proposed label specifies that tembotrione is a ground applied post-emergence herbicide intended for the control of annual broadleaf and grass weeds on field corn, silage corn, popcorn, sweet corn, and corn grown for seed. Tembotrione is a suspension concentrate that requires the use of an external adjuvant. Weed growth ceases within hours after application. Symptoms on susceptible weed species progress from yellowing and bleaching to necrosis resulting in eventual plant death generally within 7 to 14 days after application. Best control of broadleaf weeds is achieved when weeds are less than 6 inches in height and actively growing. The proposed label specifies that the maximum application rate is 6 fluid oz/acre of tembotrione per growing season (or 0.164 lbs a.i./acre/growing season). According to the proposed label, the product is to be applied at a rate of 3 fluid oz/acre (**0.082 lbs a.i./acre**) per application with a 14-day minimum interval between applications. **Two post emergent applications can be made per season.** In areas where corn could be grown twice a year, this will result in four applications per year. Tembotrione is intended for **ground application** as a foliar spray with nozzles that deliver "medium" spray droplets; this herbicide is not to be applied aerially.

Actual pesticide usage data are not available since this is a new chemical. Because this chemical is proposed for use on field corn, silage corn, popcorn, sweet corn, and corn grown for seed, the current geographic distribution of these crops is expected to be generally representative of potential tembotrione application areas. The growing areas throughout the U.S. for corn (excluding corn grown for seed) are shown in **Figure 2.** Individual maps of each corn type are provided in Appendix J. Data for the growing areas of seed corn are not available from the U.S. Department of Agriculture National Agriculture Statistics Service (NASS).

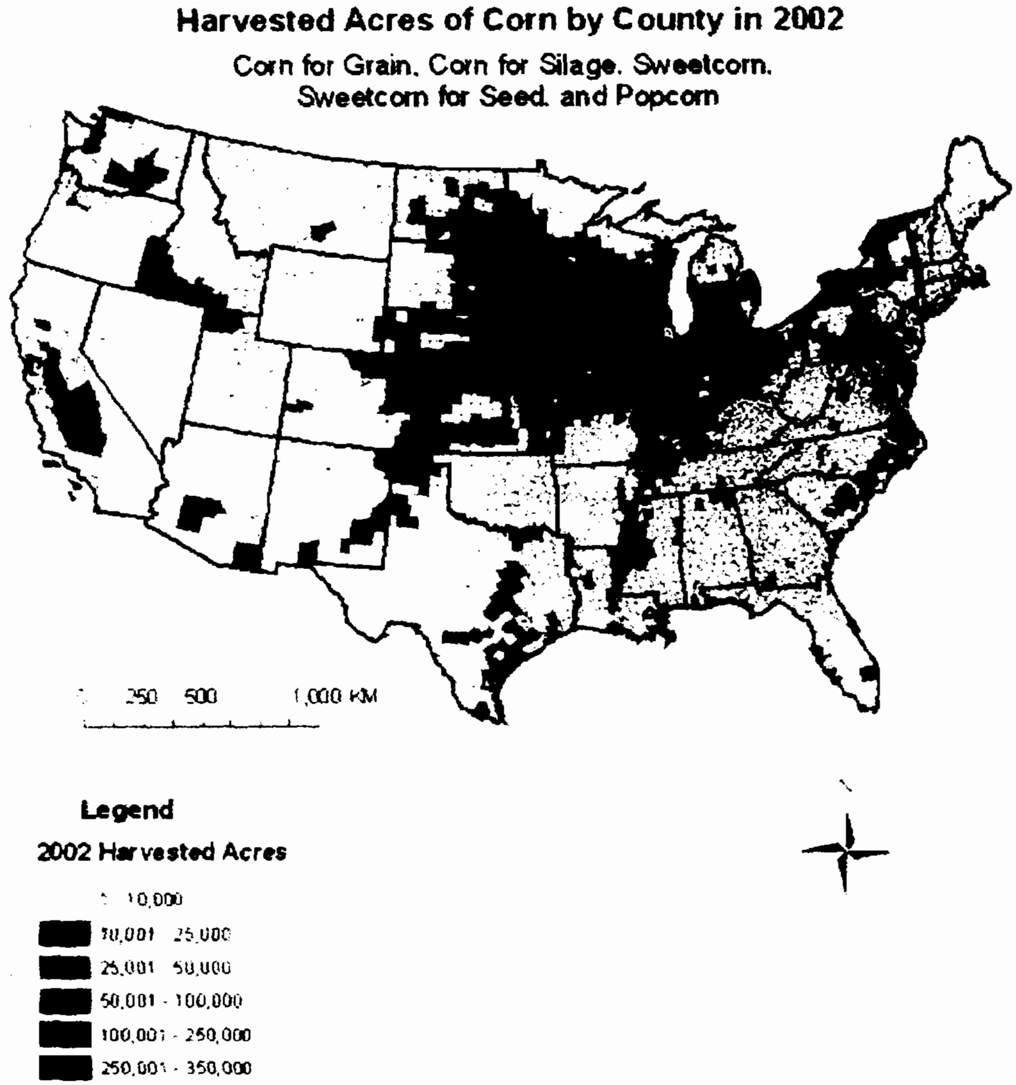


Figure 2. Distribution of Corn Acreage in the Conterminous U.S. Based on USDA 2002 Census of Agriculture (Data on Corn Grown for Seed not Available).

B. Receptors

Each assessment endpoint requires one or more measures of ecological effect, which are defined as changes in the attributes of an assessment endpoint itself or changes in a surrogate entity or attribute in response to exposure to a pesticide. Ecological measures of effect for the screening level risk assessment are based on a suite of registrant-submitted toxicity studies performed on a limited number of organisms in broad groupings listed in **Table 3**.

Table 3. Taxonomic Groups and Test Species Evaluated for Ecological Effects in Screening-Level Risk Assessments	
Taxonomic Group	**Example(s) of Representative Species**
Birds [a]	Mallard duck (*Anas platyrhynchos*) Bobwhite quail (*Colinus virginianus*)
Mammals	Laboratory rat (*Rattus norvegicus*)
Freshwater fish [b]	Bluegill sunfish (*Lepomis macrochirus*) Rainbow trout (*Oncorhynchus mykiss*)
Freshwater invertebrates	Water flea (*Daphnia magna*)
Estuarine/marine fish	Sheepshead minnow (*Cyprinodon variegatus*)
Estuarine/marine invertebrates	Eastern oyster (*Crassostrea virginica*) Mysid shrimp (*Americamysis bahia*)
Terrestrial plants	Monocot and dicot
Insects	Honeybee
Aquatic plants	Bluegreen alga Green alga Saltwater diatom Duckweed (*Lemna gibba*)

[a] Birds are considered surrogates for amphibians (terrestrial phase) and reptiles when no data are available.
[b] Freshwater fish may be surrogates for amphibians (aquatic phase) when no data are available.

Within each of these very broad taxonomic groups, an acute and/or chronic endpoint is selected from the available test data. A complete discussion of all toxicity data available for this risk assessment and the resulting measures of effect selected for each taxonomic group are included in Appendix E.

1. Aquatic Effects

Direct application of tembotrione to streams, lakes, and ponds is forbidden by the product label. Immediately following application, the highest tembotrione residue levels are expected to be located in surface waters adjacent to treated agricultural fields due to spray drift at the time of application and/or from runoff after a rain event. Tembotrione may be transported off the field in runoff for several months after application. Exposure estimates for this screening level risk assessment focused on the parent, tembotrione. Information or data on degradates indicate that they are of less concern than the parent and no significant contributor to aquatic risk. Degradates are not expected to affect the outcome of risk conclusions are not considered in this risk characterization. Fish, amphibians, and aquatic invertebrates that live in aquatic environments are potentially exposed to tembotrione residues in surface water by direct contact of their integument (covering of the body or a part such as skin, gill membranes, cuticle, etc.) and via uptake through their gills or integument. Assessment endpoints were selected to assess reduced survival, growth, and reproduction in these taxonomic groups from combined direct contact with integument and uptake across the gill or integument. Because toxicity data for amphibians are rarely available, addressing risks for fish were used as a surrogate to assess risks to aquatic-stage amphibians (USEPA 2004). Aquatic plants are also potentially exposed by contact of their outer surface area with tembotrione residues in surface water or through sorption and uptake through roots or across cell walls.

Aquatic animals may also be exposed to tembotrione residues in sediment or in their diet (i.e., detritus, aquatic plants, and/or prey). Sediment residues of tembotrione may potentially occur because of eroded soil in runoff depositing out to sediment and from tembotrione partitioning to sediment from water. Food chain transfer has the potential to occur where higher trophic level organisms feed on organisms that have taken up tembotrione from surface water through their gills or integument or on organisms or detrital matter that have sorbed tembotrione. No studies have been submitted regarding the potential for bioconcentration in aquatic organisms. However, the log K_{ow} of 2.16 indicates that bioconcentration should not be of concern. Koc also indicates that parent will not partition to sediments.

Leaching (infiltration/percolation) may result in transport of tembotrione through the soil column into ground water which may, in some circumstances, flow into a surface water body. The mobility of tembotrione in soil is considered high based on batch adsorption experiments conducted in seven soils; however, because tembotrione's persistence in soils is low, degradation may attenuate the leaching potential of this compound.

2. Terrestrial Effects

The highest tembotrione residue levels are expected to be located in the surface soil and on foliage (e.g., short and tall grasses, broadleaf weeds), seeds, and insects on the treated agriculture field immediately following ground spraying. No studies have been submitted regarding the potential for bioaccumulation in terrestrial mammals; therefore the potential for food chain transfer is uncertain. While spray drift may result in transport of tembotrione to off-target field surface soil, foliage, and insects, the highest concentrations for these media are still expected to be those in the treated field. Birds, mammals, reptiles, and amphibians that ingest foliage, insects, and/or soil invertebrates from either the treated area or from spray drift impacted areas are potentially exposed to tembotrione residues in their diet. Endpoints were included that assessed reduced survival, growth, and reproduction in these taxonomic groups from dietary exposure. Because toxicity data for reptiles and terrestrial-phase amphibians are rarely available, risk assessment results for birds were used as surrogates to assess risks to reptiles and terrestrial-phase amphibians (USEPA 2004).

Tembotrione may reach off-field terrestrial or riparian/wetland vegetation environments in spray drift at the time of application. Following a rain event, tembotrione, may also reach off-field terrestrial or riparian/wetland vegetation environments in sheet and channel flow runoff.

3. Ecosystems at Risk

Ecosystems potentially at risk are expressed in terms of the selected assessment endpoints (**Table 4**). The typical assessment endpoints for screening-level pesticide ecological risks are reduced survival, and reproductive and growth impairment for both aquatic and terrestrial animal species. Aquatic animal species of potential concern include freshwater fish and invertebrates, estuarine/marine fish and invertebrates, and amphibians. Terrestrial animal species of potential concern include birds, mammals, and beneficial insects. For both aquatic and terrestrial animal species, direct acute and direct chronic exposures are considered. In order to protect threatened and endangered species, all assessment endpoints are measured at the individual level. Although endpoints are measured at the individual level, they provide insight about risks at higher levels of biological organization (e.g., populations and communities). For example, pesticide effects on individual survivorship have important implications for both population rates of increase and habitat carrying capacity.

For terrestrial and semi-aquatic plants, the screening assessment endpoint is the perpetuation of populations of non-target species (crops and non-crop plant species). Existing testing requirements have the capacity to evaluate emergence of seedlings and vegetative vigor. Although it is recognized that the endpoints of seedling emergence and vegetative vigor may not address all terrestrial and semi-aquatic plant life cycle components, it is assumed that impacts at emergence and in active growth have the potential to impact individual competitive ability and reproductive success. For aquatic plants, the assessment endpoint is the maintenance and growth of standing crop or biomass. Measurements for this assessment endpoint focus on cell density, growth rates, and biomass in non-vascular plants (i.e., freshwater algae) and frond number, growth rate, and biomass in aquatic vascular plants (duckweed).

The ecological relevance of selecting the above-mentioned assessment endpoints is as follows: (1) complete exposure pathways exist for these receptors; (2) the receptors may be potentially sensitive to pesticides in affected media and in residues on plants, seeds, and insects; and (3) the receptors could potentially inhabit areas where pesticides are applied, or areas where runoff and/or spray drift may impact the sites because suitable habitat is available.

Table 4. Summary of Assessment Endpoints and Measures of Effect in Screening Level Risk Assessment

Assessment Endpoint	Measures of Effect
1. Abundance (i.e., survival, reproduction, and growth) of individuals and populations of birds in close proximity to sites	1a. Mallard duck (at least) acute oral LD_{50} 1b. Mallard duck and bobwhite quail subacute 5-day dietary LC_{50} 1c. Mallard duck (at least) reproduction NOAEL (e.g., number of eggs laid, set, cracked, etc.)
2. Abundance (i.e., survival, reproduction, and growth) of individuals and populations of mammals in close proximity to sites	2a. Laboratory rat (at least) acute oral (single dose) LD_{50} 2b. Laboratory rat (at least) chronic (reproductive) NOAEC or NOAEL
3. Survival and reproduction of individuals and communities of freshwater fish and invertebrates in close proximity to sites	3a. Rainbow trout and bluegill sunfish (at least) acute 96-hr LC_{50} 3b. Rainbow trout or bluegill sunfish (preferred species tested that of the more acutely sensitive species tested) chronic early life-stage or life-cycle NOAEC (e.g., number hatched, time to hatch, mortality, growth of young) 3c. *Daphnia magna* (at least) acute 48-hr EC_{50} (or 96-hr LC_{50} for other invertebrates) where effect measured is surrogate for death 3d. *Daphnia magna* (at least) chronic reproductive NOAEC (e.g., number of young produced, time to first brood release, parental survival, parental growth)

Table 4. Summary of Assessment Endpoints and Measures of Effect in Screening Level Risk Assessment	
Assessment Endpoint	**Measures of Effect**
4. Survival and reproduction of individuals and communities of estuarine/marine fish and invertebrates in close proximity to sites	4a. Atlantic silverside or sheepshead minnow (at least) acute 96-hr LC_{50} 4b. Eastern oyster (at least) acute 96-hr IC_{50} where the effect measured is shell deposition or embryo/larval fertilization, survival, and normal shell development 4c. Pink shrimp or mysid shrimp (at least) acute 96-hr LC_{50} or EC_{50} where the effect measured is a surrogate for mortality 4d. Fish (prefer species that matches the most acutely sensitive fish tested) early life stage or life cycle NOAEC (e.g., number hatched, time to hatch, growth of young, overall survival) 4e. Mysid shrimp (at least) chronic NOAEC
5. Survival of beneficial insect populations in close proximity to sites	1. Honey bee acute contact LD_{50}
6. Survival and growth of terrestrial plants in close proximity to sites	6a. Monocot and dicot seedling emergence EC_{25} 6b. Monocot and dicot seedling emergence EC_{05} or NOAEC 6c. Monocot and dicot vegetative vigor EC_{25} 6d. Monocot and dicot vegetative vigor EC_{05} or NOAEC
7. Standing crop or biomass and growth of aquatic plants in close proximity to sites	7a. Green and blue-green alga (at least) EC_{50} 7b. Freshwater and saltwater diatom and duckweed (at least duckweed) acute EC_{50} 7c. Green and blue-green algae, a freshwater and saltwater diatom and duckweed (at least) EC_{05} or NOAEC
LD_{50} = Lethal dose to 50% of the test population. LC_{50} = Lethal concentration to 50% of the test population. $EC_{50}/EC_{25}/EC_{05}$= Effect concentration to 50/25/5% of the test population. *IC_{25}/IC_{05} = 25/5% Inhibitory concentration.* NOAEC = No observed adverse effect level. LOAEC = Lowest observed adverse effect level.	

C. Assessment Endpoints

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected". Defining an assessment endpoint involves two steps: (1) identifying the valued attributes of the environment that are considered to be at risk; and (2) operationally defining the assessment endpoint in terms of an ecological entity (i.e., a community of fish and aquatic invertebrates) and its attributes (i.e., survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (i.e., ecological receptors), the ecosystems potentially at risk, the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticides. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern.

This ecological risk assessment considers maximum application rates of tembotrione to fields that have vulnerable soils, maximum number of applications, and minimum intervals for uses on representative crops grown on runoff prone soils to estimate exposure concentrations. In addition, this assessment is not intended to represent a site- or time-specific analysis. Instead, this assessment is intended to represent high-end exposures at a national level. Likewise, the most sensitive toxicity measures of effect are used from surrogate test species to estimate treatment-related direct effects on acute mortality and chronic reproductive, growth, and survival assessment endpoints. Toxicity tests are intended to determine effects of tembotrione exposure on birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include short-term acute, subacute, and reproductive studies and are typically arranged in a hierarchical or tiered system that progresses from basic laboratory tests to applied field studies. The toxicity studies are used to evaluate the potential of tembotrione to cause adverse effects, to determine whether further testing is required, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants (CFR 40 §158.202, 2002a). A summary of measures of effects selected to characterize potential ecological risks associated with exposure to tembotrione is provided in **Table 4**.

D. Conceptual Model

In order for a chemical to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a contaminant moves in the environment from a source to an ecological receptor. For an ecological exposure pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure. In addition, the potential mechanisms of transformation (i.e., which degradates may form in the environment, in which media, and how much) must be known, especially for a chemical whose metabolites/degradates are of greater toxicological concern. In this assessment, only the parent, tembotrione, is assessed; although toxicity data are available, degradates are not evaluated because degradates do not pose a concern. The assessment of ecological exposure pathways includes an examination of the source and potential migration pathways for constituents, and the determination of potential exposure routes (e.g., ingestion, inhalation, and dermal absorption).

1. Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (i.e., changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (USEPA 2004). For this assessment, the risk is stressor-initiated, where the stressor is the release of tembotrione to the environment. The following risk hypothesis is presumed for this screening level assessment:

The use of tembotrione as an herbicide in agricultural settings on field corn, silage corn, seed corn, sweet corn, and popcorn involves situations where terrestrial and/or aquatic animals and plants may be exposed to the chemical. Based on information on persistence, mode of action, direct toxicity and potential indirect effects to trophic food webs, EFED assumes that tembotrione has the potential to cause reduced survival and reproductive impairment to terrestrial and aquatic animals and plants.

2. Diagram

The source and mechanism of release of tembotrione is ground application to agricultural crops. The conceptual model and subsequent analysis of exposure and effects are all based on tembotrione parent. Surface water runoff from the areas of application is assumed to follow topography. Additional release mechanisms include spray drift and wind erosion, which may potentially transport contaminants into the air. Potential emission of volatile compounds is not considered as a viable release mechanism for tembotrione, because vapor pressure information suggests that volatilization is not expected to be a significant route of dissipation. The conceptual model shown in **Figure 3** depicts the potential source, release mechanisms, abiotic receiving media, and biological receptor types.

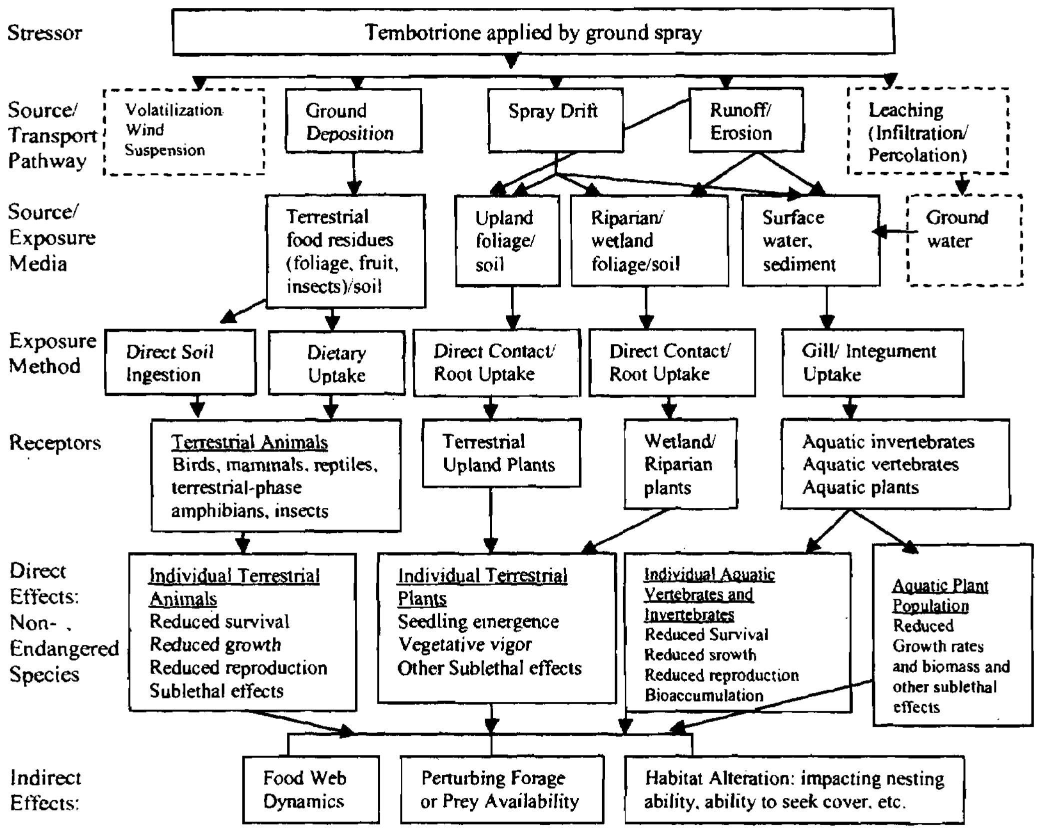


Figure 3. Conceptual Model Depicting Ecological Risk Based on the Proposed Tembotrione Application. *Exposure pathways in dotted boxes are presumed to be insignificant and will not be evaluated in this risk assessment.*

E. Analysis Plan

1. Preliminary Identification of Data Gaps and Methods

- 72-4(b) life cycle marine/estuarine invertebrate requirement is a data gap. A NOAEC for technical grade tembotrione was not established in the chronic toxicity studies submitted for estuarine/marine shrimp. Qualitative assessment of chronic risk shows that LOCs would exceed if lowest treatment level concentrations are considered. Obtaining new chronic data with an actual NOAEC will allow characterizing chronic risk to estuarine/marine invertebrates. Although there is presently only one listed estuarine/marine invertebrate, this information is important to obtain. For one, there is a vast discrepancy in response to tembotrione exposure between freshwater and estuarine/marine invertebrates, which needs to be quantified. Second, as estuarine/marine species become listed, this information will prove essential.

- Chronic toxicity data on technical grade tembotrione were not submitted for estuarine/marine fish. A chronic NOAEC was estimated with the acute-to-chronic ratio method using freshwater fish data.

- Acute and chronic toxicity data on technical grade tembotrione were not submitted for estuarine/marine mollusks.

- No studies on technical grade tembotrione were submitted for marine algae.

- Since tembotrione is a newly developed herbicide, no monitoring data are available for comparison with estimated exposure levels derived from the models.

- No foliar dissipation studies exist for tembotrione. The foliar dissipation default half-life of 35 days was used for calculating risk from plant materials to terrestrial wildlife. Based on other available fate characteristics of tembotrione, the 35days half-life assumption seems reasonable.

2. Measures to Evaluate Risk Hypotheses and Conceptual Model

a. Measures of Exposure

The proposed new uses for tembotrione are for field corn, silage corn, popcorn, sweet corn, and corn grown for seed. Since these are new uses, no statistics exist regarding the amount of tembotrione that has been applied to these crops in the past; however, the present geographic distribution for these proposed site uses are expected to generally represent potential tembotrione application areas. The geographic distribution of each crop is illustrated in Appendix J, with the exception of corn grown for seed, which is not readily available (USDA 2002).

For agricultural uses, exposure concentrations for aquatic ecosystem assessments were estimated based on EFED's aquatic Tier II model PRZM/EXAMS. A graphical user interface (pe4v01.pl) (http://www.epa.gov/oppefed1/models/water) developed by the EPA was used to facilitate inputting chemical and use specific parameters into the appropriate PRZM input files and EXAMS chemical files. This approach employs PRZM, which simulates runoff and erosion from an agricultural field on a daily time step. The runoff and erosion flux output data from PRZM are used in conjunction with spray drift as chemical loadings to EXAMS, which simulates surface water in order to predict the EECs. Nine PRZM field scenarios were modeled including CA corn; FL sweet corn; IL corn; MS corn; NC corn (east); ND corn; OH corn; PA corn; and TX corn. EECs for ecological risk assessment were determined using a Pond modeling scenario which describes a generic scenario for the EXAMS component of the modeling exercise.

Residues in potential dietary sources (eg., vegetation and insects) for mammals and birds were estimated using the Tier I model T-REX Version 1.2.3 (USEPA 2005a). This model provides estimates of concentrations (maximum, or upper bound, and average) of chemical residues on the surfaces of different types of foliage that may be sources of dietary exposure to avian, mammalian, reptilian, or terrestrial-phase amphibian receptors. The surface residue concentration (ppm) is estimated by multiplying the application rate (pounds active ingredient per acre) by a value specific to each food item. For both mammals and birds, three animal body weight classes are considered. The T-REX model was run using the maximum application rate for corn uses (e.g., 0.082 lbs a.i./acre/application with a total maximum number of 2 applications at a 14-day interval).

Exposure to terrestrial and semi-aquatic (wetland) plants was estimated using the TERRPLANT model Version 1.2.1 (USEPA 2005b). The TERRPLANT model estimates risk quotients for non-target monocot and dicot plants that may be exposed to pesticides applications via runoff and/or spray drift to terrestrial plants inhabiting dry and semi-aquatic (wetland) areas. RQs are calculated using the EC_{25} value for non-threatened/endangered plants and the EC_{05} or NOAEC value for threatened/endangered plants.

b. Measures of Effect

Measures of ecological effects are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. Registrant-submitted data suitable for quantitative risk assessment are available for acute and chronic exposure of freshwater fish and invertebrates, acute and chronic exposure of estuarine/marine invertebrates, acute exposure of estuarine/marine fish, aquatic vascular plants, and algae, acute and chronic exposure of birds, acute and chronic exposure of mammals, acute exposure of honey bees, and exposure of terrestrial plants. A generic summary of the measures of effect based on pesticide toxicity studies for different ecological receptors and effect endpoints (acute/chronic) is given in **Table 4**.

c. Measures of Ecosystem and Receptor Characteristics

For the assessments using the Tier II aquatic model PRZM/EXAMS and the Tier I terrestrial models T-REX and TERRPLANT, the ecosystems that are modeled are intended to be generally representative of any aquatic or terrestrial ecosystem associated with areas where tembotrione is used. The receptors addressed by the aquatic and terrestrial risk assessments for tembotrione are summarized in Figure 3. For aquatic assessments, fish and aquatic invertebrates in both freshwater and estuarine/marine environments are represented, as well as aquatic plants. For terrestrial assessments, three different size classes of small birds and mammals are represented, along with four potential foraging categories, as well as two terrestrial plant groups (upland plants and plants growing in semi-aquatic areas).

III. ANALYSIS

A. Use Characterization

The purpose of the ecological risk assessment (ERA) is to assist the Agency in evaluating the actions needed, if any, to address ecological risks associated with uses of the new herbicide, AE 0172747 (proposed name Tembotrione), for use on field corn, silage corn, seed corn, sweet corn, and popcorn. It is to be applied on commercial or farm plantings with ground equipment only and not to be used aerially or applied through any irrigation systems. It requires the use of an external adjuvant (methylated or ethylated seed oil) to enhance herbicidal activity and a nitrogen source such as urea ammonium nitrate. It also contains the safener isoxadifen-ethyl to protect corn from injury.

Tembotrione is a new chemical, currently unregistered for use. Therefore, there is no current chemical usage information available in the National Center for Food and Agricultural Policy (NCFAP) pesticide use database or the U.S. Department of Agriculture National Agriculture Statistics Service (NASS) chemical use database. The growing areas throughout the U.S. of field corn, silage corn, popcorn, and sweet corn are shown in Appendix J. Data for the growing areas of seed corn were not available from the NASS.

The proposed label specifies that tembotrione is intended for the control of annual broadleaf and grass weeds. Weed growth ceases within hours after tembotrione is applied. Symptoms on susceptible weed species progress from yellowing and bleaching to necrosis resulting in eventual plant death generally within 7 to 14 days after application. Tembotrione is for post-emergence use. Best control of broadleaf weeds is achieved when weeds are less than 6 inches in height and actively growing. Best control of grass weeds is achieved prior to when the grass is tillering and actively growing. Broadcast applications of tembotrione must be made to corn from emergence through the V8 stage of growth (i.e., more than 8 visible leaf collars) and not to corn that is more mature than V8. Tembotrione is rainfast 1 hour after application to most weed species. Rainfall within 2 hours of tembotrione application may necessitate retreatment for some weed species.

The proposed label specifies that the maximum application rate (**Table 5**) is 6 fluid oz/acre of tembotrione per growing season (or 0.164 lbs a.i./acre/growing season). According to the proposed label, the product is to be applied by ground as foliar spray with nozzles that deliver 'medium' spray droplets and at a rate of 3 fluid oz/acre (0.082 lbs a.i./acre) per application with a 14-day minimum interval between applications. Two applications can be made per season.

Tembotrione is a suspension concentrate that requires the use of an external adjuvant. The adjuvant type is dependant upon the weed spectrum. For labeled grass control, the use of Methylated Seed Oil (MSO) is recommended with a nitrogen source (Urea Ammonium Nitrate or Ammonium Sulfate). For labeled broadleaf weeds only, Crop Oil Concentrates (COC) is recommended with a nitrogen source.

The proposed label indicates that tembotrione can be mixed with other pesticides for spraying, including herbicides such as Atrazine, Option® Corn Herbicide, Liberty®, Define™ SC, and Glyphosate. The following foliar insecticides can also be mixed with tembotrione: Ambush®, Asana® XL, Baythroid®, Capture®, Decis®, Lorsban®, Mustang®, Pounce® 3.2EC, Sevin® XLR, and Warrior®. The compatibility of pesticides should be tested prior to mixing.

Product information:
Product Name: AE 0172747 Herbicide (proposed name tembotrione)
Active Ingredients:
AE01727472-[2-chloro-4-(methylsulfonyl)-3-[(2,2,2-trifluoroethoxy)methyl]-benzoyl]-1,3-cyclohexanedione....34.5%
Inert ingredients....65.5%
Total 100%
(CAS Number 335104-84-2)

Table 5. Application Rates of Tembotrione					
Crop	**Disease Control**	**Application Rate (lbs a.i./acre)**	**Maximum No. Applications per Season**	**Interval**	**Restrictions**
Field corn, silage corn, seed corn, sweet corn, and popcorn	Annual broadleaf and grass weeds	0.082	2	14-day minimum interval between applications	Do not apply on corn after the V8 stage of growth. Do not apply via aerial methods.

B. Exposure Characterization

1. Environmental Fate and Transport Characterization

Data were submitted regarding the hydrolysis, photolysis, biodegradation, soil adsorption properties, and field dissipation of tembotrione. These data are sufficient to characterize the transport, partitioning, mobility, and degradation of tembotrione and several of its major metabolites in the environment. The physical and chemical properties used to characterize the environmental fate of tembotrione were summarized in **Table 2**. Chemical names and structures of the metabolites discussed below are provided in Appendix A.

a. Summary of Empirical Data

Registrant submitted studies indicate that tembotrione is not persistent in the environment, degrading primarily through biodegradation in soil and water. Tembotrione appears to be stable to hydrolysis at environmental pH (pH range 5–9) but may be susceptible to photolysis in soil and water. Due to its vapor pressure and Henry's Law constant, volatilization from water and soil is not expected to be an important environmental fate process. Tembotrione and several of its metabolites have high mobility in soil and have the potential to leach into ground water.

b. Degradation and Metabolism

Tembotrione did not undergo abiotic hydrolysis in pH 5, 7, and 9 aqueous buffered solutions maintained at 25 °C over the course of a 30 day incubation period (MRID 46695410). The environmental photolysis half-life (33.36 °N latitude) of tembotrione in pH 7, 25 °C aqueous solution was estimated as 172 days and the soil photolysis half-life of tembotrione (33.36 °N latitude) was estimated as 29–32 days (MRID 46695411, MRID 46695412). The non-linear biodegradation half-life of tembotrione in four European and two U.S. soils ranged from approximately 5 to 72 days under aerobic conditions (MRIDs 46695414, 46695415, 46695416). Under anaerobic conditions the rate of biodegradation appears to be much slower. Tembotrione degraded with non-linear half-lives of 231 (cyclohexyl ^{14}C label) and 257 days (phenyl ^{14}C label) in a silt loam from Germany maintained under anaerobic conditions. The non-linear anaerobic aquatic degradation half-life of tembotrione was 351 (cyclohexyl ^{14}C label) and 448 (phenyl ^{14}C label) days in a pond water/silty clay sediment system from Kansas (MRID 46695423, MRID 46695424). The aerobic aquatic degradation half-life of tembotrione was 168 days in a river water/silt loam sediment system from Germany (MRID 46695421) and 62 days in a river water/sand sediment system from Germany (MRID 46695422).

The degradation of two tembotrione metabolites was studied in three soils under aerobic conditions, and both of these metabolites appear to be non-persistent. Based on non-linear regression analysis, the half-life of AE 0941989 in two clay loam soils from England and a sandy loam soil from Germany ranged from about 1.3–1.8 days (MRID 46695417) and the half-life of the metabolite AE 1392936 ranged from about 7.6–15.6 days in the same soils (MRID 46695418).

c. Transport and Mobility

Volatilization of tembotrione from treated fields and water surfaces is not expected to be an important environmental fate process based on a Henry's Law constant of 1.69×10^{-15} atm-m^3/mol, and vapor pressure of 8.2×10^{-11} mm Hg (MRID 46695412). It is noted that tembotrione exists in equilibrium between its dione form and enol form, with a pK_a of 3.2 (MRID 46695419). This pK_a indicates that the enol will exist as an anion under most environmental conditions (pH 5–9) and anions do not volatilize.

Tembotrione is expected to possess high mobility in soils based upon K_{oc} values ranging from 20–131, measured in six soils from the U.S. and Europe (MRID 46695404). Given the range of K_{oc} values in the six soils tested, tembotrione possesses the potential to leach into ground water; however, its relatively rapid rate of biodegradation may attenuate this process.

The mobility of tembotrione metabolites AE 0456148, AE 0941989, AE 0968400, AE 1124336, and AE 1392936 were also studied. AE 0456148, AE 0968400, and AE 1392936 are all expected to possess high mobility in soils based upon the submitted data and have the potential to leach into ground water. K_{oc} values of <1 to 3.65 L/kg were observed for AE 0456148 in five soils (MRID 46695405) and K_{oc} values of 25 to 123 L/kg were observed for AE 0968400 in five soils (MRID 46695407). Almost no adsorption was observed for AE 1392936 in batch adsorption experiments using four soils, and all K_{oc} values were <1 for this metabolite (MRID 46695409). The mobility of metabolite AE 0941989 is considered moderate to low based upon K_{oc} values in the range of 400–1743 L/kg that were measured in four soils (MRID 46695406) and the mobility of metabolite AE 1124336 is moderate given a K_{oc} range of 201–332 L/kg (MRID 46695408). It is noted that metabolites AE 1392936 and AE 0941989 were shown to biodegrade readily in aerobic soil metabolism studies, which may attenuate the potential of these compounds to leach into ground water.

d. Field Studies

Terrestrial field dissipation studies (MRID 46695425) for tembotrione were studied in four bare plots cropped with field corn in New York (Site 1; loamy sand/sand soil), Illinois (Site 2; silt loam soil), Nebraska (Site 3; silt loam/clay loam soil), and California (Site 4; sandy loam soil). The field dissipation half-lives of tembotrione were: 24.5 days (New York site); 25.3 days (Illinois site); 48 days (Nebraska site); 6 days (California site). At the New York site, tembotrione was not detected below a depth of 15 cm; however, the metabolite AE 0456148 was identified, not quantified, at depths of 15–30 cm, 30–45 cm, and 45–60 cm. At the Illinois site, tembotrione and its metabolite AE 0456148 were not detected below the 0–15 cm depth. The reviewer-calculated half-life for AE 0456148 in the 0–15 cm soil core was 21.0 days. In the Nebraska test plot, tembotrione was detected in the 0–15 cm, 15–30 cm, and 30–45 cm soil cores. The transformation product AE 0456148 was not detected above the limits of quantification in any of the soil cores except the 0–15 cm depth and the reviewer-calculated half-life for AE 0456148 was 75.3 days. At the California site, tembotrione dissipated rapidly and was only detected once in the 15–30 cm soil depth. AE 0456148 was identified, but not quantified, at depths of 15–30 cm, 30–45, cm and 45–60 cm, and no half-life was determined for this metabolite at the California site.

2. Measures of Exposure

a. Aquatic Exposure Modeling

Exposure concentrations of tembotrione for aquatic ecosystems assessments were estimated based on the EFED aquatic Tier II model PRZM/EXAMS. A graphical user interface (pe4v01.pl), (http://www.epa.gov/oppefed1/models/water) developed by the EPA, was used to facilitate inputting chemical and use specific parameters into the appropriate PRZM input files (inp) and EXAMS chemical files. This approach employs PRZM, which simulates runoff and erosion from an agricultural field on a daily time step. Spray drift, runoff, and erosion flux output data from PRZM are used as chemical loadings to EXAMS, which simulates surface water in order to predict the EECs. EECs for ecological risk assessment were determined using a 1-ha pond surrounded by the appropriate treated crop modeling scenario.

Application dates for the different scenarios (CA corn; FL sweet corn; IL corn; MS corn; NC corn (east); ND corn; OH corn; OR sweet corn; PA corn; TX corn), were based on the time it typically takes for corn to reach the V8 stage following emergence. The initial application was selected as 10 days after crop emergence with a second application 14 days later.

Model inputs used in the aquatic exposure modeling are provided in **Table 6**.

Table 6. PRZM/EXAMS Chemical Specific Input Parameters for AE 0172747 (Tembotrione)		
Parameter	**Input Value and Unit**	**Source**
Maximum application rate	0.092 kg a.i./ha (0.082 lbs a.i./acre)	Product Label AE 0172747 (EPA Reg. No. 264-xxx)
Maximum number of applications	2	Product Label AE 0172747 (EPA Reg. No. 264-xxx)
Method of application (CAM = 1) (Applied predominantly to the soil even though it is a post emergence herbicide which can be applied to foliage)	Ground spray	Product Label AE 0172747 (EPA Reg. No. 264-xxx)
Minimum interval between applications	14 days	Product Label AE 0172747 (EPA Reg. No. 264-xxx)
Application efficiency	0.99 (ground spray)	EFED Model Input Guidance, Version II (2002b)[a]
Spray drift	0.01 (ground)	EFED Model Input Guidance, Version II (2002b)[a]
Partition coefficient K_{oc}[b]	110 mL/g	MRID 46695404
Application date	10 days post-emergence	
Henry's Law constant	1.69×10^{-15} atm-m^3/mol	Calculated from vapor pressure and solubility
Hydrolysis	Stable	MRID 46695410
Aerobic soil metabolism[c]	46 days	MRID 46695410, MRID46695411, MRID 46695412
Aerobic aquatic metabolism ($t_{1/2}$)[d]	278 days	MRID 46695421, MRID 46695422
Anaerobic aquatic metabolism ($t_{1/2}$)[e]	1198 days	MRID 46695423, MRID 46695424
Aquatic photolysis $t_{1/2}$ (days)	172 days	MRID 46695411
Vapor pressure	8.2×10^{-11} mm Hg	MRID 46695412
Solubility in water (pH 7, 20 °C)	283,000 mg/L (pH 7 and 20 °C)	MRID 46695412 (solubility x 10)
Molecular weight	440.8	MRID 46695412

[a] *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version II,* dated February 28, 2002.
[b] Average K_{oc}
[c] 90% mean UCL calculated using half-lives of 4.6, 63, 14, 6, 72.1, 6.9 days
[d] 90% mean UCL calculated using half-lives of 168 and 62.4 days
[e] 3 x 399.3 days

Output values for each of the crop scenarios are summarized in **Table 7**. The largest 1-in-10 year peak concentration occurs in the Florida sweet corn scenario. The field and meteorological data used for the PRZM scenario in Florida are located in Palm Beach County in Southeast Florida, although sweet corn production occurs throughout the state. The cumulative rainfall from this meteorological file is much greater than the total rainfall in any of the other PRZM corn scenarios, and as a consequence the runoff flux from this site is much greater than in any of the other PRZM scenarios. The large runoff flux results in higher loadings to adjacent water bodies and hence greater EECs. For comparison, the annual average rainfall from the Florida sweet corn scenario is 154.8 cm (70.0 inches), as compared to the California scenario (located in Stanislaus/San Joaquin Counties, Central Valley) that receives on average about 44.6 cm (17.6 inches) rainfall annually and has the lowest EECs. Moreover, the rainy season in Southeast Florida typically runs through October, leading to large single event rainfalls during the expected application dates of tembotrione and large runoff events. Changing the application date from October 24 to November 24 in the Florida sweet corn scenario resulted in EECs that were approximately one third of those shown in **Table 7**; however, using an initial application date of September 24, resulted in similar EECs as those shown in **Table 7**. Therefore, a great deal of variability can be expected in the EECs for Florida depending upon the application date. Based on preliminary analysis, it appears that the application dates selected for modeling produce "high-end"runoff and erosion.

Table 7. Surface Water EECs (ppb or µg/L) Ecological Risk Assessment for Tembotrione Applied by Ground Methods at Proposed Label Rates [a]

PRZM Scenario	Peak	21-Day Value	60-Day Value
California Corn	0.39	0.38	0.36
Florida Sweet Corn	9.09	8.85	8.06
Illinois Corn	4.60	4.52	4.42
Mississippi Corn	3.73	3.65	3.46
North Carolina Corn–East	1.74	1.70	1.64
North Dakota Corn	3.10	3.04	2.96
Ohio Corn	2.97	2.90	2.82
Oregon Sweet Corn	1.25	1.24	1.22
Pennsylvania Corn	1.75	1.74	1.72
Texas Corn	3.01	2.92	2.81

[a] *Based on 1-in-10 year exceedance probability (0.10)*

b. Aquatic Exposure Monitoring and Field Data

Since tembotrione is a new use chemical that has not been registered, no monitoring data exist at this time.

3. Measures of Terrestrial Exposures

a. Terrestrial Exposure Modeling

The EFED terrestrial exposure model T-REX (T-REX, Version 1.2.3, dated December 7, 2005) (USEPA 2005a) is used to estimate exposures and risks to avian and mammalian species. The model provides estimates of exposure concentrations and risk quotients (RQs). Specifically, the model provides estimates of concentrations (maximum, or upper bound, and average, or mean) of chemical residues on the surface of different types of foliage and insects that may be dietary sources of exposure to terrestrial wildlife receptors. EECs are converted to oral dose by multiplying the EEC by the percentage of body weight consumed as estimated through allometric relationships. These consumption-weighted EECs are determined for each food source and a range of body sizes for mammals (15, 35, and 1000 g) and birds (20, 100, and 1000 g).

The EECs on food items may be compared directly with subacute dietary toxicity data or converted to an ingested whole body dose (single-oral dose), as is the case for small mammals and birds. Single-oral dose estimates represent, for many pesticides, an exposure scenario where absorption of the pesticide is maximized over a single ingestion event. Subacute dietary estimates provide for possible effects of the dietary matrix on pesticide absorption. T-REX was run for the proposed new use of tembotrione on corn using the input values provided in **Table 8.**

Table 8. Input Parameters Used in T-REX Version 1.2.3 to Determine Terrestrial EECs for Tembotrione Application on Corn

Input Variable	Parameter Value	Source
Maximum application rate	0.082 lbs a.i./acre	Product label
Maximum number of applications per year	2	Product label
Minimum application interval	14 days	Product label
Foliar half-life	35 days	default value
Mineau *et al.* scaling factor	1.15	default value
Application type	Broadcast – liquid	Product label
Toxicity values	Avian, acute oral : LD_{50} >2250 mg a.i./kg-bw	MRID 46695501 (Acceptable)
	Avian, acute dietary: LC_{50} >5790 mg a.i./kg diet	MRID 46695502 (quail; Acceptable) MRID 46695503 (duck; Acceptable)
	Avian, chronic dietary: NOAEC = 65.3 mg a.i./kg diet/day	MRID 46695505 (Supplemental)
	Mammalian, acute: LD_{50} >2000 a.i./kg-bw	MRID 46695618 (Acceptable)
	Mammalian, chronic dietary: NOAEC = 20 mg a.i./kg diet/day	MRID 46695704 (Acceptable)

A summary of the terrestrial EECs generated by T-REX for use of tembotrione on corn is presented in **Table 9**. More detailed summaries of the T-REX output are presented in Appendix D. Tembotrione residues (ppm) ranged from 2.16 (fruits/pods/large insects) to 34.59 (short grass) for maximum residues and 1.01 (fruits/pods/large insects) to 12.25 (short grass) for mean residues.

Table 9. Peak Terrestrial EECs Estimated Using Kenaga Values for Tembotrione Applied to Corn

Forage Type	Maximum Residue (ppm)	Mean Residue (ppm)
Short grass	34.59	12.25
Tall grass	15.86	5.19
Broadleaf plants and small insects	19.46	6.49
Fruits/pods/large insects	2.16	1.01

TERRPLANT (TERRPLANT, Version 1.2.1, dated November 9, 2005) was used to estimate exposures and risks to terrestrial plant species. Input parameters for the model included: (1) toxicity values for monocots and dicots; (2) application rate; (3) runoff, based on chemical solubility; and (4) soil incorporation depth. The model provides estimates of exposure concentrations and risk quotients (RQs) for non-listed and listed terrestrial and semi-aquatic plants. Input values used for estimating terrestrial and semi-aquatic plant exposure risks to tembotrione are summarized in **Table 10**. Due to the lack of toxicity data, input values for vegetative vigor are not included. Only one application is considered in this assessment due to model limitations. However, since tembotrione degrades rather quickly under aerobic conditions (aerobic soil metabolism half-lives for silt loam soils < 10 days), does not bioaccumulate, and applications are at least 14 days appart, the modeling of one application at 0.082 lbs a.i./A should not underestimate risk to terrestrial plants. More detailed information on TERRPLANT Version 1.2.1 is presented in Appendix C.

Table 10. Input Parameters Used in TERRPLANT 1.2.1 to Determine Terrestrial EECs for Plants for Tembotrione Application on Corn Crops

Input Variable	Parameter Value	Source
Maximum application rate	0.082 lbs a.i./acre	Product label
Runoff value (0.01, 0.02, or 0.05 if chemical solubility <10, 10–100, or >100 ppm, respectively)	0.05 [a]	MRID 46695412
Minimum incorporation depth (inches)	0 (unincorporated)	Product label
Toxicity Values	Seeding emergence Monocots (onion): EC_{25}: 0.028 lbs a.i./acre NOAEC: 0.00018 lbs a.i./acre Dicots (lettuce): EC_{25}: lbs a.i./acre NOAEC: 0.00039 lbs a.i./acre Vegetative vigor: Monocots (onion) EC_{25}: 0.005 NOAEC: 0.0026 Dicots (tomato): EC_{25}: 0.00039 NOAEC: 0.00033	MRID 46695511 MRID 46695512

[a] Based on the water solubility of 283,000 mg/L (pH 7 and 20 °C)

Table 11. Summary Output EECS from TERRPLANT for Tembotrione

Application Method	EECs for Plants Inhabiting Areas Adjacent to Treatment Site (lbs a.i./acre), Run off & Drift Load	EECs for Semi-Aquatic Plants Inhabiting Areas Adjacent to Treatment Site (lbs a.i./acre), Run off & Drift Load	Drift EEC (lbs a.i./acre)
Ground spray (unincorporated)	0.0049	0.0418	0.0008

b. Terrestrial Residue Studies

No residues studies were submitted for the proposed new use of tembotrione on corn.

C. Ecological Effects Characterization

In screening-level ecological risk assessments, the effects characterization describes the types of effects a pesticide can have on aquatic or terrestrial organisms. This characterization is based on registrant-submitted studies that describe information regarding acute and chronic toxicity effects for various aquatic and terrestrial animals. Appendix E summarizes the results of the registrant-submitted toxicity studies used to characterize effects for this risk assessment.

1. Aquatic Effects Characterization

The most sensitive acute and chronic toxicity reference values associated with tembotrione exposure of freshwater and estuarine/marine species are summarized in **Table 12**. All toxicity reference values used to assess the potential aquatic risks of tembotrione exposure are obtained from studies using technical grade tembotrione rather than from studies with tembotrione formulated products or tembotrione metabolites. A detailed summary of the available aquatic toxicity data used to characterize risks associated with tembotrione exposure is given in Appendix E.

Table 12. Tembotrione Selected Toxicity Values for Screening Risk to Aquatic Organisms

Exposure Scenario	Species	Exposure Duration	Toxicity Value [a]	Reference (Classification)
		Freshwater Fish		
Acute	Bluegill sunfish	96 hours	LC_{50} >100,000 µg a.i./L, (no mortality observed)	MRID 46695436 (Acceptable)
Chronic	Fathead minnow	34 days	**NOAEC (fry survival) = 604 µg a.i./L**	MRID 46695443 (Acceptable)
		Freshwater Invertebrates		
Acute	Water flea	48 hours	**EC_{50}/LC_{50} (immobility/ mortality) = 48,900 µg a.i./L**	MRID 46695430 (Acceptable)
Chronic	Water flea	21 days	**NOAEC (total length) = 5,100 µg a.i./L**	MRID 46695440 (Acceptable)
		Estuarine/Marine Fish		
Acute	Sheepshead minnow	96 hours	LC_{50} >100,000 µg a.i./L, (no mortality observed)	MRID 46695435 (Supplemental)
		Estuarine/Marine Invertebrates		
Acute	Mysid shrimp	96 hours	**LC_{50} = 100 µg a.i./L**	MRID 46695434 (Acceptable)
Acute	Mollusk	NA	No data submitted	NA
Chronic	Mysid shrimp	28 days	NOAEC (reproduction) <1.6 µg a.i./L	MRID 46695442 (Supplemental)
		Aquatic Plants		
Acute	Duckweed (macrophytes)	14 days	**EC_{50} (reduced frond number) = 5.2 µg a.i./L** **NOAEC (reduced frond number) = 2.86 µg a.i./L**	MRID 46695513 (Acceptable)
Acute	*Pseudokircheriella subcapitata* (freshwater algae)	96 hours	**EC_{50} (cell density) = 310 µg a.i./L** **NOAEC (biomass) = 200 µg a.i./L**	MRID 46695517 (Acceptable)
Acute	Marine algae	NA	No data submitted	NA

[a] Values in **bold** are used to quantitatively assess risk.

a. Aquatic Animals

(1). Acute Effects

Freshwater Fish

The acute toxicity of technical grade tembotrione was tested in two species. Study details and results are summarized in Appendix E, **Table E-1a**. The 96-hour LC_{50} values reported in these studies were >100 mg a.i./L and >101 mg a.i./L in bluegill sunfish (MRID 46695436) and rainbow trout (MRID 46695437), respectively, indicating that tembotrione is practically non-toxic to freshwater fish. Note that only one concentration of technical grade tembotrione (approximately 100 mg a.i./L) was tested in each study. Since an LC_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive RQs for freshwater fish.

The acute toxicity of formulated tembotrione (33.9% tembotrione + 18.1% isoxadifen-ethyl SC 420+210) was tested in one species. Study details and results are summarized in Appendix E, **Table E-1b**. The reported 96-hour LC_{50} was 1.83 mg a.i./L in rainbow trout (MRID 46695438) indicating that the tembotrione formulation tested was moderately toxic to freshwater fish on an acute basis and more than 50 times more toxic than the technical grade tembotrione.

The acute toxicity of the tembotrione metabolite AE 0456148 was tested in one species. Study details and results are summarized in Appendix E, **Table E-1c**. The reported LC_{50} was >105 mg/L in rainbow trout (MRID 46695439), indicting that metabolite AE 0456148 is practically non-toxic to freshwater fish and no more toxic to freshwater fish on an acute basis than the parent compound.

Freshwater Invertebrates

The acute toxicity study of technical grade tembotrione was evaluated in the water flea (daphnids). Study details and results are summarized in Appendix E, **Table E-3a**. A 48-hour EC_{50} of 48.9 mg a.i./L was reported for immobilization/mortality (MRID 46695430), indicating that technical grade tembotrione is slightly toxic to the water flea on an acute basis. Since the study did not distinguish between mortality and immobility the EC_{50} value of 48.9 mg a.i./L is used as a surrogate value for lethality to evaluate acute toxic exposure of freshwater invertebrates to technical grade tembotrione. EFED will use the EC_{50} value of 48.9 mg a.i./L to assess acute risks to freshwater invertebrates.

The acute toxicity study of formulated tembotrione (33.9% tembotrione + 18.1% isoxadifen-ethyl) was evaluated in the water flea (MRID 46695431). Study details and results are summarized in Appendix E, **Table E-3b**. A 48-hour EC_{50} of 11.6 mg a.i./L was reported based on immobilization/mortality, indicating that the tembotrione formulated product is slightly toxic to *D. magna* and approximately 4-fold more toxic to *D. magna* on an acute basis than technical grade tembotrione.

No acceptable or supplemental acute studies on the toxicity of tembotrione metabolite AE 0456149 to freshwater invertebrates were submitted.

Estuarine/Marine Fish

The acute toxicity study of technical grade tembotrione was evaluated in one estuarine/marine fish species. Study details and results are summarized in Appendix E, **Table E-6**. The acute LC_{50} of technical grade tembotrione in sheepshead minnow was >100 mg a.i./L (MRID 46695435), indicating that technical grade tembotrione is practically non-toxic to estuarine/marine fish on an acute basis.. Since this study was classified as supplemental, no RQs will be derived.

No acute toxicity studies of tembotrione formulations or degradates in estuarine/marine fish were submitted.

Estuarine/Marine Invertebrates

The acute toxicity of technical grade tembotrione was evaluated in mysids (MRID 46695434). Study details and results are summarized in Appendix E, **Table E-7**. An LC_{50} of 100 µg a.i./L indicates that technical grade tembotrione is highly toxic to saltwater mysids on an acute basis (MRID 46695434). EFED will use the LC_{50} value of 100 µg a.i./L to assess acute risk to estuarine/marine invertebrates. No acceptable or supplemental acute toxicity studies of technical grade Tembotrione in estuarine/marine mollusks were submitted.

No acute toxicity studies of tembotrione formulations or degradates in estuarine/marine invertebrates were submitted.

(2). Chronic Effects

Freshwater Fish

An early life-stage study with technical grade tembotrione was conducted in fathead minnow (MRID 46695443). Study details and results are summarized in Appendix E, **Table E-2**. The 34-day NOAEC and LOAEC for fry survival (the most sensitive endpoint) were 0.604 and 1.10 mg a.i./L, respectively. The 34-day NOAEC for reductions in fry survival (0.604 mg a.i./L) will be used to assess the risk of chronic exposure of freshwater fish to technical grade tembotrione. Reductions in growth (length and dry weight) and an increased incidence of kyphoscoliosis (a lateral curvature of the spine with vertebral rotation, associated with a flexed spinal column) were observed. Kyphoscoliosis was observed in fish in the 4.85 and 9.74 mg a.i./L groups, indicating a NOAEC and LOAEC for morphological effects of 2.25 and 4.85 mg a.i./L, respectively. The NOAEC and LOAEC for reductions in both length and dry weight were 1.10 and 2:25 mg a.i./L, respectively. The time to hatch and hatching success were unaffected by exposure.

No chronic toxicity studies of tembotrione formulations or degradates in freshwater fish were submitted.

Freshwater Invertebrates

The chronic toxicity of technical grade tembotrione was evaluated in the water flea (MRID 46695440). Study details and results are summarized in Appendix E, **Table E-4a**. The most sensitive effect was a reduction in mean total length, with NOAEC and LOAEC values of 5.10

and 10.19 mg a.i./L, respectively. Parental survival, time to first offspring emergence, total number of live neonates per surviving adult, and dry weights of surviving adults were not affected at any of the doses tested. EFED will use the NOAEC of 5.10 mg a.i./L for reduction in length to assess chronic risk to aquatic invertebrates.

