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/OPP# 12-23-98

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

OFFICE OF
PREVENTION, PESTICIDES, AND
TOXIC SUBSTANCES

PC Code: 103301
Case No.: 0042

DPBarcode: D251602

MEMORANDUM:

SUBJECT: ACEPHATE: Revision of EFED Risk Assessment for the Reregistration Eligibility Decision (RED) Document to Include Registrant's Comments

FROM: Stephanie Syslo, Environmental Scientist 12/23/98
and
Michael Davy, Agronomist
Environmental Risk Branch II
Environmental Fate and Effects Division (7507C)

THRU: Betsy Grim, Chief (Acting)
ERBII/EFED (7507C)

TO: Angel Chiri, Chemical Review Manager
Special Review Branch
Special Review and Reregistration Division (7508C)

Attached please find a revised EFED Risk Assessment for the Reregistration Eligibility Decision (RED) Document which includes corrections to errors identified by the registrant Valent, Inc. The following changes (as listed in the "error comments" table of Attachment B of the December 10, 1998 letter from Valent; attached) were made:

- The typographical error noted by the registrant on page 39 was corrected.
- All transcription errors noted by the registrant were addressed.
- The computational error noted by the registrant on page 61 was corrected.

In addition, EFED's responses to some non-error-related comments follow:

Comment:
Page 12. "Terrestrial Exposure Assessment - Nongranular applications. In the table, "Broadleaf/forage plants and small insects" and "Fruits, pods, seeds and large insects" are not

categories in either the Kenega nomograph (values under Predicted Maximum Residue) of the Fletcher reference (values under Predicted Mean Residue). Therefore, Valent does not know how the Agency obtained the values 135, 15, 45 and 7."

EPA response:
The information was obtained from pg. 1390 of following citation:

Fletcher, John S., Nellessen, James E., Pflleeger, Thomas G. 1994. Literature Review and Evaluation of the EPA Food-Chain (Kenaga) Nomogram, an Instrument for Estimating Pesticide Residues on Plants. Environmental Toxicology and Chemistry, Vol 13, No. 9, pp 1383-1391.

Comment:
"Pages 12, 13, 14 mention the model FATE. Valent has a model called FATE but it does not calculate concentrations or produce outputs as seen in Appendix F. Valent would like to ask the Agency for a complete reference of their FATE model. Is it available on the Web?"

EPA Response:
A description of the FATE model and how it operates was provided as Appendix 31 in the documents prepared for a SAP presentation held December 8, 1998 titled "A Comparative Analysis of Ecological Risks from Pesticides and Their Uses: Background, Methodology& Case Study." This appendix is available as a hard-copy only and is available through the OPP Docket under the docket number "OPP-00562".

The responses listed above will not qualitatively change the results of the EFED risk assessment for acephate.

Given the short timeframe in which to respond, all other issues raised in non-error-related comments will be addressed during the official public docket 60-day comment period.

Attachments

EFED Acephate RED Chapter
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1. Use Characterization

Acephate is a broad-spectrum non-fumigant system/contact organophosphate insecticide primarily registered to control a variety of plant and soil insects in agricultural field crops; there is also substantial homeowner and food-handling establishment applications. There are granular and soluble concentrate formulations used as soil and seed treatments in-furrow at time of planting and as foliar treatments during the growing season. The maximum rate per application is 1 lb/A. Multiple foliar applications are used to control a variety of insect pests, and timing and application rate depend upon which pest is being controlled.

There is no master label for acephate, but information provided by the registrant (Appendix E) includes maximum seasonal application rates of up to 6 lbs a.i./acre (on cotton). Acephate can be applied by broadcast to the foliage postemergence, but there are preplant or at-planting applications as well in which incorporation in the top 2 to 4 inches of soil is typical; maximum application rates for these uses are up to 1 lb a.i./acre.

Major crops include cotton (up to 1.4 million acres treated in AZ, TX and MS), tobacco (up to 700,000 acres), vegetable crops (up to 400,000 acres mostly in CA, AZ, FL, IL, WI, TX, MI, GA, NJ), turf (100,000 acres in the south) and mint (77,000 acres in ID and OR). The trend shows increasing vegetable acreage treated by acephate.

In order to assess risk, one must know what the exposure of the pesticide would be. The exposure of organisms to pesticide is based on the rate of application, method of application, and the use site of the application, in combination with the fate and transport of the chemical in the environment. Specific information on the uses and application methods and rates for acephate are presented in Appendix E. Below are the use sites and applications used in this risk assessment and characterization to derive exposure for acephate.

Use Site	Application Type	Application Method	Application Rate (lb ai/A)	Number of Applications	Interval Between Application (days)
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper	spray granular (1)	aerial & ground spray, in-furrow incorporation	1	2	3
Pepper in Puerto Rico	spray granular	aerial & ground spray, in-furrow incorporation	0.5	2	7
Cranberries, Non-Bell Pepper	spray granular (1)	aerial & ground spray, in-furrow incorporation	1	1	---
Beans	spray	aerial & ground spray	1	2	7
Peanut	spray granular	aerial & ground spray, in-furrow incorporation	1	4	3
Soybeans	spray	aerial & ground spray	0.75 (2)	2	3
Tobacco	spray	aerial & ground spray	0.67 (3)	6	3

Use Site	Application Type	Application Method	Application Rate (lb ai/A)	Number of Applications	Interval Between Application (days)
Tobacco in Tennessee	spray	aerial & ground spray	1.33 (4)	3	3
Cotton	spray granular	aerial & ground spray, in-furrow incorporation	1	6	3
Turf	granular	ground broadcast	1	1	—

(1) The in-furrow incorporation with granular only applies to peppers.
(2) The maximum application is 1 lb ai/A and the maximum per season is 1.5 lb/A; therefore EFED assumes a split with 2 applications of 0.75 lb/A each.
(3) The maximum application in a season is 4 lb ai/A. Since there are 6 applications permitted, EFED assumes an application rate of 0.67 lb ai/A for each application.
(4) The maximum application in a season is 4 lb ai/A. Since there are 3 applications permitted, EFED assumes an application rate of 1.33 lb ai/A for each application.

2. Exposure Characterization

a. Chemical Profile

Identifying information on acephate and its metabolites is presented in the following table.

Chemical	CAS Number	PC Code Number	Chemical names and synonyms
Acephate	30560-19-1	103301	O,S-dimethyl acetylphosphoramidothioate; RE-12420
Methamidophos	10265-92-6	101201	O,S-dimethyl phosphoramidothioate; O,S-dimethyl thiophosphoric acid amide; RE-9006
O-Desmethyl methamidophos	17808-29-6	-	S-methyl phosphoramidothioate
DMPT	42576-53-4	-	O,S-dimethyl phosphorothioate; RE18421
SMPT	-	-	S-methyl N-acetylphosphoramidothioate; RE-17245
RE-18420	-	-	O-methyl N-acetylphosphoramidate
Methyl disulfide	-	-	Methyl disulfide

The physical and chemical properties of acephate are presented in the following table:

Physical and chemical properties of acephate.		
Property	**Value**	**Data Source**
Molecular formula	$C_4H_{10}NO_3PS$	
Molecular weight	183.16 g/mol	
Physical State	White powder (TGAI)	40390601
Odor	Strong, mercaptan-like (TGAI)	40390601
Melting Point	86.9-91.0°C	40390601
Boiling Point	N/A	40390601
Solubility	Technical at 25°C: Water: 80.1-83.5 g/100 mL; Absolute alcohol (ethanol:methanol 95:5 v:v): 28.0-30.3 g/100mL; ethyl acetate: 4.6-5.1 g/100 mL; toluene: 1.0 g /100 mL; hexane: 0.0084-0.0089 g/mL	40390601
Vapor Pressure	1.7 x 10^{-6} mm Hg at 24°C (Technical); by gas saturation method 3.0 x 10^{-7} mm Hg)	40390601; 40645901
Dissociation constant (pKa)	8.35 at 20°C (TGAI)	40390601
Octanol/water Partition Coefficient (K_{ow})	K_{ow}: 0.13; Log K_{ow}: -0.9	40390601

b. Environmental Fate Assessment

Aerobic soil metabolism is the main degradation process for acephate. Observed half-lives are less than two days under the nominal or expected use conditions, producing the intermediate degradate methamidophos, which is also an insecticidally active compound. Methamidophos is itself rapidly metabolized by soil microorganisms to carbon dioxide and microbial biomass (half-lives of < 10 days). Acephate is stable against hydrolysis except at high pH's (half-life at pH 9 of 18 days) and does not photodegrade. Acephate is not persistent in anaerobic clay sediment:creek water systems in the laboratory, with a half-life of 6.6 days. The major degradates under anaerobic conditions were carbon dioxide and methane, comprising > 60% of the applied after 20 days of anaerobic incubation. No other anaerobic degradates were present at > 10% during the incubation. There are no acceptable data for the aerobic aquatic metabolism of acephate; supplemental information indicates that acephate degrades more rapidly in aquatic systems when sediment is present.

Acephate is very soluble (80.1-83.5g/100 mL) and very mobile (K_{oc} = 2.7) in the laboratory. Only one K_{oc} value is available, because acephate was adsorbed in only one of the five soils (a clay loam) used in the batch equilibrium studies. When tested in the same soils, methamidophos was determined to be more mobile than acephate; again, only one K_{oc} value is available (K_{oc} = 0.9 in the clay loam soil). Because acephate is not persistent under aerobic conditions, very little acephate is expected to leach to groundwater. If any acephate did reach ground water, it would not be expected to persist, due to its short anaerobic half-life. Volatilization from soil or water is not expected to be a route of dissipation for either acephate or methamidophos.

Field studies conducted in Mississippi (tobacco on silt loam soil), California (bell peppers on silt loam soil), Florida (cauliflower on sand soil) and Iowa (soybeans on loam soil) produced half-lives of 2 days or less with no detections of parent or the degradate methamidophos below a depth of 50 cm.

Laboratory studies showed that bioaccumulation of acephate in bluegill sunfish was insignificant. A maximum bioaccumulation factor of 10x occurred after 14 days' exposure to acephate at 0.007 and 0.7 ppm.

Environmental Fate and Transport Data

i. Degradation

Abiotic Hydrolysis

Acephate was hydrolytically stable in pH 5 and 7 aqueous buffer solutions (92.97% and 87.68% of the applied radioactivity remained as parent compound after 31 days). Minor degradates (formed at <10% of the applied) in the pH 5 and 7 solutions were: DMPT (formed by hydrolysis of the P-N bond); RE-17245 (formed by hydrolysis of the O-methyl-P bond); and methamidophos (formed by hydrolysis of the N-C bond). In pH 9 aqueous buffer solution, [O-methyl-^{14}C]acephate degraded with a first-order half-life of 18 days (r^2= 0.98); [S-methyl -^{14}C]acephate appeared to exhibit similar hydrolysis behavior. At pH 9, the major degradate (formed at > 30% of the applied) was DMPT. Additional degradates were formed depending on which methyl group was radiolabelled; in the [O-methyl-^{14}C]acephate treated system, the only other major degradate was RE-18420 (formed by hydrolysis of the P-S bond); in the [S-methyl-^{14}C]acephate treated system, the only other degradate was methyl disulfide, apparently formed from the dimerization of the methyl mercaptan formed by hydrolysis of the P-S bond. Degradates were apparently stable at the pHs at which they were formed. This study is acceptable and satisfies the data requirement for aqueous hydrolysis of acephate at pHs 5 and 7 (GLN 161-1; 41081604). The data requirement is partially fulfilled; data remain outstanding for the aqueous hydrolysis of [S-methyl-^{14}C]acephate at pH 9, due to an incomplete material balance during the study, likely due to volatile losses.

Photodegradation in Water

Acephate, at 8.94 ppm, was photolytically stable in sterile pH 7 phosphate buffer solution that was irradiated for 35 days under natural sunlight. In sterile buffer in the presence of a photosensitizer (1% acetone), acephate, at 9.35 ppm, degraded with a dark-control-corrected half-life of 39.6 days in sterile pH 7 aqueous buffer solution that was irradiated for 31 days under natural sunlight. Two of the three degradates detected in the irradiated and dark control samples without photosensitizer (DMPT, 3.6%; RE-17245, 4.6%; and methamidophos, 1.6% of the applied in the irradiated solutions) were observed in greater amounts in the irradiated solutions with photosensitizer (40.6%, 2.5% and 8.6% of the applied, respectively). In addition to the three degradates listed above, methyl disulfide was also detected only in the dark control solutions at 2.3% (at day 35) and ≤1.6% (at days 26 and 31) of the applied without and with photosensitizer, respectively. This study is acceptable and satisfies the data requirement for aqueous photolysis of acephate (GLN 161-2; 41081603).

Photolysis on Soil

In a supplemental study, acephate, when applied at a nominal application rate of 1 lb/A, was photolytically stable on Crevasse sandy loam soil that was irradiated with natural sunlight in Richmond, CA, for up to 10 days. Acephate dissipated more rapidly in dark control samples than in irradiated samples, likely due to greater moisture content and greater microbial activity. The major degradate following 10 days of incubation was CO_2, which accounted for 28.2% and 44.4% of the nominal application, respectively, in irradiated and dark control soils; organic volatiles were detected at 1.5% and 5.2%, respectively. However, low material balances after 3 days of irradiation may have been partially due to unrecovered $^{14}CO_2$ trapped in the tubing used to connect the test vessels to the volatile traps. The minor degradate methamidophos was detected in both irradiated and dark control soils, at maximums of 5.3% (day 2) and 8.4% (day 3) of the nominal application, respectively, and decreased thereafter. Unidentified extractable radioactivity and nonextractable ^{14}C soil residues were present less than 10% of the nominal application.

Although this study cannot be used to fulfill data requirements due to incomplete material balances, it does show that photodegradation was not observed to occur in the irradiated soils; any degradation observed was likely due to aerobic soil metabolism. This observation is consistent with supplemental information from an earlier study (00015202) in which acephate spotted directly onto glass and paper was not degraded by UV light; half-lives were greater than 4 weeks in both irradiated and dark control samples. It is therefore unlikely that a new study would provide additional information on the photodegradation of acephate on soil; available information from these two studies (00015202 and 40504810) satisfies the data requirement for soil photolysis of acephate (GLN 161-3).

Photodegradation in Air

Based on the vapor pressure of acephate (Pure active: 1.7 x 10^{6} mm Hg/Torr [40390601]) and its calculated Henry's constant (5.1 x 10^{13} atm mole /m^3), it is not expected that acephate will volatilize from either soil or water in significant amounts. Therefore it is not expected that there will be sufficient residues of acephate in air for photodegradation in air to be a significant route of dissipation for acephate.

Aerobic Soil Metabolism

Acephate degraded in aerobic soils with half-lives of generally < 3 days. The loss of acephate is due to microbial metabolism, which occurs faster under aerobic as opposed to anaerobic conditions. Methamidophos is the primary nonvolatile intermediate degradate which is rapidly degraded to CO_2 as the terminal metabolite.

In a preliminary study, acephate (at concentrations of 1 or 10 ppm) is rapidly lost from a wide variety of soils (eight soils - 3 clays, loam, loamy sand, sandy clay loam, silty clay loam, muck) when incubated at 24°C at field capacity open to the air (volatiles not trapped and degradates other than methamidophos were not identified). In all cases, half-lives in mineral soils were <3 days at 10 ppm and ≤ 1.5 days at 1 ppm. Half-lives in an Ocoee muck soil (pH 5.3, 68% organic matter) were 6 days at 1 ppm and 13 days at 10 ppm. Average maximum concentrations of methamidophos were approximately 10% of the applied. In sterile Norwalk silty clay loam and Greenville clay (incubation conditions not specified), after 4 days, approximately 90-100% of the applied remained as acephate, compared to approximately 20 % in the non sterile. The effect of varying moisture contents (5 and 15%) was tested with the Hanford loamy sand treated with 20 ppm acephate; volatiles were not trapped. Degradation was more rapid at 15% (4 days) than at 5% (7 days).

Definitive studies were conducted using Fresno loam (pH 5.7, 1.3% organic matter) Mt. Holly sandy clay loam (pH 5.6, 2.4% organic matter), and Norwalk silty clay loam (pH 6.2, 4.1% organic matter) treated with acephate at 1 ppm and incubated at field capacity for up to 6 days in flowthrough flasks. Effluent air was trapped in methyl cellusolve and methyl cellusolve plus ethanolamine. Methanol extracts of soil samples were analyzed by TLC for acephate, methamidophos, and DMPT on days 1 and 2; there was no analysis at 6 days posttreatment. After 6 days incubation, 54, 76, and 86% of the applied radioactivity was evolved as CO_2 in the loam, sandy clay loam, and silty clay loam soils, respectively. Apparent half-lives for acephate in the soils were <2 days in loam and <1 day in the other two soils, which is consistent with the results in the preliminary study. Methamidophos was formed at up to 23 % of the applied in Fresno loam after 2 days; it was < 10 % at both sampling times in the other two. DMPT was not detected at either sampling interval. After 6 days, 21, 15, and 17% of the applied was not extractable from the loam, sandy clay loam, and silty clay loam soils, respectively. This study is acceptable and satisfies the data requirement for aerobic soil metabolism of acephate (GLN 162-1; 00014991).

Anaerobic Aquatic Metabolism

[S-methyl-^{14}C]Acephate degraded with a first-order half-life of 6.6 days ($r^2 = 0.998$; degradation constant of 0.1045 day^{-1}) in anaerobic flooded clay sediment. The initial pH of the system was 7.0, increasing to pH 7.9 by the final sampling interval (day 20). The major degradates were [^{14}C]**volatiles** which accounted for 64.5% of the applied at 20 days posttreatment. Radiolabeled $^{14}CO_2$ was a maximum of 32.9% of the applied radioactivity at 10 days posttreatment and was 17.7% at 20 days posttreatment. Radiolabeled $^{14}CH_4$ was present at 1.1% of the applied radioactivity at 3 days posttreatment and accounted for 46.8% of the applied at 20 days posttreatment. In the **water phase**, the parent compound was 84.6% of the applied radioactivity at 0 days posttreatment, decreased to 38.8% of the applied by 7 days posttreatment and was 10.1% at 20 days posttreatment. The minor degradate methamidophos was present in the water phase at 0.5% of the applied radioactivity at 0 days posttreatment, increased to a maximum of 5.0% of the applied by 7 days posttreatment and was 1.8% at 20 days posttreatment. The minor degradates DMPT and SMPT were present in the water at a combined maximum of 2.9% of the applied at 7 days posttreatment. In the **sediment extracts**, parent compound was initially present at 8.4% of the applied radioactivity, increased to a maximum of 9.6% of the applied by 3 days posttreatment and then decreased to 1.8% by 20 days posttreatment. The degradates methamidophos, DMPT, and SMPT never exceeded 1% of the applied in the sediment. This study is acceptable and satisfies the data requirement for anaerobic aquatic metabolism of acephate (GLN 162-3; 43971601).