One chronic toxicity study with the tembotrione metabolite AE 0456148 was conducted in the water flea (MRID 46695441). Study details and results are summarized in Appendix E, **Table E-4b**. No effect on mortality, parent mobility, time to first brood, reproduction, parental total length, or dry weight was observed at 113 mg metabolite/L, the highest concentration tested (NOAEC = 113 mg metabolite/L). Thus, the tembotrione metabolite AE 0456148 is less toxic to freshwater invertebrates than technical grade tembotrione on a chronic basis.

No life-cycle toxicity studies of tembotrione formulations in freshwater aquatic invertebrates were submitted.

Estuarine/Marine Fish

No chronic toxicity study was submitted for estuarine/marine fish with technical grade tembotrione, formulations, or degradates. However, acute and chronic freshwater animal data are available to estimate an estuarine/marine chronic NOAEC using the ACR method. The Rainbow trout 96-h LC_{50} of 100,000 µg a.i./L and fathead minnow 34-d NOAEC of 604 µg a.i./L were used in these calcuations. Thus the freshwater fish ACR is 165.5. The daphnid 48-h EC_{50} of 48,900 µg a.i./L and 21-d chronic NOAEC of 5,100 µg a.i./L were used to derive a freshwater invertebrate ACR of 9.5. Using the sheepshead minnow LC_{50} of 100,000 µg a.i./L, a chronic value for estuarine/marine fish would lie between 604 ppb and 10,500 ppb. Actual exposure concentrations will determine whether there is concern for chronic risk to estuarine/marine organisms (see risk description section for discussion).

Estuarine/Marine Invertebrates

One life-cycle (28-day) toxicity study was conducted in mysid shrimp (MRID 46695442). Study details and results are summarized in Appendix E, **Table E-8**. Reproductive effects (reductions in the number of offspring produced per female per reproductive day) observed in all the concentrations tested could not established a NOAEC. The lowest concentration tested was 1.6. EFED will not derive chronic RQs for estuarine/marine invertebrates because the NOAEC was not established during the study and significant adverse effects on reproduction were observed at every treatment level.

No chronic toxicity studies of tembotrione formulations or degradates in estuarine/marine invertebrates were submitted.

Benthic Organisms

A non-guideline 28-day chironomid emergence test with tembotrione TGAI was submitted (MRID 46695444). Study details and results are summarized in Appendix E, **Table E-5**. Due to the low K_{oc} and high water solubility of tembotrione, EFED does not require a benthic study. Furthermore, tembotrione is not expected to partition into sediment, thereby limiting exposure of benthic organisms. Thus, risks to benthic organisms are not assessed.

No study was submitted for tembotrione formulations or degradates and their effects on freshwater benthic organisms.

(3). Sublethal Effects

Freshwater Fish

No sublethal effects were observed in acute toxicity studies in freshwater fish exposed to tembotrione TGAI. Sublethal effects (labored respiration, low activity or hyperactivity, loss of equilibrium, open mouths, laying on the bottom of aquarium, laying on their sides or backs, turned in a vertical position, remaining at the water surface, dark coloration, and convulsions) were observed in all tembotrione treatment groups in the 96-hour acute toxicity test of a tembotrione formulation in rainbow trout (NOAEC <0.127 mg a.i./L; LOAEC 0.127 mg a.i./L) (MRID 46695438). These data indicate that the tembotrione formulated product tested is expected to produce sublethal effects to rainbow trout on an acute basis than technical grade tembotrione. Additional study details are summarized in Appendix E, **Table E-1b**.

Results of the 34-day, early life-stage study with technical grade tembotrione in fathead minnow show reduction in fry growth (length and dry weight) and an increased incidence of kyphoscoliosis (a lateral curvature of the spine with vertebral rotation, associated with a flexed spinal column). These results established a NOAEC and LOAEC for morphological effects of 2.25 and 4.85 mg a.i./L, respectively. The NOAEC and LOAEC for reductions in length and dry weight were 1.10 and 2.25 mg a.i./L, respectively.

Freshwater Invertebrates

No sublethal effects were observed in acute toxicity studies in freshwater invertebrates exposed to tembotrione TGAI or the tembotrione formulated product. Sublethal effects were observed in the chronic toxicity study with technical grade tembotrione in the water flea (MRID 46695440). NOAEC and LOAEC values of 5.10 and 10.19 mg a.i./L, respectively, were established based on reductions in mean total length. Additional study details and results are summarized in Appendix E, **Table E-4a**.

Estuarine/Marine Fish

No sublethal effects were observed during an acute toxicity study of technical grade tembotrione in sheepshead minnow (MRID 46695435).

Estuarine/Marine Invertebrates

Sublethal effects (lethargy and/or partial loss of equilibrium) were observed at the two highest concentrations tested in an acute toxicity study with technical grade tembotrione in mysids (MRID 46695434), with NOAEC and LOAEC values of 46 µg a.i./L and 79 µg a.i./L, respectively. Additional study details are summarized in Appendix E, **Table E-7**. A reduced reproduction rate was observed during a life-cycle (28-day) toxicity study with technical grade tembotrione in the mysid shrimp (MRID 46695442). The 28-day NOAEC and LOAEC values were <1.6 µg a.i./L and 1.6 µg a.i./L, respectively. Study details and results are summarized in Appendix E, **Table E-8**.

(4). Field Studies

No aquatic field studies for tembotrione were submitted.

b. Plants Inhabiting Aquatic Areas

Acute toxicity studies using technical grade tembotrione, tembotrione formulated product, and a tembotrione metabolite were submitted for freshwater algae or aquatic vascular plants. Study details and results for studies with technical grade tembotrione, tembotrione formulations, and a tembotrione metabolite are summarized in Appendix E, **Tables E-9a**, **E-9b**, and **E-9c**, respectively.

Acute toxicity studies in freshwater algae were conducted with technical grade tembotrione (two studies), tembotrione formulated product (one study), and a tembotrione metabolite (one study). All studies were classified as Acceptable or Supplemental. Study details and results for studies with technical grade tembotrione, tembotrione formulations, and a tembotrione metabolite are summarized in Appendix E, **Tables E 9a**, **E-9b**, and **E-9c**, respectively. Acute toxicity studies with technical grade tembotrione in freshwater algae yielded EC_{50} values ranging from 0.31 mg a.i./L for reductions in cell density in *Pseudokirchneriella subcapitata* (MRID 46695517) to 9.0 mg a.i./L for reductions in biomass in *Navicula pelliculosa* (MRID 46695518), indicating that technical grade tembotrione is moderately to highly toxic to freshwater algae on an acute basis. EFED will use the EC_{50} of 0.31 mg a.i./L for reductions in cell density in *Pseudokirchneriella subcapitata* (MRID 46695517) to assess acute risks of tembotrione to non-listed freshwater algae and the NOAEC of 0.200 mg a.i./L to assess acute risks of tembotrione to listed freshwater algae.

An acute toxicity study with a tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl) showed an EC_{50} of 2.7 mg a.i./L for reductions in cell density in *P. subcapitata* (MRID 46695519), indicating that the tembotrione formulated product was moderately toxic to freshwater algae on an acute basis. Compared to technical grade tembotrione, the formulated product was approximately 9 times less toxic to *P. subcapitata* (MRID 46695519) but was approximately 3 times more toxic to *Navicula pelliculosa* (MRID 46695518). An EC_{50} of >103 mg metabolite/L (for cell density and growth rate) was observed in *P. subcapitata* exposed to the tembotrione metabolite AE 0456148 (MRID 46695520), indicating that the tembotrione metabolite was practically non-toxic to freshwater algae on an acute basis. The tembotrione metabolite was more than 300 times less toxic than technical grade tembotrione to freshwater algae on an acute basis. No acceptable or supplemental studies with estuarine/marine algae were submitted.

Acute toxicity studies were conducted in vascular plants exposed to technical grade tembotrione (one study) and a tembotrione metabolite (one study). Both studies were classified as Acceptable. A 14-day study in duckweed (*Lemna gibba*, a freshwater vascular plant) using technical grade tembotrione yielded an EC_{50} of 5.2 µg a.i./L (for reductions in frond number) (MRID 46695513), indicating that technical grade tembotrione is very highly toxic to freshwater vascular plants on an acute basis. EFED will use the EC_{50} of 5.2 µg a.i./L for reduced frond number in *Lemna gibba* (MRID 46695513) to assess the risk of tembotrione to non-listed freshwater vascular plants and the NOAEC of 2.86 µg a.i./L to assess the risk of tembotrione to listed freshwater vascular plants.

A 14-day study in duckweed with the tembotrione metabolite AE 0456148 yielded an EC_{50} >105 mg metabolite/L (MRID 46695514), indicating that the tembotrione metabolite AE 0456148 is practically non-toxic to freshwater vascular plants and more than 20,000 times less toxic than technical grade tembotrione to freshwater vascular plants on an acute basis.

Overall, these results indicate that aquatic macrophytes are more sensitive than freshwater algae to technical grade tembotrione.

2. Terrestrial Effects Characterization

The most sensitive acute and chronic toxicity reference values associated with tembotrione exposure to mammals, birds, and terrestrial plants are summarized in **Table 13**. All toxicity reference values used to assess the potential terrestrial risks of tembotrione exposure are obtained from studies using technical grade tembotrione, rather than from studies with tembotrione formulated products or tembotrione metabolites. Note that since acute toxicity studies in birds and mammals did not establish LC_{50} values, with no mortalities or sublethal effects observed at the highest doses/concentrations tested, acute risk quotients will not be derived for these species. A more detailed summary of the available terrestrial toxicity data used to characterize risks associated with tembotrione exposure is given in Appendix E.

Table 13. Tembotrione Selected Toxicity Values for Screening Risk to Terrestrial Organisms				
Exposure Scenario	**Species**	**Exposure Duration**	**Toxicity Value [a]**	**Reference (Classification)**
Mammals				
Acute (Dose-based)	Rat	Single oral dose	LD_{50} >2000 mg a.i./kg-bw, (no mortality)	MRID 46695618 (Acceptable)
Chronic (Diet-based)	Rat	Two-generation	**NOAEC** (reduced body weight gain) = **20 mg ai/kg diet**	MRID 46695704 (Acceptable)
Birds				
Acute (Dose-based)	Bobwhite quail	Single oral dose	LD_{50} >2250 mg a.i./kg-bw, (no mortality observed)	MRID 46695501 (Acceptable)
Acute (Diet-based)	Bobwhite quail and mallard duck	8-day dietary	LC_{50} >5790 mg a.i./kg diet, (no mortality observed)	MRID 46695502 (Acceptable) MRID 46695503 (Acceptable)
Chronic (Diet-based)	Mallard duck	20-week avian reproduction study	**NOAEC =65.3 mg a.i./kg diet** (reduction in parental body weight gain, including reductions in the ratio of eggs hatched to eggs laid and eggs set, including reduced embryo survival)	MRID 46695505 (Supplemental pending submission of frozen storage stability data)
Plants – Seedling Emergence				
Monocot	Onion	Single application	**NOAEC** (dry weight) = **0.011 lbs a.i./acre** **EC_{25}** (dry weight) = **0.028 lbs a.i./acre**	MRID 46695511 (Acceptable)
Dicot	Lettuce	Single application	**NOAEC** (dry weight) = **0.00018 lbs a.i./acre** **EC_{25}** (dry weight) = **0.00039 lbs a.i./acre**	MRID 46695511 (Acceptable)
Plants – Vegetative Vigor				
Monocot	Onion	Single application	**NOAEC** (dry weight) = **0.0026 lbs a.i./acre** **EC_{25}** (dry weight) = **0.005 lbs a.i./acre**	MRID 46695512 (Acceptable)
Dicot	Tomato	Single application	**NOAEC** (dry weight) = **0.00033 lbs a.i./acre** **EC_{25}** (dry weight) = **0.00039 lbs a.i./acre**	MRID 46695512 (Acceptable)

[a] Values in **bold** are used to quantitatively assess risk.

a. Terrestrial Animals

(1). Acute Effects

Birds

The acute oral toxicity of technical grade tembotrione was evaluated in bobwhite quail (MRID 46695501). The acute oral LD_{50} of >2250 mg a.i./kg-bw observed in this study indicates that technical grade tembotrione is practically non-toxic to bobwhite quail on an acute oral basis.

No acute oral toxicity studies of tembotrione formulations or degradates in avian species were submitted. Since an LD_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive dose-based acute RQs for avian species.

The acute dietary toxicity of technical grade tembotrione was evaluated in mallard duck (MRID 46695502) and bobwhite quail (MRID 46695503). No mortality was observed at any the concentrations tested in these studies. Thus, the acute dietary LC_{50} was >5790 mg a.i./kg diet (the highest concentration tested) in mallard duck and bobwhite quail. These results indicate that tembotrione TGAI is practically non-toxic to birds on an acute dietary basis. Since an LC_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive dietary-based acute RQs for avian species.

No acute dietary toxicity studies of tembotrione formulations or degradates in avian species were submitted.

All study details and results are summarized in Appendix E, Table E-10 and E-11.

Mammals

An acute oral toxicity study was conducted with tembotrione TGAI in four female rats (MRID 46695618). There were no deaths at the two doses tested, yielding an acute oral LD_{50} >2000 mg a.i./kg-bw. Thus, tembotrione TGAI is practically non-toxic to mammals on an acute oral basis. Since an LD_{50} value was not established, with no mortalities or sublethal effects, EFED will not calculate dose-based acute RQs for mammals.

An acute oral toxicity study of tembotrione formulated product (34.3% tembotrione + 17.1% isoxadifen-ethyl) was conducted in female rats (MRID 46695619). This study yielded an estimated oral LD_{50} of 1750 mg formulation/kg-bw in rats. Thus, the tembotrione formulation tested is slightly toxic to mammals on an acute oral basis but more than 1.14 times more toxic to rats than the tembotrione TGAI.

Acute oral toxicity studies in rats were conducted with three tembotrione metabolites (AE 0456148, AE 1392936, and AE 1417268). Each metabolite was administered to rats as a single dose of 2000 mg metabolite/kg-bw. No deaths, clinical effects, or abnormal findings at necropsy were observed in any of the studies at 2000 mg metabolite/kg-bw, indicating that these three metabolites were practically non-toxic to mammals on an acute oral basis.

All study details are summarized in in Appendix E in Tables E-13 to E-15.

Terrestrial Invertebrates

A 72-hour contact toxicity study of technical grade tembotrione in honey bees yielded an LD_{50} >100 µg a.i./bee (MRID 46695507, supplemental), indicating that technical grade tembotrione is practically non-toxic to honey bees

A 72-hour acute oral toxicity study of technical grade tembotrione in honey bees yielded an acute oral LD_{50} of >92.8 µg a.i./bee (MRID 46695508, supplemental).

A 48-hour acute contact toxicity study of tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl) in honey bees yielded a contact LD_{50} of >130.4 µg a.i./bee (MRID 46695509, supplemental), indicating that the tembotrione formulated product is practically non-toxic to honey bees.

A 48-hour acute oral toxicity study of tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl) in honey bees yielded an acute oral LD_{50} of 153.4 µg a.i./bee (MRID 46695510, supplemental).

All study details and results are summarized in Appendix E, **Table E-17 and E-18**.

(2). Chronic Effects

Birds

Reproductive toxicity of technical grade tembotrione in bobwhite quail (MRID 46695504) and mallard duck (MRID 46695505) were observed in mallard ducks at 65.3 mg a.i./kg diet and 250 mg ai/kg diet for decreased body weight gain in adults and Reductions in the ratio of eggs hatched to eggs laid and eggs set, including reduced embryo survival, respectively. Reduced embryo viability and other developmental effects were observed in bobwhite quail at ≥260 mg a.i./kg diet. EFED will use the NOAEC value of 65.3 mg a.i/kg diet in mallard ducks to assess chronic risk of tembotrione exposure in avian species.

No chronic toxicity studies of tembotrione formulations or degradates in avian species were submitted.

Mammals

F_1 and F_2 male and female juvenile (post-weaning) rats showed reduced body weight and body weight gain at 200 mg a.i./kg diet (equivalent to 30.7 mg/kg-bw/day) with a NOAEC of 20 mg a.i./kg diet (equivalent to 3.2 mg/kg-bw/day). Reported body weights decreased by 5-6% and 11-12% in females and male rats, respectively. There were no effects on reproduction at any dose level in either generation, establishing a NOAEC for reproductive effects of 1500 mg a.i./kg diet. A dose-related incidence of corneal opacities was observed in a two-generation reproductive toxicity study of technical grade tembotrione in all treated male and female rats from at all treatment levels. Severity at the lowest concentration tested (20 mg a.i./kg diet) ranged from 1.0-2.3 on a scale of 5. The NOAEC for corneal opacity was not established and is <20 mg a.i./kg diet.

EFED will use the NOAEC of 20 mg a.i./kg diet for adverse effects to offspring to assess chronic risk to mammals exposed to tembotrione. A NOAEC of <20 mg a.i./kg diet for corneal opacities will be used to assess the chronic risk to listed mammals exposed to tembotrione.

All study details and results are summarized in Appendix E, Table E-16.

Terrestrial Invertebrates

No chronic toxicity study was submitted for technical grade tembotrione, its formulations, or degradates in terrestrial invertebrates.

(3). Sublethal Effects

Birds

Clinical signs of toxicity (ruffled appearance and/or lethargy) were observed in bobwhite quail during an acute oral toxicity study with technical grade tembotrione (MRID 46695501). This study established a NOAEL and a LOAEL of 486 mg a.i./kg-bw and 810 mg a.i./kg-bw, respectively, for clinical signs of toxicity.

Studies of acute dietary toxicity of technical grade tembotrione in mallard duck (MRID 46695502) and bobwhite quail (MRID 46695503) show treatment-related reductions in body weight gain, with NOAEC values of <580 and 1890 mg a.i./kg diet, respectively.

Results of a reproductive study in mallard ducks show sublethal effects (reductions in parental body weight gain, reductions in the ratio of eggs hatched to eggs laid and eggs set, reduced embryo survival), with a NOAEC of 65.3 mg a.i./kg diet (MRID 46695505). Reduced embryo viability and other developmental effects (live 3-week embryos to viable embryos; number hatched; number hatched as a proportion of eggs laid, eggs set, and live 3-week embryos; hatchling survival; hatchling survivors of eggs set; survivor weight) were observed in bobwhite quail at ≥260 mg a.i./kg diet (MRID 46695504).

Additional study details are summarized in Appendix E, **Table E-10, E-11, and E-12**.

Mammals

No significant sublethal effects were observed in acute oral exposure studies on technical grade tembotrione in mammals. Sublethal effects (piloerection, hypoactivity, hunched posture) were observed in a 14-day, acute oral toxicity study of tembotrione formulated product, with a NOAEL of 550 mg formulation/kg body weight.

The reproductive toxicity of technical grade tembotrione showed decreased parental body weight and dilated renal pelvis (NOAEC 20 mg a.i/kg diet), decreased body weight gain in offspring (NOAEC 20 mg a.i/kg diet), and dose-related corneal opacity (NOAEC <20 mg a.i/kg diet) (Bayer 2005). Study details and results are summarized in Appendix E, Table E-16. No offspring showed reduced body weight and body weight gain at 30.7 mg/kg-bw/day with a NOAEL of 3.2 mg/kg-bw/day.

Terrestrial Invertebrates

Available studies on terrestrial invertebrates did not include an evaluation of sublethal effects of exposure to technical grade tembotrione.

(4). Field Studies

No field studies were submitted for chronic effects of tembotrione on terrestrial organisms.

b. Terrestrial Plants

The effect of the tembotrione formulation AE 0172747 SC52 (34.8% a.i.) on seed emergence in terrestrial plants was evaluated in a Tier II study (MRID 46695511) and conducted in monocots: corn, onion, ryegrass, and wheat; and dicots: cucumber, lettuce, radish, soybean, sunflower, and tomato (MRID 46695511). Onion was the most sensitive monocot and dry weight was the most sensitive endpoint, with NOAEC and EC_{25} values of 0.011 lbs a.i./acre and 0.028 lab a.i./acre, respectively. Lettuce was the most sensitive diocot and dry weight was the most sensitive endpoint with EC_{05} and EC_{25} values of <0.00018 and 0.00039 lbs a.i./acre, respectively. These values will be used to assess the effects of exposure to tembotrione on seedling emergence in non-listed and listed terrestrial plants.

No Tier II vegetative vigor studies on the effect of the tembotrione formulation AE 0172747 SC52 (34.8% a.i.) in terrestrial plants is available.

Additional details on study findings are summarized in Appendix E, Tables E-19 and E-20.

IV. RISK CHARACTERIZATION

Risk characterization is the integration of exposure and effects characterization to determine the ecological risk from the use of tembotrione and the likelihood of effects on aquatic life and wildlife based on various use scenarios for application to corn. The risk characterization provides estimation and description of the risk; articulates risk assessment assumptions, limitations, and uncertainties; synthesizes an overall conclusion; and provides the risk managers with information to make regulatory decisions.

A. Risk Estimation – Integration of Exposure and Effects Data

Results of the exposure and toxicity effects data are used to evaluate the likelihood of adverse ecological effects on non-target species. For the assessment of tembotrione risks, the risk quotient (RQ) method is used to compare exposure and measured toxicity values (see Appendix F). Estimated environmental concentrations (EECs) are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency's levels of concern (LOCs). The LOCs, as summarized in Appendix F, are the Agency's interpretive policy used to analyze potential risk to non-target organisms and the need to consider regulatory action. For non-target aquatic animals (i.e., fish and invertebrates) and plants (i.e., algae and macrophytes), surface water EECs were obtained from the Tier II model PRZM/EXAMS (see **Table 7**). For non-target terrestrial species, EECs and RQs were obtained from the Tier I models T-REX for terrestrial animals (i.e., birds and mammals) (see Appendix D) and TERRPLANT for terrestrial and semi-aquatic plants (See Appendix C). Toxicity reference values for aquatic and terrestrial organisms exposed to tembotrione are summarized in **Table 12** and **Table 13**, respectively. Details of all RQs are provided in Appendix G.

1. Non-Target Aquatic Animals and Plants

To assess risks of use on corn to non-target aquatic organisms (i.e., fish, invertebrates, plants), surface water EECs were obtained from the Tier II model PRZM/EXAMS for 10 application scenarios of tembotrione applied by ground application (see **Table 7**). Application scenarios were selected to represent the entire range of soil and environmental conditions for the proposed use. EFED uses the peak concentration to derive RQs for acute exposure. EECs and RQs were derived only for the parent compound (tembotrione TGAI), not for individual degradates, total residues (i.e., parent plus degradates), or the formulated product.

a. Acute Risk to Aquatic Animals

Freshwater Animals

Acute toxicity studies in freshwater fish did not observe mortalities or sublethal effects at the highest concentrations tested; thus, acute RQs were not derived for freshwater fish. However, the lowest 96-hour LC_{50} value of >100 mg a.i./L is approximately 11,000-fold greater than the highest EEC of 9.09 µg a.i./L modeled by PRZM/EXAMS for the Florida sweet corn scenario. Thus, acute RQs for freshwater fish would be several orders of magnitude below the LOC for acute risk (0.5), acute restricted use (0.1), and acute listed risk (0.05) for all corn application scenarios considered. All acute RQs derived for freshwater invertebrates are <0.01 for all corn application scenarios (see Appendix G, **Table G-2**). Actual acute RQs for freshwater invertebrates are several orders of magnitude below the LOC for acute risk (0.5), acute restricted use (0.1), and acute listed risk (0.05).

Estuarine/Marine Animals

Acute toxicity studies in estuarine/marine fish did not observe mortalities or sublethal effects at the highest concentrations tested; thus, acute RQs were not derived for estuarine/marine fish. However, the lowest 96-hour LC_{50} value of >100 mg a.i./L is approximately 11,000-fold greater than the highest EEC of 9.09 µg a.i./L modeled by PRZM/EXAMS for the Florida sweet corn scenario. Thus, acute RQs for freshwater fish would be several orders of magnitude below the LOC for acute risk (0.5), acute restricted use (0.1), and acute listed risk (0.05) for all corn application scenarios.

Acute RQs for estuarine/marine invertebrates were determined for corn scenarios in states that border with estuarine/marine habitat (**Table 14**). All acute RQs are below the LOC for acute risk (0.5) and acute restricted use (0.1). However, acute RQs meet or exceeded the LOC for acute listed risk (0.05) for the Florida sweet corn (RQ 0.09). Toxicity data were not available for estuarine/marine mollusks (typically, the Eastern oyster); thus, acute RQs could not be derived for estuarine/marine mollusks.

Table 14. Acute RQs for Estuarine/Marine Invertebrates Exposed to Tembotrione by Ground Application

Application Scenario	Organism	LC_{50} [a] (µg a.i./L)	EEC Peak [b] (µg a.i./L)	Acute RQ (EEC/LC_{50})
California Corn	Mysid shrimp	100	0.39	<0.01
Florida Sweet Corn	Mysid shrimp	100	9.09	**0.09***
Mississippi Corn	Mysid shrimp	100	3.73	0.04
North Carolina Corn-East	Mysid shrimp	100	1.74	0.02
Oregon Sweet Corn	Mysid shrimp	100	1.25	0.01
Texas Corn	Mysid shrimp	100	3.01	0.03

[a] RQs are based on the mysid shrimp 96-hour EC_{50} = 100 µg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.
* Exceeds Acute Listed Species LOC (≥0.05)

b. Chronic Risk to Aquatic Animals

Freshwater Animals

Chronic RQs for freshwater fish and invertebrates are summarized in Appendix G, **Tables G-1** and **G-3**, respectively. Chronic RQs for freshwater fish and invertebrates are ≤0.1. In both cases the highest RQ of 0.01 was derived for the Florida sweet corn scenario. The chronic LOC of 1 was not exceeded for any corn application scenarios considered. A toxicity study in benthic organisms was submitted by the registrant. However, due to the low K_{oc} and high water solubility of tembotrione, EFED does not require a benthic study. Furthermore, tembotrione is not expected to partition into sediment, thereby limiting exposure of benthic organisms. Thus, RQs for benthic organisms are not derived.

Estuarine/Marine Animals

Chronic toxicity data for estuarine/marine fish are not available. Freshwater fish and invertebrate acute and chronic data were used to estimate a NOAEC for estuarine/marine fish. The estimated values are ≤0.604 ppb and 10.5 ppb, respectively. These estimated toxicity values can be used to bracket risk to estuarine/marine fish. Using the most sensitive estimated NOAEC (derived from freshwater fish data), the Florida sweet corn scenario would result in the highest RQ of 0.01; this RQ is well below the LOC of 1.

A chronic study for an estuarine/marine invertebrate (mysid) is classified supplemental (no NOAEC established), and therefore, no RQs are derived. Results will be qualitatively discussed in the risk description section Toxicity data were not available for estuarine/marine mollusks (typically, the Eastern oyster); thus, acute RQs could not be derived for estuarine/marine mollusks.

c. Risks to Aquatic Plants

Acute RQs for non-listed (based on EC_{50} values) and listed (based on EC_{05} values) aquatic macrophytes and freshwater algae are summarized in **Table 15**. Based on the EC_{50} of 5.2 µg a.i./L, RQs for non-listed aquatic macrophytes range 0.08 to 1.75. The LOC for non-listed aquatic plants (≥1) was exceeded for only one scenario (Florida sweet corn; RQ 1.75). Based on the NOAEC value of 2.86, RQs for listed macrophytes range from >0.41 to >9.67, exceeding the LOC for risk to aquatic plants (≥1) for all except one scenario (California corn). Since toxicity was observed at the lowest concentration tested, considerable uncertainty is added to the acute RQs derived for listed macrophytes. The overall risk conclusion does not change with this added uncertaintly; the magnitude of risk is uncertain however..

Risk quotients for non-listed freshwater algae were based on the EC_{50} of 310 µg a.i./L, resulting in RQs below the LOC for risk to aquatic plants (≥1); RQs range from <0.01 to 0.03.

Due to lack of estuarine/marine data, risk to estuarine/marine plants cannot be derived.

Table 15. Risk Quotients for Aquatic Macrophytes and Freshwater Algae Exposed to Tembotrione by Ground Application						
Application Scenario	**Organism**	**EC_{50} [a] (µg a.i./L)**	**NOAEC [a] (µg a.i./L)**	**EEC Peak [b] (µg a.i./L)**	**Acute RQ Non-Listed (EEC/EC_{50})**	**Acute RQ Listed (EEC/NOAEC)**
Aquatic Macrophytes						
California Corn	Duckweed	5.2	2.84	0.39	0.08	0.14
Florida Sweet Corn	Duckweed	5.2	2.84	9.09	**1.75*****	**3.20**
Illinois Corn	Duckweed	5.2	2.84	4.60	0.88	**1.62**
Mississippi Corn	Duckweed	5.2	2.84	3.73	0.72	**1.19**
North Carolina Corn–East	Duckweed	5.2	2.84	1.74	0.33	0.61
North Dakota Corn	Duckweed	5.2	2.84	3.10	0.60	**1.09**
Ohio Corn	Duckweed	5.2	2.84	2.97	0.57	**1.05**
Oregon Sweet Corn	Duckweed	5.2	2.84	1.25	0.24	0.44
Pennsylvania Corn	Duckweed	5.2	2.84	1.75	0.34	0.62
Texas Corn	Duckweed	5.2	2.84	3.01	0.58	**1.06**
Freshwater Algae						
California Corn	*P. subcapitata*	310	200	0.39	<0.01	0.0020
Florida Sweet Corn	*P. subcapitata*	310	200	9.09	0.03	0.045
Illinois Corn	*P. subcapitata*	310	200	4.60	0.01	0.0030
Mississippi Corn	*P. subcapitata*	310	200	3.73	0.01	0.017
North Carolina Corn–East	*P. subcapitata*	310	200	1.74	<0.01	0.0087
North Dakota Corn	*P. subcapitata*	310	200	3.10	0.01	0.016
Ohio Corn	*P. subcapitata*	310	200	2.97	<0.01	0.015
Oregon Sweet Corn	*P. subcapitata*	310	200	1.25	<0.01	0.0063
Pennsylvania Corn	*P. subcapitata*	310	200	1.75	<0.01	0.0088
Texas Corn	*P. subcapitata*	310	200	3.01	<0.01	0.015

[a] RQs are based on the duckweed 14-day EC_{50} (non-listed) =5.2 µg a.i./L and the 14-day EC_{05} (listed) <0.94 µg a.i./L for aquatic macrophytes and the freshwater algae (*Pseudokircheriella subcapitata*) 96-hour EC_{50} =0.310 mg a.i./L (listed) and EC_{05} (non-listed) <0.070 mg a.i./L

[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.

* Exceeds Acute Listed Species LOC (≥1)

*** Exceeds Acute Non-Listed Species LOC for Aquatic Plants (≥1)

2. Non-Target Terrestrial Animals

To assess risks of Tembotrione to non-target terrestrial animals, EECs and acute and chronic RQs for residues on various forage categories (short grass, tall grass, broadleaf plants/small insects, fruits/pods/large insects, and seeds) were obtained from the Tier I model T-REX for applications to corn. Explanation of the model and output are presented in Appendix D.

a. Acute Risk to Mammals and Birds

Acute toxicity studies in mammals did not result in mortalities at the highest dose tested; thus, acute RQs were not derived for acute exposure of mammals. The acute LD_{50} value of >2000 mg a.i./kg-bw in rats is approximately 60-fold greater than the highest EEC of 32.98 mg/kg-bw modeled by T-REX for dose-based exposure of a small mammal to residues on short grass (see Appendix D). Thus, acute dose-based RQs for mammals would be below the LOC for acute risk (0.5), acute restricted use (0.2), and acute listed risk (0.1).

For birds, acute toxicity studies did not result in mortalities at the highest dose tested; thus, acute RQs were not derived for acute exposure of birds. For acute oral exposure of birds, the acute LD_{50} value of >2250 mg a.i./kg-bw is approximately 57-fold greater than the highest EEC of 39.4 mg/kg-bw modeled by T-REX for dose-based exposure of a small bird to residues on short grass (see Appendix D). For acute dietary exposure of birds, the acute LC_{50} value of >5790 mg a.i./kg diet is approximately 167-fold greater than the highest EEC of 34.59 mg a.i./kg diet modeld by T-REX for dietary-based exposure to residues on short grass. Thus, acute dose-based and dietary-based RQs for mammals would be below the LOC for acute risk (0.5), acute restricted use (0.2), and acute listed risk (0.1).

b. Chronic Risk to Birds and Mammals

Dietary-based chronic RQs for birds are summarized in **Table 16.** Chronic RQs for birds are below the LOC for chronic risk (≥1) for all categories of residue exposure, ranging from 0.03 to 0.53.

Table 16. Dietary-Based Chronic RQs for Birds Based on Upper Bound Residues as Calculated by T-REX

Crop Use	Avian Chronic Risk Quotients [a]			
	Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/Pods/ Large Insects
Corn	0.53	0.24	0.30	0.03

[a] Chronic dietary-based RQ = EEC/NOAEC, where EECs values are upper bound residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of <65.3 mg a.i./kg diet in mallard ducks. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Dose-based and dietary-based chronic RQs for mammals are summarized in **Table 17**. Dose-based chronic RQs for mammals range from 0.10 (large mammal feeding on seeds) to 15.01 (small mammal feeing on short grass), exceeding the chronic LOC (≥1) for exposure of small-, medium- and large-sized mammals feeding on short grass, tall grass, and broadleaf plants/small insects. Dose-based chronic RQs for mammals feeding on fruits/pods/large insects and seeds are below the chronic LOC. Dietary-based chronic RQs range from 0.11 to 1.73, exceeding the chronic LOC for exposure from residues on short grass.

Table 17. Dose-Based and Dietary-Based Chronic RQs for Mammals Based on <u>Upper Bound</u> Residues and Chronic NOAEC of 20 ppm for Decreased Body Weight in Offspring as Calculated by T-REX

Crop Use	Body Weight (g)	Mammalian Chronic Risk Quotients				
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/Pods/ Large Insects	Seeds
Dose-Based						
Corn [a]	15	**15.01**	**6.88**	**8.44**	0.94	0.21
	35	**12.82**	**5.88**	**7.21**	0.80	0.18
	1000	**6.87**	**3.15**	**3.87**	0.43	0.10
Dietary-Based						
Corn [b]	NA	**1.73**	0.79	0.97	0.11	NA

[a] Dose-base chronic RQ = EEC/NOAEL, where EECs values are upper bound residues expressed as equivalent dose (mg a.i./kg-bw) generated from T-REX and the chronic toxicity value is the chronic NOAEL = 1 mg a.i./kg-bw in rats, converted from the NOAEC of 20 mg a.i./kg diet in the rat using the standard FDA lab rat conversion by T-REX. See Appendix D for full T-REX output.
[b] Dietary-based RQs = EEC/NOAEC, where EECs values are upper bound residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of 20 mg a.i./kg diet in rats. See Appendix D for full T-REX output.
Bolded RQs exceed LOC of 1

c. Risk to Terrestrial Invertebrates

Although EFED does not quantitatively assess risks to non-target terrestrial invertebrates, acute toxicity studies show that tembotrione TGAI is practically non-toxic to honey bees. Due to lack of toxicity data, risks to earthworms cannot be assessed.

3. Non-target Plants Inhabiting Terrestrial and Semi-Aquatic Areas

Terrestrial and semi-aquatic plants may be exposed to pesticides from runoff, spray drift, or volatilization. Semi-aquatic plants are those that inhabit low-laying wet areas that may be dry at certain times of the year. The TERRPLANT model was used to estimate risk quotients to non-listed, non-target monocots and dicots using the EC_{25} value and to listed monocots and dicots plants using the NOAEC; a description of the model, the assumptions used in calculating RQ values, and model output can be found in Appendix C. Risk quotients for terrestrial and semi-aquatic plants based on seedling emergence data are summarized in **Table 18**.

Risk quotients are above the LOC ($\geq$1) for emergence for non-listed and listed semi-aquatic monocots and dicots as well as for terrestrial dicots; RQs are below the LOC for emergence of non-listed and listed terrestrial monocots. Terrestrial plant vegetative vigor RQs exceed the LOC for listed and non-listed dicots but do not exceed the LOC for listed and non-listed monocots.

Table 18. Risk Quotients for Non-Listed Species and Listed Species Terrestrial and Semi-Aquatic Plant Emergence in Areas Adjacent to Treatment Sites (Due to Drift) for Tembotrione							
Application Rate (lbs a.i./acre)	Crop Use	Risk Quotients [a]					
		Terrestrial Plant Emergence (Adjacent Area)		Semi-Aquatic Plant Emergence (Adjacent Area)		Terrestrial Plant Vegetative Vigor (Drift)	
		Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
Non-Listed Terrestrial and Semi-Aquatic Plant [b]							
0.082	Corn (ground)	0.176	**12.62*****	**1.49*****	**107.23*****	0.16	**2.10**
Listed Terrestrial and Semi-Aquatic Plant [c]							
0.082	Corn (ground)	0.447	**27.33*****	**3.8*****	**232.33*****	0.32	**2.48**

[a] RQs are calculated using TERRPLANT. See Appendix C for full TERRPLANT output.
[b] Based on the EC_{25} value = 0.028 lb a.i./acre for seedling emergence and EC25 = 0.005 lb ai/ acre for vegetative vigor in monocots (onion); EC_{25} value = 0.00039 lb a.i./acre for seedling emergence ane EC25 = 0.00039 lb ai/acre in dicots (lettuce).
[c] Based on the NOAEC value = 0.011 lb a.i./acre for seedling emergence and NOAEC = 0.0026 for vegetative vigor in monocots (onion); the NOAEC value of 0.00018 lb a.i./acre for seedling emergence and NOAEC = 0.00033 lb ai/acre in dicots (lettuce).
*** Exceeds Acute Listed Species/Non-Listed Species LOC for Terrestrial and Semi-Aquatic Plants (≥1)

B. Risk Description

Aquatic and terrestrial species may be exposed to tembotrione through its agricultural uses on corn crops. Tembotrione and several of its metabolites have high mobility in soil and can reach surface waters via spray drift and rainfall events that cause runoff. Registrant-submitted studies on environmental fate and transport indicate that tembotrione is not highly persistent in the environment, degrading primarily through biodegradation in soil and water, with biodegradation under aerobic conditions identified as the major route of dissipation. Aerobic soil metabolism half-lives for tembotrione are less than 10 days in silty loam and for its metabolite AE 0941989 and AE 1392936, respectiverly, are less than 2 days and 15 days in clay loams. However, tembotrione has the potential to be more persistent in environments with loamy sand (aerobic soil metabolism half-lives between 63 and 72 days).

Registrant-submitted studies on environmental fate and transport indicate that tembotrione is not highly persistent in the environment, degrading primarily through biodegradation in soil and water under aerobic conditions. Tembotrione appears to be stable to hydrolysis at environmental pH (pH range 5–9) but may be susceptible to photolysis in soil and water. Tembotrione and several of its metabolites have high mobility in soil and can reach surface waters via spray drift and rainfall events that cause runoff. Tembotrione has a high solubility in water and low K_{oc}; thus, tembotrione is not expected to partition and accumulate in sediment. Due to its vapor pressure and Henry's Law constant, volatilization from water and soil is not expected to be an important environmental fate process. The effects of tembotrione on terrestrial and aquatic organisms are expected to remain within proximity of the Federal action due to the compounds non-volatility and propensity to degrade quickly.

EFED has completed a screening level risk assessment of tembotrione. Results indicate the potential for acute and chronic risk to estuarine/marine invertebrates based on Florida scenario only and aquatic macrophytes, and chronic risk to mammals (based on body weight gain). Chronic risk to birds did not exceed LOCs but may be underestimated (see discussion for birds).

1. Risks to Aquatic Organisms

One growing season for corn was modeled in the PRZM/EXAMS run. The PRZM/EXAMS model predicts that tembotrione applied to corn crops has the potential to reach surface water. Simulated 1-in-10 year peak surface water concentrations resulting from ground applications ranged from 0.39 for dryland/irrigated corn in CA to 9.09 μg/L for sweet corn grown in high rainfall in Florida (**Table 7**). EECs for the other corn scenarios ranged from 1.2 to 4.6 μg a.i./L. An explanation for the difference observed in the EECs for each of the simulations is provided in Section III.B. Briefly, the Florida scenario simulates a wetter climate than other geographic areas simulated in this assessment. The cumulative rainfall for the Florida scenario is greater than the total rainfall in any of the other PRZM corn scenarios; as a consequence the runoff flux from this site is much greater than in any of the other PRZM scenarios.Comparison of rainfall from the Florida and California scenarios shows that the annual average rainfall for the Florida sweet corn scenario is 154.8 cm (70.0 inches), whereas the average rainfall for the California scenario is 44.6 cm (17.6 inches). Therefore, risk conclusions in the Florida scenario will be driven by the increased rainfall as opposed to the California scenario.

a. Freshwater Animals

Results of this risk assessment indicate that the proposed use of tembotrione is not expected to result in toxic exposure to freshwater fish and invertebrates on an acute or chronic basis, with RQs well below acute and chronic LOCs. Risk to freshwater animals is not expected to exceed levels of concern since technical grade tembotrione is classified as practically non-toxic to freshwater fish and slightly toxic to freshwater invertebrates. Since sublethal effects were not observed in acute toxicity studies of freshwater animals, exposure to tembotrione is not expected to produce effects, such as erratic swimming or lethargic behavior that could result in decreased survival. In areas where corn can has two growing seasons, as may be the case in southern states such as Texas or Florida, EECs would be higher. However, EFED does not expect the risk conclusion to change for aquatic animals. For estuarine/marine invertebrates, risk quotients would be higher than presented in this assessment.

In chronic toxicity studies, sublethal effects were observed in freshwater fish (decreased growth, NOAEC = 1.10 mg a.i./L) and invertebrates (decreased growth, NOAEC = 5.10 mg a.i./L); however, NOAEC values exceed 21-day and 60-day EECs (**Table 7**) by several orders of magnitude, indicating that chronic exposure of freshwater animals is not expected to result in adverse effects under the conditions of proposed use. Thus, acute and chronic risks from exposure to tembotrione to non-listed and listed freshwater animals are not expected to exceed levels of concern.

<u>Formulated Product</u>

Results of acute toxicity studies indicate that the tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl SC 420+210) is 50-fold and 4-fold greater than that of technical grade tembotrione in freshwater fish and invertebrates, respectively.

Comparison of acute lethality values for the formulated product in freshwater fish (LC_{50} in rainbow trout of 1.83 mg a.i./L) and invertebrates (EC_{50} of 11.6 mg a.i./L in waterflea) to the highest modeled peak EEC obtained for the active ingredient (9.09 µg a.i./L for Florida sweet corn) indicates that acute RQs for the formulated product would be well below all acute LOCs and are not expected to exceed levels of concern.

b. Estuarine/Marine Animals

Estuarine/marine fish are not at acute risk from exposure to technical grade tembotrione. In addition, no sublethal effects were observed in estuarine/marine fish under acute exposure conditions, and therefore, exposure to tembotrione is not expected to produce sublethal effects that could result in decreased survivability on an acute basis.

Exposure scenarions did not result in acute LOCs being exceeded for non-listed estuarine/marine invertebrates. However, listed species LOCs are exceeded under certain environmental conditions (e.g., increased annual rainfall, Riviera sand as in Palm Beach) such as for the Florida corn scenario (RQ 0.09, **Table 14**). Since there are no listed estuarine/marine invertebrates in Florida or the continental U.S, with the exception of the white abalone in California, this risk determination is not applicable at the time.

Due to lack of toxicity data, acute risks to estuarine/marine mollusks could not be assessed.

In absence of chronic toxicity data for estuarine/marine fish, freshwater fish and invertebrate data were used to bracket the risk to these organisms (using ACR method). Based on the lowest estimated toxicity value (604 µg a.i./L) and highest expected exposure concentrations (60 day EEC of 8.06 µg a.i./L), chronic risk to estuarine/marine fish is not expected to exceed LOCs.

No chronic RQs were calculated for estuarine/marine invertebrates because of several deficiencies in the mysid study. Failure to establish a NOAEC was one of them. However, adverse effects (mortalities) were recorded at the lowest concentration tested (1.6 µg a.i./L). Table 7 shows that the 21-day surface water EECs are higher than the lowest concentration tested in the study. EECs exceed 1.6 µg a.i./L for the following corn scenarios: Florida, Mississipi, North Carolina, and Texas indicating that chronic exposure to estuarine/marine invertebrates would be of concern. Presently, there is only one listed estuarine/marine species in California; thus this risk conclusion is not applicable at the time.

Due to lack of toxicity data, chronic risks to estuarine/marine mollusks could not be assessed.

c. Aquatic Plants

Risk quotients for non-listed aquatic vascular plants were below the LOC except for the Florida scenario (RQ 1.75) (**Table 15**). Thus, for most use scenarios, aquatic vascular plants are not at risk from exposure to tembotrione. However, under environmental conditions producing a high degree of runoff (e.g., high rainfall), non-listed aquatic vascular plants appear to be at risk from exposure to tembotrione.

For listed aquatic vascular plants, RQs exceeded LOCs for all other scenarios (except California, Oregon, Pennsylvania, and North Carolinate east scenarios) indicating that listed aquatic macrophytes are at risk under mainly high rainfall and certain local soil type conditions as modeled in the Florida, Illinois, North Dakota, and Ohio corn scenarios .

Based on modeled exposure scenarios, LOCs for non-vascular aquatic plants are not exceeded from exposure to technical grade tembotrione. All RQs are well below the LOC for aquatic plants (**Table 15**). There are presently no listed non-vascular aquatic plants.

Formulated Product

Results of two studies on the toxicity of the formulated product to freshwater algae show that toxicity values are within one order of magnitude lower than those for technical grade tembotrione. Based on these data, the formulated product is assumed to pose the same risks to aquatic plants as technical grade tembotrione.

2. Risks to Terrestrial Organisms

a. Terrestrial Animals (Mammals and Birds)

To assess risks to terrestrial organisms (e.g., birds and mammals), the T-REX model was used, which provides estimates of concentrations of chemical residues on different types of food items that may be sources of dietary exposure to avian, mammalian, reptilian, or terrestrial-phase amphibian receptors. Application of tembotrione on corn crops at a one-time maximum rate of 0.082 lbs a.i./acre for a maximum of 2 applications per year was used for the terrestrial assessment.

Acute toxicity studies in mammals and birds failed to establish acute lethality values, with no mortalities or sublethal effects observed at the highest doses/concentrations tested; thus, acute RQs were not derived. Since acute toxicity values for birds and mammals exceed the highest EECs modeled by T-REX by a minimum of approximately 60-fold, it is concluded that exposure of mammals and birds to tembotrione is not of concern.

This assessment determined that exposure to tembotrione poses chronic risks to mammals based on decreased body weight and body weight gain in offspring. No adverse reproductive effects were observed, however. Based on the NOAEC of 20 mg a.i./kg diet for effects in offspring, dose-based chronic RQs for mammals exceed the chronic LOC for mammals feeding on short grass, tall grass, and broadleaf plants/small insects, indicating chronic risks for all weight classes of mammals (**Table 17**). Dietary-based chronic RQs exceeded the LOC only for mammals feeding primarily on short grass. Corneal opacity was observed under conditions of continuous dietary exposure to technical grade tembotrione over the course of two generations, and available data are not sufficient to identify the minimal exposure duration required for the development of corneal opacities (NOAEC <20 mg a.i./kg diet). Corneal opacity severity, while observed in all tested animals at all concentrations, was low and ranged from 1.0-2.1 on a scale of 1 to 5. Since tembotrione is not persistent in the environment, degradation will limit the duration of exposure to a very short time (between 6 to 15 days). Therefore, under the conditions of actual use, the exposure duration is not expected to result in the development of corneal opacity or significant decrease of body weight gain. This risk assessment concludes that there will be no exceedance in chronic LOCs in the field from the use of tembotrione.

Results of this assessment indicate that chronic RQs for birds do not exceed LOCs. Adverse reproductive effects (reductions in the ratio of eggs hatched to eggs laid and eggs set and reduced embryo survival) and decreased body weight gain in adults were observed at 1000 mg ai/kg diet (NOAEC 250 mg a.i./kg) and 250 mg ai/kg diet (NOAEC 63.5 mg ai/kg diet); these effects concentrations are above the terrestrial EECs that birds will be exposed to.

<u>Formulated Product</u>

Results of toxicity studies in mammals and birds show that the tembotrione formulated product has a similar order of toxicity as technical grade tembotrione. Based on these results, acute risks to mammals and birds from exposure to the tembotrione formulation are not of concern. Due to the lack of toxicity data, chronic risks of exposure of mammals and birds could not be assessed.

b. Insects

Although EFED does not derive RQ values for non-target insects, risks can be assessed qualitatively. Results of toxicity studies on technical grade tembotrione show that the compound is practically non-toxic to honey bees on both a contact and an oral basis (non-guideline study). Therefore, acute risks of technical grade tembotrione exposure to pollinators and other beneficial insects are not anticipated.

c. Plants

<u>Formulated Product</u>

Risks to listed and non-listed terrestrial plants were assessed using the Tier I model TERRPLANT based on a one-time maximum single application rate of 0.082 lbs a.i./acre and seedling emergence and vegetative vigor toxicity values for the most sensitive monocot and dicot species. Since tembotrione degrades rather quickly under aerobic conditions and the proposed interval between applications is 14 days, it is not expected that plants are exposed to more than 0.082 lbs a.i./acre. It would not be justified to model exposure to plants with the seasonal maximum application rate of 0.164 lbs a.i./acre. Risk quotients for emergence of non-listed and listed terrestrial plants exceed LOCs for dicots; RQs for non-listed and listed plants growing in semi-aquatic areas exceed LOCs for monocots and dicots (**Table 18**). Risk quotients for

Terrestrial plant vegetative vigor exceed LOCs for non-listed and listed dicots. Results of this assessment indicate that terrestrial dicots as well as dicots and monocots growing in semi-aquatic areas are at potential risks for emergence from the proposed use of tembotrione. Terrestrial plants are also at risk for vegetative vigor (**Table 18** for RQs). Since tembotrione is an herbicide, risks to terrestrial and semi-aquatic plants were anticipated.

3. Review of Incident Data

Incident reports submitted to EPA since approximately 1994 have been tracked by assignment of EIIS (Environmental Incident Information System) in an Incident Data System (IDS). Since tembotrione is a new chemical and has not been previously approved for use in the U.S., there are no incident reports.

4. Endocrine Effects

Results of submitted studies for birds indicate that tembotrione may have detrimental effects on the endocrine system. Chronic toxicity studies in bobwhite quail (MRID 46695504) and mallard ducks (MRID 46695505) administered dietary tembotrione TGAI for 21 weeks show treatment-related reproductive and developmental effects, including reductions in number of eggs laid and eggs set, reduced embryo viability, hatching, and hatchling survival. A chronic toxicity studies in freshwater fish (fathead minnow; MRID 46695443) show morphological anomalies (curvature of the spine with vertebral rotation) in fry. In estuarine/marine invertebrates (mysid shrimp; MRID 46695442), treatment-related reproductive effects (number of young per female per day) were observed.

Under the Federal Food, Drug and Cosmetic Act (FFDCA), as amended by the Food Quality Protection Act (FQPA), EPA is required to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate". Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen- and thyroid-hormone systems, in addition to the estrogen-hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP). When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, tembotrione may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption.

C. Federally Threatened and Endangered (Listed) Species Concerns

1. Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. At the initial screening level, the risk assessment considers broadly described taxonomic groups and so conservatively assumes that listed species within those broad groups are collocated with the pesticide treatment area. This means that terrestrial plants and wildlife are assumed to be located on or adjacent to the treated site and aquatic organisms are assumed to be located in a surface water body adjacent to the treated site. The assessment also assumes that the listed species are located within an assumed area which has the relatively highest potential exposure to the pesticide, and that exposures are likely to decrease with distance from the treatment area. This risk assessment presents the use of tembotrione on corn and establishes initial collocation of species with treatment areas.

If the assumptions associated with the screening level assessment result in RQs that are below the listed species LOCs, a "no effect" determination conclusion is made with respect to listed species in that taxa, and no further refinement of the action area is necessary. Furthermore, RQs below the listed species LOCs for a given taxonomic group indicate no concern for indirect effects upon listed species that depend upon the taxonomic group covered by the RQ as a resource. However, in situations where the screening assumptions lead to RQs in excess of the listed species LOCs for a given taxonomic group, a potential for a "may affect" conclusion exists and may be associated with direct effects on listed species belonging to that taxonomic group or may extend to indirect effects upon listed species that depend upon that taxonomic group as a resource. In such cases, additional information on the biology of listed species, the locations of these species, and the locations of use sites could be considered to determine the extent to which screening assumptions regarding an action area apply to a particular listed organism. These subsequent refinement steps could consider how this information would impact the action area for a particular listed organism and may potentially include areas of exposure that are downwind and downstream of the pesticide use site.

2. Taxonomic Groups Potentially at Risk

This screening level risk assessment indicates that uses of tembotrione will have no direct acute and chronic effects on listed freshwater fish, freshwater invertebrates, estuarine/marine fish, mammals, birds, and non-target insects. However, the screening level risk assessment has identified potential concerns for direct effects on estuarine/marine invertebrates, freshwater aquatic macrophytes, freshwater algae (none listed at this time), terrestrial plants, and terrestrial plants growing in semi-aquatic areas. There are presently no listed estuarine/marine invertebrates in the regions of concern. Therefore, this risk determination is of no concern at the time for estuarine/marine invertebrates and freshwater non-vascular plants.

There could be indirect effects to any listed species dependent upon terrestrial and aquatic plants that may experience effects from the use of tembotrione. Finally, potential risks to reptiles and terrestrial phase amphibians are characterized by the risks to birds; and potential risks to aquatic phase amphibians is characterized by the risks to freshwater fish. However, acute and chronic risks are not predicted for reptiles and terrestrial phase as well as aquatic phase amphibians.

The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that address these impacts. The Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. To analyze the potential of registered pesticide uses that may affect any particular species, EPA uses basic toxicity and exposure data developed for the REDs and considers it in relation to individual species and their locations by evaluating important ecological parameters, pesticide use information, geographic relationship between specific pesticide uses and species locations, and biological requirements and behavioral aspects of the particular species, as part of a refined use and species-specific analysis. When conducted, this species-specific analysis will take into consideration any regulatory changes recommended in this RED that have been implemented at that time.

Listed Species Risks Associated with Direct or Indirect Effects Due to Applications of Tembotrione for Use on Corn

Listed Taxonomy	Direct Effects	Indirect Effects
Semi-aquatic plants – monocots	Yes (semi-aquatic only)	None
Terrestrial and semi-aquatic plants – dicots	Yes	None
Terrestrial invertebrates *	None	Yes [e]
Birds	None [a]	Yes [e]
Terrestrial phase amphibians	None [a,d]	Yes [e]
Reptiles	None[a,d]	Yes [e]
Mammals	None [c]	Yes [e]
Aquatic vascular plants	Yes	None
Aquatic non-vascular plants	None[h]	None
Freshwater fish	None	Yes[e,f]
Aquatic phase amphibians	None [d]	Yes[f]
Freshwater invertebrates	None	Yes[f]
Mollusks	No Data	Yes[f]
Marine/estuarine fish	None	Yes[b]
Marine/estuarine invertebrates	Acute[I] and Chronic[g]	None

[I] no listed estuarine/marine invertebrates are present in states where modeling scenario indicated exceedance of LOCs.

[a] Trigger of chronic LOC for birds may be exceeded. NOAEC in study not established. Lowest concentration tested did not lead to exceedance of trigger; but reproductive effects were observed at this treatment level.

[b] Acute endangered risk LOC exceeded for marine/estuarine invertebrates. Presently, only 1 species (white abalone) is listed in California out of the entire U.S. As estuarine/marine species become threatened or endangered, risk to these organisms becomes of concern and indirect effects to estuarine/marine fish must be evaluated.

[c] While chronic LOCs are exceeded for mammals based on decrease of body weight gain (5-6% and 11-12% in females and males, respectively, and corneal opacity (low degree of severity), actual adverse effects in the field are not expected due to short exposure window.

[d] Terrestrial phase amphibians and reptiles estimated using birds as surrogates. Aquatic amphibians estimated using freshwater fish as surrogates.

[e] LOC exceedances for terrestrial and semi-aquatic plants.

[f] LOC exceedance for aquatic vascular plants

[g] no listed estuarine/marine invertebrates are present in states where modeling scenario indicated LOC exceedance

[h] no non-vascular plants are presently listed

a. Birds & Reptiles

Acute dietary- and dose-based RQs were not exceeded for birds. Chronic RQs for birds (**Table 16**) are below the LOC for chronic risk (LOC = 1) for all food categories of residue exposure. The tembotrione federal action is not expected to directly affect listed birds.

b. Mammals

Acute RQs were below the LOC (0.1) for listed mammals. However, chronic RQs exceeded the LOC (1) for chronic effects for decreased body weight gain for all weight classes of mammals foraging on short grass, tall grass, and broad-leaf plants and small insects. Additionally, chronic LOCs are exceeded for all weight classes foraging on all food categories when a chronic NOAEC for corneal opacities is used (as described in Section III). No reproductive effects were observed in the mammalian chronic toxicity study. However, screening level chronic RQs (**Table 18**) and potentially birds (**Table 17**) exceeded LOCs for all food groups except seeds and fruits/pods/large insects when corneal opacity was used as a measure of effect. Corneal opacity was observed under conditions of continuous dietary exposure to technical grade tembotrione over the course of two generations, and available data are not sufficient to identify the minimal exposure duration required for the development of corneal opacities. Severity of corneal opacity, while observed in all tested animals at all concentrations, was low and ranged from 1.0-2.1 on a scale of 1 to 5. During premating, minor decreases in parent body weight gain were observed after day 28. Since tembotrione is not persistent in the environment, degradation will limit the duration of exposure to a very short time (between 6 to 15 days). Therefore, under the conditions of actual use, the exposure duration is not expected to result in the development of corneal opacity. The tembotrione Federal action is not expected to directly affect listed mammalian species.

c. Aquatic Organisms

Acute and chronic RQs for aquatic organisms did not exceeded LOCs for listed freshwater fish, invertebrates, and estuarine/marine fish. In addition, since freshwater fish are used as surrogates for assessing risks to aquatic phase amphibians, no LOCs for the aquatic phase of amphibians are exceeded. The tembotrione Federal action is not expected to directly affect freshwater animals and estuarine/marine fish. Chronic RQs exceeded LOCs for estuarine/marine invertebrates for the Florida scenario (**Table 14**). Currently, there are no listed estuarine/marine invertebrates in Florida; thus this risk determination is not applicable at the time.

Acute RQs for duckweed exceeded the acute endangered LOC (1) for threatened and endangered vascular plants for corn scenarios with high rainfall and some local soil types, indicating that application of tembotrione for the proposed new uses may pose a threat to listed aquatic vascular plants (**Table 15**). There are currently 17 vascular aquatic plants listed in 21 states where corn is grown and the Federal action may occur.

At the present time, no aquatic non-vascular plants are included in Federal listings of threatened and endangered species. The taxonomic group is included here as a record of exceedances should future listings of non-vascular aquatic plants warrant additional evaluation of Federal actions.

d. Terrestrial Invertebrates

EFED does not derive RQ values for non-target insects; however risks can be assessed qualitatively. Toxicity tests indicate that tembotrione is practically non-toxic to honeybees. Therefore, risks to listed terrestrial invertebrates are expected to be low.

e. Terrestrial and Semi-Aquatic Plants

Acute endangered LOCs were exceeded for terrestrial plants (dicots) and semi-aquatic plants (monocots and dicots). Risk to these plants is driven by runoff as opposed to spray drift. A preliminary analysis of the LOCATES co-occurrence data indicates that over 500 listed dicots co-occur in counties where tembotrione may be applied to corn crops. In addition, LOCATES identified 62 listed monocots that may co-occur with potential tembotrione application sites.

3. Probit Dose Response Relationship

Screening level acute LOCs are exceeded for Acute Restricted Risk and Acute Endangered Risk for marine/estuarine invertebrates potentially exposed to residues by tembotrione application to corn crops. The Agency uses the dose-response relationship from the toxicity study used for calculating the RQ to estimate the probability of acute effects associated with an exposure equivalent to the EEC. This information serves as a guide to establish the need for and extent of additional analysis that may be performed using Services provided "species profiles" as well as evaluations of the geographical and temporal nature of the exposure to ascertain if a "not likely to adversely affect" determination can be made. The degree to which additional analyses are performed is commensurate with the predicted probability of adverse effects from the comparison of the dose response information with the EECs. The greater the probability that exposures will produce effects on a taxa, the greater the concern for potential indirect effects for listed species dependant upon that taxa, and therefore, the more intensive the analysis on the potential listed species of concern, their locations relative to the use site, and information regarding the use scenario (e.g., timing, frequency, and geographical extent of pesticide application).

The Agency uses the probit dose-response relationship as a tool for providing additional information on the listed animal species acute levels of concern. The acute endangered species LOCs of 0.1 and 0.05 are used for terrestrial and aquatic animals, respectively. As part of the risk characterization, an interpretation of acute LOCs for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (i.e., mortality or immobilization) should exposure at the estimated environmental concentration actually occur for a species with sensitivity to tembotrione on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose-response relationship available from the toxicity study used to establish the acute toxicity measurement endpoints for each taxonomic group. The individual effects probability associated with the LOCs is based on the mean estimate of the slope and an assumption of a probit dose-response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects, probabilities are also provided to account for variance in the slope. The upper and lower bounds of the effects probability are based on available information on the 95% confidence interval of the slope. Confidence in the applicability of the assumed probit dose response relationship for predicting individual event probabilities is also relevant. Studies with good probit fit characteristics (i.e., statistically appropriate for the data set) are associated with a high degree of confidence. Conversely, a low degree of confidence is associated with data from studies that do not statistically support a probit dose-response relationship. In addition, confidence in the data set may be reduced by high variance in the slope estimate (i.e., large 95% confidence intervals), despite good probit fit characteristics.

The individual effect probabilities for aquatic organisms were calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. Due to lack of partial mortalities derived from the dosage range tested in the submitted estuarine/marine mysid studies, the probit statistical model could not be used, and therefore the slope of the mortality curve could not be determined for the mysid toxicity studies. Instead, the binomial statistical model was used to determine the LC_{50} value for estuarine/marine mysids. Therefore, event probability was calculated for the exceeded LOC based on a default slope assumption of 4.5 with confidence intervals of 2 and 9 (**Table 18**) as per original Agency assumptions of typical slope cited in Urban and Cook (1986). The corresponding estimated chance of individual mortality associated with the aquatic Endangered Species LOC of 0.05, for estuarine/marine mysids is approximately **1 in $4*10^8$**. To explore the possible bounds of these estimates, the upper and lower values for the default mean (2–9) were used to calculate the upper and lower estimates of the effects probability associated with the listed species LOC. These values are **1 in 220** and **1 in $1.8*10^{16}$**. Presently, there is only one listed estuarine/marine species in the entire continental U.S. (white abalone in California). This abalone is found at depths of greater than 26 meters amongst rocky reefs with understory kelps off the coast of California and Baja California (Davis *et al.* 1996); Tembotrione concentrations in the Pacific waters are expected to be so dilute as to not exceed acute LOCs. Thus, exposure to tembotrione is not likely to adversely affect this species.

Table 19. Probability of Individual Mortality at the Highest Acute RQ (Tembotrione Application to Corn)					
Species	**RQ**	**Probit Slope**	**95% Confidence Interval**	**Probability of Individual Mortality at the RQ in this Assessment (C.I.)**	**MRID (Source of Probit Slope)**
FW Bluegill	<0.01	–	–	–	–
FW Water flea	<0.01	–	–	–	–
EM Mysid	0.09*	4.5	(2, 9)	1 in 4 E+8 (1 in 220 – 1 in 1.8 E+18)	Default
EM Sheepshead minnow	<0.01	–	–	–	–
– No acute endangered LOC exceedances * Exceeds LOC for acute risk to listed species (aquatic LOC = 0.05, terrestrial LOC = 0.10)					

4. Indirect Effects Analysis

The Agency acknowledges that pesticides have the potential to exert indirect effects upon the listed organisms by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, etc. In conducting a screen for indirect effects, direct effect LOCs for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-endangered organisms in these taxonomic groups as resources critical to their life cycle.

Indirect effects to any listed species that depend on terrestrial dicots and monocots and dicots growing in semi-aquatic areas are of concern. Which listed species are indirectly affected by the tembotrione Federal action will be determined in the refined risk assessment.

5. Critical Habitat

In the evaluation of pesticide effects on designated critical habitat, consideration is given to the physical and biological features (constituent elements) of a critical habitat identified by the U.S Fish and Wildlife and National Marine Fisheries Services as essential to the conservation of a listed species and which may require special management considerations or protection. The evaluation of impacts for a screening level pesticide risk assessment focuses on the biological features that are constituent elements and is accomplished using the screening level taxonomic analysis (RQs) and listed species' levels of concern (LOCs) that are used to evaluate direct and indirect effects to listed organisms.

The screening level risk assessment for tembotrione has identified potential concerns for indirect effects on listed species for those organisms dependant upon small mammals and birds and terrestrial plants containing residues (excluding fruits, seeds, and large insects). In light of the potential for indirect effects, the next step for EPA and the Service(s) is to identify which listed species and critical habitat are potentially implicated.

Analytically, the identification of such species and critical habitat can occur in either of two ways. First, the agencies could determine whether the action area overlaps critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-endangered species would affect the listed species indirectly or directly affect a constituent element of the critical habitat. Alternatively, the agencies could determine which listed species depend on biological resources, or have constituent elements that fall into the taxa that may be directly or indirectly impacted by a pesticide. Then EPA would determine whether or not use of the pesticide overlaps the critical habitat or the occupied range of those listed species. At present, the information reviewed by EPA is not sufficient to permit use of either analytical approach to make a definitive identification of species that are potentially impacted indirectly or critical habitats that are potentially impacted directly by the use of pesticides. EPA and the Service(s) are working together to conduct the necessary analysis.

D. Description of Assumptions, Limitations, Uncertainties, Strengths and Data Gaps

1. Assumptions, Limitations, Uncertainties, Strengths and Data Gaps Related to Exposure for All Taxa

There are a number of areas of uncertainty in the aquatic and terrestrial risk assessments. The toxicity assessment for terrestrial and aquatic animals is limited by the number of species tested in the available toxicity studies. Use of toxicity data on representative species does not provide information on the potential variability in susceptibility to acute and chronic exposures.

This screening level risk assessment relies on labeled statements of the maximum rate of tembotrione application, the maximum number of applications, and the shortest interval between applications. Together, these assumptions constitute a maximum use scenario. The frequency at which actual uses approach these maximums is dependant on resistance to the fungicide, timing of applications, and market forces.

2. Assumptions, Limitations, Uncertainties, Strengths and Data Gaps Related to Exposure for Aquatic Species

a. PRZM/EXAMS Standard Runoff Model

Although there are uncertainties and limitations with the use of the PRZM/EXAMS standard runoff scenario for a regional aquatic exposure assessment, it is designed to represent pesticide exposure from an agricultural watershed impacting a vulnerable aquatic environment. Extrapolating the risk conclusions from this standard small water body scenario may either underestimate or overestimate the potential risks.

Major uncertainties with the standard runoff scenario are associated with the physical construct of the watershed and representation of vulnerable aquatic environments for different geographic regions. The phyisco-chemical properties (pH, redox conditions, etc.) of the standard small water body are based on EFED's standard ecological pond. These properties are expected to be regionally specific because of local hydrogeological conditions. Any alteration in water quality parameters may impact the environmental behavior of the pesticide. The small water body represents a well mixed, static water body. Because the small water body is a static water body (no flow through); it does not account for pesticide removal through flow through or accidental water releases. However, the lack of water flow in the small water body provides an environmental condition for accumulation of persistent pesticides. The assumption of uniform mixing does not account for stratification due to thermoclines (e.g., seasonal stratification in deep water bodies). Additionally, the physical construct of the standard runoff scenario assumes a watershed water body area ratio of 10. This ratio is recommended to maintain a sustainable pond in the Southeastern U.S. The use of higher watershed water body ratios (as recommended for sustainable ponds in drier regions of the U.S.) may lead to higher pesticide concentrations when compared to the standard watershed water body ratio.

The standard small water body scenario assumes uniform environmental and management conditions exist over the standard 10 hectare watershed. Soils can vary substantially across even small areas, and thus, this variation is not reflected in the model simulations. Additionally, the impact of unique soil characteristics (e.g., fragipan) and soil management practices (e.g., tile drainage) are not considered in the standard runoff scenario. The assumption of uniform site and management conditions is not expected to represent some site-specific conditions. Extrapolating the risk conclusions from the standard small water body scenario to other aquatic habitats (e.g., marshes, streams, creeks, and shallow rivers, intermittent aquatic areas) may either underestimate or overestimate the potential risks in those habitats.

Currently, crop sites for PRZM/EXAMS modeling are chosen to represent sites which produce high-end, but not unrealistic or worst-case, EECs for that crop. The EECs in this analysis are accurate only to the extent that the site represents a hypothetical high-end exposure site. It should be remembered that while the standard pond would be expected to generate lower EECs than shallow water bodies near agricultural fields that receive most of their water as runoff from agricultural fields that have been treated with tembotrione.

There are uncertainties associated with the use of peak EECs. For an acute risk assessment, there is no averaging time for the exposure estimates. An instantaneous peak concentration, with a 1-in-10 year return frequency, is assumed. The use of the instantaneous peak assumes that instantaneous exposure is of sufficient duration to elicit acute effects comparable to those observed over more protracted exposure periods tested in the laboratory, typically 48 to 96 hours. In the absence of data regarding time-to-toxic event analyses and latent responses to instantaneous exposure, the degree to which risk is overestimated cannot be quantified.

For an acute risk assessment, there is no averaging time for exposure. An instantaneous peak concentration, with a 1-in-10 year return frequency, is assumed. The use of the instantaneous peak assumes that instantaneous exposure is of sufficient duration to elicit acute effects comparable to those observed over more protracted exposure periods tested in the laboratory, typically 48 to 96 hours. In the absence of data regarding time-to-toxic event analyses and latent responses to instantaneous exposure, the degree to which risk is overestimated cannot be quantified.

3. Assumptions, Limitations, Uncertainties, Strengths and Data Gaps Related to Exposure for Terrestrial Species

a. Residue Concentration

The data available to support the exposure assessment for tembotrione is substantially complete, with the exception of a foliar dissipation study, which is an input variable for Tier I modeling of risks to birds and mammals (i.e., T-REX Model). The terrestrial modeling was conducted with a default foliar half-life of 35 days, which may not be a realistic, however, conservative foliar half-life for this compound.

b. Variation in Habitat and Dietary Requirements

For screening terrestrial risk assessments, a generic bird or mammal is assumed to occupy either the treated field or adjacent areas receiving pesticide at a rate commensurate with the treatment rate on the field. The habitat and feeding requirements of the modeled species and the wildlife species may be different. It is assumed that species occupy, exclusively and permanently, the treated area being modeled. This assumption leads to a maximum level of exposure in the risk assessment.

The acute studies have a fixed exposure period, not allowing for the differences in response of individuals to different durations of exposure. Further, for the acute oral study, tembotrione is administered in a single dose which does not mimic wild birds' exposure through multiple feedings. Also, it does not account for the effect of different environmental matrices on the absorption rate of the chemical into the animal. Because exposure occurs over several days, both the accumulated dose and elimination of the chemical from the body for the duration of the exposure determine the exact exposure to wildlife, however, they are not taken into account in the screening assessment. There was also no assumption of an effect of repeated doses that change the tolerance of an individual to successive doses.

c. Variation in Diet Composition

The risk assessment and calculated RQs assume 100% of the diet is relegated to single food types foraged only from treated fields. The assumption of 100% diet from a single food type may be realistic for acute exposures, but diets are likely to be more variable over longer periods of time. This assumption is likely to be conservative and will tend to overestimate potential risks for chronic exposure, especially for larger organisms that have larger home ranges. These large animals (e.g., deer and geese) will tend to forage from a variety of areas and move on and off of treated fields. Small animals (e.g., mice, voles, and small birds) may have home ranges smaller than the size of a treated field and will have little or no opportunity to obtain foodstuffs that have not been treated with tembotrione. Even if their home range does cover area outside the treated field, tembotrione may have drifted or runoff to areas adjacent to the treated field.

d. Exposure Routes Other than Dietary

Screening level risk assessments for spray applications of pesticides consider dietary exposure to terrestrial organisms. Other exposure routes are possible for animals residing in or moving through treated areas. These routes include ingestion of contaminated drinking water, ingestion of contaminated soils, preening/grooming, and dermal contact. Preening exposures, involving the oral ingestion of material from the feathers remains an unquantified, but potentially important, exposure route. If toxicity is expected through any of these other routes of exposure, then the risks of a toxic response to tembotrione is underestimated in this risk assessment. Other routes of exposure, not considered in this assessment, are discussed below.

e. Incidental Soil Ingestion Exposure

This risk assessment does not consider incidental soil ingestion. Available data suggests that up to 15% of the diet can consist of incidentally ingested soil depending on the species and feeding strategy (Beyer et al. 1994). Although tembotrione it is not expected to be persistent in soils, incidental ingestion of soil within days of tembotrione application may be an important exposure pathway.

f. Inhalation Exposure

The screening risk assessment does not consider inhalation exposure, due to the low volatility of tembotrione; it is not expected to be an important exposure pathway.

g. Dermal Exposure

The screening assessment does not consider dermal exposure. Dermal exposure may occur through three potential sources: (1) direct application of spray to terrestrial wildlife in the treated area or within the drift footprint; (2) incidental contact with contaminated vegetation; or (3) contact with contaminated water or soil.

The available measured data related to wildlife dermal contact with pesticides are extremely limited. The Agency is actively pursuing modeling techniques to account for dermal exposure via direct application of spray and by incidental contact with vegetation.

h. Drinking Water Exposure

Drinking water exposure to a pesticide active ingredient may be the result of consumption of surface water or consumption of the pesticide in dew or other water on the surfaces of treated vegetation. Given that tembotrione has a high solubility in water, there is the potential for tembotrione to dissolve in runoff and puddles on the treated field. Consumption of drinking water would appear to be inconsequential if water concentrations were equivalent to the concentrations from PRZM/EXAMS; however, concentrations in puddled water sources on treated fields may be higher than concentrations estimated in the 1 ha pond used in EXAMS. Given that this exposure route is not included in the assessment, overall risk may be underestimated.

i. Dietary Intake – Differences Between Laboratory and Field Conditions

Several aspects of the dietary test introduce uncertainty into calculation of the LC_{50} value (Mineau et al. 1994; ECOFRAM 1999). The endpoint of this test is reported as the concentration mixed with food that produces a response rather than as the dose ingested. Although food consumption sometimes allows for the estimate of a dose, calculations of the mg/kg/day dose are confounded by undocumented spillage of feed and how consumption is measured over the duration of the test. Usually, if measured at all, food consumption is estimated once at the end of the five-day exposure period. Furthemore, for studies in avian, group housing of birds undergoing testing only allows for a measure of the average consumption per day for a group; consumption estimates can be further confounded if birds die within a treatment group. The exponential growth of young birds also complicates the estimate of the dose; controls often nearly double in size over the duration of the test. Since weights are only taken at the initiation of the exposure period and at the end, the dose per body weight (mg/kg) is difficult to estimate with any precision. The interpretation of this test is also confounded because the response of birds is not only a function of the intrinsic toxicity of the pesticide, but also the willingness of the birds to consume treated food.

Further, the acute and chronic characterization of risk rely on comparisons of wildlife dietary residues with LC_{50} or NOAEC values expressed in concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. On gross energy content alone, direct comparison of a laboratory dietary concentration based effects threshold to a fresh-weight pesticide residue estimate would result in an underestimation of field exposure by food consumption by a factor of 1.25–2.5 for most food items. Only for seeds would the direct comparison of dietary threshold to residue estimate lead to an overestimate of exposure.

Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods do not account for a potentially important aspect of food requirements. Depending upon species and dietary matrix, bird assimilation of wild diet energy ranges from 23–80%, and mammal's assimilation ranges from 41–85% (USEPA 1993). If it is assumed that laboratory chow is formulated to maximize assimilative efficiency (e.g., a value of 85%), a potential for underestimation of exposure may exist by assuming that consumption of food in the wild is comparable with consumption during laboratory testing. In the screening process, exposure may be underestimated because metabolic rates are not related to food consumption.

Finally, the screening procedure does not account for situations where the feeding rate may be above or below requirements to meet free living metabolic requirements. Gorging behavior is a possibility under some specific wildlife scenarios (e.g., bird migration) where the food intake rate may be greatly increased. Kirkwood (1983) has suggested that an upper-bound limit to this behavior might be the typical intake rate multiplied by a factor of 5. In contrast is the potential for avoidance, operationally defined as animals responding to the presence of noxious chemicals in their food by reducing consumption of treated dietary elements. This response is seen in nature where herbivores avoid plant secondary compounds.

In the absence of additional information, the acute oral LD_{50} test provides the best estimate of acute effects for chemicals where exposure can be considered to occur over relative short feeding periods, such as the diurnal feeding peaks common to avian species (ECOFRAM 1999).

4. Assumptions, Limitations, Uncertainties, Strengths and Data Gaps Related to Effects Assessment

a. Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The screening risk assessment acute toxicity data for fish are collected on juvenile fish between 0.1 and 5 grams. Aquatic invertebrate acute testing is performed on recommended immature age classes (e.g., first instar for daphnids, second instar for amphipods, stoneflies, and mayflies, and third instar for midges). Similarly, acute dietary testing with birds is also performed on juveniles, with mallard ducks being 5–10 days old and bobwhite quail 10–14 days old.

Testing of juveniles may overestimate toxicity of older age classes for pesticidal active ingredients, such as tembotrione, that act directly (without metabolic transformation) because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

b. Use of the Most Sensitive Species Tested

Although the screening risk assessment relies on a selected toxicity endpoint from the most sensitive species tested, it does not necessarily mean that the selected toxicity endpoint reflects sensitivity of the most sensitive species existing in a given environment. The relative position of the most sensitive species tested in the distribution of all possible species is a function of the overall variability in sensitivity among species to a particular chemical. In the case of listed species, there is uncertainty regarding the relationship of the listed species' sensitivity and the most sensitive species tested.

The Agency is not limited to a base set of surrogate toxicity information in establishing risk assessment conclusions. When available, the Agency also considers toxicity data on non-standard test species.

V. REFERENCES

MRID Environmental Fate Studies Submitted to EPA

MRID 46695404 Mathew, A.E. and D.A. Desmarteau. 2003. Adsorption/desorption of [phenyl-UL-14C]AE 0172747 in six soils and a sediment. Unpublished study performed by Bayer CropScience, Stilwell, Kansas; sponsored and submitted by Bayer CropScience, Monheim, Germany. Bayer Report Number 200375. Bayer Study Number A7182101. Study start date September 2002, and completion date December 2002 (p. 14). Final report issued October 3, 2003.

MRID 46695405 Simmonds, M. 2005. [14C]-AE 0456148: adsorption to and desorption from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/073. Bayer CropScience AG Reference Number MEAEX054. Experiment start date October 27, 2003, and completion date February 2, 2004 (p. 6). Final report issued May 16, 2005.

MRID 46695406 Mills, E.A.M. 2005. [14C]-AE 0941989: adsorption/desorption in four soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/04/050. Bayer CropScience AG Reference Number MEAEX068. Experiment start date September 17, 2004, and completion date December 22, 2004 (p. 7). Final report issued May 16, 2005.

MRID 46695407 Simmonds, M. 2005. [14C]-AE 0968400: adsorption/desorption to and from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/063. Bayer CropScience AG Reference Number MEAEX012. Experiment start date February 19, 2004, and completion date May 22, 2004 (p. 5). Final report issued May 18, 2005.

MRID 46695408 Simmonds, M. 2005. [14C]-AE 1124336: adsorption/desorption to and from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/074. Bayer CropScience AG Reference Number MEAEX062. Experiment start date February 19, 2004, and completion date May 20, 2004 (p. 5). Final report issued May 18, 2005.

MRID 46695409 Mills, E.A.M. 2005. [14C]-AE 1392936: adsorption to and desorption from four soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/04/044. Bayer CropScience AG Reference Number MEAEX070. Experiment start date September 17, 2004, and completion date December 23, 2004 (p. 7). Final report issued April 5, 2005.

MRID 46695410 Fliege, R. 2003. Abiotic hydrolysis of 14C-AE 0172747 in buffered aqueous solutions at pH 4, pH 7, and pH 9. Unpublished study performed, sponsored, and submitted by Bayer CropScience GmbH, Frankfurt, Germany. Laboratory Project ID: CP 02/020. Experimental start date November 28, 2002, and completion date February 24, 2003 (p. 6). Final report issued June 5, 2003.

MRID 46695411 Hellpointner, E. 2004. Phototransformation of AE 0172747 in sterile water buffered at pH 7. Unpublished study performed, sponsored and submitted by Bayer CropScience AG Development, Monheim, Germany. Bayer CropScience Study No.: M1121297-3. Experiment start date June 24, 2003, and completion date July 8, 2003 (p. 6). Final report issued April 14, 2004.

MRID 46695412 Desmarteau, D.A. 2004. [Phenyl-UL-14C]AE 0172747: phototransformation on soil. Unpublished study performed by Bayer CropScience, Stilwell, KS and Monheim, Germany, and Agvise Laboratories, Inc. Northwood, ND; sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: A7082101. Bayer Report No.: 200764. Experimental start date August 18, 2003, and completion date December 19, 2003 (p. 6). Final report issued April 16, 2004.

MRID 46695413 Desmarteau, D.A. 2004. [Cyclohexyl-UL-14C]AE 0172747: phototransformation on soil. Unpublished study performed by Bayer CropScience, Environmental Research Section, Stilwell, KS and Monheim, Germany, and Agvise Laboratories, Inc. Northwood, ND; sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: A7082102. Bayer Report No.: 200804. Experimental start date October 14, 2003, and completion date December 3, 2003 (p. 6). Final report issued June 18, 2004.

MRID 46695414 Fliege, R. 2003. Route and rate of degradation of [phenyl-U-14C]-AE 0172747 and [cyclohexyl-U-14C]-AE 0172747 in one European soil under aerobic laboratory conditions at 20°C and 10°C. Unpublished study performed, sponsored and submitted by Bayer CropScience Gmbh, Frankfurt, Germany. Laboratory Project ID: CB 01/018. Experiment initiated on October 22, 2001, and completed on February 03, 2003 (p. 7). Final report issued June 12, 2003.

MRID 46695415 Fliege, R. 2003. Rate of degradation of [phenyl-U-14C]-AE 0172747 in three European soils under aerobic laboratory conditions at 20°C. Unpublished study performed, sponsored, and submitted by Bayer CropScience Gmbh, Frankfurt, Germany. Laboratory Project ID: CB 01/019. Experiment initiated on December 3, 2001, and completed on February 5, 2003 (p. 7). Final report issued July 24, 2003.

MRID 46695416 Dominic, A.R., E.L. Arthur and S.G. Mislankar. 2005. The route and rate of degradation of [phenyl-U-14C]AE 0172747 in two US soils and [cyclohexyl-U-14C]AE 0172747 in one soil under laboratory aerobic conditions at 25°C. Unpublished study performed by Bayer CropScience, Stilwell, KS, and sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: 602 DO. Bayer Report No.: 200684. Experiment started July 8, 2002, and completed January 25, 2004 (p. 6). Final report issued August 5, 2005.

MRID 46695417 Roohi, A. 2005. [14C]-AE 0941989: rate of degradation in three soils at 20°C. Unpublished study performed by Battelle AgriFood Ltd, Ongar, Essex, UK, and sponsored and submitted by Bayer CropScience, Monheim am Rhein, Germany. Battelle Report Number/Batelle Laboratory Project ID: CX/04/043. Experiment started on May 24, 2004, and completed on November 18, 2004 (p. 7). Final report issued May 26, 2005.

MRID 46695418 Simmonds, M. 2005. [14C]-AE 1392936: rate of degradation in three soils at 20°C. Unpublished study performed by Battelle AgriFood Ltd, Essex, UK, and sponsored and submitted by Bayer CropScience, Monheim am Rhein, Germany, Battelle Report and Laboratory No.: CX/04/046. Experiment start date June 7, 2004, and completion date November 8, 2004 (p. 6). Final report issued May 18, 2005.

MRID 46695419 Desmarteau, D.A. and A.E. Matthew. 2005. [Cyclohexyl-UL-14C]AE 0172747: anaerobic soil metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 201111. Study Number: A7042104. Experiment initiated on June 3, 2003 and completed on February 11, 2004 (p. 6). Final report issued on March 30, 2005.

MRID 46695420 Desmarteau, D.A. and A.E. Matthew. 2004. [Phenyl-UL-14C]AE 0172747: anaerobic soil metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 200836. Study Number: A7042103. Experiment initiated on May 8, 2003 and completed on December 1, 2003 (p. 6). Final report issued on November 18, 2004.

MRID 46695421 Nicolaus, B. 2004. [Cyclohexyl-U-14C]- and [phenyl-U-14C]-AE 0172747 aerobic aquatic metabolism in a fine sediment system. Unpublished study performed, submitted and sponsored by Bayer CropScience GmbH, Frankfurt, Germany. Study Identification Number: CB02-008. Experiment initiated on June 17, 2002 and completed on September 1, 2003 (p. 6). Final report issued on May 6, 2004.

MRID 46695422 Nicolaus, B. 2004. [Cyclohexyl-U-14C]- and [phenyl-U-14C]-AE 0172747 aerobic aquatic metabolism in sediment system Rhein. Unpublished study performed, submitted and sponsored by Bayer CropScience GmbH, Frankfurt, Germany. Study Identification Number: CB02-009. Experiment initiated on September 5, 2002 and completed on August 1, 2003 (p. 6). Final report issued on May 27, 2004.

MRID 46695423 Mathew, A.E., and D.A. Desmarteau. 2005. [Phenyl-UL-14C]AE 0172747: anaerobic aquatic metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 201110; Study Number: A7042401. Experiment initiated on January 28, 2003 and completed on February 23, 2004 (p. 6). Final report issued on February 25, 2005.

MRID 46695424 Desmarteau, D.A. and A.E. Matthew. 2005. [Cyclohexyl-UL-14C]AE 0172747: anaerobic aquatic metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 03MEAEY004; Study Number: A7042402. Experiment initiated on March 18, 2003 and completed on November 23, 2004 (p. 6). Final report issued on April 1, 2005.

MRID 46695425 Wyatt, D.R. 2005. Terrestrial field dissipation of AE 0172747 at four locations in the United States. Unpublished study performed by A.C.D.S. Research, Inc., Lyons, NY; Alvey Agricultural Research, Inc., Carlyle, IL; Midwest Research, Inc., York, NE; Research For Hire, Inc., Porterville, CA; Bayer CropScience, Stilwell, KS and AgVise Laboratories, Northwood, ND; and submitted by Bayer CropScience, Research Triangle Park, NC. Laboratory Study No. 02DO36414. Experiment initiation May 20, 2002 and completion January 18, 2005 (p. 16). Final report issued October 14, 2005.

MRID Ecological Effects Studies Submitted to EPA

MRID 46695430 Sowig, P. 2002. Acute toxicity to *Daphnia magna* (Waterflea) under static testing conditions AE 0172747; substance, technical. Unpublished study performed by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Study No. CE02/023. Study sponsored by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. The final report issued November 11, 2002

MRID 46695431 Dorgerloh, M. 2005. Acute toxicity of AE 0172747 and Isoxadifen-ethyl SC 420+210 to the Waterflea, *Daphnia magna* in a Static Laboratory Test System. Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. E 320 2848-7. Study sponsored by Bayer CropScience AG. The final report issued March 16, 2005.

MRID 46695434 Lima, W. 2003. AE 0172747- Acute Toxicity to Mysids (*Americamysis bahi*a) Under Flow-Through Conditions. Unpublished study performed by Springborn Smithers Laboratories. Study No. 13798.6102/35401. Study sponsored by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued January 22, 2003.

MRID 46695435 Lima, W. 2003. AE 0172747 – Acute Toxicity to Sheepshead Minnow (*Cyprinodon variegatus*) Under Static-Renewal Conditions. Unpublished study performed by Springborn Smithers Laboratories, Wareham, MA. Laboratory Project No. 13798.6109. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated October 14, 2002 and submitted January 22, 2003.

MRID 46695436 Dorgerloh, M. 2003. Acute toxicity of AE 0172747 technical substance to fish (*Lepomis macrochirus*) (Product code AE 0172747 00 1C97 0001). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. DOM 22065/E280 2331-9. Study sponsored by Bayer CropScience AG. The final report issued February 12, 2003.

MRID 46695437 Dorgerloh, M. 2003. Acute toxicity of AE 0172747 technical substance to fish (*Oncorhynchus mykiss*) (Product code AE 0172747 00 1C97 0001). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. DOM 23034/E280 2423-1. Study sponsored by Bayer CropScience AG. The final report issued June 4, 2003.

MRID 46695438 Nieden, D. 2005. Acute toxicity of AE 0172747 and Isoxadifen-ethyl SC 420+210 to fish (*Oncorhynchus mykis*s) under static conditions (product code: AE 0172747 02 SC52 A105). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. EBAEP034/E 280 2868-4. Study sponsored by Bayer CropScience AG. The final report issued March 24, 2005.

MRID 46695439 Nieden, D. 2005. Acute toxicity of AE 0456148 to fish (*Oncorhynchus mykiss*) under static conditions (product code: AE 0456148 00 1B99 0002). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. EBAEX092/E 280 2958-4. Study sponsored by Bayer CropScience AG. The final report issued May 31, 2005.

MRID 46695440 Dorgerloh, M. 2003. Influence of AE 0172747 (tech.) on Development and Reproductive Output of the Waterflea *Daphnia magna* in a Static Renewal Laboratory Test System. Unpublished study performed and submitted by Bayer CropScience AG, Monheim, Germany. Laboratory Study No. E 321 2371-9. Study initiated March 4, 2003 and submitted October 24, 2003.

MRID 46695441 Kern, M.E., and C.V. Lam. 2004. Chronic Toxicity of AE 0456148, a metabolite of AE 0172747, to the *Daphnia magna* Under Static Renewal Conditions. Unpublished study performed and submitted by Bayer CropScience, Stilwell, KS. Laboratory Study No. EBAEX059. Study initiated July 12, 2004 and submitted December 15, 2004.

MRID 46695442 Lima, W. 2004. AE 0172747 – Life-Cycle Toxicity Test with Mysids (*Americamysis bahia*). Unpublished study performed by Springborn Smithers Laboratories. Laboratory study no. 13798.6160. Study sponsored by Bayer CropScience, Stilwell, KS. The final report issued December 6, 2004.

MRID 46695443 Dorgerloh, M. 2003. Early-life Stage Toxicity of AE 0172747 technical substance to Fish (*Pimephales promelas*) (product code AE 0172747 00 1C94 0003). Unpublished study performed and submitted by Bayer CropScience AG, Monheim, Germany. Laboratory Project No. E 284 2349-2. Study initiated November 12, 2002 and submitted May 8, 2003.

MRID 46695444 *Dorgerloh, M. 2005.* Chironomus riparius 28-day Chronic Toxicity Test with AE 0172747 (tech.) in a Water-Sediment System using Spiked Water. Unpublished study performed and submitted by Bayer CropScience AG, 40789 Monheim, Germany. Laboratory Project No. DOM 24074; Project ID: E 416 2729-1. Study Completion Date: January 10, 2005.

MRID 46695501 Gallagher, S.P., J. Grimes, and J.B. Beavers. 2002. An Acute Oral Toxicity Study with the Northern Bobwhite – AE 0172747; Substance, Technical; Product Code: AE 0172747 00 1C97 0001. Unpublished study performed by Wildlife International, Ltd., Easton, MD. Laboratory Project No. 512-119. Study submitted by Aventis CropScience, Frankfurt am Main, Germany. Study initiated February 20, 2002 and completed October 1, 2002.

MRID 46695502 Gallagher, S.P., et al. 2002. A Dietary LC50 Study with the Mallard: AE 0172747; Substance Technical; Product Code: AE 0172747 00 1C94 0002. Unpublished study performed by Wildlife International, Ltd., Easton, MD. Laboratory Project No. 149-183. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated August 28, 2002 and submitted November 22, 2002.

MRID 46695503 Gallagher, S.P., et al. 2002. A Dietary LC50 Study with the Northern Bobwhite: AE 0172747; Substance Technical; Product Code: AE 0172747 00 1C94 0002. Unpublished study performed by Wildlife International, Ltd., Easton, MD. Laboratory Project No. 149-182. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated August 28, 2002 and submitted November 21, 2002.

MRID 46695504 Frey, LT., et al. 2004. AE 0172747; Substance Technical; Product Code: AE 0172747 00 1C94 0002: A Reproduction Study with the Northern Bobwhite. Unpublished study performed by Wildlife International Ltd., Easton, MD. Laboratory Project No. 149-193. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated April 29, 2003 and submitted May 10, 2004.

MRID 46695505 Frey, LT., et al. 2004. AE 0172747; Substance Technical; Product Code: AE 0172747 00 1C94 0002: A Reproduction Study with the Mallard. Unpublished study performed by Wildlife International Ltd., Easton, MD. Laboratory Project No. 149-194. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated April 29, 2003 and submitted June 2, 2004.

MRID 46695507 Waltersdorfer, A. 2002. Contact toxicity (LD50) to honey bees (*Apis mellifera* L.), Substance technical. Unpublished study performed and submitted by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Report No. CW02/047. Study Completion Date October 21, 2002.

MRID 46695508 Waltersdorfer, A. 2002. Oral toxicity (LD50) to honey bees (*Apis mellifera* L.), Substance technical. Unpublished study performed and submitted by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Report No. CW02/013. Study Completion Date October 21, 2002.

MRID 46695509 Waltersdorfer, A. 2005. Contact toxicity to honey bees (*Apis mellifera* L.). Unpublished study performed and submitted by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Report No. CW05/019. Study Completion Date July 25, 2005.

MRID 46695510 Waltersdorfer, A. 2005. Oral toxicity (LD50) to honey bees (*Apis mellifera* L.). Unpublished study performed and submitted by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Report No. CW05/018. Study Completion Date July 29, 2005.

MRID 46695511 Christ, M.T. and C.V. Lam. 2005. Tier II Seedling Emergence Nontarget Plant Study using AE 0172747 SC52. Study performed by Bayer CropScience, Ecotoxicology Department, Stilwell, Kansas. Study report number A7451401. Study sponsored by Bayer CropScience, Research Triangle Park, NC. Study report date August 2, 2005.

MRID 46695513 Sowig, P. 2003. Duckweed (*Lemna gibba* G3) Growth Inhibition Test with Recovery Phase, AE 0172747; substance, technical. Unpublished study performed by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Study No. CE02/026. Study submitted by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued July 29, 2003.

MRID 46695514 Dorgerloh, M. 2005. *Lemna gibba* G3 Growth Inhibition Test with AE 0456148 (code: AE 0456148 00 1B99 0002). Unpublished study performed by Bayer CropScience AG, Department-Ecotoxicology, Monheim, Germany. Laboratory Study No. EBAEX080/E 412 2827-6. Study submitted by Bayer CropScience AG. The final report issued January 31, 2005.

MRID 46695517 Gosch, H. and Ebeling, M. 2002. Algal growth inhibition-*Pseudokirchneriella subcapitata*, AE 0172747; substance, technical. Unpublished study performed by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Study No. CE02/024. Study submitted by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued November 29, 2002.

MRID 46695518 Sowig, P. and Gosch, H. 2003. Algal growth inhibition-*Navicula pelliculosa*, AE 0172747; substance, technical. Unpublished study performed by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Laboratory Study No. CE02/025. Study submitted by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued March 17, 2003.

MRID 46695519 Dorgerloh, M. 2005. *Pseudokirchneriella subcapitata* Growth Inhibition Test with AE 0172747 and Isoxadifen-ethyl SC 420+210 (code: AE 0172747 02 SC52 A105). Unpublished study performed by Bayer CropScience AG, Research/Development, Department–Ecotoxicology, Monheim, Germany. Study No. EBAEP032/E 323 2838-9. Study sponsored by Bayer CropScience AG. The final report issued May 4, 2005.

MRID 46695520 Dorgerloh, M. 2005. *Pseudokirchneriella subcapitata* Growth Inhibition Limit Test with AE 0456148 (code: AE 0456148 00 1B99 0002). Unpublished study performed by Bayer CropScience AG, Research/Development, Department–Ecotoxicology, Monheim, Germany. Study No. DOM 24051/ E323 2766-9. Study sponsored by Bayer CropScience AG. The final report issued February 1, 2005.

MRID 46695619 Merkel, D. 2005. Acute Oral Toxicity- Up And Down Procedure in Rats. Product Safety Laboratories, Dayton, NJ 08810. Study No. 17105 dated 5-26-05. Unpublished.

Open Literature, Government Reports, and Product Labels

Bayer CropScience LP. Technical Grade AE 0172747: A Two-Generation Reproductive Toxicity Study in the Wistar Rat. Unpublished study performed by and submitted by Bayer CropScience LP. Study Report No. 201266. The final report issued August 31, 2005.

Beyer, W.N. 1994. Estimates of soil ingestion by wildlife. J Wildl Manage 58(2):375–382.

Davis, G.E., P.L. Haaker, and D.V. Richards. 1996. Status and trends of white abalone at the California Channel Islands. Transactions of the American Fisheries Society 125:42–48.

Fletcher, J.S., J.E. Nellesson, and T. G. Pfleeger. 1994. Literature review and evaluation of the EPA food-chain (Kenaga) nomogram, an instrument for estimating pesticide residues on plants. Environ Toxicol Chem 13(9):1383–1391.

Kirkwood JK. 1983. Minireview. A limit to metabolisable energy intake in mammals and birds. Comp Biochem Physiol A 75(1):1-3.

Martin, C. M., H. S. Zim, and A. C. Nelson. 1951. American Wildlife and Plants - A Guide to Wildlife Food Habits, Dover Publishers Inc., New York.

Mineau, P., B.T. Collins, and A. Baril. 1996. On the use of scaling factors to improve interspecies extrapolation to acute toxicity in birds. Reg Toxicol Pharmacol 24:24–29.

Urban, D.J. and Cook, N. 1986. Hazard Evaluation Division, Standard Evaluation Procedure: Ecological Risk Assessment 104.pp. Document Number No. PB 86 247 657. EPA-540/9-86-167.

USDA. 2002. 2002 Census of Agriculture. Available on-line at http://www.nass.usda.gov/Census_of_Agriculture/index.asp

U.S. EPA. 1993. Wildlife Exposure Factors Handbook. Volume I of II. EPA/600/R-93/187a. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. 20460.

U.S. EPA. 1999. ECOFRAM. U.S. Environmental Protection Agency, Washington, DC. Available on-line at http://www.epa.gov/oppefed1/ecorisk/index.htm.

U.S. EPA. 2001. Ecological Risk Assessor Orientation Package. U.S. Environmental Protection Agency, Ecological Fate and Effects Division. Draft Version, August 2001.

U.S. EPA. 2002a. Data Requirements for Registration. U.S. Environmental Protection Agency, Washington, DC. Code of Federal Regulations 40 CFR §158.202.

U.S. EPA. 2002b. Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version II. U.S. Environmental Protection Agency, Washington, DC. February 28, 2002.

U.S. EPA. 2004. Overview of Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency. Endangered and Threatened Species Effects Determinations. Office of Prevention, Pesticides, and Toxic Substances, Office of Pesticides Programs. Washington, DC. January 23, 2004.

U.S. EPA. 2005a. User's Guide for T-REX (Terrestrial Residue Exposure model) Version 1.2.3. U.S. Environmental Protection Agency. Release August 8, 2005.

U.S. EPA. 2005b. TERRPLANT Terrestrial Plant Exposure Model. Version 1.2.1. U.S. Environmental Protection Agency. Released November 9, 2005.

APPENDIX A. Environmental Fate Data

161-1. Hydrolysis

MRID 46695410 (Acceptable)

^{14}C-labeled AE 0172747 ([cyclohexyl-U-^{14}C]-labeled 2-[2-chloro-4-mesyl-3-((2,2,2-trifluoro-ethoxy)methyl)benzoyl]cyclohexane-1,3-dione; tembotrione) was stable in pH 5, 7, and 9 sterile aqueous buffered solutions at 25 °C over the course of a 30-day incubation period. Over 96% of the applied radioactivity was recovered as undegraded tembotrione at all three pH values, and no degradation products were identified. In a preliminary experiment conducted at *ca.* 50 °C for 5 days, [^{14}C]tembotrione was relatively stable, declining from averages of 97.8–99.1% of the applied radioactivity at time 0 to 94.3–94.8% at 5 days post-application. This study is classified as Acceptable.

161-2. Aqueous Photolysis

MRID 46695411(Acceptable)

^{14}C-labeled tembotrione (experiments conducted using labels at both the cyclohexyl and phenyl position) at a nominal concentration of 1.0 mg a.i./L and irradiated continuously using a UV-filtered xenon lamp for 10 days at 25 °C in aqueous pH 7 solution, degraded with a reviewer-calculated first-order linear half-life of 56 days (average of both label experiments) based on the continuous irradiation used in study. The intensity of the lamp was 640 W/m^2, and 7.79 hours of irradiation with the artificial light are approximately equivalent to one solar day in Phoenix, Arizona (33.36 °N latitude). Therefore, the environmental phototransformation half-life is expected to be *ca.* 172 days. No major transformation products were isolated from either the irradiated or dark control solutions. In the irradiated buffer solutions, the only minor transformation product that was identified was pentanedioic acid (glutaric acid) that reached a maximum 6.8% of the applied amount 10 days post-application. No significant deviations from good scientific practices were noted and the study is Acceptable.

161-3. Soil Photolysis

MRID 46695412 (Supplemental)

^{14}C-labeled tembotrione (label applied at the phenyl moiety) applied at 1.33 mg/kg to a loamy sand soil (78% sand, 18% silt, 4% clay, pH 5.3, organic matter 2.1%) from North Carolina and irradiated continuously using a UV-filtered xenon lamp for 9 days at 20 ± 1 °C, degraded with a reviewer-calculated first-order linear half-life of 9.2 days based on the continuous irradiation used in study. The intensity of the lamp was 687 W/m^2, and 6.9 hours of irradiation with the artificial light are approximately equivalent to one solar day in Phoenix, Arizona (33.36 °N latitude). Therefore, the environmental phototransformation half-life of tembotrione applied to this soil surface is expected to be *ca.* 32 days. In the irradiated samples, two major transformation products were isolated. AE 0456148 (2-chloro-4-mesyl-3-[(2,2,2-trifluoro-ethoxy)methyl]benzoic acid) averaged a maximum of 22.0% of the applied at 9 days post-application. AE 0941989 (6-methanesulfonyl-5-(2,2,2-trifluoroethoxymethyl)-3,4-dihydro-

2H-xanthene-1,9-dione) averaged a maximum of 15.3% of the applied at 3 days post-application and decreased to 12.0% at 9 days. No minor transformation products were identified. In the dark controls, no major transformation products were isolated. The only minor transformation product was AE 0456148, which averaged a maximum of 5.9% of the applied at 9 days post-application. No significant deviations from good scientific practices were noted; however, the study was terminated after only 9 days of continuous irradiation, at which time *ca.* 50% of the applied tembotrione remained undegraded and the major transformation product (AE 0456148) was continuing to increase. Subdivision N guidelines specify that a photodegradation study be conducted for 30 days (15 days if irradiation is continuous). Therefore, the study is classified as Supplemental.

MRID 46695413 (Supplemental)

^{14}C-labeled tembotrione (label applied at the cyclohexyl moiety) applied at 1.16 mg/kg to a loamy sand soil (78% sand, 18% silt, 4% clay, pH 5.3, organic matter 2.1%) from North Carolina and irradiated continuously using a UV-filtered xenon lamp for 9 days at 20 ± 1 °C, degraded with a reviewer-calculated first-order linear half-life of 7.7 days based on the continuous irradiation used in study. The intensity of the lamp was 687 W/m^2, and 6.9 hours of irradiation with the artificial light are approximately equivalent to one solar day in Phoenix, Arizona (33.36 °N latitude). Therefore, the environmental phototransformation half-life of tembotrione applied to this soil surface is expected to be *ca.* 29 days. In the irradiated samples, two major transformation products were isolated. AE 0941989 averaged a maximum of 17.9% of the applied at 1 day post-treatment and decreased to 15.3% at 9 days. Glutaric acid (1,5-pentanedioic acid) averaged a maximum of 13.8% of the applied at 3 days post-treatment and decreased to 11.1% at 9 days. No minor transformation products were identified. In the dark controls, no major transformation products were isolated and no minor transformation products were identified. No significant deviations from good scientific practices were noted; however, the study was terminated after only 9 days of continuous irradiation. Subdivision N guidelines specify that a photodegradation study be conducted for 30 days (15 days if irradiation is continuous). Therefore, the study is classified as Supplemental.

162-1. Aerobic Soil Metabolism

MRID 46695414 (Supplemental)

^{14}C-labeled tembotrione (experiments conducted using labels at both the cyclohexyl and phenyl position) was applied at 0.2 mg a.i./kg (150 g a.i./ha) to a silt loam soil (13.2% sand, 66.9% silt, 19.9% clay, pH 7.70, organic carbon 1.72%) from Germany for 120 days and maintained under aerobic conditions in the dark at 20 ± 2 °C and 45% of the maximum water holding capacity. Based on non-linear regression analysis, the half-life of tembotrione (combined labels) was 4.6 days and the linear regressed half-life was 10.5 days (both labels). In the soil treated with [phenyl-U-^{14}C]tembotrione, two major transformation products were isolated. 2-Chloro-4-mesyl-3-[2,2,2-trifluoroethoxy)methyl]benzoic acid (AE 0456148) was a maximum 72.4% of the applied at 14 days post-treatment and decreased to 21.9% at 35 days and 0.5% at 77 days. 2-Chloro-4-mesyl-3-[2,2,2-trifluoroethoxy)methyl]phenol (AE 0968400) was a maximum 14.4% of the applied at 35 days post-treatment and decreased to 1.4% at 77 days. The only minor transformation product identified was 2-chloro-4-mesyl-1-methoxy-3-[2,2,2-trifluoroethoxy)methyl]benzene (AE 1124336), which was a maximum 2.6% of the applied. Uncharacterized [^{14}C]residues totaled a maximum of 3.3% of the applied. In the soil treated with [cyclohexyl-U-^{14}C]tembotrione, no major transformation products were isolated and no minor transformation products were identified. Mineralization proceeded rapidly with 77.3% of the applied dose evolved as $^{14}CO_2$ by day 120.

In a supplementary experiment, additional silt loam soil samples were treated with [phenyl-U-^{14}C]tembotrione and incubated in the dark at 10 ± 2 °C for 224 days. Tembotrione dissipated with a non-linear half-life of 15.3 days. [^{14}C]tembotrione decreased from 94.8% of the applied at time 0 to 73.1% at 7 days, 36.4% at 21 days, and 1.2–1.8% at 120–224 days (study termination). Two major transformation products were isolated. AE 0456148 was a maximum 70.6% of the applied at 35 days post-treatment and decreased to 0.8% at 182–224 days. AE 0968400 was a maximum of 23.3% of the applied at 120 days post-treatment and decreased to 4.4% at 224 days. The minor transformation product AE 1124336 was a maximum of 4.4% of the applied. At 224 days post-application, 41.2% of the applied had been evolved as $^{14}CO_2$ and volatile organics totaled <0.1%.

No significant deviations from good scientific practices were noted; however, it could not be determined if the German soil used in this study is comparable to soils found in a typical tembotrione use area in the U.S. and the study was classified as Supplemental.

MRID 46695415 (Supplemental)

^{14}C-labeled (phenyl moiety) tembotrione was applied at 0.2 mg a.i./kg (150 g a.i./ha) to a loamy sand soil (82.0% sand, 13.6% silt, 4.4% clay, pH 5.9, organic carbon 2.76%, CEC 7.4 meq/100 g), a sandy loam soil (57.9% sand, 31.4% silt, 10.7% clay, pH 7.4, organic carbon 1.33%, CEC 8.2 meq/100 g) from Germany for 365 days and in a clay soil (20.0% sand, 35.6% silt, 44.4% clay, pH 8.2, organic carbon 2.54%, CEC 12.5 meq/100 g) from Great Britain for up to 120 days under aerobic conditions in the dark at 20 ± 2 °C and 45% of the maximum water holding capacity. Tembotrione dissipated most slowly in the loamy sand soil (most acidic, lowest CEC) and most rapidly in the clay soil (most alkaline, highest CEC). The non-linear half-lives were 63 days in the loamy sand soil, 14 days in the sandy loam soil, and 6 days in the clay soil. First-order linear half-lives were 144, 56, and 23 days, respectively. Three transformation products were identified. AE 0456148 was a major transformation product in all three soils (maximum concentrations 19.7–70.5% of the applied). AE 0968400 was a major transformation product in the clay soil (maximum 14.9% of applied) and a minor transformation product in the loamy sand and sandy loam soils. AE 1124336 was a minor transformation product in all three soils. At study termination (365 days, 120 days for clay soil), $^{14}CO_2$ totaled 45.9–57.2% of the applied.

No significant deviations from good scientific practices were noted; however, it could not be determined if the European soils used in this study are comparable to soils found in a typical tembotrione use area in the U.S. and the study was classified as Supplemental.

MRID 46695416 (Acceptable)

The biotransformation of [phenyl-U-^{14}C]- and [cyclohexyl-U-^{14}C]-labeled tembotrione (radiochemical purity ≥98.8%) was studied in a loamy sand soil (77% sand, 20% silt, 3% clay, pH 6.3, organic carbon 1.6%) from North Carolina and [phenyl-U-^{14}C]tembotrione was studied in a silt loam soil (26% sand, 56% silt, 18% clay, pH 7.6, organic carbon 4.5%) from North Dakota for up to 354 days under aerobic conditions in the dark at 25 ± 1 °C and 75% of field capacity. [^{14}C]tembotrione was applied to the soils at a nominal rate of 0.2 mg a.i./kg. In the loamy sand soil from North Carolina (combined labels), [^{14}C]tembotrione decreased from an average 92.5–97.9% of the applied at time 0 to 42.9–51.1% at 30 days post-treatment, 23.8–27.0% at 179 days, and 9.4–13.4% at 354 days (study termination). Based on non-linear and linear regression analysis, tembotrione dissipated with half-lives of 72.1 and 131 days, respectively. In the silt loam soil from North Dakota (phenyl label only), [^{14}C]tembotrione decreased from an average 99.8% of the applied at time 0 to 63.1% at 3 days post-treatment, 37.1% at 7 days, 9.6% at 30 days, 2.2% at 60 days, and was not detected thereafter (91–179 days). Based on non-linear and linear regression analysis, tembotrione dissipated with half-lives of 6.9 and 11 days, respectively. No major transformation products were isolated from and no minor transformation products were identified in the loamy sand soil treated with [cyclohexyl-^{14}C]tembotrione. In the soils treated with [phenyl-^{14}C]tembotrione], four transformation products were identified. In the loamy sand from North Carolina, AE 0456148 averaged a maximum of 25.8% of the applied at 270 days post-treatment and decreased to 14.9% at 354 days (study termination). 2-Chloro-3-hydroxymethyl-4-mesylbenzoic acid (AE 1392936) averaged a maximum of 17.1% of the applied at 354 days post-treatment. AE 0968400 was a maximum 6.1% of the applied at 179 days post-treatment and AE 1124336 was a maximum 0.8%. In the silt loam soil, the only major transformation product was AE 0456148, which averaged a maximum of 29.9% of the applied at 7 days post-treatment, decreased to 3.7% at 30 days, and was not detected after 60 days. The minor transformation product AE 0968400 averaged a maximum of 7.2–7.3% of the applied (3 and 30 days post-treatment), AE 1124336 averaged a maximum of 1.1%, and AE 1392936 averaged a maximum of 3.5%. Unidentified [^{14}C]residues totaled an average maximum of 1.7% of the applied.