Aerobic Aquatic Metabolism

No acceptable studies for the aerobic aquatic metabolism of acephate are available. However, information of marginal value was found in the scientific literature. Pond water and sediments and creek water and sediments from a forested area in British Columbia were treated with acephate at 1 ppm and incubated at 9°C in flasks plugged with glass wool. In the absence of sediments, recoveries of acephate from treated pond water were >80% after 42 days incubation, and the pH of the pond water increased from 7.5 to 8.0 after 42 days. In the presence of pond bottom sediments, acephate was less persistent, with recovery at 42 days of 16.7% in the water and 4.8% in the sediment. In creek water (pH 7.0), acephate recoveries after 50 days incubation were approximately 45%; in the presence of creek bottom sediments, acephate was less persistent, with recovery at 50 days of 25.15% in the water and 2.3% in the sediment. Autoclaving of creek water and creek water:sediment mixtures slowed degradation. At no time was methamidophos present at > 1.6%. Because the incubations were conducted at 9°C, rather than the recommended range of 18-30°C, and because volatiles were not trapped, the results should be considered supplemental information only. The data requirement for aerobic aquatic metabolism of acephate is not fulfilled (GLN 162-3; 05018064).

ii. Mobility

Batch equilibrium studies

Supplemental information from an upgradeable mobility study is available. Batch equilibrium studies using acephate, methamidophos, and DMPT were conducted using four soils ranging in texture from sand to clay loam. In three of the soils, acephate, methamidophos, and DMPT were not adsorbed in sufficient quantities to permit the calculation of Freundlich adsorption coefficients (Freundlich K_{ads}). For the clay loam soil, the reported adsorption values for parent acephate and its degradates are listed in the following table:

Soil	pH	CEC (meq/ 100g)	% clay	% Organic matter	Acephate			Methamidophos			DMPT		
					K	1/n	r^2	K	1/n	r^2	K	1/n	r^2
Clayloam	5.8	20.2	32	3.3	0.090	1.06	0.96	0.029	0.64	0.93	0.030	0.69	0.92

Calculated K_{oc}s for acephate, methamidophos, and DMPT in this clay loam soil were 2.7, 0.9, and 0.9, respectively. Because of the minimal adsorption of the chemicals in the adsorption phase of the study, it was not possible to determine desorption values in the soils.

Based on the values listed above, it appears that acephate, methamidophos, and DMPT will be very mobile in soils. This study is not acceptable at this time because the soils used in the study were not adequately identified and it could not be determined how the registrant calculated the K_{oc}s. This study can be upgraded to acceptable when the registrant submits information identifying the soils used in this study by soil series name and specifies what the % organic carbon of the clay loam soil was. The data requirement for mobility of **unaged** and **aged** acephate is not satisfied (GLN 163-1; 40504811).

Volatility

Based on the vapor pressure of acephate (Pure active: 1.7 x 10^{6} mm Hg/Torr [40390601]) and its calculated Henry's constant (5.1 x 10^{13} atm mole /m^3), it is not expected that acephate will volatilize from either soil or water in significant quantities. Therefore it is not expected that volatilization will be a significant route of dissipation for acephate.

iii. Accumulation

Bioaccumulation in Fish

Acephate residues did not bioaccumulate in the edible tissues or viscera of bluegill sunfish (*Lepomis macrochirus*) continuously exposed to 0.007 or 0.7 ppm acephate for 35 days. The average bioconcentration factor in edible tissues during the study was 10X and decreased during the 14-day depuration period. This study is acceptable and satisfies the data requirement for bioaccumulation in fish of acephate (GLN 165-4; 00015243).

iv. Field Dissipation

Terrestrial Field Dissipation

40504812, 41327605,41327601

Acephate (Orthene Tobacco Insect Spray, 75% WP) dissipated with an observed half-life of 1-3 days (calculated 1.72 days; r^2=0.99) in the upper 5 cm of a field plot of silt loam soil planted to tobacco in Greenville, Mississippi, after six foliar applications (6- to 9-day intervals) of acephate at 0.75 lb ai/A/application. Average acephate concentrations in the upper 5 cm of soil declined from 0.33 ppm immediately after the sixth application to 0.08 ppm at 3 days and to <0.02 ppm (detection limit) at 7 days. Average acephate concentrations were ≤0.05 ppm in the 5- to 10-cm depth and ≤0.02 ppm in soil deeper than 10 cm at all sampling intervals; no residues were detected in soil deeper than 45 cm. The maximum average acephate concentration in the upper 5 cm was 1.09 ppm immediately after the first foliar application; acephate did not accumulate with repeated foliar applications. Methamidophos, the only degradate measured, dissipated with a calculated half-life of ≈2 days in the 0- to 5-cm soil depth; average methamidophos concentrations declined from 0.07 ppm immediately after the sixth application of acephate to 0.02 ppm at 3 days and <0.01 ppm (detection limit) at 7 days. Average methamidophos concentrations were ≤0.03 ppm in the 5- to 10-cm depth and <0.01 ppm in soil deeper than 10 cm at all sampling intervals. The maximum average methamidophos concentration (0.11 ppm) was detected in the upper 5 cm of soil immediately after the fourth foliar application.

During the study, air temperatures ranged from 59 to 90°F. Rainfall totaled 1.62 inches between the first and second foliar treatments, 0.60 inches between the second and third, 1.85 inches between the third and fourth, 0.0 inches between the fourth and fifth, 1.1 inches between the fifth and sixth, and 0.0 inches during the 7 days following the sixth treatment.

40504813, 41327604, 41327601

Acephate (Orthene 75 S, 75% WP) dissipated with an observed half-life of <3 days (calculated 1.96 days; r^2=0.92) in the upper 5 cm of a field plot of loam soil planted to soybeans in Dallas Center, Iowa, after six preemergence applications (7-day intervals) of acephate at 1.0 lb ai/A/application. Average acephate concentrations in the upper 5 cm of soil were 0.12 ppm immediately after the sixth application, 0.24 ppm at 1 day, 0.05 ppm at 3 days, and <0.02 ppm (detection limit) at 7 days. The maximum average acephate concentration in the upper 5 cm was 0.84 ppm immediately after the third application. Average acephate concentrations in soil deeper than 5 cm were ≤0.12 ppm; no residues were detected in soil deeper than 45 cm. Acephate did not accumulate with repeated applications. Average concentrations of methamidophos, the only degradate measured, were ≤0.08 ppm in the upper 5 cm of soil; no residues were detected (<0.01 ppm, detection limit) in soil deeper than 5 cm.

During the study, air temperatures ranged from 54 to 100°F. Rainfall totaled 0.05 inches during the first and second preemergence application, 0.65 inches between the second and third, 1.80 inches between the third and fourth, 0.00 inches between the fourth and fifth, 5.05 inches between the fifth and sixth, and 0.60 inches during the 7 days following the sixth application.

40504814, 41327603, 41327601

Acephate (Orthene 75 S, 75% WP) dissipated with an observed half-life of 1-3 days (calculated 1.65 days; $r^2=0.99$) in the upper 5 cm of a field plot of silt loam soil planted to bell peppers in Fresno, California, after eight foliar applications (3- to 7-day intervals) of acephate at 1.0 lb ai/A/application. Average acephate concentrations in the upper 5 cm of soil declined from 0.99 ppm immediately after the eighth application to 0.47 ppm at 3 days and to <0.02 ppm (detection limit) at 7 days. The maximum average acephate concentration in the 5- to 10-cm depth was 0.24 ppm immediately after the eighth foliar application; after 1 day, average acephate concentrations were ≤0.04 ppm. In general, average acephate concentrations in soil deeper than 10 cm were ≤0.05 ppm. Acephate did not accumulate with repeated foliar applications. Methamidophos, the only degradate measured, dissipated with a calculated half-life of ≈3 days in the 0- to 5-cm soil depth; average methamidophos concentrations were 0.07 ppm immediately after the eighth application of acephate, 0.09 ppm at 1 day, 0.04 ppm at 4 days, and <0.01 ppm (detection limit) at 7 days. Average methamidophos concentrations were ≤0.03 ppm in the 5- to 10-cm depth and ≤0.01 ppm in the soil deeper than 10 cm at all sampling intervals.

During the study, air temperatures ranged from 62 to 114°F. No rainfall occurred during the entire study.

Based on the results of the three terrestrial field dissipation studies listed above, it appears that, following multiple applications of 1 lb ai/A, acephate dissipates with a half-life of 3 days or less and does not leach. Its degradate methamidophos was never present at greater than 0.11 ppm in the top 5 cm of soil and was not detected below a depth of 10 cm. These studies are acceptable and satisfy the data requirement for dissipation of acephate in the field (GLN 164-1; 40504812, 41327605, 41327601; 40504813, 41327604, 41327601; 40504814, 41327603, 41327601).

The following study was not acceptable because soil samples were not taken and analyzed to an adequate depth to define the extent of leaching. The maximum depth sampled was 30 cm, generally because a layer of clay hard pan at soil depths of 30- to 35-cm prevented sampling without the use of specialized equipment. Since acephate residues were detected at the 25- to 30-cm soil depth, soil samples were not taken at an adequate depth to define the extent of leaching. The registrant stated that due to this limitation in sampling procedures, the study provided as supplemental data only.

40504815, 41327602,41327601

Acephate (Orthene 75 S, 75% WP) dissipated with an observed half-life of 1-3 days (calculated 1.95 days; r^2=0.91) in the upper 5 cm of a field plot of sand soil planted to cauliflower in Ocoee, Florida, after six ground applications (7-day intervals) of acephate at 1.0 lb ai/A/application. Average acephate concentrations in the upper 5 cm of soil declined from 1.617 ppm immediately after the sixth application to 0.143 ppm at 3 days; after 7 days, residues were ≤0.027 ppm (detection limit of 0.02 ppm). The maximum average acephate concentration in the upper 5 cm was 2.653 ppm immediately after the second application. Average acephate concentrations in the 5- to 10-cm soil depth were 0.047 ppm immediately after the sixth application, 0.150 ppm at 1 day and 0.080 ppm at 3 days following the last application; after 7 days, residues were nondetectable. Acephate concentrations in the 10- to 30-cm soil depths were nondetectable immediately after the sixth application, 0.063-0.220 ppm at 1 and 3 days posttreatment, and were nondetectable after 7 days. Acephate did not accumulate with repeated ground applications. Methamidophos, the only degradate measured, dissipated with a calculated half-life of ≈3 days in the 0- to 5-cm soil depth; average methamidophos concentrations declined from 0.317 ppm immediately after the sixth application of acephate to 0.173 ppm at 1 day, 0.043 ppm at 3 days, and <0.01 ppm (detection limit) at 7 days. Average methamidophos concentrations were ≤0.033 ppm in the 5- to 30-cm soil depths at all sampling intervals. The maximum average methamidophos concentration (0.320 ppm) was detected in the upper 5 cm of soil immediately after the fourth application. Methamidophos accumulated slightly with repeated ground applications.

During the study, air temperatures ranged from 38 to 85°F. Rainfall and irrigation totaled 0.63 inches between the first the second treatments, 1.21 inches between the second and third, 1.72 inches between the third and fourth, 0.15 inches between the fourth and fifth, 0.33 inches between the fifth and sixth, and 8.09 inches during the 7 days following the last application.

v. Spray Drift

Because there are acephate products which are applied by aircraft or orchard airblast, droplet size spectrum (201-1) and drift field evaluation (202-1) studies were required due to the concern for potential risk to nontarget aquatic organisms. Four acephate spray drift-specific studies have been reviewed (40323301, 41023503; 40323302, 41023504) and were declared acceptable at the time of review. The Spray Drift Task Force (SDTF), a consortium of pesticide registrants, has submitted to the Agency a series of studies which are intended to characterize spray droplet drift potential due to various factors, including application methods, application equipment, meteorological conditions, crop geometry, and droplet characteristics. EPA is evaluating these studies, which include ground spray as well as aerial application methods. In the interim for this assessment, the Agency is relying on previously submitted spray drift data and the open literature for off-target drift rates. The amount of drift from ground spray is estimated at 1% of the applied spray volume at 100 feet downwind. After its review of the studies, the Agency will determine whether a reassessment of the potential risks from the application of acephate to nontarget organisms is warranted.

c. Terrestrial Exposure Assessment

Nongranular applications:

The Agency used the model of Hoerger and Kenaga (1972), as modified by Fletcher et al. (1994) to estimate pesticide concentrations on selected avian and mammalian food items immediately after application. The predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb ai/A are tabulated below.

Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

The acephate degradate methamidophos is very toxic via other routes of exposure than the traditional oral exposure, i.e. dermal and inhalation. Although the short grass residue exposure may not be present in field or even on edge of the field, for purposes of this assessment, the amount of residues for short grass is used as an index for inhalation, dermal, drinking water, and other routes of exposure to mammals and birds. Risks still exist from small insect and foliage present in the field.

The Agency estimated peak residues (EEC's) for a single application of acephate on cranberries and non-bell peppers by using the predicted maximum residue values directly (application rate 1.0 lb ai/A). For multiple applications, the Agency made assumptions of the application intervals and number of applications based on information provided by the Registrant, the LUIS report, and SRRD (Appendix E). The peak EEC was the cumulative residue value predicted immediately following the last application. The FATE model, which calculates cumulative residues assuming a first-order dissipation on plant foliage and insects, used the aerobic soil metabolism half-life as an estimate of rate of dissipation after application, to estimate these peak residues. The value chosen was the 90% upper bound mean aerobic soil metabolism half-life (2.3 days; see Section 2.d.i.)

For assessing chronic risk to birds and mammals, we used the predicted mean Kenaga values to calculate the risk quotients for single applications of acephate. For multiple applications, we used the mean values as an input to the FATE program with the shortest appliation intervals and the maximum number of applications to calculate the exposure (in ppm) that would be used in generating risk quotients. We also used the predicted mean Kenaga values as an input to the FATE program to estimate the length of time that residues were present at greater than the NOAEC for birds (5 ppm) and the NOAEC for mammals (50 ppm). We also used the peak mean Kenaga values as an input to the FATE program, along with application rate times application interval in days to calculate the average residues over the application time period.

Effect of Acephate Degradate Methamidophos on Birds and Mammals

Acephate degrades rapidly (observed half-lives < 2 days) by aerobic soil metabolism to methamidophos, which is also an insecticidally active compound. Another degradate of acephate, DMPT, was formed during abiotic hydrolysis of acephate at pH 9, but was not observed during aerobic soil metabolism in soils with pHs of 5.7-6.2. Therefore, it is likely that, following applications of acephate, the only degradate of acephate that birds and mammals will be exposed to is methamidophos. Exposure to methamidophos is a concern because of its toxicity to animals (Section 3.a.).

In order to calculate the EECs for acute exposure to methamidophos formed from the degradation of acephate, it was assumed that, upon application of acephate, there would be an instantaneous and complete conversion to methamidophos. (This is a very conservative assumption, because observed half-lives of acephate degrading to methamidophos can range up to approximately 2 days.) This would result in an effective application of 0.77 lb of methamidophos for every pound of acephate applied (molecular weight of methamidophos [140.25] ÷ molecular weight of acephate [182.22] = 0.77).

The Agency estimated peak residues (EECs) of methamidophos resulting from a single application of acephate by linear extrapolation of the above values for a 0.77 ai/A application rate (i.e. multiplying the above values by 0.77). For multiple applications, the Agency made the same assumptions as for acephate of the application intervals and number of applications. The peak EEC was the cumulative residue value predicted immediately following the last application using the 0.77 conversion factor.

The FATE model used a conservative estimate of the aerobic soil metabolism half-life for methamidophos (three times the observed half-life of 14 hours, or 1.75 days) as an estimate of rate of dissipation after application. The conservative estimate was used to be consistent with guidance for the selection of input parameters for models used to calculate EECs for surface water (see Section 2.d.ii.).

For assessing chronic risk to birds and mammals, we used the predicted mean Kenaga values by linear extrapolation of the above values for a 0.77 ai/A application rate (i.e. multiplying the above values by 0.77) to calculate the risk quotients for methamidophos degradate from single applications of acephate. For multiple applications, we used 0.77 times the mean values as an input to the FATE program with the shortest appliation intervals and the maximum number of applications to calculate the exposure (in ppm) that would be used in generating risk quotients. We also used 0.77 times the peak mean Kenaga values as an input to the FATE program to estimate the length of time that residues were present at greater than the NOAEC for birds (5 ppm) and the NOAEC for mammals (50 ppm). We also used 0.77 times the peak mean Kenaga values as an input to the FATE program, along with application rate times application interval in days to calculate the average residues over the application time period.

Granular applications:

The Agency assumes that exposure from granular applications would only come from soil exposure; no granules are expected to adhere to plant foliage. Furthermore, procedures for estimating chronic risk assessments have not been developed for exposure for granular formulations. Acephate can be applied as a single pre-plant in-furrow granular application to peppers, cotton and peanuts; there is a single application to turf using a broadcast unincorporated application. We assumed 1% of the application was present on the surface of the soil from the pre-plant, in-furrow application and 100% from the broadcast unincorporated. The exposure would be based on the number of pounds of ai per square foot; specific calculations are included in the exposure assessement for birds and mammals in Section 4.a. Due to lack of labeling data, the following assumptions were made for determining the RQ for granular applications in-furrow to peppers, cotton, and peanuts:

> There are 43,560 ft^2 in an acre. There are 43.56 12-inch wide 1000-ft long rows in an acre. There are 87.12 (43.56 x 2) 6-inch rows in an acre. EFED assumes that acephate will be incorporated in 6-inch strips in pepper, cotton and peanuts fields that have 30-inch rows. For every 6 inches that is treated, there will be 24 inches untreated (1:4 ratio). Therefore, one fourth of the acre will have acephate incorporated. Since acephate is incorporated at 1 lb ai/A, the rate of application for acephate within the 6-inch strips will be 4 lb ai/A (64 oz. ai/A). The rate of application per 1000 foot row is: 0.735 oz. per 1000-ft row (64 oz/87.12 rows).

No granular EECs were calculated for methamidophos formed from acephate because it is not certain whether there would be an instantaneous conversion of acephate to methamidophos in the granules applied to the soil.

d. Water Resource Assessment

i. Ground Water

Based on the laboratory and field studies conducted, it does not appear that acephate and its degradate methamidophos will pose a significant threat to ground water resources. Acephate has high mobility (K_{ads} 0.09 mL/g); however, it is very susceptible to aerobic soil metabolism ($t_{½} < 2$ days). Acephate is also not persistent under anaerobic conditions degrading with a half-life of 6.6 days in clay sediment:creek water systems in the laboratory, producing carbon dioxide and methane as the major degradates. Three acceptable terrestrial field dissipation studies suggest that the parent compound does not persist long enough to exhibit substantial leaching; however, in a soil where an impermeable layer was close to the surface (within 35 cm), acephate residues were found at all depths sampled. If acephate were applied to a soil with a perched water table close to the surface, acephate residues might reach this shallow ground water; however, it would not be expected to persist under these conditions. Methamidophos also has high mobility (K_{ads} 0.029 mL/g); it also is very susceptible to aerobic soil metabolism ($t_{½}$ = 14 hours). No acceptable field dissipation studies are available for methamidophos, but reported data suggest that methamidophos, like its parent acephate, does not persist long enough to exhibit substantial leaching. No acceptable persistence or mobility information is available on the degradates of methamidophos. Limited monitoring information indicates that there were no detections of acephate in ground water.

Ground Water EECs

Groundwater calculations for acephate and its degradate methamidophos were based on the SCI-GROW model (Screening Concentrations in Ground Water), which is a model for estimating concentrations of pesticides in ground water under conditions of maximum exposure. SCI-GROW provides a screening concentration or an estimate of likely ground water concentration if the pesticide is used at the maximum allowed label rate in areas with ground water that is exceptionally vulnerable to contamination. In most cases, a majority of the use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate.

The SCI-GROW model is based on normalized ground water concentrations from ground water monitoring studies, environmental fate properties (aerobic soil half-lives and organic carbon partitioning coefficients-K_{oc}'s) and application rates. The model is based on permeable (sandy) soils that are vulnerable to leaching and that overlie shallow ground water (10-30 feet).

The input parameters for SCI-GROW are reported in the following table.

Input parameters used for calculating the ground water EEC for Acephate using SCI-GROW			
Parameter	Value	Source	Quality
Soil half-life	2.3 d	The 90% upper bound mean half-life [mean half-life + $t_{90}s/\sqrt{n}$] of three values; MRID 00014991[1]	Fair
Soil K_{oc}	2.73	Single value for a clay loam soil; MRID 40504811	Fair
Crop modeled	Cotton	Crop with maximum number of applications; information from registrant	Excellent
Number of applications	6 / year	Maximum number of applications for cotton; information from registrant	Excellent
Application rate	1.0 lb/A	Maximum application rate for cotton label; information from registrant	Excellent

1 Although current SCI-GROW guidance recommends using the simple mean half-life, this value was selected using guidance for GENEEC and PRZM-EXAMS to be more protective.

Using the SCI-GROW model to estimate concentrations of acephate in ground water, the calculated EEC resulting from the use with the maximum yearly total application (six applications at 1 lb acephate/A/application on cotton) is 0.02 μg/L .

Because acephate is not persistent under aerobic conditions, very little acephate could be expected to leach to groundwater, as indicated by the SCI-GROW estimate. If any acephate did reach ground water, it would not be expected to persist, due to its short anaerobic half-life (6.6 days).

The SCI-GROW EEC for methamidophos formed from the degradation of acephate was calculated using the assumptions described in Section 2.c.

Input parameters used for calculating the ground water EEC for Methamidophos formed from acephate using SCI-GROW			
Parameter	Value	Source	Quality
Soil half-life	1.75 d	Multiplication of a single value by 3; MRID 41372201[1]	Fair
Soil K_{oc}	0.88	Single value for a clay loam soil; MRID 40504811	Fair
Crop modeled	Cotton	Crop with maximum number of applications for acephate; information from registrant	Excellent
Number of applications	6 / year	Maximum number of applications of acephate on cotton; information from registrant	Excellent
Application rate	0.77 lb/A	From instantaneous conversion of 1 lb/A acephate to methamidophos at each application	Fair

1 Although current SCI-GROW guidance recommends using the single half-life, this value was selected using guidance for GENEEC and PRZM-EXAMS to be more protective.

The ground water EEC for the degradate methamidophos (assuming instantaneous complete conversion from acephate at time of application, resulting in six applications at 0.77 lb methamidophos/A/application on cotton) was 0.015 μg/L. If any methamidophos residues did reach ground water, they might be expected to persist (anaerobic aquatic DT_{50} of 41 days for methamidophos; undetermined persistence for degradates DMPT and O-desmethyl methamidiphos).

Ground Water Monitoring Data

A small amount of monitoring data on the occurrence of acephate between 1984 and 1993 have been collected and reported to the Pesticide in Ground Water Database and STORET; no detections of acephate in ground water have been reported. The US Geological Survey National Water Quality Assessment program (NAWQA) is not currently analyzing for acephate or methamidophos in their samples, and they do not have analytical methods for these chemicals in place. Discussion of the extracted studies follows.

Pesticides in Ground Water Database

The results of sampling conducted in 1984-89 associated with the Well Inventory Database in California were reported. No detections of acephate were reported in samples taken from unfiltered and untreated wells in 58 counties scattered throughout the agricultural areas of the state; data were reported for 793 wells, with detection limits ranging from 0.04 μg/L to 830 μg/L. High detection limits were from the analyses performed in 1987; the more recent samples achieved the lower detection limit. Since the bulk of the data (approximately 70%) is based on sampling done by Department of Health Services and seven other agencies, detection limits will vary. In a follow-up conversation with CALEPA/DPR, the data from 1990 to 1997 still shows no detections of acephate, so one can be fairly confident that the earlier reports of no detections are valid.

In 1987-88, 188 wells from 10 counties scattered throughout the agricultural areas of Texas were sampled. These were unfiltered and untreated wells for domestic use, which were protected from surface water contamination. The wells were located in areas of shallow ground water close to agricultural production. No detections were reported; however, the limits of detection and the analytical recoveries are unknown.

Sampling was conducted in Collier County, Florida on 36 wells in 1986-1987. The wells were located in a 60-mile-square area with a shallow aquifer system. Wells installed for the study were < 15 ft deep; the study also included irrigation wells > 80 ft deep and public water supply wells. No detections were reported; the limit of detection was 0.91 μg/L, and no information was available on analytical recoveries.

Two wells were sampled in 1986 in Oklahoma, one in Cherokee County and one in Woodward County. Samples were taken in areas overlying alluvium and terrace aquifers where the pesticide was used from wells constructed to preclude contamination by surface waters. No detections were reported; the detection limit was 1 ppb, but analytical recoveries were not reported.

STORET

A small amount of ground water monitoring data for acephate have been collected and reported to the STORET system. These are: one record of a sample taken in 1986 from a spring in Santa Cruz county, California; 844 samples taken in 1984-1987 for a statewide survey of municipal water intakes from ambient streams and ambient wells in California; and 27 samples taken in 1992-1993 by USGS from ambient wells in Sarasota and Hillsborough counties, Florida. In all samples, the actual value was known to be less than 10 μg/L, but it is uncertain what the actual detection limit was and if samples were taken from an area where acephate was not in use.

ii. Surface Water Assessment

Summary

Based on the modeling results, acephate and its degradate methamidophos will pose a significant threat to surface water resources on an acute basis. Although acephate is very susceptible to aerobic soil metabolism (observed $t_{1/2}$ < 2 days), it is highly mobile (K_{ads} 0.09 mL/g). No acceptable data are available on the persistence of acephate in aerobic aquatic systems; however, acephate is not persistent under anaerobic aquatic conditions, degrading with a half-life of 6.6 days. The acephate degradate methamidophos also has high mobility (K_{ads} 0.029 mL/g); it also is very susceptible to aerobic soil metabolism ($t_{½}$ = 14 hours). No information is available on the degradates of methamidophos. Limited monitoring information on acephate indicates that there were no detections of acephate in surface water.

Surface Water EECs

Screening-level exposure estimates for surface water sources were generated using GENEEC (Version 1.0, executable dated May 3, 1995) for the use sites and applications described in the Use Characterization (Section 1) for use in the acephate ecological risk assessment. GENEEC is a single event model (one runoff event), but can account for spray drift from multiple applications. GENEEC is hardwired to represent a 10 ha field immediately adjacent to a 1 ha pond, 2 m deep with no outlet. The pond receives a spray drift event from each application plus one runoff event, which moves a maximum of 10% of the applied pesticide into the pond. This runoff can be reduced by degradative processes in the field and by the effects of binding to soil in the field. In the GENEEC model, spray drift is equal to 1% of the applied for ground spray application and 5% of the applied for aerial application.

GENEEC may not be an ideal tool for use in all environmental exposure risk assessments. GENEEC assumes that essentially the whole 10 hectares receives a uniform application of the chemical without considering the percentage of the surrounding area that is cropped. Furthermore, the persistence of the chemical is usually overestimated because there is always at least some flow in a river or turnover in a reservoir or lake. However, the EECs calculated using GENEEC will be appropriate for assessing risk to any aquatic organisms and plants that are directly exposed to undiluted runoff.

Although GENEEC does have these limitations, it can be used in screening calculations and does provide an upper bound on the environmental concentrations of a pesticide. If a risk assessment based on GENEEC does not exceed the level of concern, then the actual risk is not likely to be exceeded. However, since GENEEC can substantially overestimate true environmental concentrations, it will be necessary to refine the GENEEC estimate when the level of concern is exceeded. In those situations where the level of concern is exceeded and the GENEEC value is a substantial part of the total exposure, EFED can use a variety of methods to refine the exposure estimates.

The GENEEC input values used for **acephate** (and the sources for them) for cotton (the crop with the maximum rate of acephate application per year) are listed in the following table:

Input parameters used for calculating the surface water EECs for Acephate using GENEEC			
Parameter	Value	Source	Quality
Crop modeled	Cotton	Crop with maximum number of applications; information from registrant	Excellent
Number of applications	6 / year	Maximum number of applications for cotton; information from registrant	Excellent
Application rate	1.0 lb/A	Maximum application rate for cotton label; information from registrant	Excellent
Application interval	3 d	Minimum retreatment interval for cotton; information from LUIS	Good
Application method	Aerial/ Ground	Aerial application scenario assumes 5% drift / ground application assumes 1% drift	Good
Soil half-life	2.3 d	The 90% upper bound mean half-life [mean half-life + $t_{90}s/\sqrt{n}$] of three values; MRID 00014991[1]	Fair
Soil K_{oc}	2.73	Single value for a clay loam soil; MRID 40504811	Fair
Solubility	8.01×10^5 mg/L	At 25°C (pH not specified); MRID 40390601	Good
Hydrolysis	163 d	At pH 7; MRID 41081603	Good
Aqueous photolysis	Stable	MRID 41081603	Good
Aerobic aquatic metabolism	Stable	Acceptable data were not available; assumed that the parent was stable	Fair

1 Draft Internal Guidance: Model Parameter Selection Criteria for PRZM and EXAMS, Environmental Fate and Effects Division, August 5, 1997.

Because EFED does not have any acceptable aerobic aquatic metabolism data and acephate is photolytically stable as well as hydrolytically stable ($t_{1/2}$ =163days), we assumed that acephate was stable in aerobic aquatic systems, which is the most conservative assumption. For this reason, the GENEEC runs showed that there was little degradation once acephate reaches the pond and that the EEC's did not decrease much over time (Table A). To rebut this assumption, the registrant may choose to submit the aerobic aquatic metabolism study (GLN 162-4) for acephate to improve our understanding of the dissipation of acephate in aquatic environments and to refine our calculation of aquatic EEC's.

Table A. Generic EECs (in ppb) for Acephate for six applications of 1 lb/A to cotton				
Application method	PEAK GEEC	AVERAGE 4 DAY GEEC	AVERAGE 21 DAY GEEC	AVERAGE 56 DAY GEEC
Aerial	105	104	100	93
Ground	95	95	91	85

Because of the high ecotoxicity of the acephate degradate methamidophos, the EECs for methamidophos formed from the degradation of acephate were calculated using the assumptions described in Section 2.c.

The GENEEC input values used for **methamidophos formed from applications of acephate** (and the sources for them) are listed in the following table.

Input parameters used for calculating the surface water EECs for Methamidophos formed from Acephate using GENEEC			
Parameter	Value	Source	Quality
Crop modeled	Cotton	Crop with maximum number of applications; information from registrant	Excellent
Number of applications	6 / year	Maximum number of applications for cotton; information from registrant	Excellent
Application rate	0.77 lb/A	From instantaneous conversion of 1 lb/A acephate to methamidophos at each application	Fair
Application interval	3 d	Minimum retreatment interval for cotton; information from LUIS	Good
Application method	Aerial/ Ground	Aerial application scenario assumes 5% drift / ground application assumes 1% drift	Good
Soil half-life	1.75 d	Multiplication of a single value by 3; MRID 41372201[1]	Fair
Soil K_{oc}	0.88	Single value for a clay loam soil; MRID 40504811	Fair
Solubility	2.0×10^5 mg/L	Temperature and pH not specified; MRID 43661003	Fair
Hydrolysis	27 d	At pH 7 and 25°C; MRID 00150609	Good
Aqueous photolysis	90 d	At pH 5; MRID 00150610	Fair
Aerobic aquatic metabolism	Stable	Acceptable data were not available; assumed that the parent was stable	Fair

1 Draft Internal Guidance: Model Parameter Selection Criteria for PRZM and EXAMS, Environmental Fate and Effects Division, August 5, 1997.

Because EFED does not have any acceptable aerobic aquatic metabolism data, we assumed that methamidophos was stable in aerobic aquatic systems, which is the most conservative assumption. GENEEC then used the contributions of hydrolysis and aqueous photolysis to estimate persistence in the pond; the EEC's decreased to approximately one-half the peak concentrations by 56 days (Table M). To rebut this assumption, the registrant may choose to submit the aerobic aquatic metabolism study (GLN 162-4) for methamidophos to improve our understanding of the dissipation of methamidophos in aquatic environments and to refine our calculation of aquatic EEC's.

Table M. Generic EECs (IN PPB) for Methamidophos formed after six applications of 1.0 lb/A Acephate to cotton

Application method	PEAK GEEC	AVERAGE 4 DAY GEEC	AVERAGE 21 DAY GEEC	AVERAGE 56 DAY GEEC
Aerial	69	67	54	37
Ground	63	61	49	34

Based on the Tier I estimates of environmental concentrations that were calculated in Section 4.b., ecotoxicity Levels of Concern (LOCs) were exceeded for many crops. The assessment then proceeded to Tier II, in which the EECs are refined using PRZM-EXAMS.

Tier II Surface Water Exposure Assessment - PRZM-EXAMS

Because ecological LOCs were exceeded during the Tier I screen (GENEEC), a refinement of the EECs was required. Tier II estimated environmental concentrations (EECs) for acephate as applied to cotton in Mississippi and tobacco in North Carolina were determined using PRZM-EXAMS because these were scenarios with the highest GEECs as determined by GENEEC. The PRZM scenarios were chosen to represent sites that were expected to produce greater mass pesticide runoff than 90% of the sites where the modeled crops may be grown greater than 90% of the time. Tier II upper tenth percentile EECs for the maximum exposure scenarios are listed in Table 1; EECs from acephate applied as aerial broadcast applications were higher on cotton than on tobacco.

Table 1. Tier II upper tenth percentile EECs for Acephate (µg/L)*

Crop	Peak	4-Day	21-Day	60-day	90-day	Over-all Mean	90% CB Mean
Cotton, Mississippi	71	42	14	6.5	4.3	1.4	0.75
Tobacco, North Carolina	15	11	3.7	1.7	1.1	0.3	0.20

*Upper 90th percent confidence bound on concentrations.

The acephate degradate methamidophos is also toxic to wildlife, so the algorithms included in PRZM were used to simulate the parent/daughter relationship of acephate/methamidophos. Tier II upper tenth percentile EECs for Methamidophos formed as a consequence of acephate applications to cotton in Mississippi are reported in Table 2.

Table 2. Tier II upper tenth percentile EECs for Methamidophos formed as a consequence of acephate applications (μg/L)*

Crop	Peak	4-Day	21-Day	60-day	90-day	Over-all Mean	90% CB Mean
Cotton, Mississippi	71	49	18	8.2	5.5	1.7	0.75

* Upper 90th percent confidence bound on concentrations.

Background

A Tier II exposure assessment uses a single site which represents a high exposure scenario for pesticide use at a particular crop or non-crop site. A high exposure scenario is one that is expected to yield a mass loading of pesticide to surface water that is equal to or greater than 90% of the sites where the chemical may be applied. The weather and agricultural practices are simulated at the site over multiple (in this case, 36) years so the probability of an EEC occurring at that site can be estimated. EECs for acephate were calculated for cotton and tobacco because those were the crops that indicated a potential risk to aquatic wildlife during Tier I screening (Section 4).

Tier II EECs generated in this analysis were calculated using PRZM 3.1 (Executable file dated October 17, 1997) for simulating the agricultural field and EXAMS 2.97.5 (Executable file dated June 19, 1997) for fate and transport in surface water. All scenarios used aerial broadcast application of the maximum rates and number of applications provided by the Registrant. In all scenarios, it is assumed that aerial transport to the pond does occur, but runoff is the primary mechanism of transport to the pond.

Limitations of this Analysis

There are several factors which limit the accuracy and precision of this analysis including the selection of the high exposure scenarios, the quality of the input data, the ability of the models to represent the real world, and the number of years that were modeled.

Scenarios that are selected for use in Tier II EEC calculations are ones that are likely to produce large concentrations in the aquatic environment. Scenarios should represent a site that actually exists and would be likely to have the pesticide in question applied. Scenarios should be extreme enough to provide conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. Currently, sites are chosen by best professional judgement to represent areas which generally produce EECs larger than 90% of all sites planted in that crop. The EECs in this analysis are accurate only to the extent that a site represents this hypothetical high exposure site. The most limiting part of site selection is the use of a standard pond with no outlet. Obviously, a Georgia pond, even with appropriately modified temperature data is not the most appropriate water body for use in New York. It should be remembered that while the standard pond would be expected to generate higher EECs than most water bodies, some water bodies would likely have higher concentrations. These may include shallow water bodies near agricultural fields that receive most of their water as runoff from agricultural fields that have been substantially treated with acephate.

The quality of the analysis is directly related to the quality of the input parameters. In general, the fate data for acephate is good based on accepted studies. In particular, the lack of aerobic aquatic metabolism data limit the accuracy of this analysis. Aerobic aquatic metabolism data would greatly increase our confidence in an exposure assessment by providing direct measurements of acephate behavior in aquatic environments.

The models themselves represent a limitation on the analysis quality. While the models are some of the best environmental fate estimation tools available, they have significant limitations in their ability to represent some processes. Spray drift is estimated as a straight percentage of the application rate reaching the pond for each application from aircraft, air-blast, or ground application. In actuality, this value should vary with each application from zero to perhaps as high as 25 percent or more. A second major limitation of the models is the lack of validation at the field level for pesticide runoff. While several of the algorithms (volume of runoff water, eroded sediment mass) are well validated and well understood, no adequate validation has yet been made of PRZM 3.1 for the amount of pesticide transported in runoff events. Other limitations of the models used is the inability to handle within site variation (spatial variability), no crop growth algorithms, and an overly simple soil water transport algorithm (the "tipping bucket" method).

A final limitation is associated with the limited years of weather data available for the analysis at all sites. Consequently there is approximately one chance in ten in the years simulated that the true 10% exceedence EECs are larger than the maximum EEC calculated in the analysis. If the number of years of weather data could be increased it would increase the confidence that the estimated value for the 10% exceedence EEC was close to the true value.

Pesticide Use

Surface water concentrations were estimated using the method for each crop that generally produces the greatest exposure; in both cases, it was the aerial broadcast application to the foliage without incorporation.

There is no master label for acephate, but information provided by the registrant (Appendix E) contains maximum seasonal application rates of up to 6 lbs a.i./acre (on cotton). Acephate can be applied by broadcast to the foliage postemergence, but there are preplant or at-planting applications as well in which incorporation in the top 2 to 4 inches of soil is typical; maximum application rates for these uses are up to 1 lb a.i./acre. Surface water concentrations were estimated using the method for each crop that generally produces the greatest exposure; in both cases, it was the aerial broadcast application to the foliage without incorporation.

Application Rates and Timing

Application information for acephate for the modeled crops was provided by the Registrant and extracted from LUIS and is listed in Table 2. These values were used to generate Tier II EECs for the crops listed. Applications were assumed to have been made by aerial broadcast spray to the foliage, where it was assumed that 95% of the application hit the target site; no incorporation was assumed[1]. Application intervals were chosen based on the minimum indicated on the labels and abstracted by LUIS. Application dates were chosen based on pest being controlled and appropriate stage of maturity of the crop.

Table 2. Usage Practices used for modeling Acephate on various crops.

Crop	Location, (Soil), Hydrologic Group, and (MLRA)	Maximum Labeled Rate (lb ai/A), App. Dates, Pre-Harvest Interval (PHI)
Cotton	Yazoo County, MS (Loring silt loam), Group C, (MLRA 134)	1.0 lb (6 x 1.0 lbs ai) at 3 day interval July 1 - 16; PHI=NA
Tobacco	Wake County, NC (Norfolk loamy sand), Group B, (MLRA 133a)	1.33 lb (3 x 1.33 lbs ai) at 3 day interval June 1 - 7; PHI=NA

Methamidophos formed as a degradate from acephate parent was modeled using the parent/daughter algorithms within PRZM.