This study is classified as Acceptable. No significant deviations from good scientific practices were noted.

MRID 46695417 (Supplemental)

The biodegradation of the tembotrione metabolite AE 0941989 (6-methanesulfonyl-5-(2,2,2-trifluoroethoxymethyl)-3,4-dihydro-2H-xanthene-1,9-dione) was studied (application rate 0.13 mg a.i./kg) in two clay loam soils from England and a sandy loam soil from Germany for 119 days under aerobic conditions in the dark at 20 °C and 40–53% of the maximum water holding capacity. The behavior of AE 0941989 was very similar in the three soils. [^{14}C]AE0941989 degraded rapidly in three soils, decreasing from an average of 68.67% of the applied at time 0 to 27.19–32.18% at 2 days post-treatment, 1.87–4.44% at 14 days, and ≤0.38% at 62 days. Based on non-linear regression analysis and using individual sampling points, the half-lives of AE 0941989 were determined to be 1.3–1.8 days in the three soils. First-order linear half-lives were 7.9 and 8.8 days in the two clay loam soils from England, and 15.0 days in the sandy loam soil from Germany. Since degradation products were not identified, the study is classified as Supplemental.

MRID 46695418 (Supplemental)

The biodegradation of tembotrione metabolite 2-chloro-3-hydroxymethyl-4-mesylbenzoic acid (AE 1392936) was studied (application rate 0.8 mg a.i./kg) in two clay loam soils from England and a sandy loam soil from Germany for 58 days under aerobic conditions in the dark at 20 °C and 50–55% of the maximum water holding capacity. [^{14}C]AE 1392936 degraded rapidly in all three soils. In the two clay loam soils from England, [^{14}C]AE 1392936 decreased from an average of 98.09–99.39% of the applied at time 0 to 11.71–28.93% at 21 days, the last sampling interval for the Flint Hall soil, and was ≤0.78% at 41 days, the last sampling interval for the Shelley Field soil. In the sandy loam soil from Germany, AE 1392936 decreased from 97.82% of the applied at time 0 to 4.11% at 41 days (last sampling interval). Based on non-linear regression analysis and using individual sampling points, the half-lives of AE 1392936 were determined to be 7.6, 11.5, and 15.6 days, in the Flint Hall clay loam, Shelley Field clay loam, and Laacher Hof sandy loam soil, respectively. First-order linear half-lives were 6.7 days in the Flint Hall clay loam, 6.6 days in the Shelley Field clay loam, and 9.8 days in the Laacher Hof sandy loam soil, respectively. Since transformation products were not identified, the study is classified as Supplemental.

162-2 Anaerobic Soil Metabolism

MRID 46695419 (Acceptable)

[Cyclohexyl-U-^{14}C]-labeled tembotrione applied at 0.134 mg a.i./kg was studied in a silt loam soil (15% sand, 62% silt, 23% clay, pH 8.3, organic carbon 1.3%) from Germany for 5 days under aerobic conditions (45% of maximum water holding capacity), followed by 120 days under anaerobic conditions (flooding plus nitrogen gas; 125 days total) in dark at 20 ± 1 °C. The dissipation of [^{14}C]tembotrione slowed significantly after flooding; tembotrione decreased by *ca.* 40% of the applied in the 5 days of aerobic incubation and but by only *ca.* 16% during 120 of anaerobic incubation. [^{14}C]tembotrione decreased from an average of 93.3% of the applied amount at time 0 to 62.5% of the applied at 5 days post-treatment (final sampling interval prior to flooding). Immediately after flooding the system, the concentration of [^{14}C]tembotrione in the total system (water + soil) averaged 62.0% of the applied, with 37.5% associated with the water and 24.5% associated with the soil. Total [^{14}C]tembotrione averaged 62.0–65.2% of the applied at 0–15 days post-flooding, 56.4–60.1% at 30 and 60 days, and 48.8–48.9% at 91 and 120 days (study termination). After flooding, the concentration of [^{14}C]tembotrione in the water was a maximum of 46.6% of the applied at 7 days post-flooding, then decreased to 21.1–21.4% at 91–120 days. In the flooded soil, [^{14}C]tembotrione was a maximum of 36.1% of the applied at 60 days post-flooding, then decreased to 27.5% at 120 days. Half-lives were not determined during the aerobic incubation period. Based on non-linear regression analysis and using individual sample data (post-flooding data only), tembotrione dissipated with a half-life of 231 days in the total system. Based on first-order linear regression analysis, the half-life in the total system was estimated to be 301 days. The only significant transformation product identified was carbon dioxide. No significant deviations from good scientific practices were noted and the study is Acceptable.

MRID 46695420 (Acceptable)

[Phenyl-U-^{14}C]-labeled tembotrione applied at 0.138 mg a.i./kg was studied in a silt loam soil (15% sand, 62% silt, 23% clay, pH 8.3, organic carbon 1.3%) from Germany for 5 days under aerobic conditions (45% of maximum water holding capacity), followed by 120 days under anaerobic conditions (flooding plus nitrogen gas; 125 days total) in dark at 20 ± 1 °C. The dissipation of [^{14}C]tembotrione slowed significantly after flooding; tembotrione decreased by *ca.* 45% of the applied in the 5 days of aerobic incubation but by only *ca.* 14% during 120 of anaerobic incubation. [^{14}C]tembotrione decreased from an average of 96.4% of the applied amount at time 0 to 51.4% of the applied at 5 days post-application (final sampling interval prior to flooding). Immediately following flooding, the concentration of [^{14}C]tembotrione in the total system (water + soil) averaged 49.6% of the applied, with 27.9% associated with the water and 21.7% associated with the soil. Total [^{14}C]tembotrione increased to an average 56.0% of the applied at 1 day post-flooding, ranged from 45.2–50.1% at 3–59 days, and was 33.8% at 90 days, and 41.0% at 120 days (study termination). After flooding, the concentration of [^{14}C]tembotrione in the water was a maximum of 39.9% of the applied at 1 day post-flooding, then decreased to 16.3% at 120 days. In the flooded soil, [^{14}C]tembotrione was a maximum of 24.8% at 120 days post-flooding. Half-lives were not calculated for the aerobic portion of the study because data were collected at only two sampling intervals. The linear and non-linear half-life of tembotrione in the total system was 257 days. The only major transformation product identified was AE 0456148, which was 40.2% of the applied at 5 days post-treatment, increased to a maximum of 46.4% at 30 days post-flooding (41.6% in water and 4.8% in soil), and was 41.6% at 120 days (35.6% in water, 6.0% in soil). No minor transformation products were identified. No significant deviations from good scientific practices were noted and the study is Acceptable.

162-3 Anaerobic Aquatic Metabolism

MRID 46695423 (Acceptable)

[Phenyl-U-^{14}C]-labeled tembotrione was applied at 0.03 mg a.i./kg to a pond water/silty clay sediment system (water pH 7.5, dissolved organic carbon 11.7%, sediment pH 7.0, organic carbon 1.1%) from Kansas for 365 days in dark at 20 ± 1 °C. In the total system, tembotrione decreased from an average of 99.1% of the applied amount at time 0 to 54.6% at 365 days post-treatment (study termination). In the water, [^{14}C]tembotrione decreased from an average of 96.6% of the applied at time 0 to 51.2% at 15 days post-treatment and 31.9–32.5% at 182–365 days. In the sediment, [^{14}C]tembotrione increased from an average of 2.5% of the applied at time 0 to a maximum of 27.1% at 91 days post-treatment, then declined to 22.3% at 365 days. Based on non-linear regression analysis and using individual data, [^{14}C]tembotrione dissipated with a half-life of 448 days in the total system, 168 days in the water, and 1105 days in the sediment. Linear half-lives were 533, 289, and 1155 days, respectively. No major transformation products were isolated. The only minor transformation product identified was [^{14}C]AE 0456148, which was a maximum average of 2.4% in the total system. The study was classified as Acceptable.

MRID 46695424 (Acceptable)

[Cyclohexyl-U-^{14}C]-labeled tembotrione was applied at 0.03 mg a.i./kg to a pond water/silty clay sediment system (water pH 7.5, dissolved organic carbon 11.7%, sediment pH 7.0, organic carbon 1.1%) from Kansas for 269 days in dark at 20 ± 1 °C. In the total system, [^{14}C]tembotrione decreased from an average of 98.5% of the applied at time 0 to 52.6–55.6% at 181–269 days post-treatment (study termination). In the water, [^{14}C]tembotrione decreased from an average of 97.1% of the applied at time 0 to 49.2% at day 14, and was 31.1–33.9% at 120–269 days post-treatment. In the sediment, [^{14}C]tembotrione increased from an average of 1.4% of the applied at time 0 to a maximum of 25.3% at 62 days, then declined slightly to 23.0% at 269 days. Based on non-linear regression analysis and using individual data, [^{14}C]tembotrione dissipated with a half-life of 351 days in the total system, 151 days in the water, and 1141 days in the sediment. Linear half-lives were 408, 239, and 1155 days, respectively. No major or minor transformation products were identified. This study is classified as Acceptable.

162-4 Aerobic Aquatic Metabolism

MRID 46695421 (Acceptable)

The aerobic biotransformation of [cyclohexyl-U-^{14}C]- and [phenyl-U-^{14}C]-labeled tembotrione applied at 0.06–0.08 mg/L to a river water/silt loam sediment system (water pH 7.1, dissolved organic carbon 3 mg/L; sediment, pH 5.9, organic carbon 4.2%) from Germany for 365 days in dark at 20 ± 2 °C was studied. In the total system (water + sediment, combined data), [^{14}C]tembotrione decreased from 98.3–103.6% of the applied radioactivity at time 0 to 66.1–66.8% at 139 days post-treatment and 16.6–21.9% at 365 days. In the water, [^{14}C]tembotrione decreased from 97.3–102.8% of the applied amount at time 0 to 42.8–46.5% at 19 days post-treatment, 22.7–25.2% at 32 days, 4.2–4.6% at 165 days, and 1.9–2.4% at 365 days. In the sediment, [^{14}C]tembotrione increased from 0.8–1.0% at time 0 to a maximum of 59.0–68.1% of the applied amount at 77–139 days post-treatment, then declined to 14.8–19.5% at 365 days. Based on non-linear regression analysis, the half-lives of [^{14}C]tembotrione (combined radiolabels) were 168 days in the total system (water + sediment), 17 days in the water, and 143 days in sediment. Linear half-lives were 165 days in the total system, 64 days in the water, and 148 days in sediment. No major transformation products were isolated from the samples treated with the cyclohexyl label. The only major transformation product isolated from the samples treated with the phenyl label was AE 0456148, which was a maximum of 61.6% of the applied in the total system (39.5% in water, 22.1% in sediment) at 365 days post-treatment. No minor transformation products were identified. No significant deviations from good scientific practices were noted and the study was Acceptable.

MRID 46695422 (Acceptable)

The aerobic biotransformation of [cyclohexyl-U-^{14}C]- and [phenyl-U-^{14}C]-labeled tembotrione applied at 0.06–0.07 mg/L to a river water/sand sediment system (water pH 7.7, dissolved organic carbon 1.8 mg/L, sediment pH 7.1, organic carbon 0.45%) from Germany for 175 days in dark at 20 ± 2 °C was studied. In the total system (water + sediment), [^{14}C]tembotrione decreased from 104.2–106.3% of the applied at 0–1 days post-treatment to 61.8–71.1% at 64 days, 39.3–49.1% at 83 days, 12.4–28.7% at 119 days, and 2.9–13.2% at 175 days. In the water,

[^{14}C]tembotrione decreased from 103.6–105.9% of the applied at time 0 to 60.8–62.9% at 42 days post-treatment, 14.1–15.0% at 105 days, and 0.8–8.6% at 175 days. In the sediment, [^{14}C]tembotrione increased from 0.4–0.6% of the applied at time 0 to a maximum of 25.2–28.2% at 29–42 days post-treatment, then decreased to 16.3–17.3% at 83 days and 2.2–4.6% at 175 days. Based on non-linear analysis, the half-lives of [^{14}C]tembotrione (combined radiolabels) were 62.4 days in the total system (water + sediment), 44.7 days in the water, and 43.9 days in sediment. Linear half-lives were 41.5 days in the total system, 33.0 days in the water, and 38.1 days in sediment. The only identified transformation products were associated with the phenyl label. In the samples treated with [cyclohexyl-^{14}C]tembotrione, no major transformation products were isolated and no minor transformation products were identified. In the samples treated with [phenyl-^{14}C]tembotrione, the only major transformation product detected was AE 0456148, which was a maximum of 95.2% of the applied at 141 days post-treatment (76.0% in water, 19.2% in sediment) and decreased slightly to 90.2% at 175 days (70.8% in water, 19.5% in sediment). The only minor transformation product that was identified was AE 0968400, which was a maximum 4.4% of the applied (3.0% in water, 1.4% in sediment) at 175 days post-treatment.

163-1 Adsorption/Desorption

MRID 46695404 (Supplemental)

The adsorption and desorption properties of tembotrione in six soils and a sediment along with the physical characteristics of the soils are summarized in **Table A-1**. The adsorption phase of the study was carried out by equilibrating air-dried soils with [phenyl-U-^{14}C]tembotrione at nominal test concentrations of 0.013, 0.13, 0.33, 0.67, and 1.33 mg a.i./kg soil for the SLS silt loam, SL2.3 sandy loam, Flint Hall loamy sand, EFS-138 silt loam, and EFS-139 loamy sand soils; 0.02, 0.2, 0.5, 1.0, and 2.0 mg a.i./kg soil for the LS2.2 and EFS-139 loamy sand soils; and 0.06, 0.6, 1.5, 3.0, and 6.0 mg a.i./kg soil for the EFS-142 sandy loam sediment. The samples were shaken in the dark at 20 ± 2 °C for 24 hours. The equilibrating solution used was 0.01M $CaCl_2$ solution, with soil/solution ratios ranging from 2–9:12 (w:v) for all test soils. The desorption phase of the study was carried out by replacing the adsorption solution with an equivalent amount volume of pesticide-free 0.01M $CaCl_2$ solution and equilibrating in the dark at 20 ± 2 °C for 24 hours. For all test soils, one desorption cycle was conducted for the desorption phase. After 24 hours of equilibration, 28.1–42.3%, 19.7–30.1%, 66.4–76.9%, 30.3–44.1%, 64.1–67.0%, 49.2–59.9%, and 86.4–90.8% of the applied [phenyl-U-^{14}C]tembotrione was adsorbed to the SLS silt loam, SL2.3 sandy loam, LS2.2 loamy sand, Flint Hall clay, EFS-138 silt loam, EFS-139 loamy sand, and EFS-142 sandy loam, respectively. Registrant-calculated Freundlich adsorption K_f values were 0.54, 0.35, 3.62, 0.51, 2.40, 2.09, and 47.4 for the SLS silt loam, SL2.3 sandy loam, LS2.2 loamy sand, Flint Hall clay, EFS-138 silt loam, EFS-139 loamy sand, and EFS-142 sandy loam, respectively; corresponding Freundlich adsorption K_{oc} values were 32, 27, 131, 20, 53, 130, and 379. At the end of the desorption phase, 20.8–38.0%, 31.7–43.6%, 12.6–21.8%, 19.0–30.1%, 0.7–3.2%, 17.0–32.2%, and 2.3–7.5% of the applied [phenyl-U-^{14}C]tembotrione desorbed from the SLS silt loam, SL2.3 sandy loam, LS2.2 loamy sand, Flint Hall clay, EFS-138 silt loam, EFS-139 loamy sand, and EFS-142 sandy loam, respectively. Registrant-calculated Freundlich desorption K_f values were 1.62, 1.60, 6.02, 2.20, 14.3, 3.48, and 45.1 for the SLS silt loam, SL2.3 sandy loam, LS2.2 loamy sand, Flint Hall clay, EFS-138 silt loam, EFS-139 loamy sand, and EFS-142 sandy loam, respectively; corresponding Freundlich desorption K_{oc} values were 95, 123, 218, 87, 318, 218, and 361.

Table A-1. Adsorption and Desorption Properties of AE 0172747 (Tembotrione) in Six Soils and a Sediment

Textural Classification	SLS Silt Loam	SL2.3 Sandy Loam	LS2.2 Loamy Sand	Flint Hall Clay	EFS-138 Silt Loam	EFS-139 Loamy Sand	EFS-142 Sandy Loam Sediment
% Sand	13.2	57.9	82.0	20.0	26.0	77.0	71.0
% Silt	66.9	31.4	13.6	35.6	56.0	20.0	24.0
% Clay	19.9	10.7	4.4	44.4	18.0	3.0	5.0
% Organic carbon	1.7	1.3	2.8	2.5	4.5	1.6	12.5
% Organic matter	2.9	2.3	4.7	4.4	7.8	2.7	21.8
CEC mEq/100g	12.8	8.2	7.4	12.5	27.8	5.6	13.8
pH (soil:water)	7.7	7.4	5.6	7.8	7.6	6.3	6.0
Adsorption Phase							
K_f	0.54	0.35	3.62	0.51	2.4	2.09	47.4
K_{oc}	32.0	27.0	131.0	20.0	53.0	130.0	379
Desorption Phase							
K_f	1.62	1.6	6.02	2.2	14.3	3.48	45.1
K_{oc}	95.0	123.0	218.0	87.0	318.0	218.0	361.0
CEC = Cation exchange capacity							

The range of K_{oc} values suggest that tembotrione will have high to moderate mobility in soil, with the potential to leach. There was no soil with organic carbon content less than 1%, and the study was classified as Supplemental.

MRID 46695405 (Supplemental)

The adsorption/desorption characteristics of [^{14}C]-labeled AE 0456148 were studied in a sandy loam soil and a silt loam from the U.S., and a loamy sand, a sandy loam soil, and a silt loam soil, each from Germany, in a batch equilibrium experiment. The soil characteristics and the adsorption/desorption data are summarized in **Table A-2**.

Table A-2. Adsorption and Desorption Properties of the Tembotrione Metabolite AE 0456148 in Five Soils					
Property	**Speyer 2.2**	**Speyer 2.3**	**Sarotti**	**Pikeville**	**Horse Camp Bridge**
Soil texture (USDA)	Loamy Sand	Sandy Loam	Silt Loam	Sandy Loam	Silt Loam
% Sand (50–2000 μm)	86.56	67.38	19.61	75.80	15.26
% Silt (2–50 μm)	8.73	24.22	61.20	19.25	61.18
% Clay (<2 μm)	4.71	8.41	19.20	4.95	23.56
pH					
Deionized water	6.6	6.9	7.4	6.7	7.4
1M KCl	5.9	6.6	7.6	5.7	7.6
0.01M $CaCl_2$	6.0	6.4	7.1	5.9	7.2
Organic carbon (%)	1.5	1.1	1.5	1.0	4.0
Organic matter (%)	2.6	1.9	2.6	1.7	6.9
CEC (meq/100 g)	7.7	5.7	12.9	5.6	20.9
Moisture at 1/3 bar (%)	12.6	19.3	31.9	11.4	53.3
Adsorption Phase					
K_f	0.01	0.04	0.00	3.63	1.7
K_{oc}	0.70	3.65	0.07	0.04	0.07
Desorption Phase					
K_f	0.18	0.83	0.04	0.55	0.28
K_{oc}	12.09	75.04	2.98	54.99	7.06
CEC = Cation exchange capacity					

The mobility of AE 0456148 is very high based upon the adsorption data from this study.

MRID 46695406 (Supplemental)

The adsorption/desorption characteristics of the tembotrione metabolite AE 0941989 were studied in a loamy sand soil and a sandy loam soil, each from Germany, and two clay loam soils from the United Kingdom, in a batch equilibrium experiment. The physical characteristics of the soils and the adsorption/desorption data are provided in **Table A-3**.

Table A-3. Adsorption and Desorption Properties of the Tembotrione Metabolite AE 0941989 in Four Soils				
Property	**Speyer 2.2 03/24 Loamy Sand**	**Flint Hall 04/13 Clay Loam**	**Shelley 04/31 Clay Loam**	**Laacherhof AXXa 04/32 Sandy Loam**
Soil texture (USDA)	Loamy Sand	Clay Loam	Clay Loam	Sandy Loam
% Sand	86.56	32.32	28.32	72.51
% Silt	8.73	34.52	41.86	16.85
% Clay	4.71	33.15	29.82	10.63
pH				
Deionized water	6.6/NA	8.3/7.9	7.9/7.5	7.5/7.3
1M KCl	6.0/NA	7.4/7.1	7.0/7.0	7.0/6.8
0.01M $CaCl_2$	5.9/NA	7.8/7.5	7.1/7.1	7.3/7.2
Organic carbon (%)	1.6	2.5	2.1	1.7
Organic matter (%)	2.8	4.3	3.6	2.9
CEC (meq/100 g)	7.7	16.6	11.6	7.6
Moisture at 1/3 bar (%)	12.6	28.5	30.9	15.0
Adsorption Phase				
K_f	6.77	23.6	36.60	6.81
K_{oc}	423.0	944.0	1743.0	400.0
Desorption Phase				
K_f	13.81	31.17	41.18	14.82
K_{oc}	863.0	1247.0	1961.0	872.0
CEC = Cation exchange capacity				

The mobility of AE 0941989 is moderate to low based upon the adsorption data from this study.

MRID 46695407 (Supplemental)

The adsorption/desorption characteristics the tembotrione metabolite AE 0968400 were studied in a sandy loam soil and a silt loam, each from the U.S., and a loamy sand soil, a sandy loam soil, and a silt loam soil, each from Germany, in a batch equilibrium experiment. The physical properties of the soil and accompanying adsorption/desorption data for AE 0968400 are illustrated in **Table A-4**.

Table A-4. Adsorption and Desorption Properties of the Tembotrione Metabolite AE 0968400 in Five Soils					
Property	**Speyer 2.2**	**Speyer 2.3**	**Sarotti**	**Pikeville**	**Horse Camp Bridge**
Soil texture (USDA)	Loamy Sand	Sandy Loam	Silt Loam	Sandy Loam	Silt Loam
% Sand (50–2000 μm)	86.56	67.38	19.61	75.80	15.26
% Silt (2–50 μm)	8.73	24.22	61.20	19.25	61.18
% Clay (<2 μm)	4.71	8.41	19.20	4.95	23.56
pH					
Deionized water	6.6	6.9	7.4	6.7	7.4
1M KCl	5.9	6.6	7.6	5.7	7.6
0.01M $CaCl_2$	6.0	6.4	7.1	5.9	7.2
Organic carbon (%)	1.5	1.1	1.5	1.0	4.0
Organic matter (%)	2.6	1.9	2.6	1.7	6.9
CEC (meq/100 g)	7.7	5.7	12.9	5.6	20.9
Moisture at 1/3 bar (%)	12.6	19.3	31.9	11.4	53.3
Adsorption Phase					
K_f	1.03	1.04	0.27	1.23	1.00
K_{oc}	69.0	94.0	18.0	123.0	25.0
Desorption Phase					
K_f	4.13	5.86	1.03	4.24	4.22
K_{oc}	276.0	533.0	69.0	424.0	105.0
CEC = Cation exchange capacity					

The mobility of AE 0968400 is very high to high based upon the adsorption data from this study.

MRID 46695408 (Supplemental)

The adsorption/desorption characteristics the tembotrione metabolite AE 1124336 were studied in a sandy loam soil and a silt loam, each from the U.S., and a loamy sand soil, a sandy loam soil, and a silt loam soil, each from Germany, in a batch equilibrium experiment. The physical properties of the soil and accompanying adsorption/desorption data for AE 1124336 are illustrated in **Table A-5**.

Table A-5. Adsorption and Desorption Properties of the Tembotrione Metabolite AE 1124336 in Five Soils					
Property	**Speyer 2.2**	**Speyer 2.3**	**Sarotti**	**Pikeville**	**Horse Camp Bridge**
Soil texture (USDA)	Loamy Sand	Sandy Loam	Silt Loam	Sandy Loam	Silt Loam
% Sand (50–2000 μm)	86.56	67.38	19.61	75.80	15.26
% Silt (2–50 μm)	8.73	24.22	61.20	19.25	61.18
% Clay (<2 μm)	4.71	8.41	19.20	4.95	23.56
pH					
Deionized water	6.6	6.9	7.4	6.7	7.4
1M KCl	5.9	6.6	7.6	5.7	7.6
0.01M $CaCl_2$	6.0	6.4	7.1	5.9	7.2
Organic carbon (%)	1.5	1.1	1.5	1.0	4.0
Organic matter (%)	2.6	1.9	2.6	1.7	6.9
CEC (meq/100 g)	7.7	5.7	12.9	5.6	20.9
Moisture at 1/3 bar (%)	12.6	19.3	31.9	11.4	53.3
Adsorption Phase					
K_f	3.4	3.5	3.0	3.1	13.3
K_{oc}	227.0	317.0	201.0	310.0	332.0
Desorption Phase					
K_f	6.6	10.2	5.7	5.7	21.5
K_{oc}	443.0	928.0	379.0	568.0	539.0
CEC = Cation exchange capacity					

The mobility of AE 1124336 is moderate based upon the adsorption data from this study.

MRID 46695409 (Supplemental)

The adsorption/desorption characteristics of tembotrione metabolite AE 1392936 were studied in a loamy sand soil and a sandy loam soil, each from Germany, and two clay loam soils from the United Kingdom, in a batch equilibrium experiment. The physical characteristics of the soils and the adsorption/desorption data are provided in **Table A-6**.

Table A-6. Adsorption and Desorption Properties of the Tembotrione Metabolite AE 1392936 in Four European Soils				
Property	**Speyer 2.2 03/24 Loamy Sand**	**Flint Hall 04/13 Clay Loam**	**Shelley 04/31 Clay Loam**	**Laacherhof AXXa 04/32 Sandy Loam**
Soil texture (USDA)	Loamy Sand	Clay Loam	Clay Loam	Sandy Loam
% Sand	86.56	32.32	28.32	72.51
% Silt	8.73	34.52	41.86	16.85
% Clay	4.71	33.15	29.82	10.63
pH				
Deionized water	6.6/NA	8.3/7.9	7.9/7.5	7.5/7.3
1M KCl	6.0/NA	7.4/7.1	7.0/7.0	7.0/6.8
0.01M $CaCl_2$	5.9/NA	7.8/7.5	7.1/7.1	7.3/7.2
Organic carbon (%)	1.6	2.5	2.1	1.7
Organic matter (%)	2.8	4.3	3.6	2.9
CEC (meq/100 g)	7.7	16.6	11.6	7.6
Moisture at 1/3 bar (%)	12.6	28.5	30.9	15.0
Adsorption Phase				
K_f	0.0019	NA	NA	NA
K_{oc}	0.11	NA	NA	NA
Desorption Phase				
K_f	0.52	0.0015	0.08	0.31
K_{oc}	28.7	0.06	4.0	18.1
CEC = Cation exchange capacity NA = Not enough was adsorbed to calculate the coefficient				

Almost no adsorption of the metabolite AE 1392936 was observed in these four soils and leaching potential is considered very high for this metabolite.

164-1 Terrestrial Field Dissipation

MRID 46695425 (Acceptable)

Terrestrial field dissipation studies for tembotrione under U.S. field conditions was studied in bare plots cropped with field corn in New York (Site 1; loamy sand/sand soil), Illinois (Site 2; silt loam soil), Nebraska (Site 3; silt loam/clay loam soil), and California (Site 4; sandy loam soil). Tembotrione formulated as a suspension concentrate was broadcast once at each test site at a target rate of 0.200 kg a.i./ha (0.178 lbs a.i./acre) to four 23.8x36.6 m, 5x41 m, 6x40 m, and 12x17 m subplots at Sites 1, 2, 3, and 4, respectively.

At the New York site tembotrione decreased from an initial concentration of 0.052 mg/kg (time 0) to 0.020 ppm by 1 day, 0.014 ppm by 7 days, and was detected below the levels of quantification (LOQ) (0.01 ppm) from 14 to 92 days post-treatment. Tembotrione was not detected below the 0–15 cm soil depth. Tembotrione had a half-life value of 24.5 days in soil (r_2 = 0.53), based on all available replicate data, and 4.8 days in soil (r_2 = 0.45) based on 0–7 day data. The only major transformation product detected at Site 1 was AE 0456148, which was not detected at a mean concentration above the LOQ. However, the maximum replicate detection of AE 0456148, 0.0121 ppm (or 14.4% of the applied tembotrione) at 30 days, did exceed the LOQ.

The maximum average detection of AE 0456148 was 0.0077 ppm at 30 days, and represented a reviewer-calculated 9.2% of the applied tembotrione, based on the registrant-calculated day 0 theoretical amount. AE 0456148 was detected at levels below the LOQ in the 15–30 cm depth from 14 to 120 days and in the 30–45 and 45–60 cm depths at 120 days only. These data are consistent with the soil adsorption studies on this metabolite which suggests it has high mobility in soil.

In the Illinois test plot (Site 2), the measured zero-time recovery of tembotrione in the 0–15 cm soil layer was 0.062 mg/kg or 62% of the theoretical limit. The concentration of tembotrione decreased to 0.043 ppm by 1 day, 0.023–0.027 ppm by 8–14 days, and was detected below the LOQ from 30 to 120 days post-treatment in the 0–15 cm soil depth. Tembotrione was not detected below the 0–15 cm soil depth. Tembotrione had a half-life value of 25.3 days in soil (r_2 = 0.63), based on all available replicate data. The only major transformation product detected at Site 2 was AE 0456148, which was detected in the 0–15 cm soil depth at a mean concentration of 0.0121 ppm at 1 day, increased to a maximum of 0.0401 ppm or 39.7% of the applied tembotrione (based on the registrant-calculated day 0 theoretical value for tembotrione) by 14 days, decreased to 0.0179 ppm by 30 days, and was detected below the LOQ at 60 and 91 days post-treatment. AE 0456148 was not detected above the LOQ in soil below the 0–15 cm depth. The reviewer-calculated half-life for AE 0456148 was 21.0 days (r_2 = 0.82), calculated using linear regression and all replicate data points following the maximum detection at 14 days.

In the Nebraska test plot (Site 3), the measured zero-time recovery of tembotrione in the 0–15 cm soil layer was 0.044 mg/kg or 42% of the theoretical. The concentration of tembotrione decreased to 0.017–0.020 ppm from 1–14 days, was <LOQ at 30 days, and was last detected at 182 days post-treatment in the 0–15 cm soil depth. Tembotrione was only detected once each in the 15–30 cm and 30–45 cm soil depths. Tembotrione had a half-life value of 47.5 days in soil (r_2 = 0.66), based on all available replicate data, and 7.5 days in soil (r_2 = 0.29) based on 0–7 day data. The only major transformation product detected at Site 3 was AE 0456148, which was detected in the 0–15 cm soil depth at a mean concentration of 0.0117 ppm at 1 day, increased to a maximum of 0.0294 ppm or 27.7% of the applied tembotrione (based on the registrant-calculated day 0 theoretical value for tembotrione) by 7 days, decreased to 0.0146 ppm by 120 days, and was detected below the LOQ at 151 and 182 days post-treatment. AE 0456148 was not detected above the LOQ in soil below the 0–15 cm depth. The reviewer-calculated half-life for AE 0456148 was 75.3 days (r_2 = 0.59), calculated using linear regression and all replicate data points following the maximum detection at 7 days.

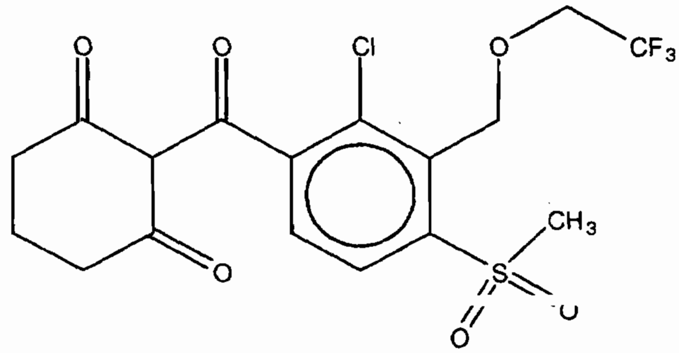
In the California test plot (Site 4), the measured zero-time recovery of tembotrione in the 0–15 cm soil layer was 0.052 mg/kg or 66% of the theoretical limit. The concentration of tembotrione decreased to 0.030 ppm by 3 days, 0.022 ppm by 7 days, was detected at a mean concentration below the LOQ at 14 days, and was not detected by 30 days post-treatment in the 0–15 cm soil depth. Tembotrione was only detected once in the 15–30 cm soil depth. Tembotrione had a half-life value of 5.9 days in soil (r_2 = 0.72), based on all available replicate data. The only major transformation product detected at Site 4 was AE 0456148. AE 0456148 was detected in the 0–15 cm soil depth below the LOQ at 1 day, increased to 0.0121 ppm by 3 days and a maximum of 0.0289 ppm or 36.1% of the applied tembotrione (based on the registrant-calculated day 0 theoretical value for tembotrione) by 14 days, and was detected below the LOQ from 30 to 120 days post-treatment. AE 0456148 was detected above the LOQ in two of four replicate samples in the 15–30 cm depth at 30 days post-treatment, 0.0106–0.0130 ppm, and was not detected following 30 days. AE 0456148 was also detected in the 30–45 cm depth below the LOQ at the 30-day sampling interval. No half-life for AE 0456148 was calculated because concentrations were below the LOQ at the next sampling interval following the maximum concentration.

The important metabolites formed by the degradation of tembotrione are provided in **Table A-7** and the chemical structures of these metabolites are illustrated in **Table A-8**.

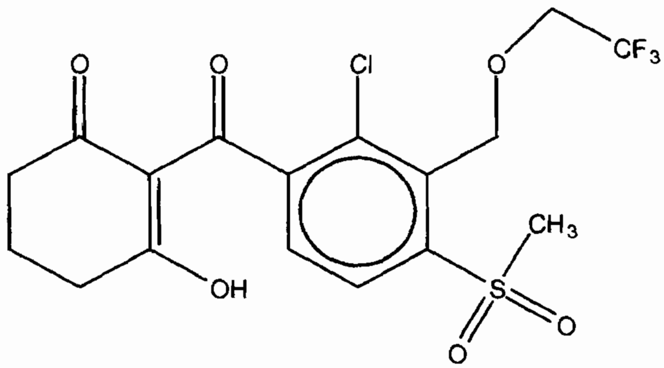
Table A-7. Maximum Amounts of AE 0172747 (Tembotrione) Metabolites in Degradation Studies Characterized by Study Type

Study Type	Metabolite (% Maximum)	MRID
161-1 Hydrolysis	No degradation products observed	MRID 46695410
161-2 Aqueous photolysis	Glutaric acid (6.8%)	MRID 46695411
161-3 Soil photolysis	AE 0456148 (22%) AE 0941989 (15.3%) AE 0941989 (17.9%) glutaric acid (13.8%)	MRID 46695412 MRID 46695412 MRID 46695413 MRID 46695413
162-1 Aerobic soil metabolism	AE 0456148 (72.4%) AE 0968400 (14.4%) AE 0456148 (19.7–70.5%) AE 0968400 (14.9%) AE 1124336 (8.7%) AE 0456148 (25.8%) AE 1392936 (17.1%) AE 0968400 (7.3%) AE 1124336 (1.1%)	MRID 46695414 MRID 46695414 MRID 46695415 MRID 46695415 MRID 46695415 MRID 46695416 MRID 46695416 MRID 46695416 MRID 46695416
162-2 Anaerobic soil metabolism	CO_2 was the only significant degradation product. AE 0456148 (46.4%)	MRID 46695419 MRID 46695420
162-3 Anaerobic aquatic metabolism	AE 0456148 (2.4%)	MRID 46695423
162-4 Aerobic aquatic metabolism	AE 0456148 (61.6%) AE 0456148 (95.2%) AE 0968400 (4.4%)	MRID 46695421 MRID 46695422 MRID 46695422

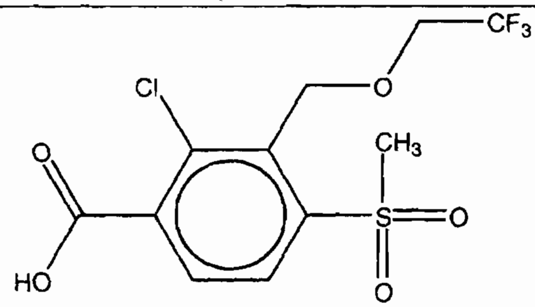
Table A-8. The Chemical Structure of AE 0172747 (Tembotrione) and its Metabolites



AE 0172747 (Tembotrione - Dione form)

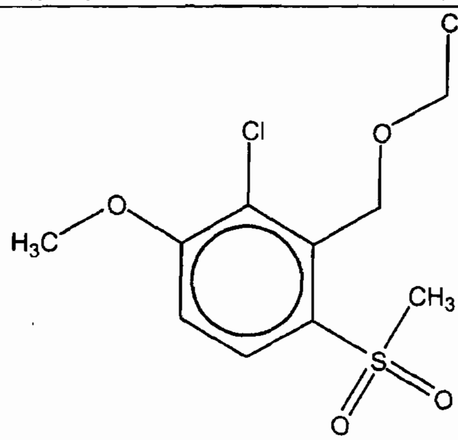


AE 0172747 (Tembotrione - Enol form)

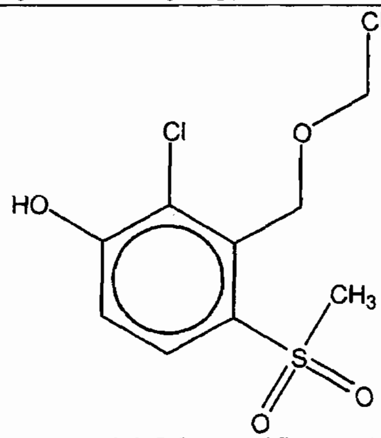


2-Chloro-4-mesyl-3-[(2,2,2-trifluoroethoxy)methyl]benzoic acid (AE 0456148)

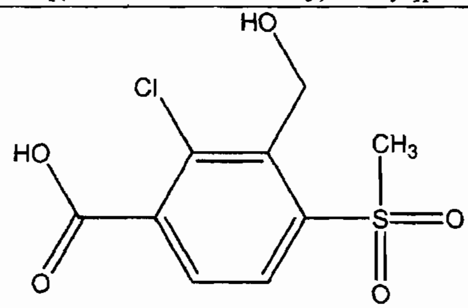
Table A-8. The Chemical Structure of AE 0172747 (Tembotrione) and its Metabolites



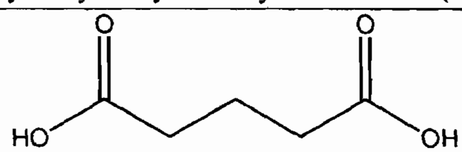
2-Chloro-4-mesyl-1-methoxy-3-[(2,2,2-trifluoroethoxy)methyl]benzene (AE 1124336)



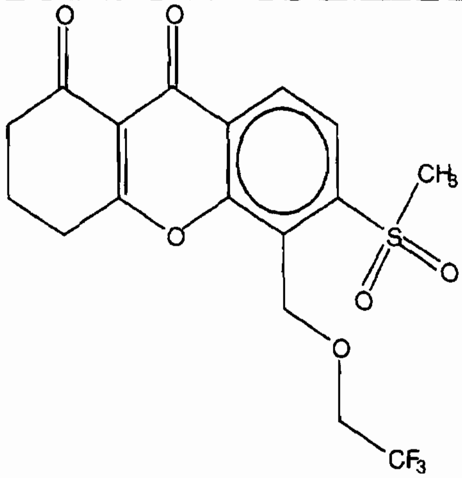
2-Chloro-4-mesyl-3-[(2,2,2-trifluoroethoxy)methyl]phenol (AE 0968400)



2-Chloro-3-hydroxymethyl-4-mesylbenzoic acid (AE 1392936)



Glutaric acid (AE 1275213)

Table A-8. The Chemical Structure of AE 0172747 (Tembotrione) and its Metabolites

6-Methanesulfonyl-5-(2,2,2-trifluoroethoxymethyl)-3,4-dihydro-2H-xanthene-1,9-dione (AE 0941989)

APPENDIX B. PRZM/EXAMS Aquatic Exposure Model Output

California Corn
stored as Corn_Pond.out
Chemical: Tembotrione
PRZM environment: CAcornC.txt modified Friday, 6 December 2002 at 07:49:36
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w23232.dvf modified Wedday, 3 July 2002 at 05:04:22
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.08989	0.08914	0.08671	0.08177	0.07814	0.04687
1962	0.292	0.2904	0.284	0.273	0.2525	0.1355
1963	0.3141	0.3129	0.3087	0.2981	0.29	0.2501
1964	0.2844	0.2832	0.2788	0.2689	0.261	0.2263
1965	0.2819	0.2807	0.276	0.2662	0.2588	0.2248
1966	0.2737	0.2726	0.2679	0.2575	0.2497	0.22
1967	0.389	0.3872	0.3797	0.3644	0.3553	0.2798
1968	0.3153	0.3141	0.3091	0.2976	0.2894	0.2512
1969	0.2924	0.2911	0.286	0.2752	0.2673	0.2286
1970	0.2711	0.2699	0.2648	0.2542	0.2464	0.21
1971	0.2606	0.2595	0.2554	0.2462	0.2387	0.2005
1972	0.248	0.2468	0.2424	0.2327	0.2253	0.1893
1973	0.2414	0.2402	0.2355	0.2251	0.2174	0.183
1974	0.2401	0.239	0.235	0.2261	0.2243	0.1909
1975	0.2518	0.2506	0.2458	0.2354	0.2277	0.1896
1976	0.238	0.2368	0.232	0.2217	0.2142	0.178
1977	0.3294	0.3278	0.3216	0.3079	0.2975	0.2248
1978	0.2864	0.2851	0.2799	0.2691	0.2613	0.2242
1979	0.2717	0.2704	0.2655	0.2549	0.247	0.2125
1980	0.2668	0.2657	0.2614	0.2522	0.2449	0.2085
1981	0.2696	0.2684	0.2636	0.2528	0.2448	0.2039
1982	0.2533	0.2522	0.2478	0.2388	0.2322	0.1991
1983	0.3704	0.3686	0.3611	0.3455	0.3347	0.2556
1984	0.3031	0.3017	0.2958	0.2835	0.2757	0.2374
1985	0.2756	0.2745	0.27	0.2595	0.2513	0.2138
1986	0.2566	0.2555	0.251	0.2411	0.2335	0.1973
1987	0.2448	0.2436	0.2388	0.2287	0.2215	0.1902
1988	0.5028	0.5001	0.4905	0.4717	0.4585	0.3267
1989	0.3851	0.3835	0.3767	0.3649	0.3581	0.3312
1990	0.696	0.6923	0.6755	0.6398	0.6148	0.4582

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	0.696	0.6923	0.6755	0.6398	0.6148	0.4582
0.0645161290322581	0.5028	0.5001	0.4905	0.4717	0.4585	0.3312

0.0967741935483871	0.389	0.3872	0.3797	0.3649	0.3581	0.3267
0.129032258064516	0.3851	0.3835	0.3767	0.3644	0.3553	0.2798
0.161290322580645	0.3704	0.3686	0.3611	0.3455	0.3347	0.2556
0.193548387096774	0.3294	0.3278	0.3216	0.3079	0.2975	0.2512
0.225806451612903	0.3153	0.3141	0.3091	0.2981	0.29	0.2501
0.258064516129032	0.3141	0.3129	0.3087	0.2976	0.2894	0.2374
0.290322580645161	0.3031	0.3017	0.2958	0.2835	0.2757	0.2286
0.32258064516129	0.2924	0.2911	0.286	0.2752	0.2673	0.2263
0.354838709677419	0.292	0.2904	0.284	0.273	0.2613	0.2248
0.387096774193548	0.2864	0.2851	0.2799	0.2691	0.261	0.2248
0.419354838709677	0.2844	0.2832	0.2788	0.2689	0.2588	0.2242
0.451612903225806	0.2819	0.2807	0.276	0.2662	0.2525	0.22
0.483870967741936	0.2756	0.2745	0.27	0.2595	0.2513	0.2138
0.516129032258065	0.2737	0.2726	0.2679	0.2575	0.2497	0.2125
0.548387096774194	0.2717	0.2704	0.2655	0.2549	0.247	0.21
0.580645161290323	0.2711	0.2699	0.2648	0.2542	0.2464	0.2085
0.612903225806452	0.2696	0.2684	0.2636	0.2528	0.2449	0.2039
0.645161290322581	0.2668	0.2657	0.2614	0.2522	0.2448	0.2005
0.67741935483871	0.2606	0.2595	0.2554	0.2462	0.2387	0.1991
0.709677419354839	0.2566	0.2555	0.251	0.2411	0.2335	0.1973
0.741935483870968	0.2533	0.2522	0.2478	0.2388	0.2322	0.1909
0.774193548387097	0.2518	0.2506	0.2458	0.2354	0.2277	0.1902
0.806451612903226	0.248	0.2468	0.2424	0.2327	0.2253	0.1896
0.838709677419355	0.2448	0.2436	0.2388	0.2287	0.2243	0.1893
0.870967741935484	0.2414	0.2402	0.2355	0.2261	0.2215	0.183
0.903225806451613	0.2401	0.239	0.235	0.2251	0.2174	0.178
0.935483870967742	0.238	0.2368	0.232	0.2217	0.2142	0.1355
0.967741935483871	0.08989	0.08914	0.08671	0.08177	0.07814	0.04687
0.1	**0.38861**	**0.38683**	**0.3794**	**0.36485**	**0.35782**	**0.32201**

Average of yearly averages: **0.222929**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_Pond
Metfile: w23232.dvf
PRZM scenario: CAcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	

Kd Kd mg/L
Koc Koc 110 mg/L
Photolysis half-life kdp 172 days Half-life
Aerobic Aquatic Metabolism kbacw 278 days Halfife
Anaerobic Aquatic Metabolism kbacs 1198 days Halfife
Aerobic Soil Metabolism asm 46 days Halfife
Hydrolysis: pH 7 0 days Half-life
Method: CAM 1 integer See PRZM manual
Incorporation Depth: DEPI cm
Application Rate: TAPP 0.092 kg/ha
Application Efficiency: APPEFF 0.99 fraction
Spray Drift DRFT 0.01 fraction of application rate applied to pond
Application Date Date 17-4 dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1 interval 14 days Set to 0 or delete line for single app.
Record 17: FILTRA
IPSCND
UPTKF
Record 18: PLVKRT
PLDKRT
FEXTRC 0.5
Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)
Write Benthic Porewater File? benthic
Write Benthic Sediment File? benthicsed

Florida Sweet Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: FLsweetcornC.txt modified Friday, 6 December 2002 at 07:54:36
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w12844.dvf modified Wedday, 3 July 2002 at 05:04:30
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.7739	0.7677	0.7451	0.7178	0.5121	0.1263
1962	0.6672	0.6638	0.6506	0.6227	0.6033	0.4694
1963	1.191	1.182	1.149	1.025	0.7712	0.4699
1964	4.06	4.035	3.933	3.14	2.349	1.224
1965	5.055	5.022	4.889	4.664	3.771	2.932
1966	4.507	4.489	4.434	4.28	4.166	3.216
1967	2.754	2.735	2.68	2.637	2.32	2.022
1968	2.457	2.447	2.41	2.337	2.286	1.845
1969	3.467	3.449	3.382	3.297	2.653	1.729
1970	3.208	3.196	3.148	3.046	2.968	2.237
1971	1.616	1.607	1.575	1.513	1.45	1.239
1972	11.28	11.18	10.8	9.379	6.494	2.404
1973	9.264	9.215	9.017	8.637	8.37	6.229
1974	4.279	4.262	4.196	4.058	3.955	3.112
1975	2.857	2.844	2.793	2.684	2.606	2.114
1976	2.188	2.18	2.15	2.089	2.03	1.71
1977	2.54	2.528	2.472	2.041	1.927	1.622
1978	6.93	6.89	6.728	6.11	4.625	2.463
1979	5.897	5.871	5.767	5.558	5.41	4.124
1980	3.027	3.019	2.982	2.905	2.845	2.276
1981	2.524	2.509	2.461	2.306	1.992	1.709
1982	9.231	9.16	8.977	8.134	5.877	2.85
1983	7.858	7.822	7.677	7.38	7.173	5.59
1984	7.024	6.98	6.808	5.55	4.611	3.962
1985	6.269	6.244	6.144	5.926	5.756	4.316
1986	3.106	3.098	3.064	2.97	2.909	2.349
1987	2.969	2.95	2.875	2.742	2.209	1.812
1988	2.652	2.641	2.595	2.501	2.434	1.965
1989	1.959	1.951	1.916	1.844	1.794	1.466
1990	1.596	1.588	1.559	1.494	1.448	1.09

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	11.28	11.18	10.8	9.379	8.37	6.229
0.0645161290322581	9.264	9.215	9.017	8.637	7.173	5.59
0.0967741935483871	9.231	9.16	8.977	8.134	6.494	4.316
0.129032258064516	7.858	7.822	7.677	7.38	5.877	4.124

0.161290322580645	7.024	6.98	6.808	6.11	5.756	3.962
0.193548387096774	6.93	6.89	6.728	5.926	5.41	3.216
0.225806451612903	6.269	6.244	6.144	5.558	4.625	3.112
0.258064516129032	5.897	5.871	5.767	5.55	4.611	2.932
0.290322580645161	5.055	5.022	4.889	4.664	4.166	2.85
0.32258064516129	4.507	4.489	4.434	4.28	3.955	2.463
0.354838709677419	4.279	4.262	4.196	4.058	3.771	2.404
0.387096774193548	4.06	4.035	3.933	3.297	2.968	2.349
0.419354838709677	3.467	3.449	3.382	3.14	2.909	2.276
0.451612903225806	3.208	3.196	3.148	3.046	2.845	2.237
0.483870967741936	3.106	3.098	3.064	2.97	2.653	2.114
0.516129032258065	3.027	3.019	2.982	2.905	2.606	2.022
0.548387096774194	2.969	2.95	2.875	2.742	2.434	1.965
0.580645161290323	2.857	2.844	2.793	2.684	2.349	1.845
0.612903225806452	2.754	2.735	2.68	2.637	2.32	1.812
0.645161290322581	2.652	2.641	2.595	2.501	2.286	1.729
0.67741935483871	2.54	2.528	2.472	2.337	2.209	1.71
0.709677419354839	2.524	2.509	2.461	2.306	2.03	1.709
0.741935483870968	2.457	2.447	2.41	2.089	1.992	1.622
0.774193548387097	2.188	2.18	2.15	2.041	1.927	1.466
0.806451612903226	1.959	1.951	1.916	1.844	1.794	1.239
0.838709677419355	1.616	1.607	1.575	1.513	1.45	1.224
0.870967741935484	1.596	1.588	1.559	1.494	1.448	1.09
0.903225806451613	1.191	1.182	1.149	1.025	0.7712	0.4699
0.935483870967742	0.7739	0.7677	0.7451	0.7178	0.6033	0.4694
0.967741935483871	0.6672	0.6638	0.6506	0.6227	0.5121	0.1263
0.1	**9.0937**	**9.0262**	**8.847**	**8.0586**	**6.4323**	**4.2968**

Average of yearly averages: **2.35575333333333**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w12844.dvf
PRZM scenario: FLsweetcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism kbacs 1198 days Halfife
Aerobic Soil Metabolism asm 46 days Halfife
Hydrolysis: pH 7 0 days Half-life
Method: CAM 1 integer See PRZM manual
Incorporation Depth: DEPI cm
Application Rate: TAPP 0.092 kg/ha
Application Efficiency: APPEFF 0.99 fraction
Spray Drift DRFT 0.01 fraction of application rate applied to pond
Application Date Date 24-10 dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1 interval 14 days Set to 0 or delete line for single app.
Record 17: FILTRA
IPSCND
UPTKF
Record 18: PLVKRT
PLDKRT
FEXTRC 0.5
Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)
Write Benthic Porewater File? benthic
Write Benthic Sediment File? benthicsed

Illinois Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: ILCornC.txt modified Friday, 6 December 2002 at 09:08:12
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w14923.dvf modified Wedday, 3 July 2002 at 05:04:40
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.662	0.6576	0.6477	0.6177	0.6037	0.3113
1962	1.395	1.388	1.359	1.311	1.285	0.9054
1963	1.419	1.411	1.382	1.326	1.295	1.149
1964	1.719	1.711	1.683	1.622	1.572	1.289
1965	1.766	1.757	1.725	1.676	1.634	1.402
1966	3.515	3.496	3.417	3.287	3.2	2.345
1967	5.468	5.446	5.348	5.09	4.918	3.649
1968	4.022	4.019	4.005	3.973	3.945	3.529
1969	3.462	3.447	3.399	3.29	3.19	2.911
1970	4.61	4.585	4.521	4.423	4.304	3.388
1971	4.11	4.097	4.03	3.928	3.885	3.458
1972	4.314	4.292	4.225	4.037	3.91	3.395
1973	4.543	4.52	4.461	4.362	4.228	3.544
1974	4.929	4.912	4.837	4.701	4.581	3.835
1975	3.73	3.714	3.692	3.665	3.644	3.364
1976	3.038	3.03	3.003	2.937	2.874	2.705
1977	3.097	3.081	3.038	2.907	2.836	2.54
1978	3.114	3.103	3.08	2.992	2.916	2.527
1979	2.495	2.483	2.438	2.365	2.325	2.181
1980	3.206	3.191	3.143	3.021	2.912	2.339
1981	2.398	2.388	2.358	2.305	2.28	2.163
1982	3.252	3.237	3.194	3.125	3.035	2.402
1983	3.28	3.264	3.2	3.02	2.906	2.536
1984	4.174	4.151	4.059	3.946	3.828	3.024
1985	3.428	3.415	3.386	3.289	3.211	2.929
1986	3.709	3.695	3.674	3.571	3.478	2.912
1987	3.56	3.545	3.5	3.362	3.258	2.866
1988	2.704	2.695	2.653	2.618	2.601	2.36
1989	2.395	2.384	2.339	2.264	2.206	1.99
1990	2.977	2.964	2.908	2.833	2.762	2.216

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	5.468	5.446	5.348	5.09	4.918	3.835
0.0645161290322581	4.929	4.912	4.837	4.701	4.581	3.649
0.0967741935483871	4.61	4.585	4.521	4.423	4.304	3.544
0.129032258064516	4.543	4.52	4.461	4.362	4.228	3.529

0.161290322580645	4.314	4.292	4.225	4.037	3.945	3.458
0.193548387096774	4.174	4.151	4.059	3.973	3.91	3.395
0.225806451612903	4.11	4.097	4.03	3.946	3.885	3.388
0.258064516129032	4.022	4.019	4.005	3.928	3.828	3.364
0.290322580645161	3.73	3.714	3.692	3.665	3.644	3.024
0.32258064516129	3.709	3.695	3.674	3.571	3.478	2.929
0.354838709677419	3.56	3.545	3.5	3.362	3.258	2.912
0.387096774193548	3.515	3.496	3.417	3.29	3.211	2.911
0.419354838709677	3.462	3.447	3.399	3.289	3.2	2.866
0.451612903225806	3.428	3.415	3.386	3.287	3.19	2.705
0.483870967741936	3.28	3.264	3.2	3.125	3.035	2.54
0.516129032258065	3.252	3.237	3.194	3.021	2.916	2.536
0.548387096774194	3.206	3.191	3.143	3.02	2.912	2.527
0.580645161290323	3.114	3.103	3.08	2.992	2.906	2.402
0.612903225806452	3.097	3.081	3.038	2.937	2.874	2.36
0.645161290322581	3.038	3.03	3.003	2.907	2.836	2.345
0.67741935483871	2.977	2.964	2.908	2.833	2.762	2.339
0.709677419354839	2.704	2.695	2.653	2.618	2.601	2.216
0.741935483870968	2.495	2.483	2.438	2.365	2.325	2.181
0.774193548387097	2.398	2.388	2.358	2.305	2.28	2.163
0.806451612903226	2.395	2.384	2.339	2.264	2.206	1.99
0.838709677419355	1.766	1.757	1.725	1.676	1.634	1.402
0.870967741935484	1.719	1.711	1.683	1.622	1.572	1.289
0.903225806451613	1.419	1.411	1.382	1.326	1.295	1.149
0.935483870967742	1.395	1.388	1.359	1.311	1.285	0.9054
0.967741935483871	0.662	0.6576	0.6477	0.6177	0.6037	0.3113
0.1	**4.6033**	**4.5785**	**4.515**	**4.4169**	**4.2964**	**3.5425**