Detailed information on the selection of input parameters for PRZM and EXAMS are included in Appendices A, B, C, and D.

Surface Water Monitoring Data

A small amount of monitoring data on the occurrence of acephate between 1977 and 1993 have been collected and reported to STORET; no detections of acephate in surface water have been reported. The US Geological Survey National Water Quality Assessment program (NAWQA)

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[1] The current EFED standard input for the application efficiency from aerial application is 75%. However, there is undocumented information that supports the choice of the 95% application efficiency.

is not currently analyzing for acephate or methamidophos in their samples, and they do not have analytical methods for these chemicals in place. Discussion of the extracted studies follows.

STORET

STORET contains no records for acephate in samples from lakes, ocean, estuary, canal, or reservoir sites.

There are records of three samples taken in 1987 from municipal water intakes from ambient streams in Santa Clara county, California; the actual value was known to be less than 10 μg/L, but it is uncertain what the actual detection limit was and if samples were taken from an area where acephate was not in use. There are records of eight samples taken in April 1977 from a stream in Piscataquis county, Maine. These samples were part of a field study involving insecticide application. Maximum values in the stream were 135 μg/L, which decreased with time. However, because of the age of the data (20 years), it may not be possible to obtain further information on this study.

There is one record of a sample taken in 1986 from a spring in Santa Cruz county, California; the actual value was known to be less than 10 μg/L, but it is uncertain what the actual detection limit was and if the sample was taken from an area where acephate was not in use.

There are records of 844 samples taken in 1984-1987 for a statewide survey of municipal water intakes from ambient streams and ambient wells in California. In all samples, the actual value was known to be less than 10 μg/L, but it is uncertain what the actual detection limit was and if samples were taken from an area where acephate was not in use. There are records of 27 samples taken in 1992-1993 by USGS from ambient wells in Sarasota and Hillsborough counties, Florida. The samples were analyzed for and acephate was not detected; however, it is uncertain what the actual detection limit was and if samples were taken from areas where acephate was not in use.

iii. Drinking Water Assessment

Groundwater Concentration Estimates

The ground water Tier I EEC for both acute and chronic drinking water exposure estimates was calculated using SCI-GROW as previously described for the acephate use with the maximum yearly total application (six applications at 1 lb acephate/A/application on cotton). The EEC was 0.02 μg/L.

The ground water Tier I EEC for the degradate methamidophos (assuming instantaneous complete conversion from acephate at time of application, resulting in six applications at 0.77 lb methamidophos/A/application on cotton) was 0.015 μg/L.

As previously discussed, a majority of the use areas will have ground water that is less vulnerable to contamination than that in the areas used to derive the SCI-GROW estimate.

Surface Water Concentration Estimates

Using the PRZM-EXAMS model and available environmental fate data for acephate as previously described, EFED calculated the following Tier II upper tenth percentile EEC's for acephate in use in determining surface water drinking water exposure estimates from the uses with the maximum yearly total applications (six aerial applications at 1 lb acephate/A/application on cotton and three aerial applications at 1.33 lb acephate/A/application on tobacco):

Surface water drinking water exposure estimates for Acephate		
Use site	Acute/peak EECs (μg/L)	Chronic (60-day) EECs (μg/L)
Cotton in Mississippi	71	6.5
Tobacco in North Carolina	15	1.7

Surface water EEC's for drinking water exposure estimates for the acephate degradate methamidophos were generated using the algorithms included in PRZM to simulate the parent/daughter relationship of acephate/methamidophos for the cotton use:

Surface water drinking water exposure estimates for Methamidophos formed as a degradate of Acephate		
Use site	Acute/peak EECs (μg/L)	Chronic (60-day) EECs (μg/L)
Cotton in Mississippi	71	8.2

It should be remembered in interpreting these results that they represent the upper limit for possible exposure from these use patterns to aquatic environments at a single high exposure site. In actual practice, the true environmental concentrations will probably be less than indicated by this analysis because most sites will produce less loading to aquatic environments than these scenarios. In addition, surface-water-source drinking water tends to come from bodies of water that are substantially larger than a 1 hectare pond. Furthermore, any extrapolation from the EECs generated would be based on the assumption that essentially the whole basin containing the scenario modeled receives an application of the chemical. In virtually all cases, basins large enough to support a drinking water facility will contain a substantial fraction of area which does not receive the chemical. Furthermore, the persistence of the chemical near the drinking water facility is usually overestimated because there is always at least some flow in a river or turn over in a reservoir or lake.

3. Ecological Effects Toxicity Assessment

The following toxicological endpoints will be used for determining risk quotients in this document:

Oral acute bird: mallard 234 mg/kg, bobwhite 109 mg/kg, junko 106 mg/kg
Dietary bird: mallard >5000 ppm, bobwhite quail 1280 ppm, junko 1485 ppm
Chronic bird: mallard 5 ppm (NOAEL due to mortality)
Acute mammals: female rat 739 mg/kg, meadow vole 321 mg/kg
Chronic mammals: rat 50 ppm (3-generation NOAEL)
Acute freshwater fish: trout 730 ppm
Chronic freshwater fish: none available
Acute freshwater invertebrates: Daphnids 1.3 ppm
Chronic freshwater invertebrates: Daphnids 0.15 ppm (NOAEC due to mortality)
Acute estuarine fish: pinfish 85 ppm
Chronic estuarine fish: none available
Acute estuarine invertebrate (shrimp): pink shrimp 3.8 ppm
Acute estuarine invertebrate (oyster): oyster 5.4 ppm
Chronic estuarine invertebrate (shrimp): mysid shrimp 0.58 ppm

a. Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

Acute oral toxicity and avian subacute dietary toxicity studies using the technical grade of the active ingredient (TGAI) are required to establish the toxicity of acephate and its degradate methamidophos to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). Results of these tests are tabulated below.

Studies using the parent chemical, acephate.

Avian Acute Oral Toxicity for Acephate

Species	% ai	LD_{50} (mg ai/kg)	Toxicity Category	MRID No. Author/Year	Study Classification
Mallard duck (*Anas platyrhynchos*)	89	350	moderately toxic	00014700 Mastalski, 1970	core
Mallard duck (*Anas platyrhynchos*)	93.2	234	moderately toxic	00160000 Hudson, 1984	core
Mallard duck (*Anas platyrhynchos*)	89	350	moderately toxic	00015962 Hudson, 1972	core
Bobwhite quail (*Colinus virginianus*)	15 (2)	109	moderately toxic	43939301 Campbell, 1992	core
Pheasant (*Phasianus colchicus*)	89	140	moderately toxic	00014701 Mastalski, 1970	core
Dark eyed junko (*Junco hyemalis*)	75	106	moderately toxic	00093911 Zinkl, 1981	supplemental

(1) Smith, G.J., 1987. Pesticide Use and Toxicology in Relation to Wildlife: Organophorous and Carbamate Compounds. U.S. Dept. Of Interior, FWS Resource Publication 170. pg. 11.
(2) This is a granular formulation.

These avian studies with technical grade acephate indicate that it is moderately toxic to birds on an acute oral basis (LD_{50} = 51-500 mg/kg). The guideline (71-1) is fulfilled (MRID 43939301, 00015962, 00014701, 00014700, 00093911).

Avian Subacute Dietary Toxicity for Acephate

Species	% ai	5-Day LC_{50} (ppm ai)	Toxicity Category	MRID No. Author/Year	Study Classification
Northern bobwhite quail (*Colinus virginianus*)	95.3	1280 ppm	slightly toxic	00015956 Fletcher, 1976	core
Mallard duck (*Anas platyrhynchos*)	95.3	>5000	practically non-toxic	00015957 Fletcher, 1976	core
Dark eyed junko (*Junco hyemalis*)	75	1485	slightly toxic	00093911 Zinkl, 1981	supplemental
Japanese Quail (*Coturnix japonica*)	15.6	718	moderately toxic	(1)	supplemental
Japanese Quail (*Coturnix japonica*)	98	3275	slightly toxic	(1)	supplemental
Northern bobwhite quail (*Colinus virginianus*)	formulation	3/6 dead within 100 minutes (2)	inhalation study	(3)	ancillary

(1) Smith, G.J., 1987. Pesticide Use and Toxicology in Relation to Wildlife: Organophorous and Carbamate Compounds. U.S. Dept. Of Interior, FWS Resource Publication 170. pg. 71.
(2) In this inhalation study, bobwhites were exposed to 2.2 mg/L of acephate for 100 minutes.
(3) Bertem, P.E., R.E. Chiles. Studies on the Inhalation Toxicity of Two Phosphoramidothioate Insecticides to Rodents and Quail. University of California, School of Public Health, Naval Biosciences Laboratory, Naval Supply Center, Oakland, California

These avian studies with technical and formulated grade acephate indicate that the toxicity ranges from practically non-toxic to moderately toxic to birds on a subacute dietary basis (LC_{50} = 501 - 1000 ppm). The guideline (71-2) is fulfilled (MRID 00015956, 00015957, 00093911).

Studies using the degradate methamidophos.

Avian Acute Oral Toxicity for the degradate methamidophos

Species	% ai	LD_{50} (mg ai/kg)	Toxicity Category	MRID No. Author/Year	Study Classification[1]
Northern bobwhite quail *(Colinus virginianus)*	75	8	very highly toxic	00014094, 00109717 Fletcher, 1971	supplemental
Northern bobwhite quail *(Colinus virginianus)*	75	10.1 (male) 11.0 (female)	highly toxic	00041313 Nelson, 1979	core
Mallard duck *(Anas platyrhynchos)*	75	8.48	very highly toxic	0016000 Hudson 1984	core
Mallard duck *(Anas platyrhynchos)*	75	29.5	highly toxic	00014095, 00109718 Fletcher, 1971	supplemental
Dark eyed junco *(Junco hyemalis)*	73	8	very highly toxic	00093914 Zinkl, 1981	supplemental
Common grackle *(Quiscalur quiscula)*	55	12.2	highly toxic	00144428 Lamb, 1972	supplemental

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

Since the LD_{50} falls in the range of <10 to 50 mg/kg, methamidophos is categorized as very highly to highly toxic to avian species on an acute oral. The guideline (71-1) is fulfilled (MRID 00014094, 00014095, 00041313, 0016000, 00093914, 00109717, 00109718, 00144428).

Two subacute dietary studies using the TGAI are required to establish the toxicity of methamidophos to birds. The preferred test species are mallard duck and bobwhite quail. Results of these tests are tabulated below.

Avian Subacute Dietary Toxicity for the degradate methamidophos

Species	% ai	5-Day LC_{50} (ppm ai)	Toxicity Category	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	75	42	very highly toxic	00093904 Fink,1979	core
Northern bobwhite quail *(Colinus virginianus)*	75	47.04	Very highly toxic	00014304 00145655 00130823 Lamb ,1977	supplemental
Northern bobwhite quail *(Colinus virginianus)*	75	57.5	Highly toxic	00014064 Jackson, 1968	supplemental
Northern bobwhite quail *(Colinus virginianus)*	75	59	highly toxic	44484404 Thompson-Cowley, 1981	supplemental
Mallard duck *(Anas platyrhynchos)*	75	1302	slightly toxic	00041658, Nelson 1979	core
Mallard duck *(Anas platyrhynchos)*	75	847.7	Moderately toxic	00130823 00014304 00145655 Lamb 1977	supplemental
Mallard duck *(Anas platyrhynchos)*	75	1650	slightly toxic	44484403 Shapiro, 1981	supplemental
Japanese Quail	73	92	highly toxic	(1)	supplemental
Starling	75	10 (2)	very highly toxic	00146286 Schafer, 1984	ancillary
Redwing blackbird	75	1.78 (2)	very highly toxic	00146286 Schafer, 1984	ancillary

(1) Smith, G.J., 1987. *Pesticide Use and Toxicology in Relation to Wildlife: Organophorous and Carbamate Compounds*. U.S. Dept. Of Interior, FWS Resource Publication 170. pg. 71.
(2) Dermal LD_{50} = 17.8 mg/kg for starling and 31.6 mg/kg for redwing blackbird.

Since the LC_{50} falls in the range of <50 to 5000 ppm, methamidophos is categorized as slight toxic to very highly toxic to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID 00093904, 00014304, 00014064, 00041658, 00146286).

ii. Birds, Chronic

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

The above criteria were developed when the test was primarily used to determine effects of organochlorine pesticides and other persistent chemicals and reflect the concern for pesticides with chronic exposure patterns. The criteria would not necessary trigger a test for pesticides that pose risk of adverse reproductive effects from short term exposure. Several pesticides have been shown to reduce egg production within days after initiation of dietary exposure (Bennett et al 1991). Effects of eggshell quality (Bennett and Bennett, 1990) and incubation and brood rearing behavior (Bennett et al, 1991) have also resulted from short-term pesticide exposures.

Results of these tests are tabulated below.

Studies using the parent chemical, acephate.

Avian Reproduction for acephate

Species/ Study Duration	% ai	NOAEC/LOAEC (ppm)	LOAEC Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	tech	20/80	(1)	00029692 Beavers, 1979	core
Mallard duck *(Anas platyrhynchos)*	tech	5/20	(2)	00029691 Beavers, 1979	core

(1) reduced body weight, number of eggs laid, eggs set, viable embryos, live 3-week embryos, normal hatchlings, and 14-day old survivors.
(2) reduced number viable embryos, live 3-week embryos.

These avian reproduction studies with technical grade acephate indicate that when parents are fed between 5 and 20 ppm acephate, the survival of embryos and chicks are adversely affected. The guideline (71-4) is fulfilled, MRID 00029692, 00029691).

Studies using the degradate methamidophos.

Avian Reproduction for Methamidophos

Species/ Study Duration	% ai	NOAEC/ LOAEC (ppm)	LOAEC Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	73	>3<5	egg thickness	00014114 Beavers, 1978	core
Mallard duck *(Anas platyrhynchos)*	73	>15	no effect	00014113 Fink, 1977	core

The guideline (71-4) is fulfilled (MRID 00014114, 00014113) for the degradate methamidophos.

iii. 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 patterns, 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. However, for acephate and it degradate methamidophos, there are several sources of data in literature on wild mammals.

These may also be used for risk assessment purposes. These toxicity values are reported below.

Mammalian Toxicity for Acephate

Species	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
rat	97	oral acute	LD_{50} = 1400 mg/kg(M)	mortality	241253
rat	97	oral acute	LD_{50}= 1000 mg/kg (F)	mortality	237478
rat	23.7	oral acute	LD_{50}= 1900 mg/kg (m)	mortality	237478
rat	23.7	oral acute	LD_{50}= 970 mg/kg (f)	mortality	237487
rat	85	oral acute	LD_{50}= 1490 mg/kg (m) 739 mg/kg (f)	mortality	236863, 236864
rat	98	oral acute	LD_{50}= 945 mg/kg (m) 866 mg/kg (f)	mortality	00014675
white-footed mouse	98	oral acute	LD_{50}= 380 mg/kg	mortality	(1)
meadow vole	98	oral acute	LD_{50}= 321 mg/kg	mortality	(1)
mouse	70%	oral acute	LD_{50}= 720 mg ai/kg	mortality	(2)
mouse	98	oral acute	LD_{50}= 351 mg/kg	mortality	(1)
brown bat	70%	oral acute	LD_{50}>1500 mg ai/kg ED_{50}= 687 mg ai/kg (3)	mortality	(2)
white-footed mouse	98	stomach gavage	see affected endpoints	50% AChE brain inhibition at 100 mg/kg and significant decrease of plasma luteinizing hormone (LH).	(4)
		dietary		Dietary concentrations showed AChE inhibition by 22% at 25 ppm, 42% at 100 ppm, and 57% at 400 ppm. LH depression was not affected in dietary study.	
Charles River rat	98.7	3-generation reproductive	NOAEL = 50 ppm LOAEL = 500 ppm	parental and pup weight, food consumption, litter size, mating performance and viability	40323401 40605701
Mouse	formulation	inhalation	3/8 dead	3/8 mice died at 2.2 mg/L from 5-hr exposure	(5)

(1) Rattner, B.A., D.J. Hoffman. 1984. Comparative toxicity of acephate in laboratory mice, white-footed mice, and meadow voles. Arch. Environ. Contam. Toxicol. 13:483-491.
(2) Clarke Jr., D.R., B.A. Rattner. 1987. Orthene® Toxicity to Little Brown Bats (*Myotis lucifugus*): Acetylchlorinesterase Inhibition, Coordination Loss, and Mortality. Environ. Toxicol. and Chem. Vol 6 pp. 705-708.
(3) ED_{50} (effective dose) = 687 mg ai/kg. The effective dose includes the ability for the bats to right themselves (coordination). Uncoordinated bats are very susceptible to mortality from predation, drowning, exposure, etc.
(4) Rattner, B.A., S.D. Michael. 1985. Organophosphorous insecticide induced decrease in plasma luteinizing hormone concentration in white-footed mice. Toxicology Letters, 24:65-69.
(5) Bertem, P.E., R.E. Chiles. *Studies on the Inhalation Toxicity of Two Phosphoramidothioate Insecticides to Rodents and Quail*. University of California, School of Public Health, Naval Biosciences Laboratory, Naval Supply Center, Oakland, California.

An analysis of the results indicates that acephate is categorized as moderately toxic to small mammals on an acute oral basis. There does not appear to be a palatability problem in the above studies (personal communication Nancy McCarroll, HED, 2/10/98).

Mammalian Toxicity for the degradate Methamidophos

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
laboratory rat *(Rattus norvegicus)*	75	acute oral	LD_{50}= 21 mg/kg (m) LD_{50}= 18.9 mg/kg (f)	mortality (ChE depression syptoms observed)	00014045
laboratory rat *(Rattus norvegicus)*	95	acute oral	LD_{50}= 15.6 mg/kg (m) LD_{50}= 13.0 mg/kg (f)	mortality and ChE inhibition symptom observed	00014044
laboratory rat *(Rattus norvegicus)*	70	2-year feeding		ChE depression measured at doses <0.1 mg/kg/day	00148452
New Zealand white rabbit	72-76	primary dermal irritation	tox category I	0.5 ppm exposure for 24 hrs. Results in 66% of animals died within 48 hrs. ChE inhibition syptoms observed	00014222
New Zealand white rabbit	73	primary dermal irritation	tox category I	5/9 animals died within 24 hrs. After exposure to 0.1 ppm of 73% monitor dilution for 24 hrs. ChE syptoms observed shortly after exposure	00014220
New Zealand white rabbit	72-76	primary eye irritation	tox category I	0.1 ppm of technical applied to one eye results in death of one animal within 30 minutes. ChE syptoms observed in animals	00014221
New Zealand white rabbit	75	acute dermal	LD_{50}= 118mg/kg (m) tox category I	mortality and ChE inhibition syptoms observed.	00014049
laboratory mouse *(Mus musculus)*	95	acute oral	LD_{50}= 16.2 mg/kg (f)	mortality (ChE depression syptoms observed)	00014047
laboratory mouse *(Mus musculus)*	75	acute oral	LD_{50}= 18 mg/kg (f)	mortality	00014048
laboratory mouse *(Mus musculus)*	70.5	2-generation reproductive	Noael=10 ppm (1) LOEL= 33 ppm (1)	births, pup body weight, pup survival	00148455 41234301
Laboratory mouse *(Mus musculus)*	70	2 year feeding	Noael = 0.7 ppm LOEL = 3.6 ppm	ChE depression measured	00145579
dog	70	one year feeding	Noael < 0.05 mg/kg/day	ChE depression measured	00147938
Guinea pigs	40.2	dermal sensitization	tox category I	undiluted formulation caused death of the animals. ChE inhibition syptoms observed.	40985201 Porter, 1987
Rat	TEP	inhalation	LD_{50}= 9.0 mg/kg	5-hr inhalation study in which rats were exposed to 0.65 mg/L methamidophos	(2)
Mouse	TEP	inhalation	LD_{50} = 18.7 mg/kg	5-hr inhalation study in which rats were exposed to 0.65 mg/L methamidophos	(2)

(1) The study indicates that 10 ppm = 0.5 mg/kg/day and 33 ppm = 1.65 mg/kg/day.
(2) Bertem, P.E., R.E. Chiles. *Studies on the Inhalation Toxicity of Two Phosphoramidothioate Insecticides to Rodents and Quail*. University of California, School of Public Health, Naval Biosciences Laboratory, Naval Supply Center, Oakland, California. TEP is typical end use product.