Average of yearly averages: **2.53882333333333**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w14923.dvf
PRZM scenario: ILCornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism		kbacs	1198	days	Halfife
Aerobic Soil Metabolism	asm	46	days	Halfife	
Hydrolysis:	pH 7	0	days	Half-life	
Method:	CAM	1	integer	See PRZM manual	
Incorporation Depth:	DEPI		cm		
Application Rate:	TAPP	0.092	kg/ha		
Application Efficiency:		APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond		
Application Date	Date	10-5	dd/mm or dd/mmm or dd-mm or dd-mmm		
Interval 1	interval	14	days	Set to 0 or delete line for single app.	
Record 17:	FILTRA				
	IPSCND				
	UPTKF				
Record 18:	PLVKRT				
	PLDKRT				
	FEXTRC	0.5			
Flag for Index Res. Run	IR	Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)		
Write Benthic Porewater File?		benthic			
Write Benthic Sediment File?	benthicsed				

Mississippi Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: MScornC.txt modified Friday, 6 December 2002 at 09:11:04
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w13893.dvf modified Wedday, 3 July 2002 at 05:06:20
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.1744	0.1731	0.1681	0.1574	0.1499	0.09364
1962	0.291	0.2889	0.2804	0.2641	0.2534	0.2056
1963	0.95	0.9433	0.9212	0.8705	0.831	0.5865
1964	2.348	2.333	2.297	2.178	2.082	1.4
1965	1.798	1.787	1.742	1.647	1.577	1.397
1966	2.157	2.146	2.109	2.013	1.93	1.518
1967	2.085	2.074	2.03	1.928	1.853	1.53
1968	1.375	1.37	1.363	1.35	1.338	1.206
1969	1.039	1.037	1.032	1.02	1.01	0.861
1970	1.681	1.67	1.64	1.566	1.502	1.088
1971	1.234	1.229	1.21	1.177	1.137	0.9905
1972	1.155	1.149	1.127	1.075	1.043	0.8593
1973	2.586	2.57	2.543	2.436	2.33	1.586
1974	3.13	3.115	3.05	2.876	2.835	2.21
1975	2.474	2.462	2.413	2.301	2.228	1.961
1976	1.781	1.771	1.732	1.666	1.633	1.508
1977	1.845	1.837	1.82	1.759	1.668	1.451
1978	4.589	4.557	4.44	4.16	3.953	2.566
1979	3.654	3.635	3.56	3.407	3.296	2.705
1980	2.266	2.264	2.253	2.228	2.208	1.863
1981	1.604	1.597	1.582	1.534	1.49	1.318
1982	1.06	1.059	1.055	1.045	1.034	0.9039
1983	2.534	2.517	2.449	2.303	2.194	1.443
1984	3.815	3.791	3.694	3.47	3.307	2.338
1985	3.743	3.724	3.664	3.492	3.35	2.622
1986	2.313	2.31	2.299	2.271	2.244	1.851
1987	1.436	1.435	1.429	1.413	1.396	1.202
1988	1.005	1.004	0.9998	0.9896	0.9795	0.858
1989	0.7278	0.7248	0.7126	0.7	0.6926	0.6251
1990	1.054	1.048	1.027	0.9821	0.9402	0.758

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.0322580645161290	4.589	4.557	4.44	4.16	3.953	2.705
0.0645161290322581	3.815	3.791	3.694	3.492	3.35	2.622
0.0967741935483871	3.743	3.724	3.664	3.47	3.307	2.566
0.129032258064516	3.654	3.635	3.56	3.407	3.296	2.338

0.161290322580645	3.13	3.115	3.05	2.876	2.835	2.21
0.193548387096774	2.586	2.57	2.543	2.436	2.33	1.961
0.225806451612903	2.534	2.517	2.449	2.303	2.244	1.863
0.258064516129032	2.474	2.462	2.413	2.301	2.228	1.851
0.290322580645161	2.348	2.333	2.299	2.271	2.208	1.586
0.32258064516129	2.313	2.31	2.297	2.228	2.194	1.53
0.354838709677419	2.266	2.264	2.253	2.178	2.082	1.518
0.387096774193548	2.157	2.146	2.109	2.013	1.93	1.508
0.419354838709677	2.085	2.074	2.03	1.928	1.853	1.451
0.451612903225806	1.845	1.837	1.82	1.739	1.668	1.443
0.483870967741936	1.798	1.787	1.742	1.666	1.633	1.4
0.516129032258065	1.781	1.771	1.732	1.647	1.577	1.397
0.548387096774194	1.681	1.67	1.64	1.566	1.502	1.318
0.580645161290323	1.604	1.597	1.582	1.534	1.49	1.206
0.612903225806452	1.436	1.435	1.429	1.413	1.396	1.202
0.645161290322581	1.375	1.37	1.363	1.35	1.338	1.088
0.67741935483871	1.234	1.229	1.21	1.177	1.137	0.9905
0.709677419354839	1.155	1.149	1.127	1.075	1.043	0.9039
0.741935483870968	1.06	1.059	1.055	1.045	1.034	0.861
0.774193548387097	1.054	1.048	1.032	1.02	1.01	0.8593
0.806451612903226	1.039	1.037	1.027	0.9896	0.9795	0.858
0.838709677419355	1.005	1.004	0.9998	0.9821	0.9402	0.758
0.870967741935484	0.95	0.9433	0.9212	0.8705	0.831	0.6251
0.903225806451613	0.7278	0.7248	0.7126	0.7	0.6926	0.5865
0.935483870967742	0.291	0.2889	0.2804	0.2641	0.2534	0.2056
0.967741935483871	0.1744	0.1731	0.1681	0.1574	0.1499	0.09364
0.1	**3.7341**	**3.7151**	**3.6536**	**3.4637**	**3.3059**	**2.5432**

Average of yearly averages: **1.38348466666667**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w13893.dvf
PRZM scenario: MScornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism		kbacs	1198	days	Halfife
Aerobic Soil Metabolism		asm	46	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life	
Method:	CAM	1	integer	See PRZM manual	
Incorporation Depth:	DEPI		cm		
Application Rate:	TAPP	0.092	kg/ha		
Application Efficiency:		APPEFF		0.99	fraction
Spray Drift	DRFT	0.01	fraction of application rate applied to pond		
Application Date	Date	20-4	dd/mm or dd/mmm or dd-mm or dd-mmm		
Interval 1	interval	14	days	Set to 0 or delete line for single app.	
Record 17:	FILTRA				
	IPSCND				
	UPTKF				
Record 18:	PLVKRT				
	PLDKRT				
	FEXTRC	0.5			
Flag for Index Res. Run		IR	Pond		
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)	
Write Benthic Porewater File?			benthic		
Write Benthic Sediment File?		benthicsed			

North Carolina Corn-East
stored as CornEast_pond.out
Chemical: Tembotrione
PRZM environment: NCcornEC.txt modified Friday, 6 December 2002 at 09:13:40
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w13722.dvf modified Wedday, 3 July 2002 at 05:05:50
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.6222	0.6177	0.6005	0.5659	0.5412	0.3001
1962	0.5655	0.5624	0.551	0.5306	0.5162	0.43
1963	1.106	1.1	1.072	1.025	0.9847	0.6875
1964	0.7715	0.7676	0.7516	0.7396	0.7352	0.6795
1965	0.8365	0.8323	0.8186	0.7849	0.7638	0.6402
1966	1.026	1.021	0.9991	0.9507	0.9224	0.7345
1967	1.027	1.022	1.014	0.9749	0.9472	0.7805
1968	0.7906	0.7878	0.7737	0.7527	0.7381	0.6627
1969	0.9258	0.9213	0.9128	0.879	0.8499	0.6761
1970	1.151	1.145	1.13	1.087	1.051	0.8201
1971	1.335	1.328	1.315	1.26	1.215	0.9512
1972	1.45	1.444	1.428	1.372	1.325	1.065
1973	1.634	1.627	1.606	1.588	1.545	1.219
1974	1.701	1.693	1.663	1.595	1.543	1.258
1975	1.237	1.234	1.212	1.177	1.157	1.053
1976	1.327	1.32	1.303	1.248	1.201	0.9778
1977	1.021	1.017	0.9983	0.962	0.9395	0.8439
1978	2.905	2.888	2.829	2.69	2.593	1.718
1979	1.882	1.875	1.86	1.809	1.77	1.61
1980	1.747	1.739	1.705	1.64	1.586	1.351
1981	1.404	1.398	1.376	1.309	1.268	1.129
1982	1.065	1.06	1.047	1.032	1.009	0.897
1983	0.9993	0.9954	0.9797	0.9364	0.9044	0.7677
1984	1.384	1.377	1.343	1.292	1.26	0.9702
1985	1.427	1.421	1.395	1.356	1.321	1.07
1986	1.685	1.676	1.637	1.547	1.482	1.158
1987	1.17	1.165	1.144	1.123	1.112	1.006
1988	1.018	1.014	0.9965	0.9548	0.9228	0.8123
1989	1.201	1.195	1.176	1.134	1.095	0.857
1990	1.381	1.373	1.352	1.3	1.255	0.9749

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.905	2.888	2.829	2.69	2.593	1.718
0.0645161290322581	1.882	1.875	1.86	1.809	1.77	1.61
0.0967741935483871	1.747	1.739	1.705	1.64	1.586	1.351
0.129032258064516	1.701	1.693	1.663	1.595	1.545	1.258

0.161290322580645	1.685	1.676	1.637	1.588	1.543	1.219
0.193548387096774	1.634	1.627	1.606	1.547	1.482	1.158
0.225806451612903	1.45	1.444	1.428	1.372	1.325	1.129
0.258064516129032	1.427	1.421	1.395	1.356	1.321	1.07
0.290322580645161	1.404	1.398	1.376	1.309	1.268	1.065
0.32258064516129	1.384	1.377	1.352	1.3	1.26	1.053
0.354838709677419	1.381	1.373	1.343	1.292	1.255	1.006
0.387096774193548	1.335	1.328	1.315	1.26	1.215	0.9778
0.419354838709677	1.327	1.32	1.303	1.248	1.201	0.9749
0.451612903225806	1.237	1.234	1.212	1.177	1.157	0.9702
0.483870967741936	1.201	1.195	1.176	1.134	1.112	0.9512
0.516129032258065	1.17	1.165	1.144	1.123	1.095	0.897
0.548387096774194	1.151	1.145	1.13	1.087	1.051	0.857
0.580645161290323	1.106	1.1	1.072	1.032	1.009	0.8439
0.612903225806452	1.065	1.06	1.047	1.025	0.9847	0.8201
0.645161290322581	1.027	1.022	1.014	0.9749	0.9472	0.8123
0.67741935483871	1.026	1.021	0.9991	0.962	0.9395	0.7805
0.709677419354839	1.021	1.017	0.9983	0.9548	0.9228	0.7677
0.741935483870968	1.018	1.014	0.9965	0.9507	0.9224	0.7345
0.774193548387097	0.9993	0.9954	0.9797	0.9364	0.9044	0.6875
0.806451612903226	0.9258	0.9213	0.9128	0.879	0.8499	0.6795
0.838709677419355	0.8365	0.8323	0.8186	0.7849	0.7638	0.6761
0.870967741935484	0.7906	0.7878	0.7737	0.7527	0.7381	0.6627
0.903225806451613	0.7715	0.7676	0.7516	0.7396	0.7352	0.6402
0.935483870967742	0.6222	0.6177	0.6005	0.5659	0.5412	0.43
0.967741935483871	0.5655	0.5624	0.551	0.5306	0.5162	0.3001
0.1	**1.7424**	**1.7344**	**1.7008**	**1.6355**	**1.5819**	**1.3417**

Average of yearly averages: **0.936673333333333**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: CornEast_pond
Metfile: w13722.dvf
PRZM scenario: NCcornEC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism			kbacs	1198	days Halfife
Aerobic Soil Metabolism		asm	46	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life	
Method:	CAM	1	integer	See PRZM manual	
Incorporation Depth:	DEPI		cm		
Application Rate:	TAPP	0.092	kg/ha		
Application Efficiency:		APPEFF		0.99	fraction
Spray Drift	DRFT	0.01	fraction of application rate applied to pond		
Application Date	Date	20-4	dd/mm or dd/mmm or dd-mm or dd-mmm		
Interval 1	interval	14	days	Set to 0 or delete line for single app.	
Record 17:	FILTRA				
	IPSCND				
	UPTKF				
Record 18:	PLVKRT				
	PLDKRT				
	FEXTRC	0.5			
Flag for Index Res. Run		IR	Pond		
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)	
Write Benthic Porewater File?			benthic		
Write Benthic Sediment File?		benthicsed			

North Carolina Corn-West
stored as CornWest_pond.out
Chemical: Tembotrione
PRZM environment: NCcornWC.txt modified Friday, 6 December 2002 at 09:14:12
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w03812.dvf modified Wedday, 3 July 2002 at 05:05:50
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1965	1.338	1.33	1.305	1.273	1.234	0.6787
1966	2.22	2.208	2.162	2.094	2.037	1.493
1967	2.662	2.649	2.606	2.512	2.449	1.999
1968	2.457	2.446	2.4	2.313	2.25	2.012
1969	2.269	2.26	2.23	2.189	2.134	1.881
1970	1.72	1.717	1.711	1.697	1.683	1.563
1971	1.826	1.818	1.789	1.748	1.712	1.467
1972	1.766	1.759	1.727	1.664	1.645	1.44
1973	4.577	4.552	4.444	4.223	4.063	2.701
1974	4.21	4.193	4.13	4.069	3.988	3.367
1975	4.375	4.361	4.288	4.116	3.99	3.403
1976	5.312	5.293	5.203	5.003	4.85	3.885
1977	3.927	3.924	3.911	3.878	3.843	3.415
1978	3.12	3.111	3.076	3.043	2.976	2.715
1979	2.554	2.544	2.525	2.471	2.43	2.23
1980	3.147	3.135	3.087	3.009	2.923	2.33
1981	3.567	3.547	3.471	3.329	3.219	2.629
1982	2.778	2.772	2.75	2.671	2.598	2.404
1983	2.654	2.642	2.61	2.55	2.478	2.145
1984	3.522	3.507	3.434	3.347	3.257	2.585
1985	2.601	2.599	2.591	2.57	2.548	2.308
1986	2.396	2.387	2.351	2.256	2.185	1.944
1987	4.258	4.238	4.178	4.022	3.877	2.738
1988	3.043	3.04	3.03	3.005	2.979	2.626
1989	3.733	3.72	3.684	3.586	3.529	2.816
1990	3.244	3.232	3.176	3.089	3.029	2.746

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.037037037037037	5.312	5.293	5.203	5.003	4.85	3.885
0.0740740740740741	4.577	4.552	4.444	4.223	4.063	3.415
0.111111111111111	4.375	4.361	4.288	4.116	3.99	3.403
0.148148148148148	4.258	4.238	4.178	4.069	3.988	3.367
0.185185185185185	4.21	4.193	4.13	4.022	3.877	2.816
0.222222222222222	3.927	3.924	3.911	3.878	3.843	2.746
0.259259259259259	3.733	3.72	3.684	3.586	3.529	2.738
0.296296296296296	3.567	3.547	3.471	3.347	3.257	2.715

0.333333333333333	3.522	3.507	3.434	3.329	3.219	2.701
0.37037037037037	3.244	3.232	3.176	3.089	3.029	2.629
0.407407407407407	3.147	3.135	3.087	3.043	2.979	2.626
0.444444444444444	3.12	3.111	3.076	3.009	2.976	2.585
0.481481481481481	3.043	3.04	3.03	3.005	2.923	2.404
0.518518518518518	2.778	2.772	2.75	2.671	2.598	2.33
0.555555555555556	2.662	2.649	2.61	2.57	2.548	2.308
0.592592592592593	2.654	2.642	2.606	2.55	2.478	2.23
0.62962962962963	2.601	2.599	2.591	2.512	2.449	2.145
0.666666666666667	2.554	2.544	2.525	2.471	2.43	2.012
0.703703703703704	2.457	2.446	2.4	2.313	2.25	1.999
0.740740740740741	2.396	2.387	2.351	2.256	2.185	1.944
0.777777777777778	2.269	2.26	2.23	2.189	2.134	1.881
0.814814814814815	2.22	2.208	2.162	2.094	2.037	1.563
0.851851851851852	1.826	1.818	1.789	1.748	1.712	1.493
0.888888888888889	1.766	1.759	1.727	1.697	1.683	1.467
0.925925925925926	1.72	1.717	1.711	1.664	1.645	1.44
0.962962962962963	1.338	1.33	1.305	1.273	1.234	0.6787
0.1	**4.4356**	**4.4183**	**4.3348**	**4.1481**	**4.0119**	**3.4066**

Average of yearly averages: **2.36618076923077**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: CornWest_pond
Metfile: w03812.dvf
PRZM scenario: NCcornWC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	1198	days	Halfife
Aerobic Soil Metabolism	asm	46	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life
Method:	CAM	1	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	0.092	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	

Application Date	Date	5-5	dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1	interval	14	days Set to 0 or delete line for single app.

Record 17: FILTRA
IPSCND
UPTKF

Record 18: PLVKRT
PLDKRT
FEXTRC 0.5

Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)
Write Benthic Porewater File? benthic
Write Benthic Sediment File? benthicsed

North Dakota Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: NDcornC.txt modified Friday, 6 December 2002 at 09:16:04
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w14914.dvf modified Wedday, 3 July 2002 at 05:05:52
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.3096	0.3083	0.3038	0.295	0.2902	0.1388
1962	1.336	1.329	1.303	1.248	1.218	0.7942
1963	1.441	1.435	1.418	1.358	1.348	1.181
1964	2.502	2.488	2.428	2.296	2.243	1.679
1965	2.106	2.098	2.071	2.03	2.004	1.892
1966	1.78	1.773	1.75	1.734	1.724	1.661
1967	1.653	1.647	1.628	1.575	1.544	1.456
1968	1.469	1.464	1.448	1.428	1.399	1.299
1969	1.941	1.931	1.89	1.824	1.779	1.469
1970	2.1	2.094	2.061	1.978	1.933	1.711
1971	1.996	1.987	1.959	1.947	1.92	1.74
1972	1.662	1.661	1.656	1.643	1.633	1.558
1973	1.443	1.44	1.435	1.424	1.414	1.362
1974	1.75	1.743	1.714	1.686	1.662	1.42
1975	3.227	3.213	3.134	2.975	2.883	2.137
1976	2.479	2.477	2.468	2.448	2.433	2.163
1977	2.672	2.658	2.6	2.495	2.436	2.082
1978	2.991	2.978	2.923	2.823	2.753	2.355
1979	2.574	2.564	2.521	2.495	2.457	2.318
1980	2.197	2.195	2.187	2.171	2.158	2.017
1981	2.435	2.427	2.401	2.362	2.327	2.02
1982	1.985	1.983	1.977	1.961	1.95	1.844
1983	1.941	1.931	1.894	1.852	1.815	1.681
1984	3.063	3.046	2.98	2.837	2.737	2.116
1985	3.216	3.204	3.173	3.104	3.065	2.634
1986	3.108	3.095	3.049	2.984	2.923	2.686
1987	2.751	2.741	2.708	2.633	2.61	2.485
1988	2.298	2.296	2.289	2.271	2.258	2.079
1989	1.982	1.977	1.953	1.927	1.891	1.82
1990	2.607	2.594	2.549	2.461	2.405	1.985

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	3.227	3.213	3.173	3.104	3.065	2.686
0.0645161290322581	3.216	3.204	3.134	2.984	2.923	2.634
0.0967741935483871	3.108	3.095	3.049	2.975	2.883	2.485
0.129032258064516	3.063	3.046	2.98	2.837	2.753	2.355

0.161290322580645	2.991	2.978	2.923	2.823	2.737	2.318
0.193548387096774	2.751	2.741	2.708	2.633	2.61	2.163
0.225806451612903	2.672	2.658	2.6	2.495	2.457	2.137
0.258064516129032	2.607	2.594	2.549	2.495	2.436	2.116
0.290322580645161	2.574	2.564	2.521	2.461	2.433	2.082
0.32258064516129	2.502	2.488	2.468	2.448	2.405	2.079
0.354838709677419	2.479	2.477	2.428	2.362	2.327	2.02
0.387096774193548	2.435	2.427	2.401	2.296	2.258	2.017
0.419354838709677	2.298	2.296	2.289	2.271	2.243	1.985
0.451612903225806	2.197	2.195	2.187	2.171	2.158	1.892
0.483870967741936	2.106	2.098	2.071	2.03	2.004	1.844
0.516129032258065	2.1	2.094	2.061	1.978	1.95	1.82
0.548387096774194	1.996	1.987	1.977	1.961	1.933	1.74
0.580645161290323	1.985	1.983	1.959	1.947	1.92	1.711
0.612903225806452	1.982	1.977	1.953	1.927	1.891	1.681
0.645161290322581	1.941	1.931	1.894	1.852	1.815	1.679
0.67741935483871	1.941	1.931	1.89	1.824	1.779	1.661
0.709677419354839	1.78	1.773	1.75	1.734	1.724	1.558
0.741935483870968	1.75	1.743	1.714	1.686	1.662	1.469
0.774193548387097	1.662	1.661	1.656	1.643	1.633	1.456
0.806451612903226	1.653	1.647	1.628	1.575	1.544	1.42
0.838709677419355	1.469	1.464	1.448	1.428	1.414	1.362
0.870967741935484	1.443	1.44	1.435	1.424	1.399	1.299
0.903225806451613	1.441	1.435	1.418	1.358	1.348	1.181
0.935483870967742	1.336	1.329	1.303	1.248	1.218	0.7942
0.967741935483871	0.3096	0.3083	0.3038	0.295	0.2902	0.1388
0.1	**3.1035**	**3.0901**	**3.0421**	**2.9612**	**2.87**	**2.472**

Average of yearly averages: **1.79276666666667**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w14914.dvf
PRZM scenario: NDcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism	kbacs	1198	days	Halfife
Aerobic Soil Metabolism	asm	46	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life
Method:	CAM	1	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	0.092	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	15-5	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	14	days	Set to 0 or delete line for single app.
Record 17:	FILTRA			
	IPSCND			
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR	Pond		
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)	
Write Benthic Porewater File?		benthic		
Write Benthic Sediment File?	benthicsed			

Ohio Corn

stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: OHCornC.txt modified Friday, 6 December 2002 at 09:17:14
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w93815.dvf modified Wedday, 3 July 2002 at 05:06:06
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	1.112	1.101	1.067	1.001	0.9596	0.4898
1962	1.67	1.66	1.617	1.541	1.489	1.089
1963	1.951	1.944	1.904	1.845	1.792	1.43
1964	1.442	1.436	1.431	1.42	1.411	1.293
1965	1.798	1.788	1.748	1.666	1.608	1.294
1966	1.294	1.291	1.272	1.252	1.244	1.14
1967	1.932	1.924	1.88	1.819	1.77	1.368
1968	2.967	2.955	2.897	2.824	2.739	2.073
1969	2.656	2.646	2.623	2.574	2.51	2.209
1970	2.122	2.113	2.084	2.026	1.982	1.841
1971	1.805	1.796	1.761	1.71	1.701	1.545
1972	2.041	2.035	2	1.931	1.879	1.578
1973	1.727	1.721	1.691	1.62	1.577	1.451
1974	2.358	2.347	2.306	2.192	2.122	1.7
1975	1.807	1.799	1.777	1.762	1.75	1.613
1976	1.735	1.726	1.694	1.639	1.591	1.408
1977	1.324	1.323	1.319	1.309	1.299	1.192
1978	1.537	1.529	1.498	1.439	1.401	1.175
1979	1.428	1.421	1.393	1.341	1.307	1.163
1980	2.455	2.441	2.384	2.263	2.172	1.596
1981	2.677	2.662	2.613	2.487	2.399	1.972
1982	2.971	2.957	2.902	2.784	2.692	2.216
1983	2.348	2.337	2.312	2.223	2.16	2.025
1984	2.346	2.339	2.311	2.226	2.163	1.873
1985	1.751	1.745	1.721	1.709	1.697	1.564
1986	1.652	1.644	1.622	1.552	1.502	1.34
1987	1.48	1.474	1.445	1.396	1.354	1.216
1988	1.208	1.203	1.183	1.136	1.123	1.048
1989	3.93	3.908	3.841	3.638	3.49	2.237
1990	3.346	3.335	3.279	3.196	3.112	2.723

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	3.93	3.908	3.841	3.638	3.49	2.723
0.0645161290322581	3.346	3.335	3.279	3.196	3.112	2.237
0.0967741935483871	2.971	2.957	2.902	2.824	2.739	2.216
0.129032258064516	2.967	2.955	2.897	2.784	2.692	2.209

0.161290322580645	2.677	2.662	2.623	2.574	2.51	2.073
0.193548387096774	2.656	2.646	2.613	2.487	2.399	2.025
0.225806451612903	2.455	2.441	2.384	2.263	2.172	1.972
0.258064516129032	2.358	2.347	2.312	2.226	2.163	1.873
0.290322580645161	2.348	2.339	2.311	2.223	2.16	1.841
0.32258064516129	2.346	2.337	2.306	2.192	2.122	1.7
0.354838709677419	2.122	2.113	2.084	2.026	1.982	1.613
0.387096774193548	2.041	2.035	2	1.931	1.879	1.596
0.419354838709677	1.951	1.944	1.904	1.845	1.792	1.578
0.451612903225806	1.932	1.924	1.88	1.819	1.77	1.564
0.483870967741936	1.807	1.799	1.777	1.762	1.75	1.545
0.516129032258065	1.805	1.796	1.761	1.71	1.701	1.451
0.548387096774194	1.798	1.788	1.748	1.709	1.697	1.43
0.580645161290323	1.751	1.745	1.721	1.666	1.608	1.408
0.612903225806452	1.735	1.726	1.694	1.639	1.591	1.368
0.645161290322581	1.727	1.721	1.691	1.62	1.577	1.34
0.67741935483871	1.67	1.66	1.622	1.552	1.502	1.294
0.709677419354839	1.652	1.644	1.617	1.541	1.489	1.293
0.741935483870968	1.537	1.529	1.498	1.439	1.411	1.216
0.774193548387097	1.48	1.474	1.445	1.42	1.401	1.192
0.806451612903226	1.442	1.436	1.431	1.396	1.354	1.175
0.838709677419355	1.428	1.421	1.393	1.341	1.307	1.163
0.870967741935484	1.324	1.323	1.319	1.309	1.299	1.14
0.903225806451613	1.294	1.291	1.272	1.252	1.244	1.089
0.935483870967742	1.208	1.203	1.183	1.136	1.123	1.048
0.967741935483871	1.112	1.101	1.067	1.001	0.9596	0.4898
0.1	**2.9706**	**2.9568**	**2.9015**	**2.82**	**2.7343**	**2.2153**

Average of yearly averages: **1.56206**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w93815.dvf
PRZM scenario: OHCornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism		kbacs	1198	days	Halfife
Aerobic Soil Metabolism	asm	46	days	Halfife	
Hydrolysis:	pH 7	0	days	Half-life	
Method:	CAM	1	integer	See PRZM manual	
Incorporation Depth:	DEPI		cm		
Application Rate:	TAPP	0.092	kg/ha		
Application Efficiency:		APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond		
Application Date	Date	10-5	dd/mm or dd/mmm or dd-mm or dd-mmm		
Interval 1	interval	14	days	Set to 0 or delete line for single app.	
Record 17:	FILTRA				
	IPSCND				
	UPTKF				
Record 18:	PLVKRT				
	PLDKRT				
	FEXTRC	0.5			
Flag for Index Res. Run	IR	Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)		
Write Benthic Porewater File?	benthic				
Write Benthic Sediment File?	benthicsed				

Oregon Sweet Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: ORswcornC.txt modified Friday, 6 December 2002 at 09:20:42
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w24232.dvf modified Wedday, 3 July 2002 at 05:06:10
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.157	0.156	0.1518	0.1436	0.1387	0.07761
1962	0.2677	0.2671	0.2643	0.2579	0.2533	0.1814
1963	0.3059	0.3048	0.3003	0.2918	0.2898	0.264
1964	0.363	0.3617	0.3563	0.3445	0.3359	0.2972
1965	0.4738	0.4718	0.4636	0.4445	0.4316	0.3542
1966	0.4346	0.4331	0.427	0.4134	0.4055	0.38
1967	0.4135	0.4119	0.4055	0.3914	0.3834	0.3613
1968	0.5859	0.5841	0.5758	0.562	0.5531	0.4659
1969	0.9346	0.9298	0.9105	0.8724	0.8529	0.6727
1970	0.7811	0.7785	0.7702	0.7604	0.7527	0.7309
1971	0.8304	0.828	0.8153	0.7852	0.7792	0.7256
1972	0.7277	0.7255	0.7166	0.7022	0.6954	0.6753
1973	0.6923	0.6901	0.6809	0.666	0.6546	0.6201
1974	0.6006	0.5986	0.5906	0.5744	0.5645	0.5326
1975	0.5238	0.5222	0.5156	0.5003	0.492	0.46
1976	0.465	0.4636	0.4579	0.4482	0.44	0.4067
1977	0.4472	0.4456	0.4388	0.4248	0.4159	0.3842
1978	0.4425	0.4406	0.4328	0.4216	0.4154	0.3833
1979	0.5098	0.5084	0.505	0.4963	0.4873	0.4102
1980	0.6138	0.6117	0.603	0.5817	0.5686	0.5005
1981	0.9701	0.9655	0.9552	0.9179	0.8903	0.6693
1982	0.7546	0.752	0.7412	0.7295	0.7228	0.6829
1983	0.7131	0.7106	0.7004	0.6922	0.679	0.6125
1984	0.837	0.8348	0.8217	0.7938	0.7768	0.6504
1985	1.685	1.676	1.639	1.562	1.51	1.065
1986	1.25	1.248	1.241	1.225	1.212	1.148
1987	1.443	1.437	1.41	1.354	1.319	1.118
1988	1.24	1.236	1.225	1.19	1.163	1.096
1989	0.9835	0.9823	0.9775	0.9674	0.9594	0.8875
1990	0.8266	0.8239	0.8134	0.7927	0.7757	0.7266

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	1.685	1.676	1.639	1.562	1.51	1.148
0.0645161290322581	1.443	1.437	1.41	1.354	1.319	1.118
0.0967741935483871	1.25	1.248	1.241	1.225	1.212	1.096
0.129032258064516	1.24	1.236	1.225	1.19	1.163	1.065

0.161290322580645	0.9835	0.9823	0.9775	0.9674	0.9594	0.8875
0.193548387096774	0.9701	0.9655	0.9552	0.9179	0.8903	0.7309
0.225806451612903	0.9346	0.9298	0.9105	0.8724	0.8529	0.7266
0.258064516129032	0.837	0.8348	0.8217	0.7938	0.7792	0.7256
0.290322580645161	0.8304	0.828	0.8153	0.7927	0.7768	0.6829
0.32258064516129	0.8266	0.8239	0.8134	0.7852	0.7757	0.6753
0.354838709677419	0.7811	0.7785	0.7702	0.7604	0.7527	0.6727
0.387096774193548	0.7546	0.752	0.7412	0.7295	0.7228	0.6693
0.419354838709677	0.7277	0.7255	0.7166	0.7022	0.6954	0.6504
0.451612903225806	0.7131	0.7106	0.7004	0.6922	0.679	0.6201
0.483870967741936	0.6923	0.6901	0.6809	0.666	0.6546	0.6125
0.516129032258065	0.6138	0.6117	0.603	0.5817	0.5686	0.5326
0.548387096774194	0.6006	0.5986	0.5906	0.5744	0.5645	0.5005
0.580645161290323	0.5859	0.5841	0.5758	0.562	0.5531	0.4659
0.612903225806452	0.5238	0.5222	0.5156	0.5003	0.492	0.46
0.645161290322581	0.5098	0.5084	0.505	0.4963	0.4873	0.4102
0.67741935483871	0.4738	0.4718	0.4636	0.4482	0.44	0.4067
0.709677419354839	0.465	0.4636	0.4579	0.4445	0.4316	0.3842
0.741935483870968	0.4472	0.4456	0.4388	0.4248	0.4159	0.3833
0.774193548387097	0.4425	0.4406	0.4328	0.4216	0.4154	0.38
0.806451612903226	0.4346	0.4331	0.427	0.4134	0.4055	0.3613
0.838709677419355	0.4135	0.4119	0.4055	0.3914	0.3834	0.3542
0.870967741935484	0.363	0.3617	0.3563	0.3445	0.3359	0.2972
0.903225806451613	0.3059	0.3048	0.3003	0.2918	0.2898	0.264
0.935483870967742	0.2677	0.2671	0.2643	0.2579	0.2533	0.1814
0.967741935483871	0.157	0.156	0.1518	0.1436	0.1387	0.07761
0.1	**1.249**	**1.2468**	**1.2394**	**1.2215**	**1.2071**	**1.0929**

Average of yearly averages: **0.584663666666667**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w24232.dvf
PRZM scenario: ORswcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism kbacs 1198 days Halfife
Aerobic Soil Metabolism asm 46 days Halfife
Hydrolysis: pH 7 0 days Half-life
Method: CAM 1 integer See PRZM manual
Incorporation Depth: DEPI cm
Application Rate: TAPP 0.092 kg/ha
Application Efficiency: APPEFF 0.99 fraction
Spray Drift DRFT 0.01 fraction of application rate applied to pond
Application Date Date 19-5 dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1 interval 14 days Set to 0 or delete line for single app.
Record 17: FILTRA
IPSCND
UPTKF
Record 18: PLVKRT
PLDKRT
FEXTRC 0.5
Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)
Write Benthic Porewater File? benthic
Write Benthic Sediment File?benthicsed

Pennsylvania Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: PAcornC.txt modified Friday, 6 December 2002 at 09:23:10
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w14737.dvf modified Wedday, 3 July 2002 at 05:06:12
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.08985	0.08928	0.08702	0.08203	0.07858	0.04693
1962	0.1581	0.1573	0.1541	0.1467	0.1416	0.1127
1963	0.21	0.2091	0.2056	0.197	0.1904	0.1598
1964	0.5469	0.5439	0.5322	0.5138	0.4981	0.3516
1965	0.454	0.4523	0.4453	0.4297	0.4209	0.3855
1966	0.5043	0.5025	0.4955	0.4783	0.4659	0.3933
1967	0.4817	0.4802	0.4744	0.4568	0.4436	0.3946
1968	0.6831	0.6804	0.6671	0.6377	0.6159	0.4952
1969	0.6392	0.6361	0.6233	0.5998	0.589	0.5399
1970	0.5907	0.5888	0.581	0.5643	0.5524	0.5169
1971	0.5478	0.5462	0.5397	0.5228	0.5115	0.4717
1972	0.7578	0.7533	0.7356	0.7041	0.6861	0.5549
1973	0.67	0.6682	0.6608	0.6423	0.6282	0.5774
1974	0.5749	0.5728	0.5677	0.5603	0.5539	0.5128
1975	0.5787	0.5766	0.5682	0.5513	0.5391	0.4955
1976	0.4907	0.4891	0.4829	0.4661	0.4558	0.4229
1977	0.4555	0.4537	0.4467	0.4311	0.4218	0.3857
1978	0.4186	0.4172	0.4129	0.3973	0.3884	0.3471
1979	0.3723	0.3709	0.3653	0.352	0.3438	0.3086
1980	0.3513	0.35	0.3444	0.3313	0.3229	0.2908
1981	0.4741	0.4721	0.464	0.4435	0.4282	0.35
1982	1.069	1.062	1.037	0.9806	0.947	0.633
1983	0.803	0.8007	0.7914	0.7718	0.759	0.7023
1984	1.329	1.324	1.292	1.224	1.179	0.8874
1985	1.311	1.306	1.288	1.253	1.219	1.026
1986	0.9639	0.9607	0.9481	0.9411	0.9347	0.8495
1987	0.7588	0.7565	0.7466	0.7273	0.7148	0.6929
1988	2.474	2.461	2.407	2.285	2.193	1.448
1989	2.494	2.484	2.446	2.347	2.278	1.907
1990	1.801	1.799	1.792	1.775	1.761	1.563

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.494	2.484	2.446	2.347	2.278	1.907
0.0645161290322581	2.474	2.461	2.407	2.285	2.193	1.563
0.0967741935483871	1.801	1.799	1.792	1.775	1.761	1.448
0.129032258064516	1.329	1.324	1.292	1.253	1.219	1.026

0.161290322580645	1.311	1.306	1.288	1.224	1.179	0.8874
0.193548387096774	1.069	1.062	1.037	0.9806	0.947	0.8495
0.225806451612903	0.9639	0.9607	0.9481	0.9411	0.9347	0.7023
0.258064516129032	0.803	0.8007	0.7914	0.7718	0.759	0.6929
0.290322580645161	0.7588	0.7565	0.7466	0.7273	0.7148	0.633
0.32258064516129	0.7578	0.7533	0.7356	0.7041	0.6861	0.5774
0.354838709677419	0.6831	0.6804	0.6671	0.6423	0.6282	0.5549
0.387096774193548	0.67	0.6682	0.6608	0.6377	0.6159	0.5399
0.419354838709677	0.6392	0.6361	0.6233	0.5998	0.589	0.5169
0.451612903225806	0.5907	0.5888	0.581	0.5643	0.5539	0.5128
0.483870967741936	0.5787	0.5766	0.5682	0.5603	0.5524	0.4955
0.516129032258065	0.5749	0.5728	0.5677	0.5513	0.5391	0.4952
0.548387096774194	0.5478	0.5462	0.5397	0.5228	0.5115	0.4717
0.580645161290323	0.5469	0.5439	0.5322	0.5138	0.4981	0.4229
0.612903225806452	0.5043	0.5025	0.4955	0.4783	0.4659	0.3946
0.645161290322581	0.4907	0.4891	0.4829	0.4661	0.4558	0.3933
0.67741935483871	0.4817	0.4802	0.4744	0.4568	0.4436	0.3857
0.709677419354839	0.4741	0.4721	0.464	0.4435	0.4282	0.3855
0.741935483870968	0.4555	0.4537	0.4467	0.4311	0.4218	0.3516
0.774193548387097	0.454	0.4523	0.4453	0.4297	0.4209	0.35
0.806451612903226	0.4186	0.4172	0.4129	0.3973	0.3884	0.3471
0.838709677419355	0.3723	0.3709	0.3653	0.352	0.3438	0.3086
0.870967741935484	0.3513	0.35	0.3444	0.3313	0.3229	0.2908
0.903225806451613	0.21	0.2091	0.2056	0.197	0.1904	0.1598
0.935483870967742	0.1581	0.1573	0.1541	0.1467	0.1416	0.1127
0.967741935483871	0.08985	0.08928	0.08702	0.08203	0.07858	0.04693
0.1	**1.7538**	**1.7515**	**1.742**	**1.7228**	**1.7068**	**1.4058**

Average of yearly averages: **0.594097666666667**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w14737.dvf
PRZM scenario: PAcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life

Aerobic Aquatic Metabolism	kbacw	278	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	1198	days	Halfife
Aerobic Soil Metabolism	asm	46	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life
Method:	CAM	1	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	0.092	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	29-4	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	14	days	Set to 0 or delete line for single app.
Record 17:	FILTRA			
	IPSCND			
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR		Pond	
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)
Write Benthic Porewater File?			benthic	
Write Benthic Sediment File?	benthicsed			

Texas Corn
stored as Corn_pond.out
Chemical: Tembotrione
PRZM environment: TXcornC.txt modified Friday, 6 December 2002 at 09:25:04
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 12:33:30
Metfile: w13958.dvf modified Wedday, 3 July 2002 at 05:06:24
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.2058	0.2046	0.2004	0.1883	0.1795	0.1098
1962	1.164	1.155	1.127	1.083	1.037	0.6365
1963	3.833	3.803	3.685	3.447	3.28	2.029
1964	2.147	2.137	2.096	1.994	1.918	1.641
1965	1.49	1.483	1.462	1.421	1.393	1.167
1966	1.648	1.639	1.603	1.521	1.456	1.104
1967	1.89	1.877	1.848	1.763	1.686	1.234
1968	1.328	1.322	1.298	1.278	1.238	1.024
1969	2.564	2.547	2.485	2.351	2.248	1.543
1970	1.473	1.467	1.44	1.386	1.368	1.194
1971	1.503	1.495	1.462	1.389	1.333	1.025
1972	1.355	1.346	1.316	1.243	1.189	0.9293
1973	1.415	1.409	1.382	1.318	1.277	0.9821
1974	1.56	1.551	1.518	1.46	1.403	1.067
1975	2.703	2.689	2.625	2.468	2.353	1.594
1976	2.651	2.638	2.61	2.524	2.435	1.851
1977	2.917	2.904	2.851	2.704	2.588	1.925
1978	3.018	2.998	2.924	2.819	2.731	2.022
1979	2.548	2.538	2.521	2.487	2.441	1.921
1980	3.611	3.592	3.511	3.466	3.362	2.367
1981	1.96	1.957	1.944	1.914	1.893	1.583
1982	1.74	1.734	1.7	1.613	1.544	1.215
1983	2.986	2.967	2.919	2.763	2.641	1.926
1984	1.76	1.758	1.748	1.722	1.701	1.412
1985	1.951	1.94	1.899	1.803	1.76	1.324
1986	1.914	1.902	1.873	1.785	1.705	1.274
1987	1.094	1.093	1.085	1.068	1.058	0.9034
1988	0.9591	0.9543	0.9391	0.9096	0.8886	0.7042
1989	1.029	1.024	1.003	0.9569	0.9196	0.6979
1990	1.194	1.186	1.155	1.095	1.042	0.7541

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	3.833	3.803	3.685	3.466	3.362	2.367
0.0645161290322581	3.611	3.592	3.511	3.447	3.28	2.029
0.0967741935483871	3.018	2.998	2.924	2.819	2.731	2.022
0.129032258064516	2.986	2.967	2.919	2.763	2.641	1.926

0.161290322580645	2.917	2.904	2.851	2.704	2.588	1.925
0.193548387096774	2.703	2.689	2.625	2.524	2.441	1.921
0.225806451612903	2.651	2.638	2.61	2.487	2.435	1.851
0.258064516129032	2.564	2.547	2.521	2.468	2.353	1.641
0.290322580645161	2.548	2.538	2.485	2.351	2.248	1.594
0.32258064516129	2.147	2.137	2.096	1.994	1.918	1.583
0.354838709677419	1.96	1.957	1.944	1.914	1.893	1.543
0.387096774193548	1.951	1.94	1.899	1.803	1.76	1.412
0.419354838709677	1.914	1.902	1.873	1.785	1.705	1.324
0.451612903225806	1.89	1.877	1.848	1.763	1.701	1.274
0.483870967741936	1.76	1.758	1.748	1.722	1.686	1.234
0.516129032258065	1.74	1.734	1.7	1.613	1.544	1.215
0.548387096774194	1.648	1.639	1.603	1.521	1.456	1.194
0.580645161290323	1.56	1.551	1.518	1.46	1.403	1.167
0.612903225806452	1.503	1.495	1.462	1.421	1.393	1.104
0.645161290322581	1.49	1.483	1.462	1.389	1.368	1.067
0.67741935483871	1.473	1.467	1.44	1.386	1.333	1.025
0.709677419354839	1.415	1.409	1.382	1.318	1.277	1.024
0.741935483870968	1.355	1.346	1.316	1.278	1.238	0.9821
0.774193548387097	1.328	1.322	1.298	1.243	1.189	0.9293
0.806451612903226	1.194	1.186	1.155	1.095	1.058	0.9034
0.838709677419355	1.164	1.155	1.127	1.083	1.042	0.7541
0.870967741935484	1.094	1.093	1.085	1.068	1.037	0.7042
0.903225806451613	1.029	1.024	1.003	0.9569	0.9196	0.6979
0.935483870967742	0.9591	0.9543	0.9391	0.9096	0.8886	0.6365
0.967741935483871	0.2058	0.2046	0.2004	0.1883	0.1795	0.1098
0.1	**3.0148**	**2.9949**	**2.9235**	**2.8134**	**2.722**	**2.0124**

Average of yearly averages: **1.30531**

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: Corn_pond
Metfile: w13958.dvf
PRZM scenario: TXcornC.txt
EXAMS environment file: pond298.exv
Chemical Name: Tembotrione

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	440.8	g/mol	
Henry's Law Const.	henry	1.69e-15	atm-m^3/mol	
Vapor Pressure	vapr	8.2e-11	torr	
Solubility	sol	283000	mg/L	
Kd	Kd		mg/L	
Koc	Koc	110	mg/L	
Photolysis half-life	kdp	172	days	Half-life
Aerobic Aquatic Metabolism	kbacw	278	days	Halfife

Anaerobic Aquatic Metabolism kbacs 1198 days Halfife
Aerobic Soil Metabolism asm 46 days Halfife
Hydrolysis: pH 7 0 days Half-life
Method: CAM 1 integer See PRZM manual
Incorporation Depth: DEPI cm
Application Rate: TAPP 0.092 kg/ha
Application Efficiency: APPEFF 0.99 fraction
Spray Drift DRFT 0.01 fraction of application rate applied to pond
Application Date Date 20-3 dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1 interval 14 days Set to 0 or delete line for single app.
Record 17: FILTRA
IPSCND
UPTKF
Record 18: PLVKRT
PLDKRT
FEXTRC 0.5
Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)
Write Benthic Porewater File? benthic
Write Benthic Sediment File? benthicsed

APPENDIX C. TERRPLANT Model

Introduction

Exposure to Terrestrial Plants including Wetlands (November 9, 2005; version 1.2.1)

The change to this model version is the removal of the 60% efficiency factor for aerial applications.

Terrestrial plants inhabiting dry and semi-aquatic (wetland) areas may be exposed to pesticides from runoff and/or spray drift. Semi-aquatic areas are low-lying wet areas that may dry up at times throughout the year.

EFED's runoff scenario is:

(1) based on a pesticide's water solubility and the amount of pesticide present on the soil surface and its top one centimeter;

(2) characterized as "sheet runoff" (one treated acre to an adjacent acre) for dry areas;

(3) characterized as "channel runoff" (10 acres to a distant low-lying acre) for semi-aquatic or wetland areas; and

(4) based on percent runoff values of 0.01, 0.02, and 0.05 for water solubilities of <10, 10–100, and <100 ppm, respectively.

EFED's Spray Drift scenario is assumed as: (1) 1% for ground application; and (2)5% for aerial, airblast, forced air, and spray chemigation applications.

The spray drift ratio used here is in agreement with the policy procedures at the time the worksheet was designed.

Currently, (1) this worksheet is designed to derive the plant exposure concentrations from a single, maximum application rate only; and (2) for pesticide applications with incorporation of depth of less than 1 inch, the total loading EECs derived for the incorporation method will be same as the unincorporated method.

To calculate RQ values for Non-Endangered Terrestrial Plants:

Terrestrial Plants Inhabiting Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Adjacent Area or EEC/Seedling Emergence EC_{25}
Drift RQ = Drift EEC/Vegetative Vigor EC_{25}

Terrestrial Plants Inhabiting Semi-aquatic Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Semi-aquatic Area or EEC/Seedling Emergence EC_{25}
Drift RQ = Drift EEC/Vegetative Vigor EC_{25}

To calculate RQ values for Endangered Terrestrial Plants:

Endangered Terrestrial Plants Inhabiting Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Adjacent Area or EEC/Seedling Emergence EC_{05} or NOAEC
Drift RQ = Drift EEC/Vegetative Vigor EC_{05} or NOAEC

Endangered Terrestrial Plants Inhabiting Semi-aquatic Areas Near Treatment Site:

Emergence RQ = Total Loading to Semi-aquatic Area or EEC/Seedling Emergence EC_{05} or NOAEC
Drift RQ = Drift EEC/Vegetative Vigor EC_{05} or NOAEC

Background for EEC Calculation

Formulas used to calculate EEC values (November 9, 2005; version 1.2.1)

To calculate EECs for terrestrial plants inhabiting **in areas adjacent** to treatment sites:

Un-incorporated Ground Application (Non-granular):

Sheet Runoff = Application Rate (lbs a.i./acre) x Runoff Value
Drift = Application Rate (lbs a.i./acre) x 0.01
Total Loading = EEC = Sheet Runoff + Drift

Incorporated Ground Application with Drift (Non-granular):

Sheet Runoff = [Application Rate (lbs a.i./acre)/Incorporation Depth (cm)] x Runoff Value
Drift = Application Rate (lbs a.i./acre) x 0.01
Total Loading = EEC = Sheet Runoff + Drift

Un-incorporated Ground Application (Granular):

Sheet Runoff = EEC = Application Rate (lbs a.i./acre) x Runoff Value

Incorporated Ground Application without Drift (Granular):

Sheet Runoff = EEC = [Application Rate (lbs a.i./acre)/Incorporation Depth (cm)] x Runoff Value

Aerial/Airblast/Spray Chemigation Applications[1]:

Sheet Runoff = Application Rate (lbs a.i./acre) x Runoff Value
Drift = Application Rate (lbs a.i./acre) x 0.05
Total Loading = EEC = Sheet Runoff + Drift

Runoff Value = 0.01, 0.02, or 0.05 when the solubility of the chemical is <10 ppm, 10-100 ppm, or >100 ppm, respectively. Incorporation Depth: Use the minimum incorporation depth reported on the label.

Formulas used to calculate EEC values:

To calculate EECs for terrestrial plants inhabiting **semi-aquatic low-lying areas** near treatment sites:

Un-incorporated Ground Application (Non-granular):

Channelized Runoff = Application Rate (lbs a.i./acre) x Runoff Value x Factor 10
Drift = Application Rate (lbs a.i./acre) x 0.01
Total Loading = EEC = Channelized Runoff + Drift

Incorporated Ground Application with Drift (Non-granular):

Channelized Runoff = [Application Rate (lbs a.i./acre)/Incorporation Depth (inch)] x Runoff Value x Factor 10
Drift = Application Rate (lbs a.i./acre) x 0.01
Total Loading = EEC = Channelized Runoff + Drift

Un-incorporated Ground Application (Granular):

Channelized Runoff = EEC = Application Rate (lbs a.i./acre) x Runoff Value x Factor 10

Incorporated Ground Application without Drift (Granular):

Channelized Runoff = EEC = [Application Rate (lbs a.i./acre)/Incorporation Depth (inch)] x Runoff Value x Factor 10

Aerial/Airblast/Spray Chemigation Applications:

Channelized Runoff = Application Rate (lbs a.i./acre) x Runoff Value x Factor 10
Drift = Application Rate (lbs a.i./acre) x 0.05
Total Loading = EEC = Channelized Runoff + Drift

Runoff Value = 0.01, 0.02, or 0.05 when the solubility of the chemical is <10 ppm, 10-100 ppm, or >100 ppm, respectively. Factor 10 represents 10 treated acres per acre of low-lying area. Incorporation Depth: Use the minimum incorporation depth reported on the label.

Terrestrial Plant EECs and Acute Non Endangered RQs (November 9, 2005; version 1.2.1)

Table C-1. Tembotrione Input Values	
Application rate (lbs a.i./acre)	0.082
Runoff value (0.01, 0.02, or 0.05 if chemical solubility <10, 10-100, or >100 ppm, respectively)	0.05
Minimum incorporation depth (cm)	0
Seedling emergence--monocot EC_{25} (lbs a.i./acre)	0.028
Seedling emergence–dicot EC_{25} (lbs a.i./acre)	0.00039
Vegetative vigor–monocot EC_{25} (lbs a.i./acre)	NA
Vegetative vigor–dicot EC_{25} (lbs a.i./acre)	NA

Table C-2. Estimated Environmental Concentrations (EECs) for NON-GRANULAR Formulation Applications (lbs a.i./acre)			
Application Method	**Total Loading to Adjacent Areas (EEC = Sheet Runoff +Drift)**	**Total Loading to Semi-aquatic Areas (EEC = Channelized Runoff + Drift)**	**DRIFT EEC (for ground: application rate x 0.01) (for aerial: application rate x 0.05)**
Ground Unincorp.	0.0049	0.0418	0.0008
Ground Incorp	0.0049	0.0418	0.0008
Aerial, Airblast, Spray Chemigation	0.0082	0.0451	0.0041

Table C-3. Risk Quotients (RQs) for NON-GRANULAR Formulation Applications					
Emergence RQs, Adjacent Areas RQ = EEC/Seedling Emergence EC_{25}		**Emergence RQs, Semi-aquatic Areas RQ = EEC/Seedling Emergence EC_{25}**		**Drift RQs RQ = Drift EEC/Vegetative Vigor EC_{25}**	
Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
0.176	12.62	1.49	107.23	#VALUE!	#VALUE!
0.18	12.62	1.49	107.23	#VALUE!	#VALUE!
0.29	21.03	1.61	115.64	#VALUE!	#VALUE!

Table C-4. EECs for GRANULAR Formulation Applications (lbs a.i./acre)		
Application Method	**Total Loading to Adjacent Areas (EEC = Sheet Runoff)**	**Total Loading to Semi-aquatic Areas (EEC = Channelized Runoff)**
Unincorp.	0.0041	0.0410
Incorp.	0.0041	0.0041

Terrestrial Plant EECs and Acute Endangered RQs (November 9, 2005; version 1.2.1)

Table C-5. Tembotrione Input Values	
Application rate (lbs a.i./acre)	0.082
Runoff value (0.01, 0.02, or 0.05 if chemical solubility <10, 10-100, or >100 ppm, respectively)	0.05

Table C-5. Tembotrione Input Values	
Minimum incorporation depth (cm)	1
Seedling emergency–monocot EC_{05} or NOAEC (lbs a.i./acre)	0.011
Seedling emergence–dicot EC_{05} or NOAEC (lbs a.i./acre)	0.00018
Vegetative vigor–monocot EC_{05} or NOAEC (lbs a.i./acre)	NA
Vegetative vigor–dicot EC_{05} or NOAEC (lbs a.i./acre)	NA

Table C-6. Estimated Environmental Concentrations (EECs) for NON-GRANULAR Formulation Applications (lbs a.i./acre)			
Application Method	**Total Loading to Adjacent Areas (EEC = Sheet Runoff + Drift)**	**Total Loading to Semi-aquatic Areas (EEC = (Channelized Runoff + Drift)**	**DRIFT EEC (for ground: application rate x 0.01) (for aerial: application rate x 0.05)**
Ground Unincorp.	0.0049	0.0418	0.0008
Ground Incorp	0.0049	0.0418	0.0008
Aerial, Airblast, Spray Chemigation	0.0082	0.0451	0.0041

Table C-7. Risk Quotients (RQs) for NON-GRANULAR Formulation Applications					
Emergence RQs, Adjacent Areas RQ = EEC/Seedling Emergence EC_{05} or NOAEC		**Emergence RQs, Semi-aquatic areas RQ = EEC/Seedling Emergence EC_{05} or NOAEC**		**Drift RQs RQ = EEC/Vegetative Vigor EC_{05} or NOAEC**	
Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
0.447	27.33	3.80	232.33	#VALUE!	#VALUE!
0.45	27.33	3.80	232.33	#VALUE!	#VALUE!
0.75	45.56	4.10	250.56	#VALUE!	#VALUE!

APPENDIX D. T-REX Output

1. Introduction

This spreadsheet based model calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. It uses the same principle as the batch code models FATE and TERREEC for calculating terrestrial estimates exposure (TEEC) concentrations on plant surfaces following application. A first-order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional applications. The decay is calculated by from the first-order rate equation:

$$C_T = C_i e^{-kT}$$

or in log form:

$$\ln (C_T/C_i) = kT$$

where:

C_T = concentration at time T = day zero.

C_i = concentration, in parts per million (ppm) present initially (on day zero) on the surfaces. C_i is calculated based on Kenaga and Fletcher by multiplying the C_i based on the Kenaga nomogram (Hoerger and Kenaga [1972] as modified by Fletcher [1994]). For maximum concentration the application rate, in pounds active ingredient per acre, is multiplied by 240 for short grass, 110 for tall grass, and 135 for broad leafed plants/small insects and 15 for fruits/pods/large insects. Additional applications are converted from pounds active ingredient per acre to ppm on the plant surface and the additional mass added to the mass of the chemical still present on the surfaces on the day of application.

k = If the foliar dissipation data submitted to EFED are found scientifically valid and statistically robust for a specific pesticide, the 90% upper-confidence limit of the mean half-lives should be used. When scientifically valid, statistically robust data are not available TETT recommends the use of a default half-life value of 35 days. The use of the 35 day half-life is based on the highest reported value (36.9 days) reported by Willis and McDowell (1987).

T = time, in days, since the start of the simulation. The initial application is on day 0. The simulation is designed to run for 365 days.

The program calculates concentration on each type of surface on a daily interval for one year. The maximum concentrations during the year are calculated for both maximum and mean residues. The inputs required are:

Application rate:	The maximum label application rate (in pounds a.i./acre)
Half-life:	The degradation half-life for the dominate process (in days)
Frequency of application:	The interval between repeated applications, from the label (in days)
Maximum number of application per year:	From the label

The calculated concentrations are used to calculate Avian and Mammalian RQ values. The maximum calculated concentration is divided by user input values for acute and chronic endpoints to give RQs for each type of plant surface.

2. Avian Species

For calculating dose-based RQs in birds, the maximum and mean Kenaga residue values are adjusted for avian class and food consumption based on the following scaling factor (USEPA 1993):

$$FI (g/d) = 0.648 (g bw)^{\wedge}0.651$$

For the three avian weight classes considered (20, 100, and 1000 g), this results in percent of body weight consumption of:

Weight (g)	FI	Wet FI	% Body Weight Consumed
20	4.555599463	22.77799731	114
100	12.98897874	64.94489369	65
1000	58.15338588	290.7669294	29

A. Dose-Based Acute RQs

Dose-based acute RQs are then calculated using the formula:

$$RQ = \text{adjusted EEC}/LD_{50} \text{ or NOAEL}$$

where the adjusted EEC is considered to be the daily dose weighted for percent of body weight consumed of a given food source.

B. Dietary-Based RQs

For dietary-based RQs, two values are given for each food group. First, the consumption-weighted RQ for each weight class (20, 100, and 1000 g birds) is displayed and calculated using the equation:

$$RQ = EEC/((LC_{50} \text{ or NOAEC})/(\%\text{bw consumed}))$$

In the second method, no adjustment is made for consumption differences among the weight classes. This RQ is calculated:

$$RQ = EEC/LC_{50} \text{ or } NOAEC$$

3. Mammalian Species

A. Dose-Based RQs

For calculating dose-based RQs in mammals, the maximum and mean Kenaga values are adjusted for mammalian class and food consumption (0.95, 0.66, and 0.15 body weight for herbivores and insectivores and 0.21, 0.15, and 0.03 body weight for granivores). Dose-based acute and chronic RQs are then calculated by dividing the adjusted EECs (daily dose) by the LD_{50} or NOAEL.

B. Dietary-Based RQs

Dietary-based RQs are calculated using the equation:

$$RQ = EEC/((LC_{50} \text{ or } NOAEC)/(\% \text{ bw consumed}))$$

4. Graph

A graph of concentration on each plant surface vs. time is plotted and a concentration of concern line can be added at a user specified level. The concentration of concern (e.g., avian LC_{50}, mammalian NOAEL) label should be entered in the cell underneath the value. The graph automatically plots a line at this concentration and the label is extracted from that cell. The graph is plotted for the first 100 days post-application. Graphs displaying acute and chronic LOCs for both birds and mammals are displayed in the "Graph" worksheet. These graphs may be useful as a visual aid to communicate risk in your assessment and can be copy/pasted into your document. To help with scaling issues on the y axis, you may want to delete one of the endpoints.

5. New Version Notes

A new look is used in this update in an effort to decrease confusion and increase transparency in the risk assessment process. This version of T-REX (v1.2.3) incorporates the ability to calculate EECs and RQs for maximum and mean residues. Mean residues are calculated exactly as the maximum residues are, except the corresponding Kenaga values are: 85 for short grass, 36 for tall grass, and 45 for broad leafed plants/small insects and 7 for fruits/pods/large insects.

TREX MODEL INPUTS

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Name:	Tembotrione
Use:	Corn (sweet, grain, seed, silage)
Product name and form:	Tembotrione (liquid)
% A.I.:	100
Application rate (lbs/acre):	0.082
Half-life (days):	35
Application interval (days):	14
Number of applications:	2

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian					
		Indicate test species below		Optional Test Organism Body weight (g)	Optional Test Species Name
LD_{50} (mg/kg-bw)		Bobwhite quail			
LC_{50} (mg/kg-diet)		Bobwhite quail			
NOAEL (mg/kg-bw)		Other			
NOAEC (mg/kg-diet)	65.30	Mallard duck			
Enter the Mineau et al. scaling factor		1.15			
Mammals					
LD_{50} (mg/kg-bw)					
LC_{50} (mg/kg-diet)					
Reported chronic endpoint	20.00	mg/kg-diet			
Estimated chronic diet concentration equivalent to reported chronic daily dose	1	mg/kg-bw based on standard FDA lab rat conversion			

LD_{50} ft-2		
Application type	Broadcast	
	Liquid	Enter data below:
	fl oz product/acre	
	Do not use this input	
	Do not use this input	
	Do not use this input	

UPPER BOUND KENAGA RESIDUES FOR RQ CALCULATION

Chemical name:	**Tembotrione**
Use	Corn (sweet, grain, seed, silage)
Formulation	Tembotrione (Liquid)
Application rate	0.082 lbs a.i./acre
Half-life	35 days
Application interval	14 days
Maximum no. of applications per year	2
Length of simulation	1 year
Acute and Chronic RQs are based on the Upper Bound Kenaga Residues. The maximum single day residue estimation is used for both the acute and reproduction RQs. RQs reported as "0.00" in the RQ tables below should be noted as <0.01 in your assessment. This is due to rounding and significant figure issues in Excel.	

Endpoints

Avian		
Bobwhite quail	LD_{50} (mg/kg-bw)	0.00
Bobwhite quail	LC_{50} (mg/kg-diet)	0.00
0	NOAEL(mg/kg-bw)	0.00
Mallard duck	NOAEC (mg/kg-diet)	65.30

Mammals	
LD_{50} (mg/kg-bw)	0.00
LC_{50} (mg/kg-diet)	0.00
NOAEL (mg/kg-bw)	1.00
NOAEC (mg/kg-diet)	20.00

Dietary-based EECs (ppm)	
	Kenaga Values
Short grass	0.00
Tall grass	0.00
Broadleaf plants/small insects	0.00
Fruits/pods/seeds/large insects	0.00

Avian Results

Avian Class	Body Weight (g)	Ingestion (Fdry) (g bw/day)	Ingestion (Fwet) (g/day)	% Body Weight Consumed	FI (kg-diet/day)
Small	20	5	23	114	2.28E-02
Mid	100	13	65	65	6.49E-02
Large	1000	58	291	29	2.91E-01

Avian Body Weight (g)	Adjusted LD_{50} (mg/kg-bw)
20	0.00
100	0.00
1000	0.00

Dose-based EECs (mg/kg-bw)			
	Avian Classes and Body Weights		
	Small	Mid	Large
	20 g	100 g	1000 g
Short grass	0.00	0.00	0.00
Tall grass	0.00	0.00	0.00
Broadleaf plants/small insects	0.00	0.00	0.00
Fruits/pods/seeds/large insects	0.00	0.00	0.00

Dose-based RQs (Dose-based EEC/adjusted LD_{50})			
	Avian Acute RQs		
	20 g	100 g	1000 g
Short grass	#DIV/0!	#DIV/0!	#DIV/0!
Tall grass	#DIV/0!	#DIV/0!	#DIV/0!
Broadleaf plants/small insects	#DIV/0!	#DIV/0!	#DIV/0!
Fruits/pods/seeds/large insects	#DIV/0!	#DIV/0!	#DIV/0!

Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)		
	RQs	
	Acute	Chronic
Short grass	#DIV/0!	0.00
Tall grass	#DIV/0!	0.00
Broadleaf plants/small insects	#DIV/0!	0.00
Fruits/pods/seeds/large insects	#DIV/0!	0.00
Note: Because the NOAEC is "less than or equal to" the reported value, the RQs are expected to be higher than those calculated here.		

Note: To provide risk management with the maximum possible information, it is recommended that both the dose-based and concentration-based RQs be calculated when data are available.

Tembotrione: Corn (sweet, grain, seed, silage) Upper bound Kenaga Residues

Mammalian Results

Mammalian Class	Body Weight	Ingestion (Fdry) (g bw/day)	Ingestion (Fwet) (g/day)	% Body Weight consumed	FI (kg-diet/day)
Herbivores/ Insectivores	15	3	14	95	1.43E-02
	35	5	23	66	2.31E-02
	1000	31	153	15	1.53E-01
Grainvores	15	3	3	21	3.18E-03
	35	5	5	15	5.13E-03
	1000	31	34	3	3.40E-02

Mammalian Class	Body Weight	Adjusted LD_{50}	Adjusted NOAEL
Herbivores/ Insectivores	15	0.00	2.20
	35	0.00	1.78
	1000	0.00	0.77
Grainvores	15	0.00	2.20
	35	0.00	1.78
	1000	0.00	0.77

Dose-Based EECs (mg/kg-bw)						
	Mammalian Classes and Body Weight					
	Herbivores/Insectivores			Granivores		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short grass	0.00	0.00	0.00			
Tall grass	0.00	0.00	0.00			
Broadleaf plants/small insects	0.00	0.00	0.00			
Fruits/pods/seeds/large insects	0.00	0.00	0.00	0.00	0.00	0.00

Dose-based RQs (Dose-based EEC/LD_{50} or NOAEL)						
	15 g Mammal		35 g Mammal		1000 g Mammal	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short grass	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.00
Tall grass	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.00
Broadleaf plants/small insects	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.00
Fruits/pods/large insects	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.00
Seeds (granivore)	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.00

Dietary-based RQs (Dietary-based EEC/LC_{50} or NOAEC)		
	Mammal RQs	
	Acute	Chronic
Short grass	#DIV/0!	0.00
Tall grass	#DIV/0!	0.00
Broadleaf plants/small insects	#DIV/0!	0.00
Fruits/pods/seeds/large insects	#DIV/0!	0.00

Note: To provide risk management with the maximum possible information, it is recommended that both the dose-based and concentration-based RQs be calculated when data are available.

MEAN KENAGA RESIDUES

For Risk Description Purposes

Note that the ratio of exposure and effects endpoints are termed "RQs" in this output. Caution should be exercised in relating these values to the Agency Levels of Concern.

Chemical Name:	**Tembotrione**
Use	Corn (sweet, grain, seed, silage)
Formulation	Tembotrione (Liquid)
Application rate	0.082 lbs a.i./acre
Half-life	35 days
Application interval	14 days
Maximum no. of applications per year	2
Length of Simulation	1 year

Endpoints

Avian		
Bobwhite quail	LD_{50} (mg/kg-bw)	0.00
Bobwhite quail	LC_{50} (mg/kg-diet)	0.00
0	NOAEL (mg/kg-bw)	0.00
Mallard duck	NOAEC (mg/kg-diet)	65.30

Mammals	
LD_{50} (mg/kg-bw)	0.00
LC_{50} (mg/kg-diet)	0.00
NOAEL (mg/kg-bw)	1.00
NOAEC (mg/kg-diet)	20.00

Dietary-based EECs (ppm)	
	Kenaga Values
Short grass	12.25
Tall grass	5.19
Broadleaf plants/small Insects	6.49
Fruits/pods/seeds/large insects	1.01

Avian Results

Avian Class	Body Weight	% Body Weight Consumed	Adjusted LD_{50}
Small	20	114	0.00
Mid	100	65	0.00
Large	1000	29	0.00

Dose-based EEC (mg/kg-bw)			
	Avian Classes and Body Weights		
	Small	**Mid**	**Large**
	20 g	**100 g**	**1000 g**
Short grass	13.97	7.96	3.55
Tall grass	5.92	3.37	1.50
Broadleaf plants/small insects	7.39	4.22	1.88
Fruits/pods/large insects	1.15	0.66	0.29

Dose-based RQs (Dose-based EEC/LD_{50})			
	Avian Acute "RQs"		
	20 g	**100 g**	**1000 g**
Short grass	#DIV/0!	#DIV/0!	#DIV/0!
Tall grass	#DIV/0!	#DIV/0!	#DIV/0!
Broadleaf plants/small insects	#DIV/0!	#DIV/0!	#DIV/0!
Fruits/pods/large insects	#DIV/0!	#DIV/0!	#DIV/0!

Dietary-based RQs (Dietary-based EEC/LC_{50} or NOAEC)		
	"RQs"	
	Acute	**Chronic**
Short grass	#DIV/0!	0.19
Tall grass	#DIV/0!	0.08
Broadleaf plants/small insects	#DIV/0!	0.10
Fruits/pods/large insects	#DIV/0!	0.02

Tembotrione: corn (sweet, grain, seed, silage) Mean Kenaga Residues

Mammalian Results

Mammalian Class	Body Weight	% Body Weight Consumed	Adjusted LD_{50}	Adjusted NOAEL
Herbivores/ insectivores	15	95	0.00	2.20
	35	66	0.00	1.78
	1000	15	0.00	0.77
Grainvores	15	21	0.00	2.20
	35	15	0.00	1.78
	1000	3	0.00	0.77

Dose-based EEC (mg/kg-bw)						
	Mammalian Classes and Body Weight					
	Herbivores/Insectivores			Granivores		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short grass	11.64	8.09	1.84			
Tall grass	4.93	3.42	0.78			
Broadleaf plants/small insects	6.16	4.28	0.97			
Fruits/pods/seeds/large insects	0.96	0.67	0.15	0.21	0.15	0.03

Dose-based RQs (Dose-based EEC/LD_{50} or NOAEL)						
	15 g mammal		35 g mammal		1000 g mammal	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short grass	#DIV/0!	5.30	#DIV/0!	4.55	#DIV/0!	2.39
Tall grass	#DIV/0!	2.24	#DIV/0!	1.93	#DIV/0!	1.01
Broadleaf plants/small insects	#DIV/0!	2.80	#DIV/0!	2.41	#DIV/0!	1.26
Fruits/pods/large insects	#DIV/0!	0.44	#DIV/0!	0.37	#DIV/0!	0.20
Seeds (granivore)	#DIV/0!	0.10	#DIV/0!	0.09	#DIV/0!	0.04

Dietary-based "RQs" (EEC/LC_{50} or NOAEC)		
	Mammal "RQs"	
	Acute	Chronic
Short grass	#DIV/0!	0.61
Tall grass	#DIV/0!	0.26
Broadleaf plants/small insects	#DIV/0!	0.32
Fruits/pods/seeds/large insects	#DIV/0!	0.05

APPENDIX E. Ecological Effects Data

I. Categories of Acute Toxicity

In general, categories of acute toxicity ranging from "practically non-toxic" to "very highly toxic" have been established for aquatic organisms (based on LC_{50} values), terrestrial organisms (based on LD_{50} values), avian species (based on LC_{50} values), and non-target insects (based on LD_{50} values for honey bees) (USEPA 2001).

Categories of acute toxicity for aquatic organisms can be classified according to the toxicity reference value (LC_{50}) given by a study:

LC_{50} (mg a.i./L)	Toxicity Category
<0.1	Very highly toxic
0.1–1	Highly toxic
>1–10	Moderately toxic
>10–100	Slightly toxic
>100	Practically non-toxic

Categories of acute oral toxicity for mammalian and avian species can be classified according to the toxicity reference value (LD_{50}) given by a study:

LD_{50} (mg a.i./kg-bw)	Toxicity Category
<10	Very highly toxic
10–50	Highly toxic
51–500	Moderately toxic
501–2000	Slightly toxic
>2000	Practically non-toxic

For avian species, categories of acute dietary toxicity for can be classified according to the toxicity reference value (LC_{50}) given by a study:

LC_{50} (mg a.i./kg diet)	Toxicity Category
<50	Very highly toxic
50–500	Highly toxic
501–1000	Moderately toxic
1001–5000	Slightly toxic
>5000	Practically non-toxic

The following toxicity category descriptions were developed by Atkins (1981) and have been used by EFED to characterize honey bee acute contact toxicity values (USEPA 2001):

LD_{50} (µg a.i./bee)	Toxicity Category
<2	Highly toxic
2–<11	Moderately toxic
≥11	Practically non-toxic

II. Toxicity to Freshwater Aquatic Animals

a. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the technical grade active ingredient (TGAI) are required to establish the acute toxicity of tembotrione to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish).

Acute limit (single concentration) toxicity studies using tembotrione TGAI have been submitted for rainbow trout (one study) and bluegill sunfish (one study). Study details and results are summarized in **Table E-1a**. The 96-hour LC_{50} values reported in these static, acute toxicity studies were >100 mg a.i./L and >101 mg a.i./L in bluegill sunfish (MRID 46695436; Acceptable) and rainbow trout (MRID 46695437; Acceptable), respectively, indicating that tembotrione is practically non-toxic to freshwater fish. The Guideline (72-1) is fulfilled. Since an LC_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive RQs for freshwater fish. In addition to lethality endpoints, sublethal effects of acute tembotrione TGAI exposure were assessed in studies in bluegill sunfish (MRID 46695436; Acceptable) and rainbow trout (MRID 46695437; Acceptable). No signs of sublethal toxicity were observed in either study (NOAEC = 100 and 101 mg a.i./L) in bluegill sunfish (MRID 46695436; Acceptable) and rainbow trout (MRID 46695437; Acceptable), respectively.

A 96-hour acute toxicity study with a tembotrione formulation (33.9% tembotrione + 18.1% isoxadifen-ethyl SC 420+210) in rainbow trout was submitted (MRID 46695438; Acceptable). Study details and results are summarized in **Table E-1b**. The reported 96-hour LC_{50} was 1.83 mg a.i./L, indicating that the tembotrione formulation tested was moderately toxic to freshwater fish on an acute basis. The results of the latter study also indicate that the formulated product tested was at least 50 times more toxic to freshwater fish on an acute basis than the tembotrione TGAI, as established by TGAI 96-hour LC_{50}s of >100 mg a.i./L and >101 mg a.i./L in bluegill sunfish (MRID 46695436; Acceptable) and rainbow trout (MRID 46695437; Acceptable), respectively. Sublethal effects were observed in all treatment groups in rainbow trout exposed to the tembotrione formulation (MRID 46695438; Acceptable). The sublethal effects were labored respiration, low activity or hyperactivity, loss of equilibrium, open mouths, laying on the bottom of aquarium, laying on their sides or backs, turned in a vertical position, remaining at the water surface, dark coloration, and convulsions. No sublethal effects were observed in the control group (MRID 46695438; Acceptable).

A 96-hour acute, single-concentration, toxicity study of the tembotrione metabolite AE 0456148 conducted in rainbow trout was submitted (MRID 46695439; Acceptable). Study details and results are summarized in **Table E-1c**. The reported LC_{50} was >105 mg p.m. (pure metabolite)/L, indicting that metabolite AE 0456148 is practically non-toxic to freshwater fish on an acute basis. Thus, metabolite AE 0456148 is no more toxic to freshwater fish on an acute basis than the parent compound, tembotrione TGAI. No sublethal effects were observed.

Table E-1a. Acute Toxicity of Tembotrione (TGAI) to Freshwater Fish

Species	**% a.i.**	**LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Bluegill sunfish (*Lepomis macrochirus*)	97.4	96-hr LC_{50}: >100 mg a.i./L	96-hour acute limit toxicity test in bluegill sunfish under static test conditions. Nominal concentrations: control, 100 mg a.i./L. Mean measured concentrations: 100 mg a.i./L. The mean measured concentration in the control group was not provided. No mortality or sublethal effects were observed in control or exposed fish. **96-hr LC_{50}: >100 mg a.i./L** (95% C.I.: not applicable; Probit Slope: not applicable) NOAEC (mortality and sublethal effects): = 100 mg a.i./L LOAEC (mortality and sublethal effects): >100 mg a.i./L Endpoints affected: none	Practically non-toxic	MRID 46695436 (Acceptable)

Table E-1a. Acute Toxicity of Tembotrione (TGAI) to Freshwater Fish					
Species	**% a.i.**	**LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Rainbow trout (*Oncorhynchus mykiss*)	97.4	96-hr LC_{50}: >101 mg a.i./L	96-hour acute limit toxicity test in rainbow trout under static test conditions. Nominal concentrations: control, 100 mg a.i./L. Mean measured concentrations: 101 mg a.i./L. The mean measured concentration in the control group was not provided. No mortality or sublethal effects were observed in control or exposed fish. **96-hr LC_{50}: >101 mg a.i./L** (95% C.I.: not applicable; Probit Slope: not applicable) NOAEC: = 101 mg a.i./L LOAEC: >101 mg a.i./L Endpoints affected: none	Practically non-toxic	MRID 46695437 (Acceptable)

Table E-1b. Acute Toxicity of Tembotrione Formulated Product to Freshwater Fish					
Species	**% a.i.**	**LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Rainbow trout (*Oncorhynchus mykiss*)	33.9	LC_{50}: 1.83 mg a.i./L	96-hour acute toxicity study of tembotrione + 18.1% isoxadifen-ethyl SC 420+210 in rainbow trout under static test conditions. Nominal concentrations: control, 0.127, 0.254, 0.509, 1.02, 2.03, and 4.07 mg a.i./L. Mean measured concentrations: 0.127, 0.262, 0.506, 1.05, 1.98, and 3.88 mg a.i./L. The mean measured concentration in the control group was not provided. Mortality: 60 and 100% in the 1.98 and 3.88 mg a.i./L treatment groups, respectively. No mortality in the control or other treatment groups. Sublethal effects: labored respiration, low activity or hyperactivity, loss of equilibrium, open mouth, laying at bottom of aquarium, on sides or backs, turned in a vertical position, remaining at the water surface, dark coloration, and/or convulsions were observed in all treatment groups. No sublethal effects were observed in the control group. **96-hr LC_{50}: 1.83 mg a.i./L** NOAEC (mortality): 1.05 mg a.i./L (95% C.I.: 1.05-3.88 mg a.i./L) Sublethal effects: NOAEC: <0.127 mg a.i./L LOAEC: 0.127 mg a.i./L (Probit Slope: N/A; 95% C.I.: N/A) Endpoints affected: mortality and sublethal effects. Most sensitive endpoints: sublethal effects.	Moderately toxic	MRID 46695438 (Acceptable)

Table E-1c. Acute Toxicity of AE 0456148 (metabolite of Tembotrione) to Freshwater Fish					
Species	**% p.m. (pure metabolite)**	**LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Rainbow trout (*Oncorhynchus mykiss*)	99.0	LC_{50}: >105 mg p.m./L	96-hour acute limit toxicity study of AE 0456148 (metabolite of tembotrione) in rainbow trout under static conditions. Nominal concentrations: control, 100 mg p.m. (pure metabolite)/L. Mean measured concentrations: 105 mg p.m./L. The mean measured concentration in the control group was not provided. No treatment-related mortalities or sublethal effects were observed. **96-hr LC_{50}: >105 mg p.m./L** 95% C.I.: not applicable NOAEC: = 105 mg p.m./L LOAEC: >105 mg p.m./L Probit Slope: not applicable 95% C.I.: not applicable Endpoints affected: none	Practically non-toxic	MRID 46695439 (Acceptable)

b. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for tembotrione because end-use products could contaminate surface water through drift or runoff events and may be transported to water from the intended use site.

An early life-stage study with tembotrione (TGAI) in fathead minnow was submitted to establish the chronic toxicity of tembotrione in freshwater fish (MRID 46695443; Acceptable). Study details and results are summarized in **Table E-2**. Reductions in fry survival and growth (length and dry weight), and increased incidence of kyphoscoliosis were observed. The 34-day NOAEC and LOAEC for fry survival (the most sensitive endpoint) were 0.604 and 1.10 mg a.i./L, respectively. Kyphoscoliosis (a lateral curvature of the spine with vertebral rotation, associated with a flexed spinal column) was observed in 5/60 and 8/60 fish from the 4.85 and 9.74 mg a.i./L groups, respectively, indicating a NOAEC and LOAEC for morphological effects of 2.25 and 4.85 mg a.i./L, respectively. The NOAEC and LOAEC for reductions in both length and dry weight were 1.10 and 2.25 mg a.i./L, respectively. The time to hatch and hatching success were unaffected by exposure. The 34-day NOAEC for reductions in fry survival (0.604 mg a.i./L) will be used to assess the risk of chronic exposure of freshwater fish to tembotrione TGAI. The Guideline (72-4[a]) is fulfilled.

No chronic toxicity studies of tembotrione formulations or degradates in freshwater fish were submitted.

Table E-2. Chronic Toxicity of Tembotrione (TGAI) to Freshwater Fish

Species	% a.i.	NOAEC	Comments	Identification Number (Study Classification)
Fathead minnow (*Pimephales promelas*)	93.6	NOAEC: 0.604 mg a.i./L (for fry survival)	34-day chronic toxicity of tembotrione (TGAI) in early life stage of fathead minnow studied under flow-through conditions. Fertilized eggs/embryos were exposed to TWA mean concentrations of <0.048 (<LOQ, negative and solvent controls), 0.604, 1.10, 2.25, 4.85, and 9.74 mg a.i./L. Endpoints monitored: time to hatch, hatching success, fry survival, growth (length and dry weight), morphological and behavioural effects. Dose-related reductions in fry survival were observed: survival was >90% in control groups, and 82, 75, 48, 43, and 25% for the TWA 0.604, 1.10, 2.25, 4.85, and 9.74 mg a.i./L groups, respectively. Total length and dry weight were significantly reduced in surviving fish ≥2.25 mg a.i./L. Kyphoscoliosis was observed in 5/60 and 8/60 fish from the 4.85 and 9.74 mg a.i./L levels, respectively. The time to hatch and hatching success were unaffected by exposure. Fry survival (most sensitive endpoints): **34-day NOAEC = 0.604 mg a.i./L** 34-day LOAEC = 1.10 mg a.i./L EC_{50}: 3.7 mg a.i./L (fry survival) 95% C.I.: 2.5 to 5.5 mg a.i./L Probit Slope: 1.42 95% C.I.: 1.17 to 1.67 Reduced growth: 34-day NOAEC = 1.10 mg a.i./L 34-day LOAEC = 2.25 mg a.i./L Kyphoscoliosis: 34-day NOAEC = 2.25 mg a.i./L 34-day LOAEC = 4.85 mg a.i./L	MRID 46695443 (Acceptable)

c. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity study using the TGAI is required to establish the toxicity of tembotrione to freshwater invertebrates. The preferred test species is the water flea (*Daphnia magna*).

One acute toxicity study of tembotrione (TGAI) in *D. magna* was submitted. Study details and results are summarized in **Table E-3a**. A 48-hour NOAEC and an EC_{50} of 15.68 mg a.i./L and 48.9 mg a.i./L, respectively, were reported for *D. magna* (MRID 46695430; Acceptable) based on immobilization and mortality. The EC_{50} of 48.9 mg a.i./L indicates that tembotrione TGAI was slightly toxic to *D. magna* on an acute basis. Since the study did not distinguish between mortality and immobility the EC_{50} value of 48.9 mg a.i./L is used as a surrogate value for lethality to evaluate acute toxic exposure of freshwater invertebrates to tembotrione TGAI. The Guideline (72-2) is fulfilled.

One acute toxicity study of tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl SC 420+210) in *D. magna* was submitted (MRID 46695431; Acceptable). Study details and results are summarized in **Table E-3b**. A 48-hour NOAEC and EC_{50} of 4.11 and 11.6 mg a.i./L, respectively, were reported for *D. magna* (MRID 46695431; Acceptable) based on immobilization and mortality. The study did not distinguish between immobilization and mortality. These data indicate that the tembotrione formulated product tested is slightly toxic to *D. magna* on an acute basis but is four times more toxic to *D. magna* on an acute basis than the tembotrione TGAI (EC_{50} 48.9 mg a.i./L) (MRID 46695430; Acceptable).

One acute toxicity study of the tembotrione metabolite AE 0456148 in *Daphnia magna* was submitted (MRID 46695432; Invalid). The study was found to be invalid because mortality at the highest concentration was lower than at four lower concentrations.

Table E-3a. Acute Toxicity of Tembotrione (TGAI) to Freshwater Invertebrates					
Species	**% a.i.**	**EC_{50}/LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Water flea (*Daphnia magna*)	97.4	EC_{50}/LC_{50} (immobility/ mortality): 48.9 mg a.i./L Endpoints affected: immobilization	48-hour acute toxicity study of tembotrione (TGAI) in *Daphnia magna* under static conditions. Nominal concentrations: 0 (negative control), 9.74, 17.53, 31.17, 54.54, and 97.40 mg a.i./L; mean measured concentrations: <0.49 (<LOQ; negative control), 11.50, 15.68, 31.78, 55.13, and 98.65 mg a.i./L. respectively. Endpoints assessed: immobilization and intoxication symptoms. No distinction was established between immobilization and mortality. By 48 hours: 30, 60, and 85% immobilization observed in the 31.78, 55.13, and 98.65 mg a.i./L groups, respectively. No immobilization was observed in the control, 11.50 or 15.68 mg a.i./L groups. No other sublethal effects were observed. **48-hr EC_{50} (immobility/ mortality): 48.9 mg a.i./L** 95% C.I.: 40.0–60.8 mg/L NOAEC (immobility/ mortality): 15.68 mg a.i./L Probit Slope: 3.95 95% C.I.: 2.61–2.59	Slightly toxic	MRID 46695430 (Acceptable)

Table E-3b. Acute Toxicity of Tembotrione Formulated Product to Freshwater Invertebrates					
Species	**% a.i.**	**EC_{50}/LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Water flea (*Daphnia magna*)	33.9	EC_{50}/LC_{50}: (immobilization/ mortality): 11.6 mg a.i./L Endpoints affected: immobilization	48-hour acute toxicity of tembotrione formulated product (tembotrione, 33.9% + isoxadifen-ethyl SC 420+210, 18.1%) in *Daphnia magna* under static conditions. Nominal concentrations: 0 (negative control), 2.12, 4.24, 8.48, 17.0, and 33.9 mg a.i./L; mean measured concentrations: <0.303 (<LOQ; negative control), 2.12, 4.11, 8.85, 17.25, and 33.35 mg a.i./L, respectively. Endpoints assessed: immobility/mortality and sublethal effects. No distinction was made between immobility and mortality. By 48 hours, 3, 37, 80, and 90% immobilization in 4.11, 8.85, 17.25, and 34.35 mg a.i./L groups, respectively. No immobilization was observed in control and 2.12 mg a.i./L treatment group. Daphnids (3 and 14%) showed decreased antennae movements and were laying at the bottom of the test chambers in the 8.85 and 17.25 mg a.i./L treatment groups, respectively. **48-hr EC_{50} (immobilization/ mortality): 11.6 mg a.i./L** 95% C.I.: 9.6–14.0 mg a.i./L NOAEC: 4.11 mg a.i./L Probit Slope: 3.53 95% C.I.: 2.58–4.47	Slightly toxic	MRID 46695431 (Acceptable)

d. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for tembotrione because the end-use product may be transported to water from the intended use site.

One chronic toxicity study with tembotrione TGAI in *D. magna* (MRID 46695440; Acceptable) was submitted. Study details and results are summarized in **Table E-4a**. NOAEC and LOAEC values of 5.10 and 10.19 mg a.i./L, respectively, were established based on reductions in mean total length. Parental survival, time to first offspring emergence, total number of live neonates per surviving adult, and dry weights of surviving adults were not affected at any of the doses tested. EFED will use the NOAEC of 5.10 mg a.i./L to assess chronic risk to aquatic invertebrates. The Guideline (72-4[b]) is fulfilled.

One chronic toxicity study with the tembotrione metabolite AE 0456148 in *D. magna* was submitted (MRID 46695441; Acceptable). Study details and results are summarized in **Table E-4b**. There was no effect on mortality or sublethal effects (parent mobility, time to first brood, reproduction, parental total length, and dry weight) in daphnids exposed to up to 113 mg metabolite/L (NOAEC = 113 mg metabolite/L). The tembotrione metabolite AE 0456148 was less toxic to freshwater invertebrates than tembotrione TGAI (MRID 46695440; Acceptable).

No life-cycle toxicity studies of tembotrione formulations in freshwater aquatic invertebrates were submitted.

Table E-4a. Chronic Toxicity of Tembotrione (TGAI) to Freshwater Invertebrates				
Species	**% a.i.**	**NOAEC**	**Comments**	**Identification Number (Study Classification)**
Water flea (*Daphnia magna*)	93.6	NOAEC: 5.10 mg a.i./L Endpoints affected: total length	21-day chronic toxicity of tembotrione TGAI in *D. magna* under static renewal conditions. Nominal concentrations of 0 (negative control), 0.078, 0.16, 0.31, 0.63, 1.25, 2.5, 5, and 10 mg a.i./L. Mean measured concentrations were <0.0073 (<LOQ, control), 0.080, 0.16, 0.32, 0.64, 1.26, 2.53, 5.10, and 10.19 mg a.i./L, respectively (TWA, reviewer-calculated). Endpoints assessed: parent and offspring mobility, parental sublethal effects, time to first offspring emergence, reproduction, and parental growth. Parental growth (mean total length) was reduced only in the 10.19 mg a.i./L group. No statistically-significant differences were observed on parental survival, time to first offspring emergence, total number of live neonates per surviving adult, or dry weights of surviving adults. Total length: **21-day NOAEC: 5.10 mg a.i./L** 21-day LOAEC: 10.19 mg a.i./L 21-day EC_{50} (immobility): >10.19 mg a.i./L 95% C.I.: N/A Probit Slope: N/A 95% C.I.: N/A Endpoints affected: total length	MRID 46695440 (Acceptable)

Table E-4b. Chronic Toxicity of AE 0456148 (metabolite of Tembotrione) to Freshwater Invertebrates				
Species	**% p.m. (pure metabolite)**	**NOAEC**	**Comments**	**Identification Number (Study Classification)**
Water flea (*Daphnia magna*)	99.0	NOAEC : 113 mg metabolite/L Endpoints affected: none	21-day chronic toxicity of AE 0456148 (metabolite of tembotrione) to *Daphnia magna* studied under static renewal conditions. Nominal concentrations of AE 0456148: 0 (negative control), 6.25, 12.5, 25.0, 50.0, and 100 mg metabolite/L; mean-measured concentrations: <0.61 (<LOQ, control), 6.96, 13.9, 28.3, 56.8, and 113 mg metabolite/L, respectively. Endpoints assessed: parent mobility, parent sublethal effects, time to first brood, reproduction, parental growth (total length and dry weight). No treatment-related effects were observed on any assessed parameter. **21-day NOAEC (all assessed endpoints): 113 mg metabolite/L** 21-day EC_{50} (for immobility) >113 mg metabolite/L Endpoints affected: none	MRID 46695441 (Acceptable)

e. Freshwater Benthic Organisms

A 28-day chironomid emergence test with tembotrione TGAI was submitted (MRID 46695444; Supplemental). Studies in benthic organisms are not a guideline requirement. Study details and results are summarized in **Table E-5**. Tembotrione concentrations were measured in overlying water and pore water in only three of the seven nominal concentrations tested. Tembotrione concentrations in sediment were not determined. Treatment with tembotrione TGAI was associated with a reduction in the emergence rate of female chironomids with a nominal NOAEC and nominal EC_{50} (for overlying water) of 2 mg/L and 11 mg/L, respectively. The measured time-weighted average (TWA) tembotrione concentrations in overlying water and pore water reported in the study summary were 68–71% and 48–56%, respectively, of the nominal values in overlying water. These reported measured TWAs for overlying water and pore water were multiplied by the nominal NOAEC of 2 mg/L in overlying water to estimate a NOAEC of 1.36 to 1.42 mg a.i./L in overlying water and a NOAEC of 0.96 to 1.12 mg a.i./L in pore water [2 mg/L (nominal NOAEC) x 68% or 71% (fraction of nominal concentration in overlying water detected in overlying water) = 1.36 mg a.i./L and 1.42 mg a.i./L overlying water; 2 mg/L (nominal NOAEC) x 48% or 56% (fraction of nominal concentration in overlying water detected in pore water) = 0.96 mg a.i./L or 1.12 mg a.i./L pore water]. The measured TWA LOAECs (corresponding to a 4 mg/L nominal LOAEC) in overlying water and pore water are 2.88 mg a.i./L overlying water and 2.08 mg a.i./L pore water.

No studies were submitted of the toxicity of tembotrione formulations or degradates in freshwater benthic organisms.

Table E-5. Toxicity of Tembotrione (TGAI) to Freshwater Benthic Organisms				
Species	**% a.i**	**NOAEC**	**Comments**	**Identification Number (Study Classification)**
Chironomid (*Chironomus riparius*)	95.4	28-day NOAEC: 1.36–1.42 mg a.i./L in overlying water (estimated); 0.96–1.12 mg a.i./L in pore water (estimated) Most sensitive endpoints: emergence rate (females)	28-day emergence test under static, aerated conditions. Chironomids were exposed to tembotrione TGAI in overlying water. Nominal concentrations: 0 (negative control), 0.50, 1.00, 2.00, 4.00, 8.00, 16.0, and 32.0 mg a.i./L overlying water. Overlying water was analyzed only in the 0, 0.50, 4.00, and 32.0 mg a.i./L treatment groups on days 0, 7, and 28. The corresponding time-weighted, mean measured concentrations were <0.0491, 0.34, 2.88, and 22.6 mg a.i./L. Given that measured concentrations are available only for three treatments, the values presented in this table are based on nominal concentrations. Endpoints assessed: emergence rate, development rate, and clinical effects. **28-day NOAEC (nominal): 2.0 mg/L** **28-day NOAEC (estimated): 1.36–1.42 mg a.i./L in overlying water; 0.96–1.12 mg a.i./L in pore water** **28-day LOAEC: 4.0 mg/L (TWA 2.88 mg a.i./L overlying and 2.08 mg a.i./L pore water)** 28-day EC_{50} (emergence rate): 11 mg/L; 95% C.I.: 7.2–16 mg/L (combined sexes); 4.5 mg/L; 95% C.I.: 2.8–7.3 mg/L (females) Slope: 1.51∀0.260 (combined sexes); 2.55∀0.524 (females) Endpoints affected: emergence rate (males, females, and combined sexes). Most sensitive endpoints: emergence rate (females).	MRID 46695444 (Supplemental) Non-guideline

III. Toxicity to Estuarine and Marine Animals

a. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine/marine fish using the TGAI is required for tembotrione. The preferred test species is the sheepshead minnow.

One acute toxicity study of tembotrione TGAI in estuarine/marine fish was submitted for sheepshead minnow (MRID 46695435; Supplemental). Study details and results are summarized in **Table E-6.** The acute LC_{50} of tembotrione TGAI in sheepshead minnow was >100 mg a.i./L, indicating that tembotrione TGAI is practically non-toxic to estuarine/marine fish on an acute basis. No sublethal effects were observed at any of the treatment levels. The Guideline (72-3[a]) is fulfilled. Since an LC_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive RQs for estuarine/marine fish.

No acute toxicity studies of tembotrione formulations or degradates in estuarine/marine fish were submitted.

Table E-6. Acute Toxicity of Tembotrione (TGAI) to Estuarine/Marine Fish

Species	% a.i.	LC_{50}	Comments	Toxicity Category	Identification Number (Study Classification)
Sheepshead minnow (*Cyprinodon variegates*)	94.0–95.0	LC_{50}: >100 mg a.i./L Endpoints affected: none	96-hour acute toxicity study with tembotrione TGAI in sheepshead minnow under static renewal conditions. Nominal concentrations: 0 (control and DMF solvent control), 13, 22, 36, 60, and 100 mg a.i./L; mean measured concentrations (TWA): <1.3 (controls), 13, 23, 38, 65, and 100 mg a.i./L, respectively. Assessed endpoints: mortality and signs of toxicity. No mortality or sublethal effects were observed at any treatment level. **96-hr LC_{50}: >100 mg a.i./L** 95% C.I.: N/A NOAEC: 100 mg a.i./L Probit Slope: N/A EC_{50}: >100 mg a.i./L Endpoints affected: none	Practically non-toxic	MRID 46695435 (Supplemental)

b. Estuarine and Marine Fish, Chronic

No life cycle toxicity test with estuarine/marine fish with tembotrione TGAI, formulations, or degradates were submitted. The Guideline (72-5) is not fulfilled.

c. Estuarine and Marine Aquatic Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for tembotrione. The preferred test species are eastern oyster (Guideline 72-3[b]) and mysid shrimp (Guideline 72-3[c]).

One acute toxicity study using tembotrione TGAI has been submitted for mysids (MRID 46695434; Acceptable). Study details and results are summarized in **Table E-7**. An LC_{50} of 100 µg a.i./L indicates that tembotrione TGAI is highly toxic to saltwater mysids on an acute basis (MRID 46695434; Acceptable). Sublethal effects (lethargy and/or partial loss of equilibrium) were observed in mysids at the two highest concentrations tested. One acute toxicity study of tembotrione TGAI in eastern oyster was submitted (MRID 46695433; Invalid). The study was found to be invalid because a significant difference in shell deposition was observed between the negative and solvent control groups. EFED will use the LC_{50} value of 100 µg a.i./L in saltwater mysids to assess acute risk to estuarine/marine shrimp. The Guideline (72-3) is fulfilled.

No acute toxicity studies of tembotrione formulations or degradates in estuarine/marine invertebrates were submitted.

Table E-7. Acute Toxicity of Tembotrione (TGAI) to Estuarine/Marine Invertebrates					
Species	**% a.i.**	**EC_{50}/LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Saltwater mysid (*Americamysis bahia*)	94.0	96-hr LC_{50}: 100 µg a.i./L	96-hour acute toxicity test with tembotrione TGAI in mysids under flow-through conditions. Nominal concentrations: 0 (negative and solvent controls), 17, 28, 47, 78, and 130 µg a.i./L; mean measured concentrations were <LOQ (<2.3–2.8 µg a.i./L in negative and solvent controls), 14, 28, 46, 79, and 130 µg a.i./L, respectively. Endpoints assessed: mortality and signs of toxicity. At 96 hours: 95% mortality in 130 µg a.i./L treatment group. No mortalities occurred in the controls or other treatment groups. Signs of toxicity: lethargy and/or partial loss of equilibrium in 79 and 130 µg a.i./L treatment groups. **96-hr LC_{50}: 100 µg a.i./L** 95% C.I.: 79–130 µg a.i./L Mortality: NOAEC: 79 µg a.i./L Sublethal effects: NOAEC: 46 µg a.i./L Probit Slope: not reported LOAEC: 79 µg a.i./L	Highly toxic	MRID 46695434 (Acceptable)

d. Estuarine and Marine Invertebrates, Chronic

The estuarine/marine aquatic invertebrate life-cycle test using the TGAI of tembotrione is required. The preferred test species is the mysid shrimp. Study details and results are summarized in **Table E-8**.

One life-cycle (28-day) toxicity study with tembotrione TGAI in the mysid shrimp was submitted (MRID 46695442; Acceptable). Study details and results are summarized in **Table E-8**. NOAEC was not established and is less than the lowest concentration tested in the study (1.6 µg a.i./L). This study is classified as supplemental and lowest concentration will not be used in RQ. The Guideline (72-4[c]) is not fulfilled.

No chronic toxicity studies of tembotrione formulations or degradates in estuarine/marine invertebrates were submitted.

Table E-8. Chronic Toxicity of Tembotrione (TGAI) to Estuarine/Marine Invertebrates				
Species	**% a.i.**	**NOAEC**	**Comments**	**Identification Number (Study Classification)**
Saltwater mysid (*Americamysis bahia*)	95.4	NOAEC: <1.6 µg a.i./L Most sensitive endpoints: reproduction	28-day, chronic toxicity test in mysid shrimp neonates under flow-through conditions. Nominal concentrations: 0 (negative control), 0 (solvent control), 1.4, 2.9, 5.8, 12, and 23 µg a.i./L; mean measured concentrations: <0.28, <0.28, 1.6, 2.4, 5.7, 11, and 22 µg a.i./L, respectively. The following endpoints were assessed: adult survival after pairing, reproduction (young/female/day), total body length and dry weight, and behavior/appearance of first-generation mysids. No NOAEC was established. Mortality at 7, 14, and 21 days and length of each mysid at the time of sexual discernment were not assessed as required under the harmonized OPPTS guidance. Survival was assessed at 28 days. The reviewer detected significant adverse effects on reproduction at every treatment level, and effects reported generally followed a dose-dependent pattern. Reproduction (most sensitive endpoints): 28-day NOAEC: <1.6 µg a.i./L Survival: NOAEC: 5.7 µg a.i./L LOAEC: 11 µg a.i./L Growth (length and dry weight): NOAEC: 11 µg a.i./L LOAEC: >11 µg a.i./L (the 22 µg a.i./L group was excluded from the statistical analysis of growth).	MRID 46695442 (Supplemental)

e. Aquatic Field Studies

No aquatic field studies were submitted.

IV. Toxicity to Plants Inhabiting Aquatic Environments

Acute toxicity testing with plants inhabiting aquatic environments using the TGAI is required for tembotrione because the active ingredient may reach aquatic environments. Guideline recommended aquatic plant test species include duckweed, freshwater algae, blue-green algae, and marine algae.

Acute toxicity studies using tembotrione TGAI (three studies), tembotrione formulated product (one study), and a tembotrione metabolite (two studies) were submitted for freshwater algae or aquatic vascular plants. All studies were classified as Acceptable or Supplemental. Study details and results for studies with tembotrione TGAI, tembotrione formulations, and a tembotrione metabolite are summarized in **Tables E-9a**, **E-9b**, and **E-9c**, respectively. Additional acute toxicity studies with tembotrione TGAI were conducted in the freshwater algae *Anabaena flos-aquae* (MRID 46695515; Invalid) and in the marine algae *Skeletonema costatum* (MRID 46695516; Invalid). Both studies were deemed invalid because significant differences in one or more endpoints were observed between the negative and solvent control groups.

Acute toxicity studies with tembotrione TGAI in freshwater algae or diatoms yielded EC_{50} values ranging from 0.31 mg a.i./L for reductions in cell density in *Pseudokirchneriella subcapitata* (MRID 46695517; Acceptable) to 9.0 mg a.i./L for reductions in biomass in *Navicula pelliculosa* (MRID 46695518; Acceptable). An EC_{50} of 2.7 mg a.i./L for reductions in cell density was observed in *Pseudokirchneriella subcapitata* exposed to a tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl SC 420+210) (MRID 46695519; Supplemental). An EC_{50} of >103 mg metabolite/L (for cell density and growth rate) was observed in *Pseudokirchneriella subcapitata* exposed to the tembotrione metabolite AE 0456148 (MRID 46695520; Supplemental). These results indicate that tembotrione TGAI is moderately to highly toxic to freshwater algae; tembotrione formulated product is moderately toxic to freshwater algae; the tembotrione metabolite AE 0456148 is practically non-toxic to freshwater algae.

Results of two 14-day studies in duckweed (a freshwater vascular plant) using tembotrione TGAI and the tembotrione metabolite AE 0456148 yielded EC_{50} values of 5.2 µg a.i./L (for reductions in frond number) (MRID 46695513; Acceptable) and >105 mg metabolite/L (MRID 46695514; Acceptable), respectively, indicating that tembotrione TGAI is very highly toxic to aquatic vascular plants and the tembotrione metabolite AE 0456148 is practically non-toxic to aquatic vascular plants.

Based on these results, aquatic macrophytes are more sensitive than freshwater algae to tembotrione TGAI. EFED will use the lowest EC_{50} values to assess acute risks to aquatic plants as follows: EC_{50} = 0.31 mg a.i./L for decreased cell density in *Pseudokirchneriella subcapitata* (MRID 46695517; Acceptable) for freshwater algae and EC_{50} = 5.2 µg a.i./L for reduced frond number in *Lemna gibba* (MRID 46695513; Acceptable) for freshwater vascular plants. The guideline requirement for Tier II growth and reproduction studies (Guideline 123-2) in aquatic plants is fulfilled.

Table E-9a. Acute Toxicity (Tier II) of Tembotrione (TGAI) to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			Freshwater Algae		
Freshwater green algae (*Pseudokircheriella subcapitata*)	97.4	EC_{50}: 0.31 mg a.i./L Most sensitive endpoints: cell density	96-hour acute toxicity study of tembotrione in *Pseudokirchneriella subcapitata* under static conditions: nominal concentrations: 0 (negative control), 0.10, 0.18, 0.31, 0.55, 0.97, 1.75, and 3.12 mg a.i./L; mean measured concentrations: <LOQ (negative control), 0.07, 0.13, 0.20, 0.41, 0.53, 1.18, and 2.11 mg a.i./L. Endpoints assessed: cell density, growth rate, and biomass. The NOAEC was 0.20 mg a.i./L based on all endpoints. The EC_{50} was 0.31 mg a.i./L for cell density, the most sensitive endpoint. **Cell density (most sensitive endpoints):** **EC_{50}: 0.31 mg a.i./L** 95% C.I.: 0.25–0.38 mg a.i./L EC_{05}: 0.089 mg a.i./L 95% C.I.: 0.056–0.14 mg a.i./L NOAEC: 0.20 mg a.i./L Probit Slope: 3.08±0.359 **Growth rate:** EC_{50}: 0.83 mg a.i./L 95% C.I.: 0.74–0.93 mg a.i./L EC_{05}: 0.12 mg a.i./L 95% C.I.: 0.085–0.16 mg a.i./L NOAEC: 0.20 mg a.i./L Probit Slope: 1.94±0.120 **Biomass:** EC_{50}: 0.35 mg a.i./L 95% C.I.: 0.26–0.47 mg	Highly toxic	MRID 46695517 (Acceptable)

Table E-9a. Acute Toxicity (Tier II) of Tembotrione (TGAI) to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			a.i./L EC_{05}: <0.070 mg a.i./L 95% C.I.: N/A NOAEC: 0.20 mg a.i./L Probit Slope: not determined Endpoints affected: cell density, growth rate and biomass. Most sensitive endpoints: cell density.		
Freshwater Diatom (*Navicula pelliculosa*)	97.4	EC_{50}: 9.0 mg a.i./L Most sensitive endpoints: reduced biomass	120-hour acute toxicity study of tembotrione TGAI in *Navicula pelliculosa* under static conditions. Nominal concentrations: 0 (negative control), 1.75, 3.12, 5.45, 9.74, 17.53, 31.17, and 54.54 mg a.i./L; mean measured concentrations: 0 (negative control), 1.61, 3.04, 5.34, 9.32, 16.92, 29.87, and 52.46 mg a.i./L. Endpoints assessed: cell density, growth rate, and biomass. **Biomass:** **EC_{50}: 9.0 mg a.i./L** 95% C.I.: 5.6–14.0 mg a.i./L EC_{05}: <1.61 mg a.i./L 95% C.I.: N/A NOAEC: 3.04 mg a.i./L Probit Slope: 2.14±0.410 **Cell density:** EC_{50}: 11.0 mg a.i./L 95% C.I.: 6.8–17.0 mg a.i./L EC_{05}: 2.0 mg a.i./L 95% C.I.: 0.70–5.8 mg a.i./L NOAEC: 3.04 mg a.i./L Probit Slope: 2.26±0.457 **Growth rate:** EC_{50}: 42.0 mg a.i./L 95% C.I.: 35.0–51.0 mg a.i./L EC_{05}: 3.7 mg a.i./L 95% C.I.: 1.9–7.2 mg a.i./L	Moderately toxic	MRID 46695518 (Acceptable)

Table E-9a. Acute Toxicity (Tier II) of Tembotrione (TGAI) to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			NOAEC: 5.34 mg a.i./L Probit Slope: 1.55±0.206 Endpoints affected: cell density, growth rate, and biomass. Most sensitive endpoints: biomass.		
Freshwater Vascular Plants					
Freshwater vascular plant, duckweed (*Lemna gibba*)	97.4	EC_{50}: 5.2 µg a.i./L (based on reduced frond number)	14-day acute toxicity study of tembotrione TGAI in duckweed under static renewal conditions. Nominal concentrations: 0, 0.97, 1.73, 3.12, 5.45, 9.74, 17.53, and 31.17 µg a.i./L; mean measured concentrations: <0.09 (<LOQ; negative control), 0.94, 1.61, 2.86, 5.06, 9.34, 17.09, and 30.88 µg a.i./L. Endpoints assessed: Number of fronds, doubling time, growth rate, and biomass. **Frond Number:** **EC_{50}: 5.2 µg a.i./L** 95% C.I.: 3.8–7.2 µg a.i./L EC_{05}: <0.94 µg a.i./L 95% C.I.: N/A NOAEC: 2.86 µg a.i./L Probit Slope: 1.95±0.233 **Frond Number Growth Rate:** EC_{50}: 8.9 µg a.i./L 95% C.I.: 6.4–12.0 µg a.i./L EC_{05}: <0.94 µg a.i./L 95% C.I.: N/A NOAEC: 2.86 µg a.i./L Probit Slope: 1.62±0.210 **Dry Weight biomass:** EC_{50}: 6.7 µg a.i./L 95% C.I.: 4.6–9.9 µg a.i./L EC_{05}: <0.94 µg a.i./L 95% C.I.: N/A NOAEC: 2.86 µg a.i./L Probit Slope: 1.66±0.223	Very Highly Toxic	MRID 46695513 (Acceptable)

Table E-9a. Acute Toxicity (Tier II) of Tembotrione (TGAI) to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			<u>Biomass Growth Rate:</u> EC_{50}: 14 µg a.i./L 95% C.I.: 11.0–18.0 µg a.i./L EC_{05}: 0.97 µg a.i./L 95% C.I.: 0.41–2.3µg a.i./L NOAEC: 2.86 µg a.i./L Probit Slope: 1.42±0.175 Endpoints affected: frond number, frond number growth rate, biomass growth rate, and biomass (dry weight). Most sensitive endpoints: frond number.		