An analysis of the results indicate that Methamidophos is categorized as highly toxic to small mammals on an acute oral and dermal basis. There does not appear to be a palatability problem in the above studies (personal communication Nancy McCarroll, HED, 2/10/98).

iv. Insects

A honey bee acute contact study using the TGAI is required for acephate and its degradate methamidophos because its use on vegetables, cotton, peanut, and soybean will result in honey bee exposure. Results of this test are tabulated below.

Nontarget Insect Acute Contact Toxicity (141-1) for Acephate

Species	product	LD_{50} (μg/bee)	Toxicity Category	MRID No. Author/Year	Study Classification
Honey bee *(Apis mellifera)*	orthene	1.20 μg/bee	highly toxic	00014714, 44038201 Atkins, 1971	core
Honey bee *(Apis mellifera)*	orthene	<0.25 ppm (1)	highly toxic.	(2)	supplemental
Honey bee *(Apis mellifera)*	orthene	(3)	highly toxic	(4)	supplemental
Green lacewing (5) *Chrysopa carnea*	orthene	5.57 μg/vial	highly toxic	05004012 Plapp, 1978	supplemental

(1) 74.5% mortality at 0.25 ppm acephate in sugar syrup after 14 days.
(2) Fielder, L. 1986. Assessment of Chronic Toxicity of Selected Insecticides to Honeybees. Journal of Apicultural Research 26(2):115-122.
(3) Acephate fed to worker bees via sugar syrup showed up in the royal jelly for the queen, indicating that acephate is systemic to bees. These concentrations of 1 ppm or less were harmless to the worker bees but levels at 0.1 ppm showed significant reduction of the surviving brood.
(4) Stoner, A., W. Wilson, J. Harvey. 1985 Acephate (Orthene®): Effects on Honey Bee Queen, Brood, and Worker Survival. American Bee Journal, June 1985, p. 448-450.
(5) Predator of tobacco budworm

An analysis of the results indicate that acephate is categorized highly toxic to bees and beneficial insects on an acute contact basis. The guideline (141-1) is fulfilled (MRID 00014714, 44038201, 05004012).

A study (MRID 05004012) tried to determine a toxicity ratio of selectivity of acephate by comparing the sensitivity of beneficial predator insects to that of the pest tobacco budworm. The ratio is calculated using the LC_{50} values for the pest divided by the LC_{50} values for the beneficial insect; a ratio greater than 1 represents that acephate is more toxic to the predator than to the pest. Green lacewing had a calculated ratio of 6.4 and the ratio for the parasitic wasp was 10.0. Acephate is more toxic to the beneficial predator than the pest.

A honey bee toxicity of residues on foliage study using the typical end-use product is not required for acephate because the acute contact honey bee LD_{50} is not less than 0.1 *ug*/bee. However, the studies were provided and are tabulated below:

Nontarget Insect Acute Residue Toxicity (141-2) for Acephate
(foliage was sprayed, collected after varying times, and then put with bees)

Species	% ai	lb ai applied	No. hrs and % dead after contact	MRID No. Author/Year	Study Classification
honey bee *(Apis mellifera)*	75%	1.0	2 hr. = 79 8 hr. = 17	00014715 Sakamoto, 1971	core
alkali bee *(Nomia melanderi)*	75%	1.0	2 hr. = 83 8 hr. = 30	00014715 Sakamoto, 1971	core
alfalfa leaf cutter bee *(Megachile rotundata)*	75%	1.0	2 hr. = 69 8 hr. = 21	00014715 Sakamoto, 1971	core
bumble bee	75%	1.0	2hr. = 43	00014715 Sakamoto, 1971	core
honey bee *(Apis mellifera)*	75%	1.0	2 hr. = 79 8 hr. = 16	05000837 Johansen, 1972	core
alkali bee *(Nomia melanderi)*	75%	1.0	2 hr. = 81 8 hr. = 23	05000837 Johansen, 1972	core
honey bee *(Apis mellifera)*	orthene	0.48	1 hr. = 4.5 24 hr. = 98.5 96 hr. = 5.0	00014714 Atkins, 1971	core
honey bee *(Apis mellifera)*	orthene	0.97	1 hr. = 3.2 24 hr. = 100 96 hr. = 41.7	00014714 Atkins, 1971	core

An analysis of the results indicates that acephate is highly toxic to bees, from two hours to 96 hours after application at rates of 1 lb/A and from 2 hr. To 24 hr. at 0.5 lb ai/A.

The guideline (141-2) is fulfilled (MRID 00014715, 05000837, 00014714) for acephate.

Studies for the degradate methamidophos.

Nontarget Insect Acute Contact Toxicity for the Degradate Methamidophos

Species	% ai	LD_{50} (μg/bee)	Toxicity Category	MRID No. Author/Year	Study Classification
Honey bee *(Apis mellifera)*	63	1.37	Highly toxic	00036935 Atkins, 1975	core

An analysis of the results indicate that methamidophos is categorized as highly toxic to bees on an acute contact basis. The guideline (141-1) is fulfilled (MRID 00036935) for methamidophos.

b. Toxicity to Freshwater Aquatic Animals

i. Freshwater Fish, Acute

Toxicity studies using the TGAI on two freshwater fish species are required to establish the toxicity of acephate and its degradate methamidophos to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these tests are tabulated below.

Studies for the parent acephate.

Freshwater Fish Acute Toxicity for Acephate

Species	% ai	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow trout (static) *(Oncorhynchus mykiss)*	94	110	practically non-toxic	40098001 Mayer, 1986	core
Rainbow trout (static) *(Oncorhynchus mykiss)*	75	730	practically non-toxic	40094602 Johnson, 1980	core
Rainbow trout (static) *(Oncorhynchus mykiss)*	technical	>1000	practically non-toxic	00014705 Hutchinson, 1970	core
Rainbow trout (static) *(Oncorhynchus mykiss)*	94	1100	practically non-toxic	40094602 Johnson, 1980	core
Rainbow trout (static) *(Oncorhynchus mykiss)*	75	2740	practically non-toxic	(1)	supplemental
Bluegill sunfish (static) *(Lepomis macrochirus)*	94	>50	slightly toxic	40098001 Mayer, 1981	core
Bluegill sunfish (static) *(Lepomis macrochirus)*	75	2000	practically non-toxic	00014706 Thompson, 1971	core
Bluegill sunfish (static) *(Lepomis macrochirus)*	75	>200	practically non-toxic	40098001 Mayer, 1981	core
Bluegill sunfish (static) *(Lepomis macrochirus)*	94	>1000	practically non-toxic	40098001 Mayer, 1981	core
Bluegill sunfish (static) *(Lepomis macrochirus)*	75	>1000	practically non-toxic	40094602 Johnson, 1980	core
Atlantic salmon	97	>50	practically non-toxic	40098001 Mayer, 1981	supplemental
Brook trout (static) *(Salvelinus fontinalis)*	75	>100	practically non-toxic	40098001 Mayer, 1981	core
Brook trout (static) *(Salvelinus fontinalis)*	94	>100	practically non-toxic	40094602 Johnson, 1980	supplemental
Largemouth bass (static) *(Micropterus salmoides)*	75	3000 (2)	practically non-toxic	00014707 Thompson, 1971	supplemental

Freshwater Fish Acute Toxicity for Acephate

Species	% ai	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Cutthroat trout (static) (*Salmo clarki*)	94	>50	slightly toxic	40098001 Mayer, 1986	supplemental
Cutthroat trout (static) (*Salmo clarki*)	94	>100	practically non-toxic	40094602 Johnson, 1980	supplemental
Cutthroat trout (static) (*Salmo clarki*)	75	>100	practically non-toxic	40094602 Johnson, 1980	supplemental
Gold fish (static) (*Carassius auratus*)	75	>4000	practically non-toxic	00014710 Thompson, 1971	supplemental
Yellow perch (static) (*Perca flavescens*)	94	>50	slightly toxic	40098001 Mayer, 1986	supplemental
Yellow perch (static) (*Perca flavescens*)	75	>100	practically non-toxic	40098001 Mayer, 1986	supplemental
Channel Catfish (static) (*Ictiobus cyrinallus*)	94	>1000	practically non-toxic	40098001 Mayer, 1986	core
Channel Catfish (static) (*Ictiobus cyrinallus*)	75	560-1000	practically non-toxic	40094602 Johnson, 1980	supplemental
Channel Catfish (static) (*Ictiobus cyrinallus*)	75	1500	practically non-toxic	00014708 Thompson, 1971	core
Fathead Minnow (static) (*Pimephales promelas*)	94	>1000	practically non-toxic	40094602 Johnson, 1980	supplemental
Fathead Minnow (static) (*Pimephales promelas*)	75	>1000	practically non-toxic	40098001 Mayer, 1986	supplemental
Mosquito fish (static) (*Gambusia affinis*)	75	6000	practically non-toxic	00014709 Thompson, 1971	supplemental

1 Geen, G.H., B.A. McKeown, P.C. Oloffs, 1984. Acephate in Rainbow Trout (*Salmo gairdneri*), Acute Toxicity, Uptake, and Elimination. J. Environ. Science and Health B19(2) p. 131-155.

2 There was 100% mortality at 12,000 ppm.

Since the LC_{50} falls in the range of 50 to >100 ppm, acephate is categorized as slightly to practically non-toxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 40098001, 40094602, 00014705, 05020323, 00014709, 00014708, 00014706, 00014707, 05017149, 00014710).

Studies for the degradate methamidophos.

Freshwater Fish Acute Toxicity for the Degradate Methamidophos

Species	% ai	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow trout (static) *(Oncorhynchus mykiss)*	74	25	slightly toxic	00041312 Nelson, 1979	core
Rainbow trout (static) *(Oncorhynchus mykiss)*	71	40 (ai)	slightly toxic	00144429 Hermann, 1980	ancillary
Rainbow trout (static) *(Oncorhynchus mykiss)*	40 (1)	37	slightly toxic	00144432 Lamb, 1972	ancillary
Rainbow trout (static) *(Oncorhynchus mykiss)*	75	51	slightly toxic	00014063 Schoenig, 1968	supplemental
Rainbow trout (static) *(Oncorhynchus mykiss)*	75.3	1.28 (1)	moderately toxic	44486601 McCann, 1976	supplemental
Bluegill sunfish *(static)* *(Lepomis macrochirus)*	74	34	slightly toxic	00041312 Nelson, 1979	core
Bluegill sunfish *(static)* *(Lepomis macrochirus)*	40 (2)	31	slightly toxic	00144432 Lamb, 1980	ancillary
Bluegill sunfish (static) *(Lepomis macrochirus)*	75.4	45	slightly toxic	44484402 McCann, 1977	core
Bluegill sunfish (static) *(Lepomis macrochirus)*	75	46	slightly toxic	00014063 Schoenig, 1968	supplemental
Carp (static) *(Cyprinpus carpio)*	90	681 (3)	slightly toxic	05008361 Chin, 1979	supplemental

(1) Author notes that the LC_{50} value is based on range finding test and that this product is expected to kill rainbow trout at 9 ppm based on total formulation.
(2) Formulation of 40% is in propylene glycol. Author concludes that propylene glycol contributes to toxicity of the formulation.
(3) Sublethal doses affect growth rate of carp. Brain and liver AChE activities are depressed at 20 ppm concentrations for 48 hours.

Since the LC_{50} falls in the range of 10 to 100 ppm, methamidophos is categorized as slightly toxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 00041312, 00014063, 05008361, 00144429, 00144432).

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI may be required for acephate because it is expected to be transported to water from the intended use site and it is intended for use such that its presence in water is likely to be recurrent. The preferred test species is rainbow trout *(Oncorhynchus mykiss)*. There are currently no available chronic data on fish. However, since the aquatic invertebrate, *Daphnia magna*, is more sensitive, the invertebrate life cycle can be evaluated to determine a need for the fish early life-cycle study. The invertebrate life-stage study shows that NOAEC value is much higher than the peak EEC. Therefore, the fish early-life stage study is not needed at this time.

iii. Freshwater Amphibians, Acute

Toxicity studies using the TGAI on amphibians are not required to establish the toxicity of acephate. Since toxicity data are available, they are presented below.

Amphibian Acute Toxicity for Acephate

Species	% ai	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
frog larvae (*Rani clamitans*)	75	>5000 (24 hr)	Practically non-toxic	05019255 Lyons, 1976	supplemental
frog larvae (*Rani clamitans*)	88	6433 (24 hr)	practically non-toxic	00093943 Lyons, 1976	supplemental
frog larvae (*Rani catesbelana*)	98	>5	(1)	44042901 Hall, 1980	supplemental
Salamander larvae (*Ambystoma gracile*)	97	8816 (96 hr)	practically non-toxic	(2)	supplemental

(1) This study tested for bio-concentrations to amphibians. No bio-accumulation nor toxicity was noted.
(2) Geen, G.H., B.A. McKeown, T.A. Watson, D.B. Parker. 1984. Effects of Acephate (Orthene) on Development and Survival of the Salamander,*Ambystoma gracile*, (Baird). Environ. Sci. Health, B19 (2), 157-170 (1984).

The above toxicity data suggest that acephate may be practically non-toxic for amphibians.

iv. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of acephate and its degradate methamidophos to aquatic invertebrates. The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Freshwater Invertebrate Acute Toxicity for Acephate

Species	% ai	48-hour LC_{50}/ EC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Waterflea (*Daphnia magna*)	75	1.3	Moderately toxic	GS0042021 Thompkins, 1978	core
Waterflea (*Daphnia magna*)	98	67.17	Slightly toxic	00014565 Wheeler, 1978	core
Scud (*Gammarus pserdolimneaus*)	94	>50 (96 hr)	Slightly toxic	40094602 Johnson, 1986 40098001 Mayer, 1986	core
Scud (*Gammarus pserdolimneaus*)	94	>100	Practically non-toxic	00014861, 05018314 Schoettger, 1970	core
Stonefly (*Pteronarella badia*)	94	6.4 (96 hr)	Moderately toxic	40098001 Mayer, 1986	supplemental
Stonefly (*Pteronarella badia*)	94	9.5	Moderately toxic	40094602 Johnson, 1980	supplemental

Freshwater Invertebrate Acute Toxicity for Acephate

Stonefly *(Isogenus)*	94	11.7 (96 hr)	Slightly toxic	40098001 Mayer, 1986	supplemental
Stonefly *(Isogenus)*	75	12 (96 hr)	Slightly toxic	40098001 Mayer, 1986	supplemental
Stonefly (*Skwala*)	75	12	Slightly toxic	40094602 Johnson, 1980	supplemental
Stonefly (*Skwala*)	95	12	Slightly toxic	40094602 Johnson, 1980	supplemental
Midge (*Chironomus plumosus*)	94	>1000	practically non-toxic	40094602 Johnson, 1980	core
Midge (*Chironomus plumosus*)	94	>50	Slightly toxic	40098001 Mayer, 1986	core
Midge (*Chironomus plumosus*)	75	>1000	Practically non-toxic	40098001, Mayer, 1986	core
Mayfly larvae	98	3.2	N/A	(1)	supplemental
Stonefly larvae	98	37	N/A	(1)	supplemental
Damselfly larvae	98	140	N/A	(1)	supplemental
Mosquito	98	650	N/A	(1)	supplemental
Water-boatman	98	8.2	Moderately toxic	(2)	supplemental
Backswimmer	98	10.4	Slightly toxic	(2)	supplemental
Crayfish *(Procamborus clarki)*	75	>750 (120 hr)	Practically non-toxic	00014712 Sleight, 1972	supplemental

(1) Hussain, M.A., R.B. Mohamad, P.C. Oloffs. 1985. *Studies on the Toxicity, Metabolism, and Anticholinesterase Properties of Acephate and Methamidophos*. J. Environ. Sci. Health, B20 (1), p. 129-147. (1985). These aquatic insects were tested in water samples. The aquatic insect, backswimmer, have ChE inhibition for 4 hours before recovery begins. This suggests that aquatic insects and possibly fish that are exposed to acephate/methamidophos may not recover by spontaneous reactivation of AchE. Therefore aquatic insects or possibly fish may be stressed for some time because of physiological effects caused by inhibition of AchE.
(2) Hussain, M.A., R.B. Mohamad, Oloffs, P.C. 1984. *Toxicity and Metabolism of Acephate in Adult and Larval Insects*. J. Environ. Sci. Health, B19(3), 355-377.

Since the LC_{50}/EC_{50} falls in the range of 1.0 to >100 ppm, acephate is categorized as moderately to practically non-toxic to aquatic invertebrates on an acute basis. The guideline (72-2) is fulfilled (MRID GS0042021, 00014565, 40094602, 00014861, 40098001, 05019255, 050018314, 00093943, 00014712).

Studies for the degradate methamidophos.

Freshwater Invertebrate Acute Toxicity for the Degradate Methamidophos

Species	% ai	48-hour LC_{50}/ EC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Waterflea (*Daphnia magna*)	74	0.026	Very highly toxic	00041311 Nelson 1979	core
Waterflea (*Daphnia magna*)	72	0.050	Very highly toxic	00014110 Wheeler 1978	core
Waterflea (*Daphnia magna*)	technical	0.027	Very highly toxic	00014305 Nelson 1977	supplemental
Freshwater Prawn [1] (*Macrobrachium rosenbergii*)	Tamaron 600 (600 g/L)	0.000042 [2] (42 ng/L; 24 hr LC_{50})	Very highly toxic	(2)	supplemental

(1) Juarez, L.M., J. Sanchez, 1989. Toxicity of the Organophosphorous Insecticide Methamidophos (O,S-Dimethyl Phosphoramidothioate) to Larvae of the Freshwater Prawn, *Macrobachium rosenbergii* (DeMan) and the Blue Shrimp, *Penaeus stylirostris* Stimpson. Bull. Environ. Contam. Toxicol. (1989) 43:302-309.

(2) This study did not provide control mortality, therefore the 24 hr. value for the postlarvae stage is used. This study tested Zoea I, IV, VII and postlarve stages with LC_{50} values for 24, 48 and 96 hr. These LC_{50} values ranges from 0.22 ppt for 96 hr. Zoea IV stage up to 42 ppt for the 24 hr. postlarve stage.

Since the EC_{50} are less than 0.1 ppm, methamidophos is categorized as very highly toxic to aquatic invertebrates on an acute basis. The guideline (72-2) is fulfilled (MRID 00041311, 00014110, 00014305).

v. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for acephate since the end-use product may be applied directly to water (former forestry use) or is expected to be transported to water from the intended use site, the pesticide is intended for use such that its presence in water is likely to be recurrent (multiple applications) regardless of toxicity, the EEC in water is equal to or greater than 0.01 of any acute EC_{50} or LC_{50} value, or the pesticide is persistent in water (*i.e.*, half-life greater than 4 days). The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species	% ai	21-day Noaec/Loaec(ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Waterflea (*Daphnia magna*)	unknown	0.150/0.375	0.237	caused reduction in numbers of young at 375 ppb and higher	44466601 Thompkins, 1978	core

[1] defined as the geometric mean of the Noaec and Loaec.

Acephate affects daphnid reproduction with an MATC of 0.237 ppm. The guideline (72-4) is fulfilled (MRID 44466601).

c. Toxicity to Estuarine and Marine Animals

i. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine/marine fish using the TGAI is required for acephate and its degradate methamidophos because the end-use product is expected to reach estuarine/marine environments because of its use in coastal counties. The preferred test species is sheepshead minnow (*Cyprinodon variegatus*). Results of these tests are tabulated below.

Estuarine/Marine Fish Acute Toxicity for Acephate

Species/Static or Flow-through	% ai	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Sheepshead minnow (flow-thru) *(Cyprinodon variegatus)*	94	910	practically non-toxic	40228401 Mayer, 1986	core
Sheepshead minnow (static) *(Cyprinodon variegatus)*	94	>3200 (28days)	practically non-toxic	40228401 Mayer, 1986	core
Mummichog (static) *(Fundulus heteroclitus)*	75	2872 (m) 3299 (f)	practically non-toxic	(1)	ancillary
Pin Fish (flow-thru) *(Lagodon rhomboides)*	94	85	slightly toxic	40228401 Mayer, 1986	core
Spot (static) *(Leinstomus xanthurns)*	94	>100	practically non-toxic	40228401 Mayer, 1986	core

(1) Fulton, M.H. and G.I. Scott. 1991. The Effects of Certain Intrinsic Variables on the Acute Toxicity of Selected Organophosphorous Insecticides to the Mummichog, *Fundulus heteroclitus*. J. Environ. Sci. Health B26 (5&6), 459-478.

Since the LC_{50} falls in the range of 10 to >100 ppm, acephate is categorized as slightly toxic to practically non-toxic to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID 40228401).

Studies for the degradate methamidophos.

Estuarine/Marine Fish Acute Toxicity for the Degradate Methamidophos

Species/Static or Flow-through	% ai	96-hour LC_{50} (ppm) (measured/nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Sheepshead minnow *(Cyprinodon variegatus)*	70.1	5.6	Moderately toxic	00144431 Larkin, 1983	core

Since the LC_{50} is 1 - 10 ppm, methamidophos is categorized as moderately toxic to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID 00144431).

ii. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using the TGAI is required for acephate because the end-use product is expected to be transported to the estuarine/marine environment from the intended use site and the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity. The preferred test species is sheepshead minnow. However since the estuarine invertebrate is more sensitive, the estuarine invertebrate life cycle would be evaluated to determine a need for the estuarine fish early life-cycle. The estuarine invertebrate life-cycle study shows that NOAEC value is mush higher than the peak EEC. Therefore, the estuarine early-life cycle study may not be needed at this time.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for acephate and its degradate methamidophos because they are expected to reach estuarine/marine environment because of the use in coastal counties. The preferred test species are mysid shrimp and eastern oyster. Results of these tests are tabulated below.

Estuarine/Marine Invertebrate Acute Toxicity for Acephate

Species/Static or Flow-through	% ai.	96-hour LC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Eastern oyster (embryo-larvae) *(Crassostrea virginica)*	89	5.41 (48 hr)	moderately toxic	00014713 Sleight, 1970	core
Eastern oyster (embryo-larvae) static *(Crassostrea virginica)*	94	150	practically non-toxic	40228401 Mayer, 1986	core
Mysid *(Americamysis bahia)* flow-thru	94	7.3	Slightly toxic	40228401 Mayer, 1986	core
Brown shrimp *(Penaeus aztecus)*	89	22.9 (48 hr)	slightly toxic	00014711 Sleight, 1970	supplemental
Pink Shrimp (flow-thru) *(Penaeus onorarum)*	94	3.8	Moderately toxic	40228401 Mayer, 1986	core
Pink Shrimp (static) *(Penaeus onorarum)*	94	>10	Slightly toxic	40228401 Mayer, 1986	core

Since the LC_{50}/EC_{50} falls in the range of 1.0 to >100 ppm, acephate is categorized as moderately toxic to practically non-toxic to estuarine/marine invertebrates on an acute basis. The guideline (72-3b and 72-3c) is fulfilled (MRID 00014711, 40228401, 00014713).

Studies for the degradate methamidophos.

Estuarine/Marine Invertebrate Acute Toxicity for the Degradate Methamidophos

Species/Static or Flow-through	% ai.	96-hour LC_{50} /EC_{50} (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Mysid shrimp (*Americamysis bahia)*	technical	1.05	Moderately toxic	00144430 Larkin, 1983	core
Blue shrimp (*Penaeus stylirostris*)	Tamaron 600 (600 g/L)	0.00016 (1) (160 ppt)	very highly toxic	(2)	supplemental

(1) The control mortality is not known, therefore the 24 hr. LC_{50} value for mysis stage was listed. This study tested the shrimp at the naupliae, protozoa, and mysis stage and determined LC_{50} values for each stage at 24 and 36 hr. The LC_{50} values range from 0.6 ppt for 36 hr. Napliae stage to 800 ppt for 12 hr. mysis stage.
(2) Juarez, L.M., J. Sanchez, 1989. Toxicity of the Organophosphorous Insecticide Methamidophos (O,S-Dimethyl Phosphoramidothioate) to Larvae of the Freshwater Prawn, *Macrobachium rosenbergii* (DeMan) and the Blue Shrimp, *Penaeus stylirostris* Stimpson. Bull. Environ. Contam. Toxicol. (1989) 43:302-309.

Since the LC_{50} /EC_{50} falls in the range of less than 0.1 to 10 ppm, methamidophos is categorized as moderately toxic to estuarine/marine invertebrates on an acute basis. The guideline (72-3b and 72-3c) is fulfilled/not fulfilled (MRID 00144430).

iv. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity test using the TGAI is required for acephate because the chemical is expected to be transported to estuarine/marine environment from the intended use site (vegetables, cotton, soybean), the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value or pesticide is persistent in water (*e.g.*, half-life greater than 4 days). The preferred test species is mysid shrimp. Results of this test are tabulated below.

Estuarine/Marine Invertebrate Life-Cycle Toxicity for Acephate

Species/(Static Renewal or Flow-through)	% ai	21-day Noaec/Loaec (ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Mysid shrimp (*Americamysis bahia)*	tech	0.58/1.4	0.90	mortality[2]	00066341, 40228401 Mayer, 1986	core

[1] defined as the geometric mean of the Noaec and Loaec.
[2] Survival of the progeny of the acephate-exposed mysids were not affected.

The guideline (72-4) is fulfilled (MRID 00066341, 40228401).

d. Toxicity to Plants

i. Terrestrial

Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (*e.g.*, labeling bears phytotoxicity warnings, incident data or literature that demonstrate phytotoxicity).

However, information has come to EFED's attention that acephate may exhibit phytotoxicity on non-target plants. The following MRID's describe the phytotoxic characteristics of acephate:

Reference	Author, Year	Phytotoxicity Information
00014623	Davis, 1977	Unacceptable phytotoxicity rating on poinsettia at 0.5 lb ai/A
00014928	Shaefer, 1975	Unacceptable injury on 18 inch tall *Viburnum suspensum* from 2 applications of 1 lb ai/A
00014929	Clark, 1975	Unacceptable phytotoxicity on Lombardy cottonwood from 2 applications of 0.5 lb ai/A
unknown	review by Holst on 7/7/78 onChevron studies:	Phytoxicity symptoms observed on the following plants with study number in parenthesis and rate of application next to plant: tomato - 0.75 lb ai/A (1035-31 to 34); watermelon, fuchsia, begonia, *Hedra helix*, and philodendron - 0.75 lb ai/A (1072-28); angelwings, coleus, and poinsettia - 0.75 lb ai/100 Gal. (1071-24 and 42); *Chrysanthemum* spp., *Diffenbachia picta, Gynura aurantiaca, Dracaena marginata, and Begonia* spp. - 10 and 20 lb ai/A (1242-12); Begonia - 0.75 lb ai/100 gal. (1035-26, 27, 30, 35 and 37).

Based on the reported information, terrestrial plant testing (vegetative vigor and seedling emergence studies) using acephate is now required. Tier I testing measures the response of plants, relative to a control, of a test level that is equal to the highest use rate (expressed as lbs ai/A). For seedling emergence and vegetative vigor testing, the following plant species and groups are tested: (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*) and the second is a root crop; and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*). If greater than 25% inhibition relative to a control is found, then tier II studies must be done for those species affected. If the registrant desires, Tier I can be waived if Tier II studies are done instead. The guideline (122-1 or 123-1) for non-target seedling emergence and vegetative vigor are not fulfilled.

ii. Aquatic Plants

Currently, aquatic plant testing is not required for pesticides other than herbicides and fungicides except on a case-by-case basis (*e.g.*, labeling bears phytotoxicity warnings incident data or literature that demonstrate phytotoxicity). The only information EFED has is below:

Skeletonema costatum EC_{50} >50 ppm (Mayer, 1986; MRID 40228401)

Therefore, EFED does not have any information to warrant further phytotoxicity testing on aquatic plants.

e. Field Testing and Literature Findings

i. Terrestrial Organisms

The tables below describe field studies and incidents concerning the use of acephate and its impact on the environment.

Terrestrial Vertebrates	Summary	Reference
Sparrows	Migratory white-throated sparrows (*Zonotrichia albicollis*) were exposed to acephate to determine its effects on migratory orientation and behavior. Birds were exposed to polarizer sheets to determine the mechanism by which acephate may affect migratory orientation. Adult birds exposed to 256 ppm acephate a.i. were not able to establish a preferred migratory orientation and exhibited random activity. All juvenile treatment groups displayed a seasonally correct southward migratory orientation. The author hypothesized that acephate may have produced aberrant migratory behavior by affecting the memory of the adult's migratory route and wintering ground. The "experiment reveals that an environmentally revelant concentration" (similar to 0.5 lb ai/A application) of an OP such as acephate "can alter migratory orientation, but its effect is markedly different between adult and juvenile sparrows. Results suggest that the survival of free-flying adult passerine migrants may be compromised following organophosphorus pesticide exposure."	Vyas et. al., 1995
Sparrows	The effects of a 14-day dietary exposure of acephate on cholinesterase activity in three regions; basal ganglia, hippocampus, and hypothamulus were examined in the brain of the white-throated sparrow, *Zonotrichia albicollis*. All three regions experienced depressed cholinesterase activity between 0.5-2 ppm ai acephate. The regions exhibited cholinesterase recovery at 2-16 ppm ai acephate; however, cholinerase activity dropped and showed no recovery at higher dietary levels (> 16 ppm acephate) which suggests that each region maintains its own ChE activity level integrity until the brain is saturated so that the differences of the regions is nil. Each region of the brain is responsible for different survival areas such as a foraging and escaping predators, memory and spatial orientation, food and water intake, reproduction and several others. Evidence indicated that the recovery is initiated by the magnitude of depression, not the duration. In general, as acephate concentration increased, depression in ChE activity among brain regions increased and differences of ChE activity among the three brain regions decreased. The pattern of ChE depression in different regions of the brain following low level exposure may prove to be a critical factor in the survival of the bird. The authors hypothesized that adverse effects to birds in the field may occur at pesticide exposure levels customarily considered negligible.	Vyas et. al., 1996

Terrestrial Vertebrates	Summary	Reference
Passerine birds	Several large acreages of forest were sprayed with 0.5, 1.0 or 2.0 lb. ai/A application rates. There was no brain ChE inhibition on day zero after application. Birds collected from the 2 lb ai/A plots from day one thru six post spray showed ChE inhibition. Brain ChE inhibition was shown in birds 33 days after treatment but not 89 days after treatment. Birds seemed to have more inhibition of ChE in summer application when compared to the fall application in the 1 lb. ai/A plots (30-50% and 25-40% depression, respectively). The greatest ChE inhibition occurred in dark-eyed juncos (65%) collected 15 days after treatment. In the 2 lb. ai/A plots, dark-eyed juncos and golden-crowned kinglets had 54% ChE inhibition. Of the 14 species collected, only pine siskins *(Siinus pinus)* did not show any ChE inhibition. Symptoms of organophosate poisoning were observed such as a warbling vireo salivating profusely, an American robin having difficulty maintaining a perching position, and a mountain chickadee having visible tremors. All of these observations were made in the 1 lb. ai/A plots. The authors concluded that since marked ChE inhibition did not occur on day zero, but was evident up to 33 days after application, there was either an accumulative effect that was detected later or acephate was converted to a more potent ChE inhibitor such as methamidophos. Spraying the forest with 0.5, 1.0 or 2.0 lb. ai/A caused marked and widespread, and prolonged ChE depression in passerine birds.	Zinkl, 1977
Birds	Acephate was sprayed in a forest at 0.5 lb ai/A. Eleven species of birds had ChE inhibition that ranged on average from 20 to 40%. The maximum depression of ChE found in chipping sparrows was 57% at day six. Western tanager species was found to have significant inhibition up to 26 days after application. Brain residue analysis of a western tanager collected on day three contained 0.318 ppm of acephate and 0.055 ppm of methamidophos. The authors concluded that brain ChE inhibition that occurred from forest application of 0.5 lb. ai/A is sufficient to be life threatening to the birds.	Zinkl, 1978
Song birds	The authors concluded that acephate applied at 0.55 kg/ha causes reduction in canopy dwelling songbirds.	05014922, 00014639
Red-eye Vireos	Site: Acephate was applied in this study on June 13 at 0.55 kg/ha (0.5 lb ai/A) on two 200 hectare plots. Significant ($P<0.05$) decline in number of red-eyed vireos was observed. The decline was concentrated in the interior of the treated plots rather than spread throughout. The authors concluded that this was directly attributed to acephate.	05014922, 00163173
Dark-eyed Juncos	The questions that the author tried to answer are: Does the dosed larvae increase toxicity of acephate, enhance ChE inhibition, and/or increase duration of inhibition? The birds initially refused to ingest larvae that contained 16 μg acephate/larvae; however, the birds were willing to consume larvae containing five μg acephate. The study found that acephate given by gavage without larvae produced more inhibition than the larvae-fed birds. The study also concludes that the higher the dose, the more ChE inhibition is found in the birds. Increased time of exposure may prolong the time for recovery from ChE inhibition. Feeding the birds larvae containing acephate may decrease the activity of the acephate when compared to the gavage. The birds fed for five days recovered in 12 to 22 days.	00093911
American Kestrels	The kestrels were dosed with 50 mg/kg of 75% acephate formulation. Serum ChE was 37% inhibited and returned to predosed levels eight days later. Then the birds were dosed again and the serum ChE activity was inhibited at 42%; brain ChE was at 26% inhibition. The kestrel prey-catching activity was not altered from the acephate at 50 mg/kg dose level.	00141694

Terrestrial Vertebrates	Summary	Reference
Forest birds	Site: Wallowa-Whitman National Forest. Applications of 1.12 (1.0 lb ai/A) and 2.24 (2.0 lb ai/A) kg/ha were made on forest plots in Oregon. Extensive inhibition of brain ChE activity (commonly at 30-50%) for up to 33 days for 11 of the 12 species of birds that were collected was observed. The highest frequency of ChE inhibition was observed on day two post spray. Two species of birds had observable population decreases. Some birds on the plots treated with 1.12 kg/ha had 65% ChE inhibition which is considered to be fatal amounts. At both plots, birds were found with coordination problems, salivating profusely, and inability to fly. These behaviors were observed up to 20 days after application in the 2.24 kg/ha plot. It was also observed that breeding pairs for the warbling vireo and yellow-rumpled warbler were decreased. The authors concluded that application of acephate at rates of 1.12 and 2.24 kg/ha can cause sickness and death to forest birds.	40644802
Birds	Site: Seven western states. USDA applied 1.05 oz ai/A ULV aerially for grasshopper control in 38,000 to 51,000 acre plots in May 1980. Most birds collected showed reduced brain ChE activity. The greatest inhibition were found in the last birds collected. Horned larks showed more than 20% inhibition at the end of the 24-day post spray period. Some of these birds were showing 40% inhibition of brain ChE.	GS0042018
Birds and Deer Mice	Site:WY, UT and AZ rangeland. In 1979 and 1980, the birds and small mammals collected up to 24 days after application had reduced ChE activity. Reduction of 20% or more is indicative of exposure to brain ChE inhibitor. Of the birds collected in AZ, 24.5% had reduced ChE activity >20%. The birds with the most ChE inhibition were the last ones collected (21-24 days post treatment). In 1981, horned larks and lark buntings were collected in WY on a 12,000 acre plot that was treated with acephate at the rate of 0.105 kg/ha. More than 20% ChE inhibition was found in 19% of the horned larks and 25% of the lark buntings. Deer mice was also collected in WY. They were found to have ChE inhibition that ranged from 12.7% to 14.6%.	00093909
Squirrel	There is a marked inhibition of brain ChE activity in squirrels after aerial treatment of forests at rates of 0.57 kg/ha (0.51 lb/A) of Orthene.	40329701
Insectivorous mammals	Increased ingestion of arthropods by insectivorous mammals has been reported following acephate application. This signifies a direct pathway for substantial exposure to acephate due to consumption of dead and dying insects.	Stehn, et. al., 1976

terrestrial invertebrates	summary	reference
queen bees	Acephate appears to be systemic in nurse bees, causing glandular secretions fed to queens to be toxic. All colonies fed the 10 ppm rate lost queens early in the study and the affected colonies were unable to rear new queens. The study implied infrequent encounters by honey bee foragers with acephate on crops at levels of 1 ppm (1 ppm is NOAEC level) or less should be harmless. However, foragers may be expected to encounter levels greater than 1 ppm in the field because of 6-9 day residue persistence and residual systemic activity of acephate in plants for up to 15 days. Consequently, the study concluded that acephate is a hazard to honey bees because of its high contact toxicity, and because of its systemic nature.	Stoner et. al., 1984
honey bees	Orthene was found to be more detrimental to honey bee populations than carbaryl. Brood cycles of some colonies were found to be permanently broken, so the colonies were technically dead. Depression in the numbers of wild foraging bees were apparent. Measured seed and fruit production of various plants were reduced from lack of pollination.	00099762
yellow jacket wasps and ants	Severe impacts on yellow jacket wasps and ants at rates of application of 1 and 2 lb ai/A sprayed on forest. Temperature seems to affect the exposure of wasps in that cooler temperature (39F) causes wasps not to forage out of nests and therefore not be exposed as much, whereas warmer temperatures (59F) increases the activity of wasps and the exposure to acephate.	00099763

terrestrial invertebrates	summary	reference
spiders	Lab study show that at 560 gm/ha (0.5 lb ai/A) application rate, spiders were found to have high mortality (74% dead) at 20 days post spray.	05020212
soil microbes	Acephate was applied at 0.5 lb ai/A on forest to study impact on soil microbial organisms. Soil residues were measured and only 1 station had detectable concentrations. It was concluded that residues degrade rapidly and did not affect soil bacteria and fungi.	00014642

Incidents:

In general, although there are many reported incidents of toxic effects to non-targeted plants and animals from acephate, the majority of these reports are not clearly documented or else acephate was applied in combination with other pesticides and it is not possible to determine which pesticide primarily caused the undesirable effect. The summary below will describe recent incidents that were caused by acephate with probable certainty.