Table E-9b. Acute Toxicity (Tier I) of Tembotrione Formulated Product to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			Freshwater Algae		
Freshwater green algae (*Pseudokircheriella subcapitata*)	33.9	EC_{50}: 2.7 mg a.i./L (for reduced cell density)	72-hour acute toxicity study of tembotrione formulation in *Pseudokirchneriella subcapitata* under static conditions. Nominal concentrations: 0, 0.868, 2.2, 5.4, 14, and 34 mg a.i./L; mean measured concentrations: <0.1104 (<LOQ, negative control), 0.773, 1.92, 5.05, 12.4, and 29.1 mg a.i./L, respectively. Endpoints assessed: cell density, growth rate, and doubling time. This study was only conducted for 72 hours and, according to EPA guidelines, should be considered for Tier 1 screening purposes only. **Cell density:** **EC_{50}: 2.7 mg a.i./L** 95% C.I.: 1.7–4.1 mg a.i./L EC_{05}: <0.773 mg a.i./L 95% C.I.: N/A NOAEC: 0.773 mg a.i./L Probit Slope: 2.70±0.513 **Growth rate:** EC_{50}: 4.5 mg a.i./L 95% C.I.: 2.7–7.5 mg a.i./L EC_{05}: 0.84 mg a.i./L 95% C.I.: 0.27–2.6 mg a.i./L NOAEC: 1.92 mg a.i./L Probit Slope: 2.25±0.453 Endpoints affected: cell density and growth rate. Most sensitive endpoints: cell density.	Moderately toxic	MRID 46695519 (Supplemental)

Table E-9c. Acute Toxicity (Tier II) of the Tembotrione metabolite AE 0456148 to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Freshwater Algae					
Freshwater green algae (*Pseudokircheriella subcapitata*)	99.0	EC_{50}: >103 mg metabolite/L (for cell density and growth rate)	72-hour acute toxicity limit study of tembotrione metabolite AE 0456148 in *Pseudokirchneriella subcapitata* under static conditions. Nominal concentrations: 0 (negative control), 100 mg metabolite/L; mean measured concentrations: <0.1041 (<LOQ, negative control) and 103 mg metabolite/L, respectively. Endpoints assessed: cell density, growth rate, and doubling time. __Cell density:__ EC_{50}: >103 mg metabolite/L 95% C.I.: N/A EC_{05}: >103 mg metabolite/L 95% C.I.: N/A NOAEC: <103 mg metabolite/L Probit Slope: N/A Growth rate: EC_{50}: >103 mg metabolite/L 95% C.I.: N/A EC_{05}: >103 mg metabolite/L 95% C.I.: N/A NOAEC: <103 mg metabolite/L Probit Slope: N/A Endpoints affected: none	Practically non-toxic	MRID 46695520 (Supplemental)

Table E-9c. Acute Toxicity (Tier II) of the Tembotrione metabolite AE 0456148 to Plants Inhabiting Aquatic Environments					
Species	**% a.i.**	**EC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Freshwater Vascular Plants					
Freshwater vascular plant, duckweed (*Lemna gibba*)	99.0	EC_{50}: >105 mg metabolite/L (for frond number, total frond area on day 7, growth rate of frond number and of frond area)	14-day acute limit toxicity study of tembotrione metabolite AE 0456148 in duckweed under static conditions. Nominal concentrations: 0 and 100 mg metabolite/L; mean measured concentration: <0.1041 (<LOQ; negative control) and 105 mg metabolite/L. Endpoints assessed: number of fronds, growth rate, doubling time, and total frond area. **Frond Number, Total Frond Area on Day 7, Growth Rate of Frond Number and of Frond Area:** EC_{50}: >105 mg metabolite/L 95% C.I.: N/A EC_{05}: >105 mg metabolite/L 95% C.I.: N/A NOAEC: 105 mg metabolite/L Probit Slope: not determined Endpoints affected: none	Practically non-toxic	MRID 46695514 (Acceptable)

V. Toxicity to Terrestrial Animals

a. Birds, Acute and Subacute

An acute oral toxicity study using technical grade tembotrione is required to establish the toxicity of tembotrione to birds. The preferred test species is either the mallard duck (a waterfowl) or bobwhite quail (an upland gamebird).

One study of the acute oral toxicity of tembotrione TGAI in bobwhite quail (MRID 46695501; Acceptable) was submitted. Study details and results are summarized in **Table E-10**. The acute oral LD_{50} of >2250 mg a.i./kg-bw indicates that tembotrione TGAI is practically non-toxic to bobwhite quail on an acute oral basis. The Guideline (71-1) is fulfilled. Since an LD_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive dose-based acute RQs for avian species. An acute oral toxicity study of tembotrione TGAI in mallard ducks was submitted (MRID 46695445; Invalid). The study was found to be invalid due to the significant regurgitation observed in this study.

Clinical signs of toxicity (ruffled appearance and/or lethargy) were observed in bobwhite quail in the ≥810 mg a.i./kg-bw treatment groups. No treatment-related mortality, effects on body weight or food consumption, or gross pathological findings were observed (MRID 46695501; Acceptable).

No acute oral toxicity studies of tembotrione formulations or degradates in avian species were submitted.

Table E-10. Acute Oral Toxicity of Tembotrione (TGAI) to Birds					
Species	**% a.i.**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Bobwhite quail (*Colinus virginianus*)	97.4	LD_{50}: >2250 mg a.i./kg-bw	17-day, acute oral toxicity study in bobwhite quail. Nominal doses: 0 (vehicle control), 292, 486, 810, 1350, and 2250 mg a.i./kg-bw. Doses were not analytically verified. Endpoints assessed: mortality, clinical signs of toxicity, food consumption, body weight, and necropsy. Clinical signs of toxicity (ruffled appearance and/or lethargy) were observed at 810 mg a.i./kg-bw (3/10 birds), 1350 mg a.i./kg-bw (6/10 birds), and 2250 mg a.i./kg-bw (6/10 birds). No treatment-related mortality, effects on body weight or food consumption, or gross pathological findings were observed. **17-day LD_{50}: >2250 mg a.i./kg-bw** 95% C.I.: N/A Probit slope: N/A 95% C.I.: N/A NOAEL: 486 mg a.i./kg-bw LOAEL: 810 mg a.i./kg-bw Endpoints affected: clinical signs of toxicity.	Practically non-toxic	MRID 46695501 (Acceptable)

Two acute dietary studies using the TGAI are required to establish the toxicity of tembotrione to birds. The preferred test species are mallard duck and bobwhite quail.

Two studies of the acute dietary toxicity of tembotrione TGAI in mallard duck (MRID 46695502; Acceptable) and bobwhite quail (MRID 46695503; Acceptable) were submitted. Study details and results are summarized in **Table E-11**. No mortality was observed at the concentrations tested in these studies. Thus, the acute dietary LC_{50} values were >5790 mg a.i./kg diet (the highest concentration tested) in mallard ducks (MRID 46695502; Acceptable) and bobwhite quail (MRID 46695503; Acceptable). These results indicate that tembotrione TGAI is practically non-toxic to birds on an acute dietary basis. The Guideline (71-2) is fulfilled. Since an LC_{50} value was not established, with no mortalities or sublethal effects, EFED will not derive dietary-based acute RQs for avian species.

No mortality or clinical signs of toxicity were observed in mallard ducks; however, treatment-related reductions in body weight gain were observed in mallard ducks from all treatment levels compared to the control during the exposure period. A treatment-related effect in food consumption was also observed in mallard ducks in the ≥1890 mg a.i./kg diet treatment groups (MRID 46695502; Acceptable). Treatment-related reductions in body weight gain were also observed at ≥3220 mg a.i./kg diet in bobwhite quail (MRID 46695503; Acceptable).

No acute dietary toxicity studies of tembotrione formulations or degradates in avian species were submitted.

Table E-11. Acute Dietary Toxicity of Tembotrione (TGAI) to Birds

Species	% a.i.	LC_{50}	Comments	Toxicity Category	Identification Number (Study Classification)
Mallard duck (*Anas platyrhynchos*)	94	LC_{50}: >5790 mg a.i./kg diet	8-day acute dietary toxicity study of in mallard duck. Nominal concentrations: 0 (control), 562, 1000, 1780, 3160, and 5620 mg a.i./kg diet; mean measured concentrations: <50 (<LOD, control), 580, 1040, 1890, 3220, and 5790 mg a.i./kg diet, respectively. Endpoints assessed: mortality, clinical signs of toxicity, body weight, and food consumption. No mortality or clinical signs of toxicity were observed. A treatment-related reduction in body weight gain was observed in birds from all treatment levels compared to the control during the exposure period. A treatment-related effect in food consumption was observed in birds in the ≥1890 mg a.i./kg diet treatment groups. **LC_{50}: >5790 mg a.i./kg diet** 95% C.I.: N/A Probit Slope: N/A 95% C.I.: N/A Reduced body weight gain: NOAEC: <580 mg a.i./kg diet LOAEC: 580 mg a.i./kg diet Endpoints affected: body weight and food consumption. Most sensitive endpoints: body weight.	Practically non-toxic	MRID 46695502 (Acceptable)

Table E-11. Acute Dietary Toxicity of Tembotrione (TGAI) to Birds					
Species	**% a.i.**	**LC_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Bobwhite quail (*Colinus virginianus*)	94	LC_{50}: >5790 mg a.i./kg diet	8-day acute dietary toxicity in bobwhite quail. Nominal concentrations: 0 (control), 562, 1000, 1780, 3160, and 5620 mg a.i./kg diet; mean measured concentrations: <50 (<LOD, control), 580, 1040, 1890, 3220, and 5790 mg a.i./kg diet, respectively. Endpoints assessed: mortality, clinical signs of toxicity, body weight, and food consumption. No treatment-related mortality, clinical signs of toxicity, or effects on food consumption were observed at any treatment level. Treatment-related reduction in body weight gain was observed at ≥3220 mg a.i./kg diet. **LC_{50}: >5790 mg a.i./kg diet** 95% C.I.: N/A Probit Slope: N/A 95% C.I.: N/A Reduced body weight gain: NOAEC: 1890 mg a.i./kg diet LOAEC: 3220 mg a.i./kg diet Endpoints affected: body weight	Practically non-toxic	MRID 46695503 (Acceptable)

b. Birds, Chronic

Avian reproduction studies using the TGAI are required for tembotrione because birds may be subjected to continuous exposure to the pesticide, especially preceding or during the breeding season. The preferred test species are mallard duck and bobwhite quail.

Studies of the reproductive toxicity of tembotrione TGAI in bobwhite quail (MRID 46695504; Supplemental) and mallard duck (MRID 46695505; Supplemental) were submitted. Study details and results are summarized in **Table E-12**. An additional study of reproductive effects of tembotrione TGAI in mallard ducks was submitted (MRID 46695506; Invalid). The design of the latter study deviated significantly from guidance. Most notable of these deviations were the lack of a pre-egg laying exposure period and failure to monitor numerous required reproductive endpoints.

No treatment-related effects on adult mortality were observed in bobwhite quail at any treatment level (MRID 46695504; Supplemental). In contrast, mortality was observed in mallard ducks at the highest concentration tested (MRID 46695505; Supplemental). Significant reductions in adult male weight gain and several reproductive endpoints were observed at all treatment levels in mallard ducks (NOAEC 65.3 mg a.i./kg diet). Numerous effects on embryo survival, hatchability, and survival were observed at ≥260 mg a.i./kg diet in bobwhite quail (MRID 46695504; Supplemental). EFED will use the NOAEC value of 65.3 mg a.i/kg diet in mallard ducks (MRID 46695505; Supplemental) to assess chronic risk of tembotrione exposure in avian species. Although they were classified as Supplemental, MRID 46695504 and MRID 46695505 did not meet the guideline requirements, thus, the Guideline (71-4) is not fulfilled.

Sublethal effects such as reductions in parental body weight gain, adverse reproductive effects, such as reductions in number of eggs laid and eggs set, and developmental effects, such as reduced embryo viability, hatching, and hatchling survival, were observed in bobwhite quail (MRID 46695504; Supplemental) and/or mallard ducks (MRID 46695505; Supplemental).

No chronic toxicity studies of tembotrione formulations or degradates in avian species were submitted.

Table E-12. Chronic Toxicity of Tembotrione (TGAI) to Birds

Species	% a.i.	NOAEC	Comments	Identification Number (Study Classification)
Northern bobwhite quail (*Colinus virginianus*)	94	NOAEC: 250 mg a.i./kg diet (for reduction in viable embryos)	One-generation reproductive toxicity study in bobwhite quail assessed over 21 weeks. Nominal concentrations: 0 (vehicle control), 63, 250, and 1000 mg a.i./kg diet; mean-measured concentrations: <10 (<LOD, control), 65.3, 260, and 1030 mg a.i./kg diet, respectively. Endpoints assessed: parental mortality, body weight, food consumption, signs of toxicity, and necropsy, reproductive effects, and offspring development. No treatment-related effects on adult mortality, body weight, or food consumption were observed at any treatment level, and there were no treatment-related clinical signs of toxicity or findings upon necropsy. Reductions in viable embryos were observed at ≥260 mg a.i./kg diet; numerous effects on embryo survival, hatchability, and survival were observed at the highest treatment level. Reduction in viable embryos: **NOAEC: 250 mg a.i./kg diet** LOAEC: 1000 mg a.i./kg diet	MRID 46695504 (Supplemental)

Table E-12. Chronic Toxicity of Tembotrione (TGAI) to Birds				
Species	**% a.i.**	**NOAEC**	**Comments**	**Identification Number (Study Classification)**
			Endpoints affected: viable embryos of eggs set; live 3-week embryos to viable embryos; number hatched; number hatched as a proportion of eggs laid, eggs set, and live 3-week embryos; hatchling survival; hatchling survivors of eggs set; and survivor weight. Most sensitive endpoints: viable embryos of eggs set.	
Mallard duck (*Anas platyrhynchos*)	94	NOAEC: 65.3 mg a.i./kg diet (adult body weight gain; developmental effects)	One-generation reproductive toxicity study in mallard ducks assessed over approximately 20 weeks. Nominal concentrations: 0 (vehicle control), 63, 250, and 1000 mg a.i./kg diet; mean-measured concentrations: <10 (<LOD, control), 65.3, 260, and 1030 mg a.i./kg diet, respectively. Endpoints assessed: parental mortality, body weight, food consumption, signs of toxicity, and necropsy, reproductive effects, and offspring development. No effect on food consumption. Significant reductions in adult male weight gain and several reproductive endpoints observed at all treatment levels. Adverse effects on adult and reproductive parameters at the highest treatment level. Single treatment-related mortality in the 1030 mg a.i./kg diet level. **Adult body weight gain; developmental effects:** **NOAEC: 65.3 mg a.i./kg diet** LOAEC: 250 mg a.i./kg diet Endpoints affected: adult male and female weight gain, eggs laid, eggs set, the ratio of eggs set to eggs laid, viable embryos, live embryos, number hatched, the ratios of number hatched to eggs laid and eggs set, 14-day old survivors, the ratios of survivors to eggs set and number hatched, and hatchling and survivor body weights. Most sensitive endpoints: adult male body weight gain, the ratios of number hatched to eggs laid and eggs set and the ratio of survivors to eggs set.	MRID 46695505 (Supplemental)

c. Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern, and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. Results of pertinent toxicity studies in laboratory mammals on tembotrione TGAI are reported below in **Tables E-13**, **E-14**, and **E-15**.

An acute oral toxicity study was conducted with tembotrione TGAI in four female rats (MRID 46695618). This study has not yet been reviewed by EPA. There were no deaths at the two doses tested, yielding an acute oral LD_{50} >2000 mg a.i./kg-bw. Thus, tembotrione TGAI is practically non-toxic to mammals on an acute oral basis. Study details and results are summarized in **Table E-13**.

A 14-day, acute oral toxicity study of tembotrione formulated product (34.3% tembotrione + 17.1% isoxadifen-ethyl) conducted in female rats (MRID 46695619; unreviewed) yielded an estimated oral LD_{50} of 1750 mg formulation/kg-bw. Thus, the tembotrione formulation tested is slightly toxic to mammals on an acute oral basis; the formulated product was more than 1.14 times more toxic than the TGAI to rats on an acute oral basis. The results of this study have not yet been reviewed by EPA. Study details and results are summarized in **Table E-14**. All rats died within 24 hours at 5000 mg formulation/kg-bw. Sublethal effects observed in surviving rats in the 1750 mg formulation/kg-bw group were piloerection, hypoactivity, hunched posture, and reduced fecal volume; however, rats recovered after 2 days (MRID 46695619; unreviewed). No adverse effects were observed in rats administered 550 mg formulation/kg-bw.

Summaries of acute oral toxicity studies in rats were available for the tembotrione metabolites

AE 0456148 (MRID 46695620), AE 1392936 (MRID 46695622), and AE 1417268 (MRID 46695621) have not yet been reviewed by EPA. Study details and results are summarized in **Table E-15**. No deaths, clinical effects, or abnormal findings at necropsy were observed in any of the studies. Thus, the three studies showed LD_{50}s that were greater than 2000 mg metabolite/kg-bw, indicating that these three metabolites were practically non-toxic to mammals on an acute oral basis.

A two-generation reproductive toxicity study of tembotrione TGAI in rats is available (MRID 46695704; Bayer 2005). The results of this study have not been reviewed by EPA. Study details and results are summarized in **Table E-16**. The most salient effect observed in this study was a dose-related incidence of corneal opacities in male and female rats from all dose groups and in both generations.

The incidence of corneal opacity in adult males and females in the parental generation was 10/30 in males at 1.3 mg/kg-bw/day and 15/30 in females at 1.6 mg/kg-bw/day; 8/30 in males at 13.1 mg/kg-bw/day and 27/30 in females at 15.4 mg/kg-bw/day in females; 13/30 in males at 98.2 mg/kg-bw/day and 24/30 in females at 115.4 mg/kg-bw/day. The incidence of corneal opacity in adult males and females in the F_1 generation was 25/30 in males and 21/30 in females at 3.2 mg/kg-bw/day; 29/30 and 27/30 in males and females, respectively, at 30.7 mg/kg-bw/day; and

27/30 and 29/30 in males and females, respectively, at 228.1 mg/kg-bw/day. Corneal opacities were not observed in control groups from either generation of rats. Thus, using the lowest doses at which the effect was observed, LOAEL of 1.3 mg/kg-bw/day and a NOAEL of <1.3 mg/kg-bw/day for corneal opacity can be derived.

Parental rats showed reduced body weight and food consumption and dilated renal pelvis at 13.1 mg/kg-bw/day in males and 15.4 mg/kg-bw/day in females with a NOAEL of 1.3 mg/kg-bw/day in males, 1.6 mg/kg-bw/day in females. F_1 and F_2 male and female juvenile (post-weaning) offspring showed reduced body weight and body weight gain at 30.7 mg/kg-bw/day with a NOAEL of 3.2 mg/kg-bw/day. There were no effects on reproductive performance at any dose level in either generation, establishing a NOAEL for reproductive effects of 98.2 mg/kg-bw/day in males and 115.4 mg/kg-bw/day in females (46695704; Bayer 2005).

Table E-13. Acute Oral Toxicity of Tembotrione TGAI to Mammals					
Species	**% a.i.**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Rat (females only)	94.0	LD_{50}: >2000 mg a.i./kg-bw	14-day, acute oral (single dose) toxicity study of tembotrione TGAI, in four female rats. Nominal doses: 630 (one animal) and 2000 (three animals) mg/kg-bw. A control group of animals was not prepared. Endpoints assessed: mortality, body weight, food consumption, and necropsy findings. **LD_{50}: >2000 mg a.i./kg-bw** Acclimated female rats were randomly selected and fasted overnight prior to treatment with tembotrione TGAI. Tembotrione was administered by gavage as a suspension in 0.5% aqueous carboxymethylcellulose at a dose volume of 10 mL/kg. Rats were observed within 30 minutes of dosing, between 30 minutes and 4 hours after dosing, and in the afternoon of the day of dosing. After the first day, clinical observations were made once each morning with a mortality check every afternoon. Body weights were recorded on the day of dosing and on days 7 and 14. All animals were sacrificed at the end of the study and were subjected to a complete post-mortem examination. There were no deaths in the exposed rats. The only clinical sign was yellow staining in the urogenital area in one rat in the 2000 mg a.i./kg-bw group. All rats gained weight; however, since a control group was not used it cannot be determined if weight gain was affected by treatment. There were no gross necropsy findings.	Practically non-toxic	MRID 46695618 (Unreviewed)

Table E-14. Acute Oral Toxicity of Tembotrione Formulated Product to Mammals					
Species	**% a.i.**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
Rat (females only)	34.3	LD_{50}: 1750 mg formulation/ kg-bw	14-day, acute oral (single dose) toxicity study of tembotrione formulated product (tembotrione, 34.3% + isoxadifen-ethyl: 17.1%) in female rats. Nominal doses: 175 mg/kg-bw (one animal), 550 (two animals), 1750 (four animals), 5000 (three animals) mg formulation/kg-bw. Endpoints assessed: mortality, gross toxicity, body weight, and necropsy findings. **LD_{50}: 1750 mg formulation/kg-bw** 5000 mg formulation/kg-bw: all animals died within one day of dosing. Red intestines, only at this dose. 1750 mg formulation/kg-bw: one animal died (1/4); surviving rats showed piloerection, hypoactivity, hunched posture, and reduced fecal volume but recovered after 2 days. 550 mg formulation/kg-bw: no mortality or clinical signs.	Slightly toxic	MRID 46695619 (Unreviewed)

Table E-15. Acute Oral Toxicity of Tembotrione Metabolites to Mammals					
Species	**% metabolite**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number. (Study Classification)**
Tembotrione metabolite AE 0456148 (2-chloro-3-(2,2,2-trifluoroethoxymethyl)-4-methylsulfonylbenzoic acid)					
Rat (females only)	99.0	LD_{50}: >2000 mg metabolite/ kg-bw	14-day, acute oral (single dose) toxicity study in female rats using the Up and Down Procedure. Nominal doses: 2000 (six animals) mg/kg-bw. A control group of animals was not prepared. Endpoints assessed: mortality, clinical abnormalities, body weight, and necropsy findings. **LD_{50}: >2000 mg metabolite/kg-bw** Female rats were administered the material by gavage. The test material was formulated in de-mineralized water with the aid of 2% Cremophor EL and given in a single dose at a volume of 10 mL/kg-bw. An initial group of three rats were dosed at 2000 mg metabolite/kg-bw. In the absence of compound-related mortality an additional group of three rats was dosed at 2000 mg metabolite/kg-bw. All animals were observed for 14 days after dosing. There were no signs of toxicity and no mortality; there were no abnormal findings at necropsy. All rats gained weight; however, since a control group was not used it cannot be determined if weight gain was "normal".	Practically non-toxic	MRID 46695620 (Unreviewed)
Tembotrione metabolite AE 1392936 (2-chloro-3-hydroxymethyl-4-mesylbenzoic acid)					
Rat (females only)	94.0	LD_{50}: >2000 mg metabolite/ kg-bw	14-day, acute oral (single dose) toxicity study in female rats using the Up and Down Procedure. Nominal doses: 2000 (six animals) mg/kg-bw.	Practically non-toxic	MRID 46695622 (Unreviewed)

Table E-15. Acute Oral Toxicity of Tembotrione Metabolites to Mammals					
Species	**% metabolite**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			A control group of animals was not prepared. Endpoints assessed: mortality, clinical abnormalities, body weight, and necropsy findings. **LD_{50}: >2000 mg metabolite/kg-bw** Female rats were administered the material by gavage. The test material was formulated in tap water with the aid of 2% Cremophor EL and given in a single dose at a volume of 10 mL/kg-bw. An initial group of three rats were dosed at 2000 mg metabolite/kg-bw. In the absence of compound-related mortality an additional group of three rats was dosed at 2000 mg metabolite/kg-bw. All animals were observed for 14 days after dosing. There were no signs of toxicity and no mortality; there were no abnormal findings at necropsy. All rats gained weight; however, since a control group was not used it cannot be determined if weight gain was "normal".		
Tembotrione metabolite AE 1417268 (2-{2-chloro-4-mesyl-3-[(2,2,2-trifluoroethoxy)methyl]benzoyl}-4,6-dihydroxycyclohexane-1,3-dione)					
Rat (females only)	97.9	LD_{50}: >2000 mg metabolite/ kg-bw	14-day, acute oral (single dose) toxicity study in female rats using the Up and Down Procedure. Nominal doses: 2000 (six animals) mg/kg-bw. A control group of animals was not prepared. Endpoints assessed: mortality, clinical abnormalities, body weight, and necropsy findings.	Practically non-toxic	MRID 46695621 (Unreviewed)

Table E-15. Acute Oral Toxicity of Tembotrione Metabolites to Mammals					
Species	**% metabolite**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			LD_{50}: >2000 mg metabolite/kg-bw Female rats were administered the material by gavage. The test material was formulated in tap water with the aid of 2% Cremophor EL and given in a single dose at a volume of 10 mL/kg-bw. An initial group of three rats were dosed at 2000 mg metabolite/kg-bw. In the absence of compound-related mortality an additional group of three rats was dosed at 2000 mg metabolite/kg-bw. All animals were observed for 14 days after dosing. There were no signs of toxicity and no mortality; there were no abnormal findings at necropsy. All rats gained weight; however, since a control group was not used it cannot be determined if weight gain was "normal".		

Table E-16. Reproductive Toxicity of Tembotrione (TGAI) to Mammals				
Species	**% a.i.**	**NOAEL**	**Comments**	**Identification Number (Study Classification)**
Rat	94	NOAEL (corneal opacity): parental: <1.3 mg/kg-bw/day in males, <1.6 mg/kg-bw/day in females; offspring: <3.2 mg/kg-bw/day. NOAEL (parental, systemic): parental: 1.3 mg/kg-bw/day in males, 1.6 mg/kg-bw/day in females; (offspring, systemic): 3.2 mg/kg-bw/day. NOAEL (reproductive): 98.2 mg/kg-bw/day in males, 115.4 mg/kg-bw/day in females.	Tembotrione TGAI was administered continuously in the feed to rats for two generations: nominal dietary concentrations: 0, 20, 200, and 1500 ppm; actual dose levels: parents: 1.3–1.6, 13.1–16.2, and 98.2–115.4 mg/kg-bw/day, respectively; offspring: 3.2, 30.7, and 228.1 mg/kg-bw/day, respectively. Endpoints assessed: body weight, food consumption, clinical examinations, estrous cycle, sperm analysis, reproductive parameters, post-weaning developmental landmarks, and post-mortem examination. **NOAEL (corneal opacities in males and females in both generations): parental: <1.3 mg/kg-bw/day in males, <1.6 mg/kg-bw/day in females; offspring: <3.2 mg/kg-bw/day** LOAEL (corneal opacities in males and females in both generations): parental: 1.3 mg/kg-bw/day in males, 1.6 mg/kg-bw/day in females; offspring: 3.2 mg/kg-bw/day. **NOAEL (parental, systemic): 1.3 mg/kg-bw/day in males, 1.6 mg/kg-bw/day in females.** LOAEL (parental, systemic): 13.1 mg/kg-bw/day in males, 15.4 mg/kg-bw/day in females (based on decreased body weight, food consumption, and dilated renal pelvis). **NOAEL (offspring, systemic): 3.2 mg/kg-bw/day.** LOAEL (offspring, systemic): 30.7 mg/kg-bw/day (based on decreased body weight and body weight gains in F_1 and F_2 male and female juvenile (post-weaning) offspring). No effects on reproductive performance at any dose level in either generation. **NOAEL (reproductive): 98.2 mg/kg-bw/day in males, 115.4 mg/kg-bw/day in females.** LOAEL (reproductive): >98.2 mg/kg-bw/day in males, >115.4 mg/kg-bw/day in females.	MRID 46695704 (Unreviewed); Bayer 2005

d. Terrestrial Insects, Acute Contact

A honey bee acute contact study using the TGAI is required because outdoor use of tembotrione will result in honey bee exposure. The acute contact LD_{50}, using the honey bee, *Apis mellifera*, is an acute contact, single-dose laboratory test designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of bees. The TGAI is administered by one of two methods: whole body exposure to technical pesticide in a non-toxic dust diluent or topical exposure to technical pesticide via micro-applicator. The median lethal dose (LD_{50}) is expressed in micrograms of active ingredient per bee (μg a.i./bee).

One acute contact toxicity study of tembotrione TGAI in honey bees was submitted (MRID 46695507; Supplemental). Study details and results are summarized in **Table E-17**. A 72-hour contact LD_{50} >100 μg a.i./bee was shown in this study, indicating that tembotrione (TGAI) is practically non-toxic to honey bees. Although MRID 46695507 was classified as Supplemental the study was also found to not meet the guideline requirements. Thus, the Guideline (141-1) is not fulfilled.

One acute oral toxicity study of tembotrione TGAI in honey bees was submitted, yielding an acute (72-hour) oral LD_{50} >92.8 μg a.i./bee (MRID 46695508; Supplemental). Study details and results are summarized in **Table E-17**. This acute oral study is scientifically sound but is classified as Supplemental because the study is a non-guideline study and does not fulfill a guideline requirement.

One acute contact toxicity study of tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl) in honey bees was submitted (MRID 46695509; Supplemental). Study details and results are summarized in **Table E-18**. A 48-hour contact LD_{50} >130.4 μg a.i./bee was shown in this study, indicating that the tembotrione formulated product is practically non-toxic to honey bees.

One acute oral toxicity study of tembotrione formulated product (33.9% tembotrione + 18.1% isoxadifen-ethyl) in honey bees was submitted, yielding an acute (48-hour) oral LD_{50} of 153.4 μg a.i./bee (MRID 46695510; Supplemental). Study details and results are summarized in **Table E-18**. This acute oral study is scientifically sound but is classified as Supplemental because the study is a non-guideline study and does not fulfill a guideline requirement.

Table E-17. Acute Toxicity of Tembotrione (TGAI) to Honey Bees					
Species	**% a.i.**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			Acute Contact Toxicity		
Honey bee (*Apis mellifera*)	95	72-hr LD_{50}: >100 µg a.i./bee	72-hour acute contact toxicity study. Tembotrione was diluted with acetone and applied to the ventral thorax of each bee using a micro-applicator. Nominal doses: 0, 10, 25, 50, 71.3, and 100 µg a.i./bee. **72-hr LD_{50}: >100 µg a.i./bee** 95% C.I.: N/A Probit Slope: N/A NOAEL: 71.3 µg a.i./bee	Practically non-toxic	MRID 46695507 (Supplemental)
			Acute Oral Toxicity		
Honey bee (*Apis mellifera*)	95	72-hr LD_{50}: >92.8 µg a.i./bee	72-hour acute oral toxicity study. Tembotrione was mixed with powdered sugar, honey, and deionized water; the pastes were provided to bees in feeding tubes for 5 hours of uptake. Calculated concentrations: 1.54, 5.17, and 92.8 µg a.i./bee. 72-hr LD_{50}: >92.8 µg a.i./bee 95% C.I.: not calculable Probit Slope: N/A NOAEL: 92.8 µg a.i./bee	Does not apply (non-guideline study)	MRID 46695508 (Supplemental) Non-guideline

Table E-18. Acute Toxicity of Tembotrione Formulated Product to Honey Bees					
Species	**% a.i.**	**LD_{50}**	**Comments**	**Toxicity Category**	**Identification Number (Study Classification)**
			Acute Contact Toxicity		
Honey bee (*Apis mellifera*)	33.9	48-hr LD_{50}: >130.4 µg a.i./bee	48-hour acute contact toxicity study. The test substance (tembotrione, 33.9% + isoxadifen-ethyl, 18.1%) was diluted with drinking water; the test solution was applied to the ventral thorax of each bee using a microapplicator. Nominal doses: 0, 32.6, 65.2, and 130.4 µg a.i./bee. 48-hr LD_{50}: >130.4 µg a.i./bee 95% C.I.: N/A Probit Slope: N/A NOAEL: 130.4 µg a.i./bee	Practically non-toxic	MRID 46695509 (Supplemental, non guideline)
			Acute Oral Toxicity		
Honey bee (*Apis mellifera*)	33.9	LD_{50}: 153.4 µg a.i./bee	48-hour acute oral toxicity study. Tembotrione formulated product (tembotrione, 33.9% + isoxadifen-ethyl, 18.1%) was mixed with 50% sucrose solution; test solutions were provided in feeding tubes for 5 hours of uptake. Calculated doses: 84.8, 121.1, and 183.1 µg a.i./bee. LD_{50}: 153.4 µg a.i./bee 95% C.I.: 139.3–173.2 µg a.i./bee Probit Slope: 7.9 95% C.I.: 5.0–10.8 NOAEL: 84.8 µg a.i./bee	Does not apply (non-guideline study)	MRID 46695510 (Supplemental) Non-guideline

e. Earthworms, Acute Toxicity

No acute toxicity studies of tembotrione TGAI, formulations, or degradates in earthworms were submitted.

f. Field Studies on Non-Target Terrestrial Invertebrates

No field studies of tembotrione TGAI, formulations, or degradates in non-target terrestrial invertebrates were submitted.

VI. Plants Inhabiting Terrestrial Environments

Terrestrial plant testing (seedling emergence and vegetative vigor) is required for herbicides that have terrestrial non-residential outdoor use patterns and/or may have endangered or threatened plant species associated with the application site. Seedling emergence and vegetative vigor testing of the following plant species and groups should be conducted: (1) six species of at least four dicotyledon families, including one soybean species (*Glycine max*) and one root crop, and (2) four species of at least two monocotyledon families, including one which is corn (*Zea mays*). Tier II tests measure the responses of plants at five or more test chemical concentrations relative to a control.

One Tier II study of the effect of the tembotrione formulation AE 0172747 SC52 (34.8% a.i.) on seed emergence in terrestrial plants was submitted (MRID 46695511; Acceptable). Study details and results of this study are summarized in **Table E-19** (for most sensitive species) and **Table E-20** (synopsis for Tier II seedling emergence testing, including all endpoints).

The Tier II seedling emergence study with the tembotrione formulation AE 0172747 SC52 (MRID 46695511; Acceptable) was conducted in monocots: corn (*Zea mays)*; onion (*Allium cepa)*; ryegrass (*Lolium perenne)*; and wheat (*Triticum aestivum)* and dicots: cucumber (*Cucumis sativus)*; lettuce *(Lactuca sativa)*; radish (*Raphanus sativus)*; soybean (*Glycine max)*; sunflower (*Helianthus annua)*; and tomato (*Lycopersicon esculentum)*. Onion was the most sensitive monocot and dry weight was the most sensitive endpoint with NOAEC, EC_{05}, and EC_{25} values of 0.011 lbs a.i./acre, 0.014 lbs a.i./acre, and 0.028 lbs a.i./acre, respectively. Lettuce was the most sensitive dicot and dry weight was the most sensitive endpoint with NOAEC, EC_{05}, and EC_{25} values of 0.00035 lbs a.i./acre, <0.00018 lbs a.i./acre, and 0.00039 lbs a.i./acre, respectively. These values will be used to assess the effects of exposure to tembotrione on seedling emergence in non-listed and listed terrestrial plants. The Guideline (23-1[a]) is fulfilled.

Phytotoxicity is rated as follows: 0%, no noticeable effect; 20%, slight plant effects or effect restricted to one area of the plant (e.g., a leaf); 40%, moderate effect involving the whole plant (mild stunting, chlorosis); 60%, severe effect with recovery possible; 80%, total plant effect (very poor vigor); and 100%, moribund or plant death was evaluated in the seedling emergence study (MRID 46695511; Acceptable). Sunflower was the only dicot species with a phytotoxicity rating of ≥50%. Effects included height inhibition, necrosis, and leaf curl; however, these effects had decreased in severity (20%) by test termination. Onion exhibited a phytotoxicity rating of 73% at the highest treatment level. All other monocot species exhibited phytotoxic effects, but not as severe as onion. Observed effects included stunting, bleaching, height inhibition, necrosis, albinism, leaf curl, leaf deformity, and mottling.

A Tier II vegetative vigor study with the tembotrione formulated product AE 0172747 SC52 (34.8% a.i.) was submitted (MRID 46695512; Acceptable). The Guideline (23-1[b]) is fulfilled.

Table E-19. Toxicity of Tembotrione Formulation to Terrestrial Plants — Results of Tier II Testing (Seedling Emergence) for the Most Sensitive Species				
Species	**% a.i.**	**Toxicity Values**	**Comments**	**Identification Number (Study Classification)**
Tier II Seedling Emergence				
Monocots: corn (*Zea mays*); onion (*Allium cepa*); ryegrass (*Lolium perenne*); and wheat (*Triticum aestivum*) Dicots: cucumber (*Cucumis sativus*); lettuce (*Lactuca sativa*); radish (*Raphanus sativus*); soybean (*Glycine max*); sunflower (*Helianthus annua*); and tomato (*Lycopersicon esculentum*)	34.8	Monocot: EC_{25}/IC_{25}: 0.028 lbs a.i./acre (onion; dry weight) Dicot: EC_{25}/IC_{25}: 0.00039 lbs a.i./acre (lettuce; dry weight)	21-day seedling emergence test. Application rates: corn and radish, nominal application rates: 0 (negative and adjuvant controls), 0.0022, 0.0046, 0.0092, 0.018, and 0.037 lbs a.i./acre; measured application rates were <LOQ (negative and adjuvant controls), 0.0024, 0.0051, 0.0095, 0.019, and 0.039 lbs a.i./acre. Lettuce, nominal application rates: 0 (negative and adjuvant controls), 0.00018, 0.00035, 0.00070, 0.0014, 0.0027, 0.0055, and 0.011 lbs a.i./acre; measured application rates were <LOQ (negative and adjuvant controls), 0.00018, 0.00035, 0.00070, 0.0014, 0.0027, 0.0054, and 0.011 lbs a.i./acre. Onion, cucumber, ryegrass, sunflower, and wheat, nominal application rates: 0 (negative and adjuvant controls), 0.0055, 0.011, 0.022, 0.044, and 0.088 lbs a.i./acre; measured application rates were <LOQ (negative and adjuvant controls), 0.0054, 0.011, 0.020, 0.040, and 0.082 lbs a.i./acre. Soybean, nominal application rates: 0 (negative and adjuvant controls), 0.0027, 0.0055, 0.011, 0.022, and 0.044 lbs a.i./acre; measured application rates were <LOQ (negative and adjuvant controls), 0.0027, 0.0054, 0.011, 0.020, and 0.040 lbs a.i./acre. Tomato, nominal application rates: 0 (negative and adjuvant controls), 0.00029, 0.00059, 0.0011, 0.0023, 0.0046, and 0.0092 lbs a.i./acre; measured application rates were <LOQ (negative and adjuvant controls), 0.00030, 0.00061, 0.0012, 0.0025, 0.0051, and 0.0095 lbs a.i./acre. On Day 21 the surviving plants per pot were recorded and cut at soil level for measuring the plant height and dry weight. **Most sensitive monocot: onion** **Most sensitive parameter: dry weight** EC_{25}/IC_{25}: 0.028 lbs a.i./acre 95% C.I.: 0.019–0.043 lbs a.i./acre EC_{50}/IC_{50}: 0.046 lbs a.i./acre 95% C.I.: 0.035–0.059 lbs a.i./acre EC_{05}/IC_{05}: 0.014 lbs a.i./acre 95% C.I.: 0.0072–0.029 lbs a.i./acre NOAEC: 0.011 lbs a.i./acre Slope: 3.27; Standard Error: 0.690	MRID 46695511 (Acceptable)

Table E-19. Toxicity of Tembotrione Formulation to Terrestrial Plants — Results of Tier II Testing (Seedling Emergence) for the Most Sensitive Species				
Species	**% a.i.**	**Toxicity Values**	**Comments**	**Identification Number (Study Classification)**
			Most sensitive dicot: lettuce **Most sensitive parameter: dry weight** EC_{25}/IC_{25}: 0.00039 lbs a.i./acre 95% C.I.: 0.000033–0.0047 lbs a.i./acre EC_{50}/IC_{50}: 0.0031 lbs a.i./acre 95% C.I.: 0.00074–0.013 lbs a.i./acre EC_{05}/IC_{05}: <0.00018 lbs a.i./acre 95% C.I.: N/A NOAEC: 0.00035 lbs a.i./acre Slope: 0.751; Standard error: 0.265	

Table E-20. Toxicity of Tembotrione Formulation to Terrestrial Plants — Results Synopsis for Tier II Seedling Emergence Testing										
Species	**Results Summary for Dry Weight (lbs a.i./acre)**									
	g*	**NOAEC**	**EC_{05}**	**95%C.I.**	**EC_{25}**	**95%C.I.**	**EC_{50}**	**95%C.I.**	**Slope**	**SE**
Corn	13.322–16.251	0.039	<0.0024	N/A	>0.039	N/A	>0.039	N/A	0.0203	0.430
Onion	0.031–0.179	0.011	0.014	0.0072–0.029	0.028	0.019–0.043	0.046	0.035–0.059	3.27	0.690
Ryegrass	0.393–0.502	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Wheat	1.167–1.307	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Cucumber	13.583–20.755	0.040	0.042	0.017–0.10	0.071	0.055–0.092	>0.082	N/A	4.25	2.66
Lettuce	0.231–0.706	0.00035	<0.00018	N/A	0.00039	0.000033–0.0047	0.0031	0.00074–0.013	0.751	0.265
Radish	1.634–2.436	0.019	ND	ND	ND	ND	>0.039	N/A	ND	ND
Soybean	2.208–2.734	0.011	0.0036	0.00026–0.051	>0.040	N/A	>0.040	N/A	0.695	0.332
Sunflower	9.989–14.054	0.040	<0.0054	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Tomato	1.124–1.781	0.0051	0.0026	0.00051–0.014	0.0074	0.0044–0.013	>0.0095	N/A	2.15	1.38
Species	**Results Summary for Plant Length (lbs a.i./acre)**									
	cm*	**NOAEC**	**EC_{05}**	**95%C.I.**	**EC_{25}**	**95%C.I.**	**EC_{50}**	**95%C.I.**	**Slope**	**SE**
Corn	78.5–82.1	0.039	>0.039	N/A	>0.039	N/A	>0.039	N/A	N/A	N/A
Onion	11.6–19.4	0.020	0.023	0.0073–0.073	0.058	0.038–0.088	0.11	0.070–0.17	2.44	1.07
Ryegrass	20.7–23.4	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Wheat	24.4–27.2	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Cucumber	30.9–37.9	0.040	0.053	0.027–0.10	>0.082	N/A	>0.082	N/A	3.61	2.53
Lettuce	7.4–11.2	0.0027	0.0024	0.00059–0.0095	0.0097	0.0062–0.015	>0.011	N/A	1.58	0.713
Radish	8.9–11.0	0.019	0.030	0.0043–0.21	>0.039	N/A	>0.039	N/A	5.36	18.2

Table E-20. Toxicity of Tembotrione Formulation to Terrestrial Plants — Results Synopsis for Tier II Seedling Emergence Testing

	Results Summary for Dry Weight (lbs a.i./acre)									
	cm*	NOAEC	EC_{05}	95%C.I.	EC_{25}	95%C.I.	EC_{50}	95%C.I.	Slope	SE
Soybean	14.1–14.5	0.040	>0.040	N/A	>0.040	N/A	>0.040	N/A	N/A	N/A
Sunflower	37.8–42.8	0.040	0.069	0.025–0.19	>0.082	N/A	>0.082	N/A	4.95	14.1
Tomato	13.2–17.1	0.0051	0.0052	0.0028–0.0095	>0.0095	N/A	>0.0095	N/A	3.01	1.45
	Results Summary for Survival (lbs a.i./acre)									
Species	%*	NOAEC	EC_{05}	95%C.I.	EC_{25}	95%C.I.	EC_{50}	95%C.I.	Slope	SE
Corn	100	0.039	>0.039	N/A	>0.039	N/A	>0.039	N/A	N/A	N/A
Onion	59–100	0.040	0.038	0.019–0.075	0.065	0.051–0.083	>0.082	N/A	4.04	1.70
Ryegrass	96–100	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Wheat	97–100	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Cucumber	95–100	0.082	ND	ND	>0.082	N/A	>0.082	N/A	N/A	N/A
Lettuce	85–100	0.0054	ND	ND	>0.011	N/A	>0.011	N/A	N/A	N/A
Radish	85–100	0.019	ND	ND	>0.039	N/A	>0.039	N/A	N/A	N/A
Soybean	100	0.040	>0.040	N/A	>0.040	N/A	>0.040	N/A	N/A	N/A
Sunflower	95–100	0.082	>0.082	N/A	>0.082	N/A	>0.082	N/A	N/A	N/A
Tomato	97–100	0.0095	>0.0095	N/A	>0.0095	N/A	>0.0095	N/A	N/A	N/A

* Range provided represents the range of the treatment means
N/A - Not applicable
ND - Not determined
SE - Standard error

APPENDIX F. The Risk Quotient Method and Levels of Concern

The risks to terrestrial and aquatic organisms are determined based on a method by which risk quotients (RQs) are compared with levels of concern (LOCs). This method provides an indication of a chemical's potential to cause an effect in the field from effects observed in laboratory studies, when used as directed. Risk quotients are expressed as the ratio of the estimated environmental concentration (EEC) to the species-specific toxicity reference value (TRV):

$$RQ = \frac{EEC}{TRV}$$

Units for EEC and TRV should be the same (e.g., µg/L or ppb). The RQ is compared to the LOC as part of a risk characterization. Acute and chronic LOCs for terrestrial and aquatic organisms are given in recent Agency guidance (USEPA 2004) and summarized in **Table F-1** below.

Table F-1. Level of concern (LOC) by risk presumption category (USEPA 2004)

Risk Presumption	RQ	LOC
Mammals and Birds		
Acute Risk [a]	EEC [b]/LC_{50} or LD_{50}/sqft [c] or LD_{50}/day [d]	0.5
Acute Restricted Use [e]	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} <50 mg/kg)	0.2
Acute Endangered Species [f]	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOEC	1
Aquatic Animals		
Acute Risk	EEC [g]/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOEC	1
Terrestrial and Semi-aquatic Plants		
Acute Risk	EEC/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOEC	1
Aquatic Plants		
Acute Risk	EEC [h]/EC_{50}	1
Acute Endangered Species	EEC [g]/EC_{05} or NOEC	1

[a] Potential for acute toxicity for receptor species if RQ > LOC (USEPA 2004).
[b] Estimated environmental concentration (ppm) on avian/mammalian food items
[c] mg/ft^2
[d] mg of toxicant consumed per day
[e] Potential for acute toxicity for receptor species, even considering restricted use classification, if RQ > LOC (USEPA 2004).
[f] Potential for acute toxicity for endangered species of receptor species if RQ > LOC (USEPA 2004).
[g] EEC = ppb or ppm in water
[h] EEC = lbs a.i./acre

For acute exposure to terrestrial and aquatic plants, an LOC of 1 is used. Currently the Agency does not perform assessments for chronic risk to plants or acute/chronic risks to non-target insects.

For the Tier II aquatic assessment of tembotrione acute exposure is represented by the maximum 24-hour EEC value calculated using PRZM/EXAMS. EECs used to assess acute and chronic risk to avian and mammalian species to tembotrione were calculated using the Tier I model T-REX.

The Agency has developed an Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts. At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984–28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future Federal Register notice. The Agency is not imposing label modifications at this time. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

Limitations in the use of tembotrione may be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. The Agency will notify the registrants if any label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

APPENDIX G. Detailed Risk Quotients (Proposed Label)

Table G-1. Chronic RQs for Freshwater Fish Exposed to Tembotrione by Ground Application

Application Scenario	Organism	NOAEC [a] (µg a.i./L)	60-Day EEC [b] (µg a.i./L)	Chronic RQ (EEC/NOAEC)
California Corn	Fathead minnow	604	0.36	<0.01
Florida Sweet Corn	Fathead minnow	604	8.06	0.01
Illinois Corn	Fathead minnow	604	4.42	<0.01
Mississippi Corn	Fathead minnow	604	3.46	<0.01
North Carolina Corn–East	Fathead minnow	604	1.64	<0.01
North Carolina Corn–West	Fathead minnow	604	4.15	<0.01
North Dakota Corn	Fathead minnow	604	2.96	<0.01
Ohio Corn	Fathead minnow	604	2.82	<0.01
Oregon Sweet Corn	Fathead minnow	604	1.22	<0.01
Pennsylvania Corn	Fathead minnow	604	1.72	<0.01
Texas Corn	Fathead minnow	604	2.81	<0.01

[a] RQs are based on the fathead minnow 34-day NOAEC = 0.604 mg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year 60-day average concentrations in surface water from PRZM/EXAMS.
+ Exceeds Chronic LOC (≥1)

Table G-2. Acute RQs for Freshwater Invertebrates Exposed to Tembotrione by Ground Application

Application Scenario	Organism	EC_{50} [a] (µg a.i./L)	EEC Peak [b] (µg a.i./L)	Acute RQ (EEC/EC_{50})
California Corn	Water flea	48900	0.39	<0.01
Florida Sweet Corn	Water flea	48900	9.09	<0.01
Illinois Corn	Water flea	48900	4.60	<0.01
Mississippi Corn	Water flea	48900	3.73	<0.01
North Carolina Corn–East	Water flea	48900	1.74	<0.01
North Carolina Corn–West	Water flea	48900	4.44	<0.01
North Dakota Corn	Water flea	48900	3.10	<0.01
Ohio Corn	Water flea	48900	2.97	<0.01
Oregon Sweet Corn	Water flea	48900	1.25	<0.01
Pennsylvania Corn	Water flea	48900	1.75	<0.01
Texas Corn	Water flea	48900	3.01	<0.01

[a] RQs are based on the waterflea 48-hour EC_{50} = 48.9 mg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.
* Exceeds Acute Listed Species LOC (≥0.05)
** Exceeds Acute Restricted Use LOC (≥0.1)
*** Exceeds Acute Risk LOC (≥0.5)

Table G-3. Chronic RQs for Freshwater Invertebrates Exposed to Tembotrione by Ground Application				
Application Scenario	**Organism**	**NOAEC [a] (µg a.i./L)**	**21-Day EEC [b] (µg a.i./L)**	**Chronic RQ (EEC/NOAEC)**
California Corn	Water flea	5100	0.38	<0.01
Florida Sweet Corn	Water flea	5100	8.85	<0.01
Illinois Corn	Water flea	5100	4.52	<0.01
Mississippi Corn	Water flea	5100	3.65	<0.01
North Carolina Corn–East	Water flea	5100	1.70	<0.01
North Carolina Corn–West	Water flea	5100	4.33	<0.01
North Dakota Corn	Water flea	5100	3.04	<0.01
Ohio Corn	Water flea	5100	2.90	<0.01
Oregon Sweet Corn	Water flea	5100	1.24	<0.01
Pennsylvania Corn	Water flea	5100	1.74	<0.01
Texas Corn	Water flea	5100	2.92	<0.01

[a] RQs are based on the water flea 21-day NOAEC = 5.10 mg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year 21-day average concentrations in surface water from PRZM/EXAMS.
+ Exceeds Chronic LOC (≥1)

Table G-4. Acute RQs for Estuarine/Marine Invertebrates (Shrimp) Exposed to Tembotrione by Ground Application				
Application Scenario	**Organism**	**LC_{50} [a] (µg a.i./L)**	**EEC Peak [b] (µg a.i./L)**	**Acute RQ (EEC/LC_{50})**
California Corn	Mysid shrimp	100	0.39	<0.01
Florida Sweet Corn	Mysid shrimp	100	9.09	**0.09***
Illinois Corn	Mysid shrimp	100	4.60	**0.05***
Mississippi Corn	Mysid shrimp	100	3.73	0.04
North Carolina Corn–East	Mysid shrimp	100	1.74	0.02
North Carolina Corn–West	Mysid shrimp	100	4.44	0.04
North Dakota Corn	Mysid shrimp	100	3.10	0.03
Ohio Corn	Mysid shrimp	100	2.97	0.03
Oregon Sweet Corn	Mysid shrimp	100	1.25	0.01
Pennsylvania Corn	Mysid shrimp	100	1.75	0.02
Texas Corn	Mysid shrimp	100	3.01	0.03

[a] RQs are based on the mysid shrimp 96-hour EC_{50} = 100 µg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.
* Exceeds Acute Listed Species LOC (≥0.05)
** Exceeds Acute Restricted Use LOC (≥0.1)
*** Exceeds Acute Risk LOC (≥0.5)

Table G-5. <u>Chronic</u> RQs for Estuarine/Marine Invertebrates (Shrimp) Exposed to Tembotrione by Ground Application				
Application Scenario	**Organism**	**NOAEC [a] (µg a.i./L)**	**21-Day EEC [b] (µg a.i./L)**	**Chronic RQ (EEC/NOAEC)**
California Corn	Mysid shrimp	<1.6	0.38	>0.24
Florida Sweet Corn	Mysid shrimp	<1.6	8.85	**>5.53+**
Illinois Corn	Mysid shrimp	<1.6	4.52	**>2.83+**
Mississippi Corn	Mysid shrimp	<1.6	3.65	**>2.28+**
North Carolina Corn–East	Mysid shrimp	<1.6	1.70	**>1.06+**
North Carolina Corn–West	Mysid shrimp	<1.6	4.33	**>2.71+**
North Dakota Corn	Mysid shrimp	<1.6	3.04	**>1.90+**
Ohio Corn	Mysid shrimp	<1.6	2.90	**>1.81+**
Oregon Sweet Corn	Mysid shrimp	<1.6	1.24	>0.78
Pennsylvania Corn	Mysid shrimp	<1.6	1.74	**>1.09+**
Texas Corn	Mysid shrimp	<1.6	2.92	**>1.8+**

[a] RQs are based on the mysid shrimp 28-day NOAEC = <1.6 µg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year 21-day average concentrations in surface water from PRZM/EXAMS.
+ Exceeds Chronic LOC (≥1)

Table G-6. <u>Acute</u> RQs for Aquatic Macrophytes Exposed to Tembotrione by Ground Application						
Application Scenario	**Organism**	**EC_{50} [a] (µg a.i./L)**	**NOAEC [a] (µg a.i./L)**	**EEC Peak [b] (µg a.i./L)**	**Acute RQ Non-Listed (EEC/EC_{50})**	**Acute RQ Listed (EEC/NOAEC)**
California Corn	Duckweed	5.2	2.84	0.39	0.08	0.14
Florida Sweet Corn	Duckweed	5.2	2.84	9.09	**1.75*****	**3.20**
Illinois Corn	Duckweed	5.2	2.84	4.60	0.88	**1.62**
Mississippi Corn	Duckweed	5.2	2.84	3.73	0.72	**1.19**
North Carolina Corn–East	Duckweed	5.2	2.84	1.74	0.33	**0.61**
North Dakota Corn	Duckweed	5.2	2.84	3.10	0.60	**1.09**
Ohio Corn	Duckweed	5.2	2.84	2.97	0.57	**1.05**
Oregon Sweet Corn	Duckweed	5.2	2.84	1.25	0.24	**0.44**
Pennsylvania Corn	Duckweed	5.2	2.84	1.75	0.34	**0.62**
Texas Corn	Duckweed	5.2	2.84	3.01	0.58	**1.06**

[a] RQs are based on the duckweed 14-day EC_{50} (non-listed) =5.2 µg a.i./L and the 14-day NOAEC (listed) = 2.84 µg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.
* Exceeds Acute Listed Species LOC (≥1)
*** Exceeds Acute Non-Listed Species LOC for Aquatic Plants (≥1)

Table G-7. Acute RQs for Freshwater Algae Exposed to Tembotrione by Ground Application						
Application Scenario	**Organism**	**EC_{50} [a] (µg a.i./L)**	**NOAEC [a] (µg a.i./L)**	**EEC Peak [b] (µg a.i./L)**	**Acute RQ Non-Listed (EEC/EC_{50})**	**Acute RQ Listed (EEC/NOAEC)**
California Corn	*P. subcapitata*	310	200	0.39	<0.01	0.0020
Florida Sweet Corn	*P. subcapitata*	310	200	9.09	0.03	0.045
Illinois Corn	*P. subcapitata*	310	200	4.60	0.01	0.0030
Mississippi Corn	*P. subcapitata*	310	200	3.73	0.01	0.017
North Carolina Corn–East	*P. subcapitata*	310	200	1.74	<0.01	0.0087
North Dakota Corn	*P. subcapitata*	310	200	3.10	0.01	0.016
Ohio Corn	*P. subcapitata*	310	200	2.97	<0.01	0.015
Oregon Sweet Corn	*P. subcapitata*	310	200	1.25	<0.01	0.0063
Pennsylvania Corn	*P. subcapitata*	310	200	1.75	<0.01	0.0088
Texas Corn	*P. subcapitata*	310	200	3.01	<0.01	0.015

[a] RQs are based on the freshwater algae (*Pseudokircheriella subcapitata*) 96-hour EC_{50} =0.310 mg a.i./L and NOAEC = 0.070 mg a.i./L.
[b] EEC values (µg/L) are 1-in-10 year peak concentrations in surface water from PRZM/EXAMS.
* Exceeds Acute Listed Species LOC (≥1)
*** Exceeds Acute Non-Listed Species LOC for Aquatic Plants (≥1)

Table G-8. Dietary-Based Chronic RQs for Birds Based on Upper Bound Residues as Calculated by T-REX				
	Avian Chronic Risk Quotients [a]			
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/Large Insects**
Corn	>0.53	>0.24	>0.30	>0.03

[a] Chronic dietary-based RQ = EEC/NOAEC, where EECs values are upper bound residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of <65.3 mg a.i./kg diet in mallard ducks. See Appendix D for full T-REX output.
\+ Exceeds Chronic LOC (≥1)

Table G-9. Dose-Based **Chronic** RQs for Mammals Based on **Upper Bound** Residues and Chronic NOAEC of <20 ppm for Corneal Opacity as Calculated by T-REX						
		Mammalian Chronic Risk Quotients				
Crop Use	Body Weight (g)	Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/Pods/ Large Insects	Seeds
Corn [a]	15	**>15.01+**	**>6.88+**	**>8.44+**	>0.94	>0.21
	35	**>12.82+**	**>5.88+**	**>7.21+**	>0.80	>0.18
	1000	**>6.87+**	**>3.15+**	**>3.87+**	>0.43	>0.10

[a] Dose-base chronic RQ = EEC/NOAEL, where EECs values are upper bound residues expressed as equivalent dose (mg a.i./kg-bw) generated from T-REX and the chronic toxicity value is the chronic NOAEL = <1 mg a.i./kg-bw in rats, converted from the NOAEC of <20 mg a.i./kg diet in the rat using the standard FDA lab rat conversion by T-REX. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-10. Dose-Based **Chronic** RQs for Mammals Based on **Mean Residues** and Chronic NOAEC of <20 ppm for Corneal Opacity as Calculated by T-REX						
		Mammalian Chronic Risk Quotients				
Crop Use	Body Weight (g)	Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/Pods/ Large Insects	Seeds
Corn[a]	15	**>5.30+**	**>2.24+**	**>2.80+**	>0.44	>0.10
	35	**>4.55+**	**>1.93+**	**>2.41+**	>0.37	>0.09
	1000	**>2.39+**	**>1.01+**	**>1.26+**	>0.2	>0.04

[a] Dose-base chronic RQ = EEC/NOAEL, where EECs values are mean residues expressed as equivalent dose (mg a.i./kg-bw) generated from T-REX and the chronic toxicity value is the chronic NOAEL = <1 mg a.i./kg-bw in rats, converted from the NOAEC of <20 mg a.i./kg diet in the rat using the standard FDA lab rat conversion by T-REX. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-11. Dose-Based **Chronic** RQs for Mammals Based on **Upper Bound** Residues and Chronic NOAEC of 20 ppm for Decreased Body Weight in Offspring as Calculated by T-REX						
		Mammalian Chronic Risk Quotients				
Crop Use	Body Weight (g)	Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/Pods/ Large Insects	Seeds
Corn [a]	15	**15.01+**	**6.88+**	**8.44+**	0.94	0.21
	35	**12.82+**	**5.88+**	**7.21+**	0.80	0.18
	1000	**6.87+**	**3.15+**	**3.87+**	0.43	0.10

[a] Dose-base chronic RQ = EEC/NOAEL, where EECs values are upper bound residues expressed as equivalent dose (mg a.i./kg-bw) generated from T-REX and the chronic toxicity value is the chronic NOAEL = 1 mg a.i./kg-bw in rats, converted from the NOAEC of 20 mg a.i./kg diet in the rat using the standard FDA lab rat conversion by T-REX. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-12. Dose-Based Chronic RQs for Mammals Based on Mean Residues and Chronic NOAEC of 20 ppm for Decreased Body Weight in Offspring as Calculated by T-REX						
		Mammalian Chronic Risk Quotients				
Crop Use	**Body Weight (g)**	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/ Large Insects**	**Seeds**
Corn[a]	15	**5.30+**	**2.24+**	**2.80+**	0.44	0.10
	35	**4.55+**	**1.93+**	**2.41+**	0.37	0.09
	1000	**2.39+**	**1.01+**	**1.26+**	0.2	0.04

[a] Dose-base chronic RQ = EEC/NOAEL, where EECs values are mean residues expressed as equivalent dose (mg a.i./kg-bw) generated from T-REX and the chronic toxicity value is the chronic NOAEL = 1 mg a.i./kg-bw in rats, converted from the NOAEC of 20 mg a.i./kg diet in the rat using the standard FDA lab rat conversion by T-REX. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-13. Dietary-Based Chronic RQs for Mammals Based on Upper Bound and Chronic NOAEC of <20 mg a.i./kg-diet for Corneal Opacity Residues as Calculated by T-REX				
	Mammalian Chronic Risk Quotients			
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/Large Insects**
Corn [a]	**>1.73+**	>0.79	>0.97	>0.11

[a] Dietary-based RQs = EEC/NOAEC, where EECs values are upper bound residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of <20 mg a.i./kg diet in rats. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-14. Dietary-Based Chronic RQs for Mammals Based on Mean Residues and Chronic NOAEC of <20 mg a.i./kg-diet for Corneal Opacity as Calculated by T-REX				
	Mammalian Chronic Risk Quotients			
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/Large Insects**
Corn [a]	>0.61	>0.26	>0.32	>0.05

[a] Dietary-based RQs = EEC/NOAEC, where EECs values are mean residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of <20 mg a.i./kg diet in rats. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-15. Dietary-Based Chronic RQs for Mammals Based on Upper Bound Residues and Chronic NOAEC of 20 mg a.i./kg-diet for Decreased Body Weight in Offspring as Calculated by T-REX				
	Mammalian Chronic Risk Quotients			
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/Large Insects**
Corn [a]	**1.73+**	0.79	0.97	0.11

[a] Dietary-based RQs = EEC/NOAEC, where EECs values are upper bound residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of 20 mg a.i./kg diet in rats. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-16. Dietary-Based Chronic RQs for Mammals Based on Mean Residues and Chronic NOAEC of 20 mg a.i./kg-diet for Decreased Body Weight in Offspring as Calculated by T-REX				
	Mammalian Chronic Risk Quotients			
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/Pods/Large Insects**
Corn [a]	0.61	0.26	0.32	0.05

[a] Dietary-based RQs = EEC/NOAEC, where EECs values are mean residues expressed as dietary concentrations (mg a.i./kg diet) generated from T-REX and the toxicity value is the chronic dietary NOAEC value of 20 mg a.i./kg diet in rats. See Appendix D for full T-REX output.
+ Exceeds Chronic LOC (≥1)

Table G-17. Risk Quotients for Non-Listed Species and Listed Species Terrestrial and Semi-Aquatic Plant Emergence in Areas Adjacent to Treatment Sites (Due to Drift) for Tembotrione							
		Risk Quotients [a]					
Application Rate (lbs a.i./acre)	**Crop Use**	**Terrestrial Plant Emergence (Adjacent Area)**		**Semi-Aquatic Plant Emergence (Adjacent Area)**		**Terrestrial Plant Vegetative Vigor (Drift)**	
		Monocot	**Dicot**	**Monocot**	**Dicot**	**Monocot**	**Dicot**
Non-Listed Terrestrial and Semi-Aquatic Plant [b]							
0.082	Corn (ground)	0.176	**12.62*****	**1.49*****	**107.23*****	NA	NA
Listed Terrestrial and Semi-Aquatic Plant [c]							
0.082	Corn (ground)	0.447	**>27.33*****	**3.8*****	**>232.33*****	NA	NA

[a] RQs are calculated using TERRPLANT. See Appendix C for full TERRPLANT output.
[b] Based on the EC_{25} value = 0.028 lbs a.i./acre for seedling emergence in monocots (onion) and the EC_{25} value = 0.00039 lbs a.i./acre in dicots (lettuce).
[c] Based on the NOAEC value = 0.011 lbs a.i./acre for seedling emergence in monocots (onion) and the EC_{05} value <0.00018 lbs a.i./acre in dicots (lettuce).
*** Exceeds Acute Listed Species/Non-Listed Species LOC for Terrestrial and Semi-Aquatic Plants (≥1)

APPENDIX H. Summary of Endangered/Threatened Species

Species Counts by State for Indicated Crops

No species were excluded.
Minimum of 1 Acre.
All Medium Types Reported

Corn for grain, corn for silage or greenchop, popcorn (irrigated), popcorn (shelled), sweet corn, sweet corn for seed

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

Alabama

The taxa Amphibian has 2 species co-occurring with indicated crops.