I001358-520 (08/18/94). Alleged lawn damage by Orthene Fire Ant Killer.

I002969-046 (09/10/95). Monkey was affected. Ingestion was the route of exposure. Product was Orthene 75 WSP. The incident report listed the effects as minor

I003299-003 (02/01/96), Lowell Hall of Hall's Nursery claimed variable growth stunting and phytotoxic on azaleas with Orthene TTO. Lawsuit awarded complainant $12,201.60.

I004215-001 (07/30/96). Bird ingested Orthene soluble powder and co-exposed to Roundup. This resulted in death.

I004215-002 (07/08/96). Dog ingested Orthene Turf, Tree, and Ornamental Spray. This resulted in minor effects.

I004215-005 (07/01/96). Rodent/lagomorph ingested Orthene resulting in death.

I004215-020 (09/24/96). Dark fired tobacco that was 1 month old or less showed symptoms similar to fertilizer damage (heart shaped leaves, absence of terminal bud with above normal suckers, mottled leaves) from Orthene 75 S.

I004535-003 (09/03/91). Bird was exposed to Orthene Turf, Tree and Ornamental Spray. This resulted in ataxia for the bird.

I003826 (08/29/94), lists a variety of incidents that include honeybees, which resulted from application of acephate.

ii. Aquatic Organisms

The tables below describe field studies and incidents concerning the use of acephate and its impact on the environment.

aquatic organisms	summary	reference
fishes	Site: Moosehead Lake, ME. A 75% acephate formulation was applied at 0.5 lb. ai/A on forest. Brook trout and landlocked salmonoid did not show any decreases in ChE activity but suckers, a bottom feeder, showed 28% drop in ChE activity. There was a gradual return to pre spray ChE activity by eight days after treatment. The brook trout changed their diet a few days after spraying in response to the killed arthropods entering the stream. Macro invertebrates increased drift into the stream moderately and temporarily from the spraying. The invertebrate standing crop was not affected. Salmonoid growth was unaffected and newly hatched smelt grew normally.	00014547, 05012201
fishes	Site: Two forest ponds and a stream in PA. 0.5 lb. ai/A was applied to two forest ponds and a stream in PA, where 65 caged fish (bluegills, perch, and bullheads) were held. The fish and the sampled benthic invertebrates showed no effect up to eight days post treatment. The authors concluded that the "aquatic ecosystem under study was not significantly affected."	00014637
fishes and invertebrates	Author compared Orthene with Sumithion, Carbaryl, Dylox, Matacil, and Dimilin regarding brook trout, Atlantic salmon, scud and stoneflies. Author concluded that "Orthene should not pose any significant toxicity hazard to fish or (aquatic) invertebrates" when compared to the other chemicals.	00014861
fishes and invertebrates	Direct application to stream for 5 hour at concentration of 1000 ppb from 8 a.m. to 1 p.m. Measurements of acephate remained constantly at 1100 to 1200 ppb during this time. No mortality was noted in trout and benthic insects in the stream.	Geen et. al., 1981
rainbow trout	"Brain ChE activity was depressed (38.2%) in trout exposed for 24 hours to 400 mg acephate per liter. After 24 hours of being in uncontaminated water, brain ChE was still depressed (42.5%)." There was no significant difference in the 100 mg/L for ChE depression when compared to control. Brain ChE activity remains depressed 8 days after a 24-hour exposure to 25 mg/L of methamidophos and 15 days after exposure to 400 mg/L of acephate. Because of low toxicity of acephate to rainbow trout, the study failed to determine at what % ChE inhibition would cause death. The level of depression that suggests poisoning by acephate or methamidophos is greater than 70% since brain ChE inhibition is at least this much in some trout that did not die. There is persistent ChE depression (8 days for methamidophos and 15 days for acephate) which suggests sublethal effects such as inability to sustain physical activity in search of food, eluding predators, and maintaining position in flowing water would occur. The author suggested that trout could die as a indirect result of sublethal toxicity.	Zinkl et. al., 1987
mussel and clam	Reports of mussel die-off occurring in North Carolina prompted this study (See Fleming et. al. 1995). *Elliptio complanata* (freshwater mussel) and *Corbicula fluminea* (asiatic clam) were both tested. *E. Complanata* ChE depression was significant at 1.3 mg/L at the adductor muscle at 21°C at 96 hour exposure (no mortality was observed). When the temperature was raised to 30°C, there was significant mortality at observed at 5 mg/L. Cholinesterase activities of the adductor muscle (which was depressed 94-96%), began to recover 12 days after exposure, but was not fully recovered until more than 24 days after exposure. Acephate reduced the shell closure responsiveness at 5 mg/L with more pronounced affect at 27°C. This appears to confirm a die-off of mussels in North Carolina in August at a time of low water flow and seasonly peaked temperatures. When compared to carbamates, recovery is less rapid due to the accepted generalization (O'Brien, 1976) that OP chemicals irreversibly bind (phosphorylation) to ChE sites whereas carbamates reversibly bind (carbamylation) to ChE sites.	Moulton et. al., 1996

aquatic organisms	summary	reference
mussels	"In 1990, we investigated a die-off of freshwater mussels in north-central North Carolina. An estimated 1,000 mussels of several species were found dead or moribund, including about 111 Tar spinymussels (Elliptio steinstansana), a federally listed endangered species. The die-off occurred during a period of low flow and high water temperature in a stream reach dominated by forestry and agriculture. Pathological examinations did not show any abnormalities and indicated that the die-off was an acute event. Chemical analyses of mussels, sediments, and water revealed no organophosphorus or carbamate pesticides. Cholinesterase activity in adductor muscle from Eastern elliptios (Elliptio complanata) collected at the kill site and downstream was depressed 73 and 65%, respectively, compared with upstream reference samples. The depression is consistent with a diagnosis of anticholinesterase poisoning. This is the first documented case in which cholinesterase-inhibiting compounds have been implicated in a die-off of freshwater mussels."	Fleming et. al., 1995

Incidents:

In general, although there are many reported incidents of toxic effects to non-targeted aquatic animals from acephate, the majority of these reports are not clearly documented or else acephate was applied in combination with other pesticides and it is not possible to determine which pesticide primarily caused the undesirable effect. There is only one incident found that shows some certainty that acephate caused an adverse effect to aquatic organisms. This incident is described below.

I000468-001 (06/06/92). Allegheny, Penn. A fishkill occurred in a backyard pond as a result of acephate on a lawn. Application rate, fish species and number of dead fish were not available.

4. Exposure and Risk Characterization

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are used by OPP to analyze potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** -- potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification, (2) **acute restricted use** -- the potential for acute risk is high, but may be mitigated through restricted use classification, (3) **acute endangered species** - endangered species may be adversely affected, and (4) **chronic risk** - the potential for chronic risk is high regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to birds or mammals.

The ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC50 (aquatic plants and aquatic invertebrates) and (4) EC25 (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOAEL (birds, fish, and aquatic invertebrates), (2) NOAEC (birds, fish and aquatic invertebrates), and (3) MATC (fish and aquatic invertebrates). For birds and mammals, the Noaec generally is used as the ecotoxicity test value in assessing chronic effects, although other values may be used when justified. Generally, the MATC (defined as the geometric mean of the NOAEC and LOAEL) is used as the ecotoxicity test value in assessing chronic effects to fish and aquatic invertebrates. However, the NOAEC is used if the measurement end point is production of offspring or survival.

Risk presumptions and the corresponding RQs and LOCs, are tabulated below.

Risk Presumptions for Terrestrial Animals

Risk Presumption	RQ	LOC
Birds		
Acute High Risk	EEC[1]/LC50 or LD50/sqft[2] or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOAEC	1
Wild Mammals		
Acute High Risk	EEC/LC50 or LD50/sqft or LD50/day	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{mg/ft^2}{LD_{50} * \text{wt. of bird}}$

[3] $\frac{\text{mg of toxicant consumed/day}}{LD_{50} * \text{wt. of bird}}$

Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOAEC	1

[1] EEC = (ppm or ppb) in water

Risk Presumptions for Plants

Risk Presumption	RQ	LOC
Plant Inhabitating Terrestrial and Semi-Aquatic Areas		
Acute High Risk	EEC[1]/EC25	1
Acute Endangered Species	EEC/EC05 or NOAEC	1
Aquatic Plants		
Acute High Risk	EEC[2]/EC50	1
Acute Endangered Species	EEC/EC05 or NOAEC	1

[1] EEC = lbs ai/A
[2] EEC = (ppb or ppm) in water

In order to assess risk, one must know what the exposure of the pesticide would be. The exposure of organisms to pesticide is contingent upon the rate of application, method of application and the use site of the application. Below are the use sites and applications used in this risk assessment and characterization to derive exposure.

Use Site	Application Type	Application Method	Application Rate (lb ai/A)	Number of Applications	Interval Between Application (days)
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper	spray granular (1)	aerial & ground spray, in-furrow incorporation	1	2	3
Pepper in Puerto Rico	spray granular	aerial & ground spray, in-furrow incorporation	0.5	2	7
Cranberries, Non-Bell Pepper	spray granular (1)	aerial & ground spray, in-furrow incorporation	1	1	—
Beans	spray	aerial & ground spray	1	2	7
Peanut	spray granular	aerial & ground spray, in-furrow incorporation	1	4	3
Soybeans	spray	aerial & ground spray	0.75 (2)	2	3
Tobacco	spray	aerial & ground spray	0.67 (3)	6	3

Use Site	Application Type	Application Method	Application Rate (lb ai/A)	Number of Applications	Interval Between Application (days)
Tobacco in Tennessee	spray	aerial & ground spray	1.33 (4)	3	3
Cotton	spray granular	aerial & ground spray, in-furrow incorporation	1	6	3
Turf	granular	ground broadcast	1	1	—

(1) The in-furrow incorporation with granular only applies to peppers.
(2) The maximum application is 1 lb ai/A and the maximum per season is 1.5 lb/A; therefore EFED assumes a split with 2 applications of 0.75 lb/A each.
(3) The maximum application in a season is 4 lb ai/A. Since there are 6 applications permitted, EFED assumes an application rate of 0.67 lb ai/A for each application.
(4) The maximum application in a season is 4 lb ai/A. Since there are 3 applications permitted, EFED assumes an application rate of 1.33 lb ai/A for each application.

a. Exposure and Risk to Nontarget Terrestrial Animals

For pesticides applied as a nongranular product (*e.g.*, liquid, dust), the estimated environmental concentrations (EECs) on food items following product application are compared to LC_{50} values to assess risk. The calculations and assumptions used to determine terrestrial EECs were discussed in Section 2.c.

i. Birds

Maximum EECs are used for acute risk and typical EECs are used for chronic risk.

Avian Acute and Chronic Risk Quotients for Multiple Applications (ground unincorporated applications) of Nongranular Acephate (Broadcast) Based on a bobwhite quail (*Colinus virginianus*) LC_{50} of 1280 ppm and a mallard duck (*Anas platyrhynchos*) NOAEC of 5 ppm.

Site Appl. Rate (Interval) [number of applications]	Food Items	Maximum EEC[1] (ppm)	Peak Mean EEC[1] (ppm)	Acute RQ (EEC)/ LC_{50})	Chronic RQ (EEC)/ NOAEC)	days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Pepper 1(3) [2]	Short Grass	337.1	119.4	0.2	23.9	14	101
	Tall Grass	154.5	50.5	0.1	10.1	12	43
	Broad Leaf	189.6	63.2	0.1	12.6	13	53
	Seed Fruit	21.0	9.8	<0.1	2.0	7	8
Pepper in Puerto Rico 0.5(7) [2]	Short Grass	134.5	47.6	0.1	9.5	15	21
	Tall Grass	61.6	20.1	<0.1	4.0	5,12	9
	Broad Leaf	75.6	25.2	<0.1	5.1	6,13	11
	Seed Fruit	8.4	3.92	<0.1	<1	—	2
Cranberries, Non-Bell Pepper 1(1) [1]	Short Grass	240.0	85.0	0.2	17.0	10	74
	Tall Grass	110.0	36.0	<0.1	7.2	7	31
	Broad Leaf	135.0	45.0	0.1	9.0	8	39
	Seed Fruit	15.0	7.0	<0.1	1.4	2	6

Site Appl. Rate (Interval) [number of applications]	Food Items	Maximum EEC[1] (ppm)	Peak Mean EEC[1] (ppm)	Acute RQ (EEC)/ LC_{50})	Chronic RQ (EEC)/ NOAEC)	days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Beans 1(7) [2]	Short Grass	269.1	95.3	0.2	19.1	18	43
	Tall Grass	123.3	40.3	0.1	8.1	15	18
	Broad Leaf	151.3	50.4	0.1	10.1	16	23
	Seed Fruit	16.8	7.8	<0.1	1.6	2,9	4
Peanut 1(3) [4]	Short Grass	392.4	138.9	0.3	27.8	22	145
	Tall Grass	179.8	58.8	0.1	11.8	19	61
	Broad Leaf	220.7	73.5	0.1	14.7	20	77
	Seed Fruit	24.5	11.4	<0.1	2.3	14	12
Soybean 0.75(3) [2]	Short Grass	252.8	89.5	0.2	17.9	14	76
	Tall Grass	115.9	37.9	<0.1	7.6	11	32
	Broad Leaf	142.2	47.4	0.1	9.5	12	40
	Seed Fruit	15.8	7.3	<0.1	1.5	2,6	6
Tobacco 0.67(3) [6]	Short Grass	269.0	95.2	0.2	19.1	27	106
	Tall Grass	123.3	40.3	0.1	8.07	24	45
	Broad Leaf	151.3	50.4	0.1	10.1	25	56
	Seed Fruit	16.8	7.8	<0.1	1.6	2,19	9
Tobacco 1.33(3) [3]	Short Grass	500.7	177.3	0.4	35.5	20	172
	Tall Grass	229.5	75.1	0.1	15.0	17	73
	Broad Leaf	281.6	93.9	0.2	18.8	18	91
	Seed Fruit	31.3	14.6	<0.1	2.9	12	14
Cotton 1(3) [6]	Short Grass	401.5	142.2	0.3	28.4	28	159
	Tall Grass	184.0	60.2	0.1	12.1	25	67
	Broad Leaf	225.8	75.8	0.1	15.2	26	85
	Seed Fruit	25.0	11.7	<0.1	2.3	20	13

1 EEC are based on Fletcher and Kenaga nomogram using FATE first-order degradation program. The peak mean value is the highest value after entering the mean value from Fletcher into the FATE program.
2 Number of days til peak mean EEC is less than NOAEC (5 ppm)
3 Value is the average EEC (ppm) during time of FATE program. This time period is (number of applications) X (interval days).

The criteria for avian reproductive studies were developed when the test was primarily used to determine effects of organochlorine pesticides and other persistent chemicals and reflect the concern for pesticides with chronic exposure patterns. The criteria would not necessary trigger a test for pesticides that pose risk of adverse reproductive effects from short term exposure. Several pesticides have been shown to reduce egg production within days after initiation of dietary exposure (Bennett et al 1991, Bennett and Bennett, 1991). Effects of eggshell quality (Bennett and Bennett, 1990, Haegele and Tucker, 1974) and incubation and brood rearing behavior (Bennett et al, 1991, Brewer et al., 1988, Busby et al.,1990) have also resulted from short-term pesticide exposures. Therefore, for purposes of this risk assessment of acephate and methamidophos, the amount of time birds can be exposed to acephate or methamidophos after initial chemical exposure that will result in chronic effects can be as little as a day.

An analysis of the above acute results indicate that avian restricted use, and endangered species levels of concern are exceeded for applications of acephate at registered maximum application rates equal to or above 0.5 lb ai/A. An analysis of the chronic results indicate that avian chronic levels of concern are exceeded for all applications of acephate.

Risk to Granular Products

Birds may be exposed to granular pesticides ingesting granules when foraging for food or grit. They also may be exposed by other routes, such as by walking on exposed granules or drinking water contaminated by granules. The number of lethal doses (LD_{50}s) that are available within one square foot immediately after application ($LD_{50}s/ft^{2}$) is used as the risk quotient for granular/bait products. Risk quotients are calculated for three separate weight class of birds: 1000 g (*e.g.*, waterfowl), 180 g (*e.g.*, upland gamebird), and 20 g (*e.g.*, songbird).

The acute risk quotients for broadcast applications of granular acephate on turf are tabulated below.

Avian Risk Quotients for Acephate Granular (Broadcast) Based on LD_{50} for mallard (234 mg/kg), bobwhite (109 mg/kg), and junko (106 mg/kg).

Site/ Application Method/Rate in lbs ai/A		% (decimal) of Pesticide Left on the Surface	Body Weight (g)	LD_{50} (mg/kg)	Acute RQ[1] (LD_{50}/ft^2)
	turf				
1	Songbird	1.0	20	106	4.91
1	Upland game bird	1.0	180	109	0.53
1	Waterfowl	1.0	1000	234	0.04

[1] $RQ = \frac{\text{App. Rate (lbs ai/A)} * (453{,}590\ \text{mg/Lbs}/43{,}560\ \text{ft}^2\text{/A})}{\text{LD50 mg/kg} * \text{Weight of Animal (Kg)}}$

The LOCs for acute risk, restricted use, and endangered species are exceeded for upland game birds and songbirds.

Due to lack of labeling data, the following assumptions were made for determining the RQ for granular applications in-furrow to peppers, cotton, and peanuts:

> There are 43,560 ft^2 in an acre. There are 43.56 12-inch wide 1000-ft long rows in an acre. There are 87.12 (43.56 x 2) 6-inch rows in an acre. EFED assumes that acephate will be incorporated in 6-inch strips in pepper, cotton and peanuts fields that have 30-inch rows. For every 6 inches that is treated, there will be 24 inches untreated (1:4 ratio). Therefore, one fourth of the acre will have acephate incorporated. Since acephate is incorporated at 1 lb ai/A, the rate of application for acephate within the 6-inch strips will be 4 lb ai/A (64 oz. ai/A). The rate of application per 1000 foot row is: 0.735 oz. per 1000-ft row (64 oz/87.12 rows).

The acute risk quotients for in-furrow applications of granular products are tabulated below.

Avian Acute Risk Quotients for Granular Products (In-furrow) Based on LD_{50} for mallard (234 mg/kg), bobwhite (109 mg/kg), and junko (106 mg/kg).

Site/Method Band Width per 1000 ft. of Row	oz.ai per 1000 ft	Bird Type and Body Weight (g)	% (decimal) of Pesticide Left on the Surface	Exposed mg/ft²	LD_{50} (mg/kg)	Acute RQ[1] (LD_{50}/ft²)
Peppers, Cotton, Peanuts/ Incorporated						
0.5	0.735	Songbird (20)	0.01	0.42	106	0.20
0.5	0.735	Upland Gamebird (180)	0.01	0.42	109	<0.10
0.5	0.735	Waterfowl (1000)	0.01	0.42	234	<0.10

[1] RQ = oz. ai per 1000 ft.* 28349 mg/oz * % Unincorporated / (bandwidth (ft) * 1000 ft) / LD_{50} (mg/kg) * Weight of the Animal (Kg)

An analysis of the results indicate that avian restricted use and endangered species levels of concern (LOC) are exceeded for in-furrow applications of granular acephate at the registered maximum application rates of 0.5 lb ai/A for songbirds. LOC for upland gamebirds and waterfowl are not exceeded.

Effects of Acephate degradate Methamidophos on Birds

Because of the high ecotoxicity of the acephate degradate methamidophos, the EECs for methamidophos formed from the degradation of acephate were also calculated using the assumptions described in Section 2.c.