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 30 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 10 species co-occurring with indicated crops.

The taxa Ferns has 3 species co-occurring with indicated crops.

The taxa Fish has 15 species co-occurring with indicated crops.

The taxa Gastropod has 10 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

Arizona

The taxa Amphibian has 2 species co-occurring with indicated crops.

The taxa Bird has 8 species co-occurring with indicated crops.

The taxa Dicot has 16 species co-occurring with indicated crops.

The taxa Fish has 17 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 9 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

Arkansas

The taxa Bird has 3 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bivalve has 6 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Fish has 3 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

California

The taxa Amphibian has 6 species co-occurring with indicated crops.

The taxa Bird has 15 species co-occurring with indicated crops.

The taxa Conf/cycds has 2 species co-occurring with indicated crops.

The taxa Crustacean has 9 species co-occurring with indicated crops.

The taxa Dicot has 153 species co-occurring with indicated crops.

The taxa Fish has 26 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 21 species co-occurring with indicated crops.

The taxa Mammal has 20 species co-occurring with indicated crops.

The taxa Marine mml has 2 species co-occurring with indicated crops.

The taxa Monocot has 16 species co-occurring with indicated crops.

The taxa Reptile has 8 species co-occurring with indicated crops.

Colorado

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 8 species co-occurring with indicated crops.

The taxa Fish has 5 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Connecticut

The taxa Bird has 3 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Delaware

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Florida

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 9 species co-occurring with indicated crops.

The taxa Bivalve has 7 species co-occurring with indicated crops.

The taxa Conf/cycds has 1 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 47 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 8 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 10 species co-occurring with indicated crops.

Georgia

The taxa Amphibian has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 16 species co-occurring with indicated crops.

The taxa Conf/cycds has 1 species co-occurring with indicated crops.

The taxa Dicot has 11 species co-occurring with indicated crops.

The taxa Ferns has 2 species co-occurring with indicated crops.

The taxa Fish has 11 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 6 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

Hawaii

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 32 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 233 species co-occurring with indicated crops.

The taxa Ferns has 12 species co-occurring with indicated crops.

The taxa Gastropod has 39 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 22 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

Idaho

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Dicot has 3 species co-occurring with indicated crops.

The taxa Fish has 8 species co-occurring with indicated crops.

The taxa Gastropod has 6 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

Illinois

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 7 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Indiana

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 11 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Iowa

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 3 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Kansas

The taxa Bird has 4 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Kentucky

The taxa Bird has 7 species co-occurring with indicated crops.

The taxa Bivalve has 22 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 10 species co-occurring with indicated crops.

The taxa Fish has 5 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

Louisiana

The taxa Bird has 6 species co-occurring with indicated crops.

The taxa Bivalve has 3 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Reptile has 7 species co-occurring with indicated crops.

Maine

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Maryland

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Massachusetts

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 3 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

Michigan

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Insect has 4 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Minnesota

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Mississippi

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 6 species co-occurring with indicated crops.

The taxa Bivalve has 9 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 3 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Reptile has 7 species co-occurring with indicated crops.

Missouri

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 6 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 7 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Montana

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 5 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

Nebraska

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Nevada

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 8 species co-occurring with indicated crops.

The taxa Fish has 21 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

New Hampshire

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

New Jersey

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

New Mexico

The taxa Amphibian has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 7 species co-occurring with indicated crops.

The taxa Crustacean has 2 species co-occurring with indicated crops.

The taxa Dicot has 13 species co-occurring with indicated crops.

The taxa Fish has 13 species co-occurring with indicated crops.

The taxa Gastropod has 5 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

New York

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

North Carolina

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 8 species co-occurring with indicated crops.

The taxa Dicot has 21 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Monocot has 5 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

North Dakota

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Ohio

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 6 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 4 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

Oklahoma

The taxa Bird has 7 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Oregon

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 11 species co-occurring with indicated crops.

The taxa Fish has 22 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Monocot has 2 species co-occurring with indicated crops.

Pennsylvania

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Rhode Island

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

South Carolina

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 12 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 6 species co-occurring with indicated crops.

The taxa Monocot has 6 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

South Dakota

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Tennessee

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 38 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 17 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 16 species co-occurring with indicated crops.

The taxa Gastropod has 3 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Texas

The taxa Amphibian has 4 species co-occurring with indicated crops.

The taxa Arachnid has 10 species co-occurring with indicated crops.

The taxa Bird has 13 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 26 species co-occurring with indicated crops.

The taxa Fish has 7 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 9 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 6 species co-occurring with indicated crops.

Utah

The taxa Bird has 3 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Dicot has 22 species co-occurring with indicated crops.

The taxa Fish has 8 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Vermont

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Virginia

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 21 species co-occurring with indicated crops.

The taxa Crustacean has 2 species co-occurring with indicated crops.

The taxa Dicot has 13 species co-occurring with indicated crops.

The taxa Fish has 7 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 3 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Monocot has 4 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

Washington

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 18 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

West Virginia

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Bivalve has 5 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

Wisconsin

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

Wyoming

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

No species were excluded.

Dispersed species included in report.

APPENDIX I. Data Requirements

Table I-1. Environmental Fate Data Requirements for Tembotrione			
Guideline No.	**Data Requirement**	**MRID No.**	**Study Classification**
161-1	Hydrolysis (dark; pH 5, 7, and 9)	46695410	Acceptable
161-2	Photodegradation in Water (pH 7)	46695411	Acceptable
161-3	Photodegradation on Soil	46695412 46695413	Supplemental Supplemental
161-4	Photodegradation in Air	No Data	
162-1	Aerobic Soil Metabolism	46695414 46695415 46695416 46695417 46695418	Supplemental Supplemental Acceptable Supplemental Supplemental
162-2	Anaerobic Soil Metabolism	46695419 46695420	Acceptable Acceptable
162-3	Anaerobic Aquatic Metabolism	46695423 46695424	Acceptable Acceptable
162-4	Aerobic Aquatic Metabolism	46695421 46695422	Acceptable Acceptable
163-1	Adsorption/Desorption	46695404 46695405 46695406 46695407 46695408 46695409	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
163-2	Laboratory Volatility	No Data	
163-3	Field Volatility	No Data	
164-1	Terrestrial Field Dissipation	46695425	Acceptable
164-2	Aquatic Field Dissipation	No Data	
164-3	Forestry Dissipation	No Data	
165-4	Accumulation in Fish	No Data	
166-1	Ground Water – small prospective	No Data	
166-2	Ground Water – small retrospective	No Data	
201-1	Droplet Size Spectrum	No Data	
202-1	Drift Field Evaluation	No Data	

Table I-2. Ecological Effects Data Requirements for Tembotrione					
Guideline No.	**Data Requirement**	**Species**	**Formulation**	**Are data adequate for ecological risk assessment?**	**MRID Number (Study Classification)**
71-1 850.2100	Avian Acute Oral Toxicity	*Anas Platyrhynchos* (mallard duck)	Technical	No	466954 (Invalid)
		Colinus virginianu (bobwhite quail)	Technical	Yes	46695501 (Acceptable)
71-2 850.2200	Avian Subacute Dietary Toxicity	*Colinus virginianu* (bobwhite quail)	Technical	Yes	46695503 (Acceptable)
		Anas Platyrhynchos (mallard duck)	Technical	Yes	46695502 (Acceptable)
71-4 850.2300	Avian Reproduction Toxicity	*Colinus virginianu* (bobwhite quail)	Technical	Yes	46695504 (Supplemental)
		Anas Platyrhynchos (mallard duck)	Technical	Yes	46695505 (Supplemental)
				No	46695506 (Invalid)
72-1 850.1075	Freshwater Fish LC_{50}	*Lepomis macrochirus* (bluegill sunfish)	Technical	Yes	46695436 (Acceptable)
		Oncorhynchus mykiss (rainbow trout)	Technical	Yes	46695437 (Acceptable)
			Formulation [a]	Yes	46695438 (Acceptable)
			Metabolite [b]	Yes	46695439 (Acceptable)
72-2 850.1010	Freshwater Invertebrate Acute LC_{50}	*Daphnia magna* (water flea)	Technical	Yes	46695430 (Acceptable)
			Formulation [a]	Yes	46695431 (Acceptable)
			Metabolite [b]	No	46695432 (Invalid)
			Technical	Yes	46695440 (Acceptable)
			Metabolite [b]	Yes	46695441 (Acceptable)
72-3(a) 850.1075	Estuarine/Marine Fish LC_{50}	*Cyprinodon variegatus* (sheepshead minnow)	Technical	Yes	46695435 (Acceptable)
72-3(b) 850.1025	Estuarine/Marine Invertebrate (Mollusk)	*Crassostrea virginica* (eastern oyster)	Technical	No	46695433 (Invalid)
72-3(c) 850.1035 850.1045	Estuarine/Marine Invertebrate (Mysid)	*Americamysis bahia* (mysid shrimp)	Technical	Yes	46695434 (Acceptable)
72-4 (a) 850.1400	Fish Early Life-Stage (Freshwater) (Marine)	*Pimephales promelas* (fathead minnow)	Technical	Yes	46695443 (Acceptable)

Table I-2. Ecological Effects Data Requirements for Tembotrione					
Guideline No.	**Data Requirement**	**Species**	**Formulation**	**Are data adequate for ecological risk assessment?**	**MRID Number (Study Classification)**
72-4 (b) 850.1300 850.1350	Aquatic Invertebrate Life-Cycle (Freshwater) (Marine)	*Americamysis bahia* (mysid shrimp)	Technical	Yes	46695442 (Acceptable)
72-5 850.1500	Fish Full Life-Cycle (Freshwater) (Marine)	No data submitted	No data submitted	No	–
122-1(a) 850.4100	Seed Germination/ Seedling Emergence (Tier I)	No data submitted	No data submitted	No	–
122-1(b) 850.4150	Vegetative Vigor (Tier I)	No data submitted	No data submitted	No	–
122-2 850.4400	Aquatic Plant Growth (Tier I)	*Lemna gibba* (duckweed)	Technical	Yes	46695513 (Acceptable)
			Technical	Yes	46695514 (Acceptable)
123-1(a) 850.4225	Seed Germination/ Seedling Emergence (Tier II)	Monocots and Dicots	Formulation [c]	Yes	46695511 (Acceptable)
123-1(b) 850.4250	Vegetative Vigor (Tier II)	Monocots and Dicots	Formulation [c]	No	46695512 (Invalid)
123-2 850.4400	Aquatic Plant Growth (Tier II)	*Lemna gibba* (duckweed)	Technical	Yes	46695513 (Acceptable)
			Technical	Yes	46695514 (Acceptable)
123-2 850.5400	Algal Plant Toxicity (Tier I and Tier II)	*Anabaena flos-aquae* (freshwater alga)	Technical	No	46695515 (Invalid)
		Skeletonema costatum (marine alga)	Technical	No	46695516 (Invalid)
		Pseudokirchneriella subcapitata	Technical	Yes	46695517 (Acceptable)
		Navicula pelliculosa (freshwater alga)	Technical	Yes	46695518 (Acceptable)
		Pseudokirchneriella subcapitata	Formulation [a]	Yes	46695519 (Supplemental)
			Metabolite [b]	Yes	46695520 (Supplemental)
141-1 850.3020	Honeybee Acute Contact Toxicity Test	*Apis mellifera* (honey bee)	Technical	Yes	46695507 (Supplemental)
			Formulation [a]	Yes	46695509 (Acceptable)

Table I-2. Ecological Effects Data Requirements for Tembotrione					
Guideline No.	**Data Requirement**	**Species**	**Formulation**	**Are data adequate for ecological risk assessment?**	**MRID Number (Study Classification)**
141-2 850.3030	Residues on Foliage Honeybee Toxicity Test	No data submitted	No data submitted	No	–
Non-Guideline	Honeybee Feeding Toxicity Test	*Apis mellifera* (honey bee)	Technical	Yes	46695508 (Supplemental)
			Formulation [a]	Yes	46695510 (Supplemental)
Non-Guideline	Benthic Organisms	*Chironomus riparius* (midge)	Technical	Yes	46695444 (Supplemental)
Non-Guideline	Earthworm Subacute	No data submitted	No data submitted	No	–

[a] End-use product AE 172747: 33.9%; Isoxadifen-ethyl: 18.1%
[b] Metabolite: 99.0%
[c] AE 017247 SC52: 34.8%

APPENDIX J. Use Characterization Maps

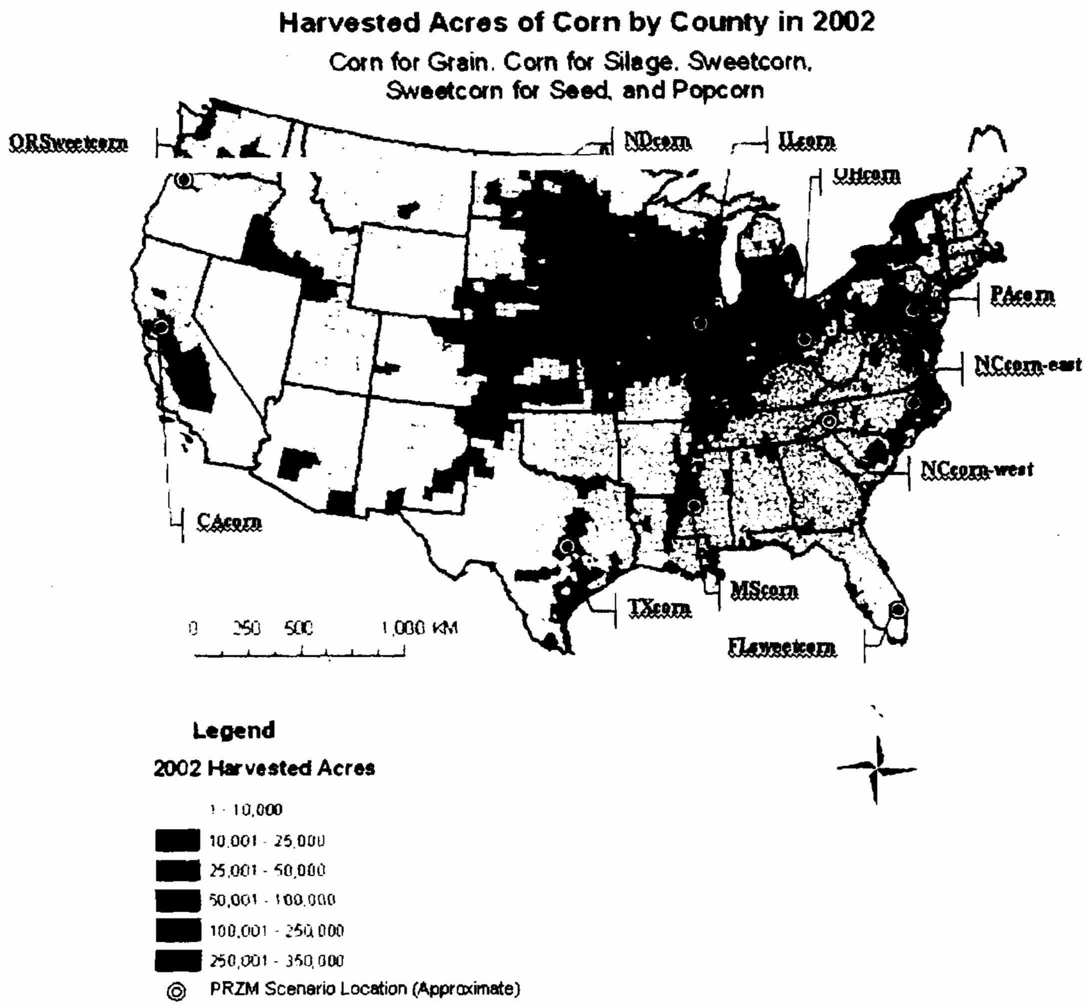


Figure J-1. Distribution of corn acreage in the conterminous U.S. based on USDA 2002 Census of Agriculture (data on corn grown for seed not available).

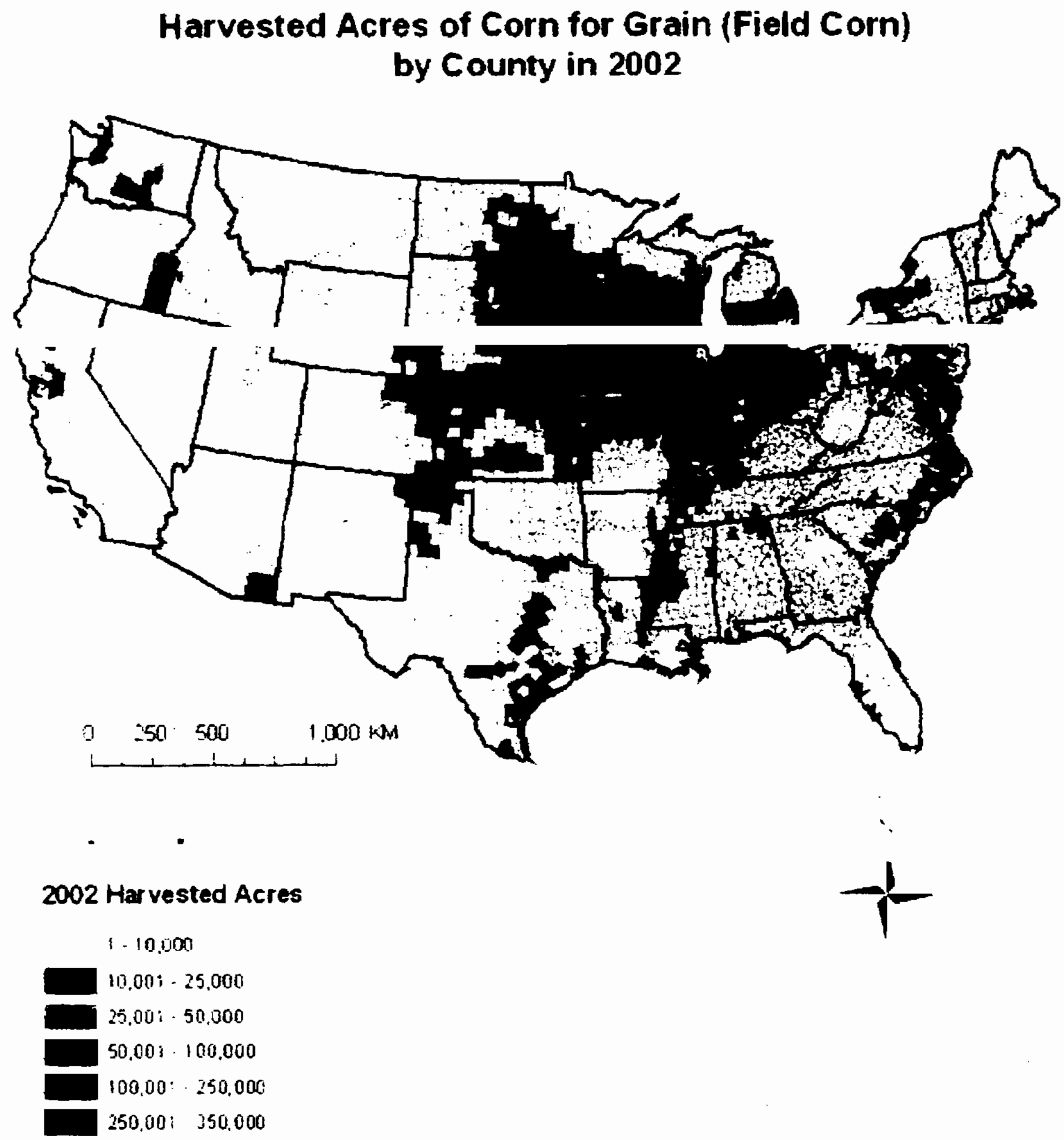


Figure J-2. Distribution of corn grown for grain in the conterminous U.S. based on USDA 2002 Census of Agriculture.

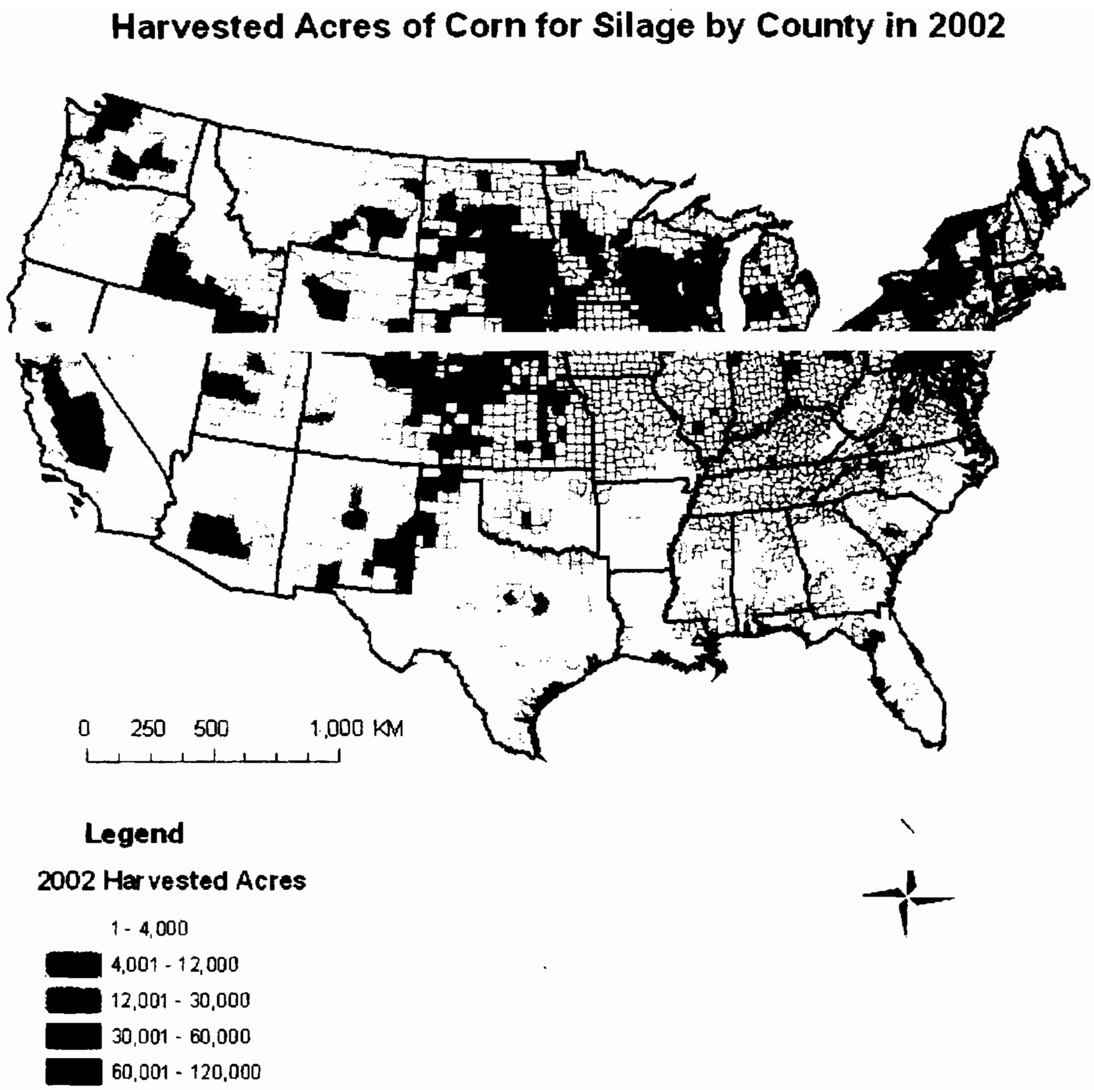


Figure J-3. Distribution of corn grown for silage in the conterminous U.S. based on USDA 2002 Census of Agriculture.

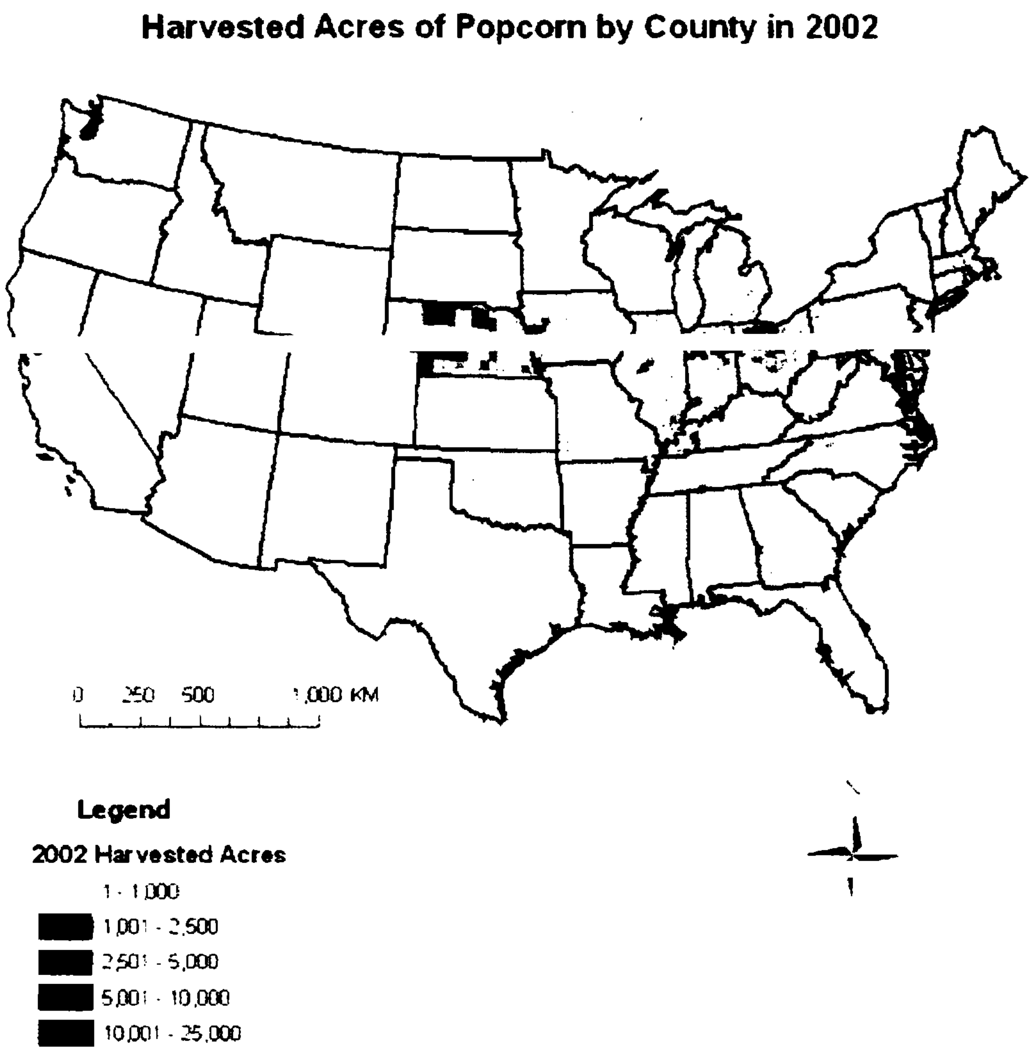


Figure J-4. Distribution of popcorn grown in the conterminous U.S. based on USDA 2002 Census of Agriculture.

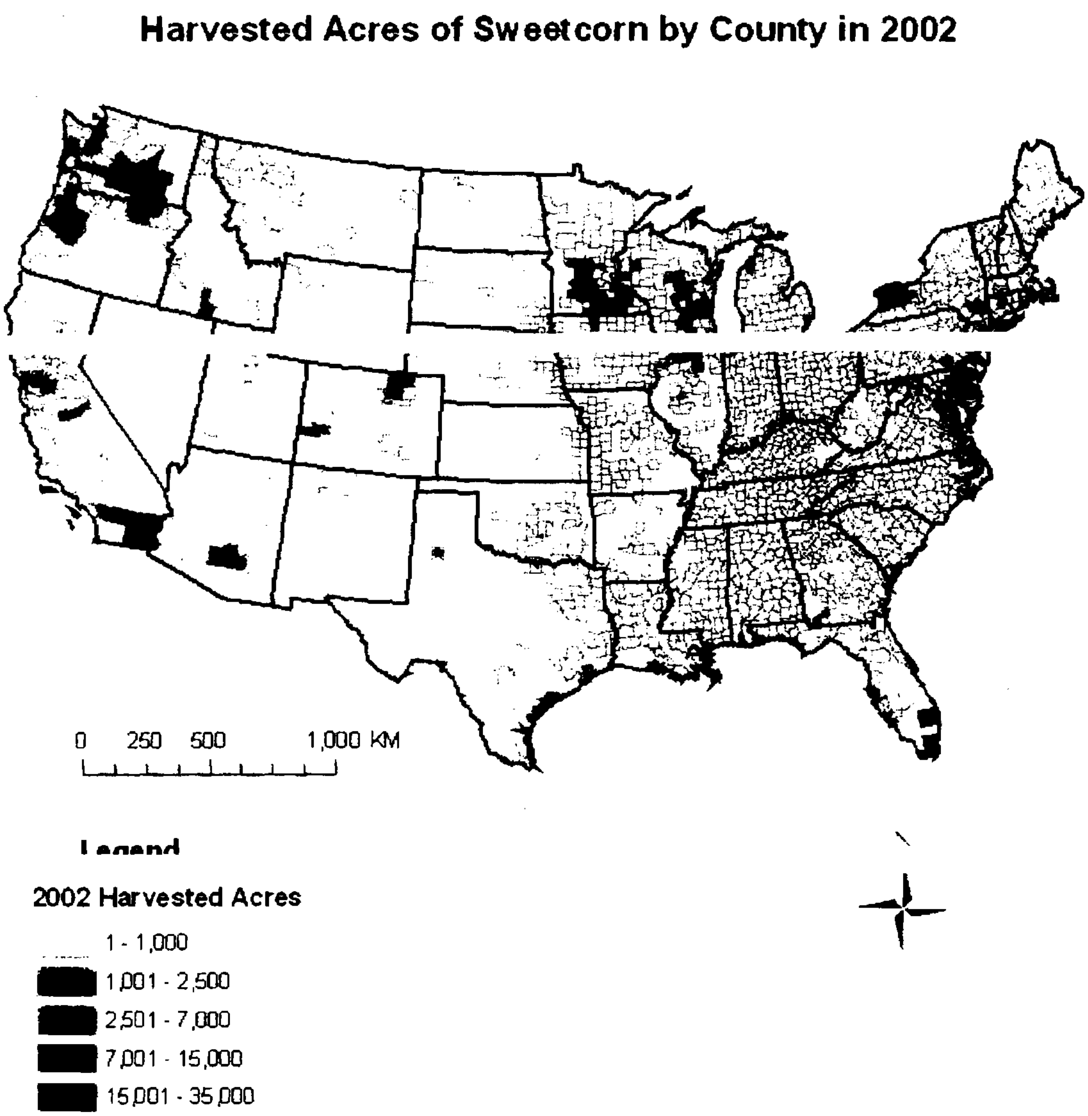


Figure J-5. Distribution of sweet corn grown in the conterminous U.S. based on USDA 2002 Census of Agriculture.

APPENDIX K. Environmental Fate Bibliography

MRID Studies Submitted to EPA

MRID 46695404 Mathew, A.E. and D.A. Desmarteau. 2003. Adsorption/desorption of [phenyl-UL-14C]AE 0172747 in six soils and a sediment. Unpublished study performed by Bayer CropScience, Stilwell, Kansas; sponsored and submitted by Bayer CropScience, Monheim, Germany. Bayer Report Number 200375. Bayer Study Number A7182101. Study start date September 2002, and completion date December 2002 (p. 14). Final report issued October 3, 2003.

MRID 46695405 Simmonds, M. 2005. [14C]-AE 0456148: adsorption to and desorption from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/073. Bayer CropScience AG Reference Number MEAEX054. Experiment start date October 27, 2003, and completion date February 2, 2004 (p. 6). Final report issued May 16, 2005.

MRID 46695406 Mills, E.A.M. 2005. [14C]-AE 0941989: adsorption/desorption in four soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/04/050. Bayer CropScience AG Reference Number MEAEX068. Experiment start date September 17, 2004, and completion date December 22, 2004 (p. 7). Final report issued May 16, 2005.

MRID 46695407 Simmonds, M. 2005. [14C]-AE 0968400: adsorption/desorption to and from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/063. Bayer CropScience AG Reference Number MEAEX012. Experiment start date February 19, 2004, and completion date May 22, 2004 (p. 5). Final report issued May 18, 2005.

MRID 46695408 Simmonds, M. 2005. [14C]-AE 1124336: adsorption/desorption to and from five soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/03/074. Bayer CropScience AG Reference Number MEAEX062. Experiment start date February 19, 2004, and completion date May 20, 2004 (p. 5). Final report issued May 18, 2005.

MRID 46695409 Mills, E.A.M. 2005. [14C]-AE 1392936: adsorption to and desorption from four soils. Unpublished study performed by Battelle AgriFood Ltd., Essex, UK; sponsored and submitted by Bayer CropScience AG, Monheim am Rhein, Germany. Battelle Report Number and Laboratory Project ID CX/04/044. Bayer CropScience AG Reference Number MEAEX070. Experiment start date September 17, 2004, and completion date December 23, 2004 (p. 7). Final report issued April 5, 2005.

MRID 46695410 Fliege, R. 2003. Abiotic hydrolysis of 14C-AE 0172747 in buffered aqueous solutions at pH 4, pH 7, and pH 9. Unpublished study performed, sponsored, and submitted by Bayer CropScience GmbH, Frankfurt, Germany. Laboratory Project ID: CP 02/020. Experimental start date November 28, 2002, and completion date February 24, 2003 (p. 6). Final report issued June 5, 2003.

MRID 46695411 Hellpointner, E. 2004. Phototransformation of AE 0172747 in sterile water buffered at pH 7. Unpublished study performed, sponsored and submitted by Bayer CropScience AG Development, Monheim, Germany. Bayer CropScience Study No.: M1121297-3. Experiment start date June 24, 2003, and completion date July 8, 2003 (p. 6). Final report issued April 14, 2004.

MRID 46695412 Desmarteau, D.A. 2004. [Phenyl-UL-14C]AE 0172747: phototransformation on soil. Unpublished study performed by Bayer CropScience, Stilwell, KS and Monheim, Germany, and Agvise Laboratories, Inc. Northwood, ND; sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: A7082101. Bayer Report No.: 200764. Experimental start date August 18, 2003, and completion date December 19, 2003 (p. 6). Final report issued April 16, 2004.

MRID 46695413 Desmarteau, D.A. 2004. [Cyclohexyl-UL-14C]AE 0172747: phototransformation on soil. Unpublished study performed by Bayer CropScience, Environmental Research Section, Stilwell, KS and Monheim, Germany, and Agvise Laboratories, Inc. Northwood, ND; sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: A7082102. Bayer Report No.: 200804. Experimental start date October 14, 2003, and completion date December 3, 2003 (p. 6). Final report issued June 18, 2004.

MRID 46695414 Fliege, R. 2003. Route and rate of degradation of [phenyl-U-14C]-AE 0172747 and [cyclohexyl-U-14C]-AE 0172747 in one European soil under aerobic laboratory conditions at 20°C and 10°C. Unpublished study performed, sponsored and submitted by Bayer CropScience Gmbh, Frankfurt, Germany. Laboratory Project ID: CB 01/018. Experiment initiated on October 22, 2001, and completed on February 03, 2003 (p. 7). Final report issued June 12, 2003.

MRID 46695415 Fliege, R. 2003. Rate of degradation of [phenyl-U-14C]-AE 0172747 in three European soils under aerobic laboratory conditions at 20°C. Unpublished study performed, sponsored, and submitted by Bayer CropScience Gmbh, Frankfurt, Germany. Laboratory Project ID: CB 01/019. Experiment initiated on December 3, 2001, and completed on February 5, 2003 (p. 7). Final report issued July 24, 2003.

MRID 46695416 Dominic, A.R., E.L. Arthur and S.G. Mislankar. 2005. The route and rate of degradation of [phenyl-U-14C]AE 0172747 in two US soils and [cyclohexyl-U-14C]AE 0172747 in one soil under laboratory aerobic conditions at 25°C. Unpublished study performed by Bayer CropScience, Stilwell, KS, and sponsored and submitted by Bayer CropScience, Research Triangle Park, NC. Bayer Study No.: 602 DO. Bayer Report No.: 200684. Experiment started July 8, 2002, and completed January 25, 2004 (p. 6). Final report issued August 5, 2005.

MRID 46695417 Roohi, A. 2005. [14C]-AE 0941989: rate of degradation in three soils at 20°C. Unpublished study performed by Battelle AgriFood Ltd, Ongar, Essex, UK, and sponsored and submitted by Bayer CropScience, Monheim am Rhein, Germany. Battelle Report Number/Batelle Laboratory Project ID: CX/04/043. Experiment started on May 24, 2004, and completed on November 18, 2004 (p. 7). Final report issued May 26, 2005.

MRID 46695418 Simmonds, M. 2005. [14C]-AE 1392936: rate of degradation in three soils at 20°C. Unpublished study performed by Battelle AgriFood Ltd, Essex, UK, and sponsored and submitted by Bayer CropScience, Monheim am Rhein, Germany, Battelle Report and Laboratory No.: CX/04/046. Experiment start date June 7, 2004, and completion date November 8, 2004 (p. 6). Final report issued May 18, 2005.

MRID 46695419 Desmarteau, D.A. and A.E. Matthew. 2005. [Cyclohexyl-UL-14C]AE 0172747: anaerobic soil metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 201111. Study Number: A7042104. Experiment initiated on June 3, 2003 and completed on February 11, 2004 (p. 6). Final report issued on March 30, 2005.

MRID 46695420 Desmarteau, D.A. and A.E. Matthew. 2004. [Phenyl-UL-14C]AE 0172747: anaerobic soil metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 200836. Study Number: A7042103. Experiment initiated on May 8, 2003 and completed on December 1, 2003 (p. 6). Final report issued on November 18, 2004.

MRID 46695421 Nicolaus, B. 2004. [Cyclohexyl-U-14C]- and [phenyl-U-14C]-AE 0172747 aerobic aquatic metabolism in a fine sediment system. Unpublished study performed, submitted and sponsored by Bayer CropScience GmbH, Frankfurt, Germany. Study Identification Number: CB02-008. Experiment initiated on June 17, 2002 and completed on September 1, 2003 (p. 6). Final report issued on May 6, 2004.

MRID 46695422 Nicolaus, B. 2004. [Cyclohexyl-U-14C]- and [phenyl-U-14C]-AE 0172747 aerobic aquatic metabolism in sediment system Rhein. Unpublished study performed, submitted and sponsored by Bayer CropScience GmbH, Frankfurt, Germany. Study Identification Number: CB02-009. Experiment initiated on September 5, 2002 and completed on August 1, 2003 (p. 6). Final report issued on May 27, 2004.

MRID 46695423 Mathew, A.E., and D.A. Desmarteau. 2005. [Phenyl-UL-14C]AE 0172747: anaerobic aquatic metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 201110; Study Number: A7042401. Experiment initiated on January 28, 2003 and completed on February 23, 2004 (p. 6). Final report issued on February 25, 2005.

MRID 46695424 Desmarteau, D.A. and A.E. Matthew. 2005. [Cyclohexyl-UL-14C]AE 0172747: anaerobic aquatic metabolism. Unpublished study performed by Bayer CropScience, Stilwell, KS; and submitted and sponsored by Bayer CropScience, Research Triangle Park, NC. Bayer Report Number: 03MEAEY004; Study Number: A7042402. Experiment initiated on March 18, 2003 and completed on November 23, 2004 (p. 6). Final report issued on April 1, 2005.

MRID 46695425 Wyatt, D.R. 2005. Terrestrial field dissipation of AE 0172747 at four locations in the United States. Unpublished study performed by A.C.D.S. Research, Inc., Lyons, NY; Alvey Agricultural Research, Inc., Carlyle, IL; Midwest Research, Inc., York, NE; Research For Hire, Inc., Porterville, CA; Bayer CropScience, Stilwell, KS and AgVise Laboratories, Northwood, ND; and submitted by Bayer CropScience, Research Triangle Park, NC. Laboratory Study No. 02DO36414. Experiment initiation May 20, 2002 and completion January 18, 2005 (p. 16). Final report issued October 14, 2005.

APPENDIX L. Ecological Effects Bibliogrpahy

MRID Studies Submitted to EPA

MRID 46695430 Sowig, P. 2002. Acute toxicity to *Daphnia magna* (Waterflea) under static testing conditions AE 0172747; substance, technical. Unpublished study performed by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. Study No. CE02/023. Study sponsored by Bayer CropScience GmbH, Ecotoxicology, Frankfurt, Germany. The final report issued November 11, 2002

MRID 46695431 Dorgerloh, M. 2005. Acute toxicity of AE 0172747 and Isoxadifen-ethyl SC 420+210 to the Waterflea, *Daphnia magna* in a Static Laboratory Test System. Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. E 320 2848-7. Study sponsored by Bayer CropScience AG. The final report issued March 16, 2005.

MRID 46695432 Kern, M.E., Banman, C.S., and Lam, C.V. 2004. Acute Toxicity of AE 0456148 to the Waterflea (*Daphnia magna*) Under Static Conditions. Unpublished study performed by Bayer CropScience, Research and Development Department, Ecotoxicology, Stilwell, KS. Study No. EBAEX055. Study sponsored by Bayer CropScience GmbH, Institute for Ecotoxicology, Monheim, Germany. The final report issued December 15, 2004.

MRID 46695433 Dionne, E. 2003. AE 0172747- Acute Toxicity to Eastern Oysters (*Crassostrea virginica*) Under Flow-Through Conditions. Unpublished study performed by Springborn Smithers Laboratories. Study No. 13798.6101/35400. Study sponsored by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued July 15, 2003.

MRID 46695434 Lima, W. 2003. AE 0172747- Acute Toxicity to Mysids (*Americamysis bahia*) Under Flow-Through Conditions. Unpublished study performed by Springborn Smithers Laboratories. Study No. 13798.6102/35401. Study sponsored by Bayer CropScience GmbH, Frankfurt, Germany. The final report issued January 22, 2003.

MRID 46695435 Lima, W. 2003. AE 0172747 – Acute Toxicity to Sheepshead Minnow (*Cyprinodon variegatus*) Under Static-Renewal Conditions. Unpublished study performed by Springborn Smithers Laboratories, Wareham, MA. Laboratory Project No. 13798.6109. Study submitted by Bayer CropScience GmbH, Frankfurt am Main, Germany. Study initiated October 14, 2002 and submitted January 22, 2003.

MRID 46695436 Dorgerloh, M. 2003. Acute toxicity of AE 0172747 technical substance to fish (*Lepomis macrochirus*) (Product code AE 0172747 00 1C97 0001). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. DOM 22065/E280 2331-9. Study sponsored by Bayer CropScience AG. The final report issued February 12, 2003.

MRID 46695437 Dorgerloh, M. 2003. Acute toxicity of AE 0172747 technical substance to fish (*Oncorhynchus mykiss*) (Product code AE 0172747 00 1C97 0001). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. DOM 23034/E280 2423-1. Study sponsored by Bayer CropScience AG. The final report issued June 4, 2003.

MRID 46695438 Nieden, D. 2005. Acute toxicity of AE 0172747 and Isoxadifen-ethyl SC 420+210 to fish (*Oncorhynchus mykiss*) under static conditions (product code: AE 0172747 02 SC52 A105). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. EBAEP034/E 280 2868-4. Study sponsored by Bayer CropScience AG. The final report issued March 24, 2005.

MRID 46695439 Nieden, D. 2005. Acute toxicity of AE 0456148 to fish (*Oncorhynchus mykiss*) under static conditions (product code: AE 0456148 00 1B99 0002). Unpublished study performed by Bayer CropScience AG, Monheim, Germany. Study No. EBAEX092/E 280 2958-4. Study sponsored by Bayer CropScience AG. The final report issued May 31, 2005.

MRID 46695440 Dorgerloh, M. 2003. Influence of AE 0172747 (tech.) on Development and Reproductive Output of the Waterflea *Daphnia magna* in a Static Renewal Laboratory Test System. Unpublished study performed and submitted by Bayer CropScience AG, Monheim, Germany. Laboratory Study No. E 321 2371-9. Study initiated March 4, 2003 and submitted October 24, 2003.

MRID 46695441 Kern, M.E., and C.V. Lam. 2004. Chronic Toxicity of AE 0456148, a metabolite of AE 0172747, to the *Daphnia magna* Under Static Renewal Conditions. Unpublished study performed and submitted by Bayer CropScience, Stilwell, KS. Laboratory Study No. EBAEX059. Study initiated July 12, 2004 and submitted December 15, 2004.

MRID 46695442 Lima, W. 2004. AE 0172747 – Life-Cycle Toxicity Test with Mysids (*Americamysis bahia*). Unpublished study performed by Springborn Smithers Laboratories. Laboratory study no. 13798.6160. Study sponsored by Bayer CropScience, Stilwell, KS. The final report issued December 6, 2004.

MRID 46695519 Dorgerloh, M. 2005. *Pseudokirchneriella subcapitata* Growth Inhibition Test with AE 0172747 and Isoxadifen-ethyl SC 420+210 (code: AE 0172747 02 SC52 A105). Unpublished study performed by Bayer CropScience AG, Research/Development, Department–Ecotoxicology, Monheim, Germany. Study No. EBAEP032/E 323 2838-9. Study sponsored by Bayer CropScience AG. The final report issued May 4, 2005.

MRID 46695520 Dorgerloh, M. 2005. *Pseudokirchneriella subcapitata* Growth Inhibition Limit Test with AE 0456148 (code: AE 0456148 00 1B99 0002). Unpublished study performed by Bayer CropScience AG, Research/Development, Department–Ecotoxicology, Monheim, Germany. Study No. DOM 24051/ E323 2766-9. Study sponsored by Bayer CropScience AG. The final report issued February 1, 2005.

MRID 46695619 Merkel, D. 2005. Acute Oral Toxicity- Up And Down Procedure in Rats. Product Safety Laboratories, Dayton, NJ 08810. Study No. 17105 dated 5-26-05. Unpublished.

Open Literature, Government Reports, and Product Labels

Atkins, E.L., D. Kellum, and K.W. Atkins. 1981. Reducing pesticide hazards to honey bees: mortality prediction techniques and integrated management strategies. University of California, Division of Agricultural Sciences, Leaflet 2883, 23 pp.

Bayer CropScience LP. Technical Grade AE 0172747: A Two-Generation Reproductive Toxicity Study in the Wistar Rat. Unpublished study performed by and submitted by Bayer CropScience LP. Study Report No. 201266. The final report issued August 31, 2005.

Fletcher, J.S., J.E. Nellesson, and T. G. Pfleeger. 1994. Literature review and evaluation of the EPA food-chain (Kenaga) nomogram, an instrument for estimating pesticide residues on plants. Environ Toxicol Chem 13(9):1383–1391.

Hoerger, F. and E.E. Kenaga. 1972. Pesticide residues on plants: correlation of representative data as a basis for estimation of their magnitude in the environment. In F. Coulston and F. Korte, eds., Environmental Quality and Safety: Chemistry, Toxicology, and Technology, Georg Thieme Publ, Stuttgart, West Germany, pp. 9–28.

USDA. 2002. 2002 Census of Agriculture. Available on-line at http://www.nass.usda.gov/Census_of_Agriculture/index.asp

U.S. EPA. 1993. Wildlife Exposure Factors Handbook. Volume I of II. EPA/600/R-93/187a. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. 20460.

U.S. EPA. 2001. Ecological Risk Assessor Orientation Package. U.S. Environmental Protection Agency, Ecological Fate and Effects Division. Draft Version, August 2001.

U.S. EPA. 2002a. Data Requirements for Registration. U.S. Environmental Protection Agency, Washington, DC. Code of Federal Regulations 40 CFR §158.202.

U.S. EPA. 2002b. Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version II. U.S. Environmental Protection Agency, Washington, DC. February 28, 2002.

U.S. EPA. 2004. Overview of Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency. Endangered and Threatened Species Effects Determinations. Office of Prevention, Pesticides, and Toxic Substances, Office of Pesticides Programs. Washington, DC. January 23, 2004.

U.S. EPA. 2005a. User's Guide for T-REX (Terrestrial Residue Exposure model) Version 1.2.3. U.S. Environmental Protection Agency. Release August 8, 2005.

U.S. EPA. 2005b. TERRPLANT Terrestrial Plant Exposure Model. Version 1.2.1. U.S. Environmental Protection Agency. Released November 9, 2005.

Willis, G.H. and L.L. McDowell. 1987. Pesticide persistence on foliage. Environ Contam Toxicol 100:23–73.