Avian Acute and Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a bobwhite quail (*Coturnix virginianus*) LC_{50} of 42 ppm and NOAEC of 3 ppm (Egg Shell Thickness) exposed to the degradate methamidophos.

Site Appl. Rate of Acephate (Interval) [Number of Applications]	Food Items	Maximum EEC[1] (ppm)	Peak Mean EEC[1] (ppm)	Acute RQ (EEC/ LC_{50})	Chronic RQ (EEC/ NOAEC)	days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Pepper 0.77(3) [2]	Short Grass	241	85	5.73	28.3	13	61
	Tall Grass	111	36	2.6	12	10	26
	Broad Leaf	136	45	3.24	15	11	32
	Seed Fruit	15	7	0.36	2.33	6	5

Avian Acute and Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on a bobwhite quail (*Coturnix virginianus*) LC_{50} of 42 ppm and NOAEC of 3 ppm (Egg Shell Thickness) exposed to the degradate methamidophos.

Site Appl. Rate of Acephate (Interval) [Number of Applications]	Food Items	Maximum EEC[1] (ppm)	Peak Mean EEC[1] (ppm)	Acute RQ (EEC/ LC_{50})	Chronic RQ (EEC/ NOAEC)	days EEC is less than NOAEC[2]	Ave. EEC during Application[3]
Pepper in Puerto Rico 0.385(7) [2]	Short Grass	99	35	2.36	11.67	14	12
	Tall Grass	45	15	1.07	5	5, 12	5
	Broad Leaf	55	18	1.3	6	5, 12	6
	Seed Fruit	6	3	0.14	1	1, 8	1
Cranberries, Non-Bell 0.77(1) [1]	Short Grass	185	66	4.4	22	8	55
	Tall Grass	85	28	2.02	9.33	6	23
	Broad Leaf	104	35	2.48	11.67	7	29
	Seed Fruit	12	5	0.29	1.67	2	4
Beans 0.7(7) [2]	Short Grass	179	63	4.26	21	15	22
	Tall Grass	82	27	1.95	9	6, 13	10
	Broad Leaf	100	34	2.38	11.33	14	12
	Seed Fruit	11	5	0.26	1.67	2, 9	2
Peanut 0.7(3) [4]	Short Grass	240	85	5.7	28.3	19	73
	Tall Grass	110	36	2.62	12	17	31
	Broad Leaf	135	45	3.21	15	17	39
	Seed Fruit	15	7	0.36	2.3	13	6
Soybean 0.5775(3) [2]	Short Grass	181	64	4.3	21.33	14	46
	Tall Grass	83	27	2	9	10	19
	Broad Leaf	102	34	2.43	11.33	10	24
	Seed Fruit	11	5	0.26	1.67	2, 5	4
Tobacco 0.5159(3) [6]	Short Grass	178	63	4.23	21	24	58
	Tall Grass	82	27	1.95	9	22	25
	Broad Leaf	100	33	2.38	11	22	30
	Seed Fruit	11	5	0.26	1.67	2, 18	5
Tobacco (TN) 1.0241(3) [3]	Short Grass	344	122	8.19	40	17	99
	Tall Grass	157	52	3.73	17.33	15	42
	Broad Leaf	193	64	4.60	21.3	15	52
	Seed Fruit	22	10	0.52	3.3	10	8
Cotton 0.77(3) [6]	Short Grass	266	94	6.33	31.33	25	86
	Tall Grass	122	40	2.90	13.33	23	37
	Broad Leaf	149	50	3.55	16.67	24	46
	Seed Fruit	17	8	0.40	2.67	19	7

[1] EEC are based on Fletcher and Kenaga nomogram using FATE first-order degradation program. The peak mean value is the highest value after enter the mean value from Fletcher into the FATE program.
2 Number of days til peak mean EEC is less than NOAEC (5 ppm)
3 Value is the average EEC (ppm) during time of FATE program. This time period is the number of applications X interval days.

An analysis of the results indicate that avian chronic and acute risk, restricted use, and endangered species levels of concern (LOC) are exceeded for the degradate methamidophos from the broadcast spray of acephate at all of the registered maximum application rates.

ii. Mammals

Estimating the potential for adverse effects to wild mammals is based upon EEB's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). The concentration of acephate in the diet that is expected to be acutely lethal to 50% of the test population (LC_{50}) is determined by dividing the LD_{50} value (usually rat LD_{50}) by the % (decimal of) body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC_{50} value. Risk quotients are calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds). The acute risk quotients for broadcast applications of nongranular products are tabulated below.

Mammalian (Herbivore/Insectivore) Acute Risk Quotients Multiple Applications of Nongranular Acephate (Broadcast) Based on a meadow vole LD_{50} of 321 mg/kg (to represent body weights of 15 g and 35 g) and rat LD_{50} 866 mg/kg (body weight of 1000g).

Site/App. Method/ Rate in lbs ai/A (No. of Applications) [Interval (days)]	Body Weight (g)	% Body Weight Consumed	Rat LD_{50} (mg/kg)	EEC (ppm) Short grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[1] Short Grass	Acute RQ Small Insects	Acute RQ Large Insects
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper 1(2) [3]	15	95	321	337	189	21.07	0.99	0.56	<0.1
	35	66	321	337	189	21.07	0.69	0.39	<0.1
	1000	15	866	337	189	21.07	<0.1	<0.1	<0.1
Peppers in Puerto Rico 0.5(2) [7]	15	95	321	134	75	8.41	0.40	0.22	<0.1
	35	66	321	134	75	8.41	0.28	0.16	<0.1
	1000	15	866	134	75	8.41	<0.1	<0.1	<0.1
Cranberries, Non-Bell Pepper 1(1)	15	95	321	240	135	15	0.71	0.40	<0.1
	35	66	321	240	135	15	0.49	0.28	<0.1
	1000	15	866	240	135	15	<0.1	<0.1	<0.1
Beans 1(2) [7]	15	95	321	269	151	16.82	0.80	0.44	<0.1
	35	66	321	269	151	16.82	0.55	0.31	<0.1
	1000	15	866	269	151	16.82	<0.1	<0.1	<0.1
Peanuts 1(4) [3]	15	95	321	392	220	24.53	1.16	0.65	<0.1
	35	66	321	392	220	24.53	0.81	0.45	<0.1
	1000	15	866	392	220	24.53	<0.1	<0.1	<0.1
Soybeans 0.75(2) [3]	15	95	321	252	142	15.81	0.75	0.42	<0.1
	35	66	321	252	142	15.81	0.52	0.29	<0.1
	1000	15	866	252	142	15.81	<0.1	<0.1	<0.1
Tobacco 0.67(6) [3]	15	95	321	269	151	16.81	0.80	0.45	<0.1
	35	66	321	269	151	16.81	0.55	0.31	<0.1
	1000	15	866	269	151	16.81	<0.1	<0.1	<0.1
Tobacco 1.33(3) [3]	15	95	321	500	281	31.30	1.48	0.83	<0.1
	35	66	321	500	281	31.30	1.03	0.58	<0.1
	1000	15	866	500	281	31.30	<0.1	<0.1	<0.1
Cotton 1(6) [3]	15	95	321	401	225	25.09	1.19	0.67	<0.1
	35	66	321	401	225	25.09	0.83	0.46	<0.1
	1000	15	866	401	225	25.09	<0.1	<0.1	<0.1

The risk quotients for granivores (seed eaters) are less than any of the levels of concern, therefore the table is not included.

An analysis of the above results indicate that for broadcast applications of nongranular acephate the following mammalian acute high risk, restricted use (R), and endangered species (ES) levels of concern (LOC)are exceeded:

Crops	15 gram mammal	35 gram mammal	1000 gram mammal
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper	All LOCs	All LOCs	No LOCs
Peppers in Puerto Rico	R, ES	R, ES	No LOCs
Cranberries, Non-Bell Peppers	All LOCs	All LOCs	No LOCs
Beans	All LOCs	All LOCs	No LOCs
Peanuts	All LOCs	All LOCs	No LOCs
Soybeans	All LOCs	All LOCs	No LOCs
Tobacco (both sites)	All LOCs	All LOCs	No LOCs
Cotton	All LOCs	All LOCs	No LOCs

The chronic risk quotients for broadcast applications of nongranular products are tabulated below.

Mammalian Chronic Risk Quotients for Multiple Applications (ground unincorporated applications) of Nongranular Acephate (Broadcast) Based on a Rat NOAEC of 50 ppm.

Site/ Appl. Rate/ (Number of Applications) [Interval]	Food Items	Peak Mean EEC[1] (ppm)	Chronic RQ (EEC)/NAOEC)	days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Pepper 1(2) [3]	Short Grass	119.4	2.39	8	101
	Tall Grass	50.58	1.01	1,5	43
	Broad Leaf	63.22	1.26	1,5	53
	Seed Fruit	9.83	0.197	—	8
Pepper in Puerto Rico 0.5 (2) [7]	Short Grass	47.65	0.95	—,8	21
	Tall Grass	20.18	0.40	—	9
	Broad Leaf	25.23	0.50	—	11
	Seed Fruit	3.92	0.08	—	2
Cranberries, Non-Bell 1(1)[1]	Short Grass	85.00	1.7	2	74
	Tall Grass	36.00	0.72	—	31
	Broad Leaf	45.00	0.90	—	39
	Seed Fruit	7.00	0.14	—	6
Beans 1(2)[7]	Short Grass	95.31	1.9	3,10	43
	Tall Grass	40.37	0.8	—	18
	Broad Leaf	50.46	1.01	1,8	23
	Seed Fruit	7.85	0.157	—	4

Mammalian Chronic Risk Quotients for Multiple Applications (ground unincorporated applications) of Nongranular Acephate (Broadcast) Based on a Rat NOAEC of 50 ppm.

Site/ Appl. Rate/ (Number of Applications) [Interval]	Food Items	Peak Mean EEC[1] (ppm)	Chronic RQ (EEC)/NAOEC)	days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Peanut 1(4)[3]	Short Grass	138.99	2.77	15 [4]	145
	Tall Grass	58.87	1.18	1,5,12	61
	Broad Leaf	73.59	1.47	2,12	77
	Seed Fruit	11.45	0.23	—	12
Soybean 0.75(2)[3]	Short Grass	89.56	1.79	2,7	76
	Tall Grass	37.93	0.76	—,4	32
	Broad Leaf	47.42	0.95	—,4	40
	Seed Fruit	7.38	0.16	—	6
Tobacco 0.67(6)[3]	Short Grass	95.28	1.9	19	106
	Tall Grass	40.35	0.81	—,4,7,10,13,16	45
	Broad Leaf	50.44	1.01	1,5,8,11,14,17	56
	Seed Fruit	7.85	0.157	—	9
Tobacco 1.33(3)[3]	Short Grass	177.36	3.54	12	172
	Tall Grass	75.12	1.5	2,9	73
	Broad Leaf	93.90	1.88	10	91
	Seed Fruit	14.61	0.29	—	14
Cotton 1(6)[3]	Short Grass	142.20	2.8	21	159
	Tall Grass	60.23	1.2	1,5,18	67
	Broad Leaf	75.85	1.52	2,19	85
	Seed Fruit	11.71	0.234	—	13

1 EEC using FATE fate program. EEC are based on Fletcher and Kenaga nomogram using FATE first-order degradation program. The peak mean value is the highest value after enter the mean value from Fletcher into the FATE program.
2 Number of days til peak mean EEC is less than NOAEC (50 ppm)
3 Value is the average EEC (ppm) during time of FATE program. This time period is the (number of applications) X (interval days).
4 When there are several days before the level of residues drop below the NOAEC level after the first application, it is noted that additional applications will also be higher than the NOAEC. Therefore, only the number of days after the first application will be noted.

The above results indicate that for multiple broadcast applications of nongranular products, the mammalian chronic level of concern is exceeded at all registered maximum application rates.

Granular Analysis

Mammalian species also may be exposed to granular/bait pesticides by ingesting granules. They also may be exposed by other routes, such as by walking on exposed granules and drinking water contaminated by granules. The number of lethal doses (LD_{50}'s) that are available within one square foot immediately after application can be used as a risk quotient (LD_{50}'s/ft^2) for the various types of exposure to bait pesticides. Risk quotients are calculated for three separate weight classes of mammals: 15 g, 35 g, and 1000 g.

The acute risk quotients for broadcast applications of granular products are tabulated below.

Mammalian Acute Risk Quotients for Granular Products (Broadcast) Based on a meadow vole LD_{50} of 321 mg/kg (body of 15 g and 35 g) and rat LD_{50} 866 mg/kg (body weight of 1000g).

Site/ Application Method/ Rate in lbs ai/a	% (decimal) of Pesticide Left on the Surface	Body Weight (g)	Rat LD_{50} (mg/kg)	Acute RQ[1] (LD_{50}/ft^2)
Turf/Unincorporated				
1	1.0	15	321	2.16
1	1.0	35	321	0.93
1	1.0	1000	866	0.01

[1] RQ = $\frac{\text{App. Rate (lbs ai/a)} * (453{,}590 \text{ mg/lbs}/43{,}560 \text{ ft}^2/\text{a})}{LD_{50} \text{ mg/kg} * \text{Weight of Animal (g)} * 1000 \text{ g/kg}}$

An analysis of the results indicate that for broadcast granular products, mammalian acute high risk, restricted use, and endangered species levels of concern are exceeded at a registered maximum application rate equal to or above 1.0 lb ai/a.

Due to lack of labeling data, the following assumptions were made for determining the RQ for granular applications in-furrow to peppers, cotton, and peanuts:

> There are 43,560 ft^2 in an acre. There are 43 12-inch wide 1000-ft long rows in an acre. There are 87.12 (43.56 x 2) 6-inch rows in an acre. EFED assumes that acephate will be incorporated in 6-inch strips in pepper, cotton and peanuts fields that have 30-inch rows. For every 6 inches that is treated, there will be 24 inches untreated (1:4 ratio). Therefore, one fourth of the acre will have acephate incorporated. Since acephate is incorporated at 1 lb ai/a, the rate of application for acephate within the 6-inch strips will be 4 lb ai/a (64 oz. ai/a). The rate of application per 1000 foot row is: 0.735 oz. per 1000-ft row (64 oz/87 rows).

The acute risk quotients for in-furrow applications of granular products are tabulated below.

Mammalian Acute Risk Quotients for Granular Products (In-furrow) Based on a Meadow Vole LD_{50} of 321 mg/kg (represents body weight of 15 g and 35 g) and rat LD_{50} 866 mg/kg (represents body weight of 1000g).

Site/Method Band Width (feet)	oz. ai. per 1000 ft of row	Body Weight (kg)	% (decimal) of Pesticide Left on the Surface	Exposed mg/ft²	Rat LD50 (mg/kg)	Acute RQ[1] (LD_{50}/ft^2)
Pepper, Cotton, and Peanuts Incorporated						
0.5	0.735	0.015	0.01	0.42	321	<0.1
0.5	0.735	0.035	0.01	6.25	321	<0.1
0.5	0.735	1.0	0.01	0.42	866	<0.1

[1] RQ = $\frac{\text{oz. ai per 1000 ft.} * 28349 \text{ mg/oz} * \text{\% Unincorporated} / (\text{bandwidth (ft)} * 1000 \text{ ft})}{LD_{50} \text{ (mg/kg)} * \text{Weight of the Animal (g)} * 1000 \text{ g/kg}}$

An analysis of the results indicate that for in-furrow granular products, no LOCs were exceeded for mammals.

Currently, EFED does not have a standard procedure for assessing chronic risk to mammalian species for granular products.

Effects of Acephate degradate on Mammals

Because of the high ecotoxicity of the acephate degradate methamidophos, the EECs for methamidophos formed from the degradation of acephate were also calculated using the assumptions described in Section 2.c.

Mammalian (Herbivore/Insectivore) Acute Risk Quotients Multiple Applications of Nongranular Acephate (Broadcast) Based on a rat LD_{50} of 13.0 mg/kg Exposed to the Degradate Methamidophos.

Site/App. Method/ Rate in lbs ai/a (No. of Applications) [Interval (days)]	Body Weight (g)	% Body Weight Consumed	Rat LD_{50} (mg/kg)	EEC (ppm) Short grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[1] Short Grass	Acute RQ Small Insects	Acute RQ Large Insects
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper 1(2) [3]	15 35 1000	95 66 15	13 13 13	241 241 241	136 136 136	15 15 15	15.3 12.2 2.8	8.6 6.9 1.6	1.0 0.8 0.2
Peppers in Puerto Rico 0.5(2) [7]	15 35 1000	95 66 15	13 13 13	99 99 99	55 55 55	6 6 6	6.2 5.0 1.1	3.5 2.8 0.6	0.4 0.3 0.1
Cranberries, Non-Bell Pepper 1(1)	15 35 1000	95 66 15	13 13 13	185 185 185	104 104 104	12 12 12	13.5 9.4 2.1	7.6 5.3 1.2	0.9 0.6 0.1
Beans 1(2) [7]	15 35 1000	95 66 15	13 13 13	179 179 179	100 100 100	11 11 11	11.3 9.3 2.1	6.3 5.1 1.2	0.7 0.6 0.1
Peanuts 1(4) [3]	15 35 1000	95 66 15	13 13 13	240 240 240	135 135 135	15 15 15	17.5 12.2 2.8	8.6 6.9 1.6	1.0 0.8 0.2
Soybeans 0.75(2) [3]	15 35 1000	95 66 15	13 13 13	181 181 181	102 102 102	11 11 11	11.5 9.2 2.1	6.5 5.2 1.2	0.7 0.6 0.1
Tobacco 0.67(6) [3]	15 35 1000	95 66 15	13 13 13	178 178 178	100 100 100	11 11 11	11.3 9.0 2.1	6.3 5.1 1.2	0.7 0.6 0.1
Tobacco 1.33(3) [3]	15 35 1000	95 66 15	13 13 13	344 344 344	193 193 193	22 22 22	21.8 17.5 4.0	12.2 9.8 2.2	1.4 1.1 0.3
Cotton 1(6) [3]	15 35 1000	95 66 15	13 13 13	266 266 266	149 149 149	17 17 17	16.8 13.5 3.1	9.4 7.6 1.7	1.1 0.9 0.2

[1] RQ=EEC/Toxicity. The Toxicity value is the LD_{50} / % Body Weight Consumed (as a decimal)

An analysis of the above results indicate that for broadcast applications of nongranular acephate, the methamidophos degradate exceeds mammalian levels of concern for acute high risk, restricted use, and endangered species at all use sites.

Mammalian Chronic Risk Quotients for Multiple Applications of Nongranular Products (Broadcast) Based on Mouse NOAEC of 10 ppm (births, pup weight and survival) Exposed to the Degradate Methamidophos.

Site Appl. Rate of Acephate (Interval) [Number of Applications]	Food Items	Peak Mean EEC[1] (ppm)	Chronic RQ (EEC)/ NOAEC)	Days EEC is less than NOAEC [2]	Ave. EEC during Application[3]
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Pepper 1(3) [2]	Short Grass	85	8.50	13	61
	Tall Grass	36	3.6	10	26
	Broad Leaf	45	4.5	11	32
	Seed Fruit	7	0.7	6	5
Pepper in Puerto Rico 0.5(7) [2]	Short Grass	35	3.5	14	12
	Tall Grass	15	1.5	5,12	5
	Broad Leaf	18	1.8	5,12	6
	Seed Fruit	3	0.3	1,8	1
Cranberries, Non-Bell 1(1) [1]	Short Grass	66	6.6	8	55
	Tall Grass	28	2.8	6	23
	Broad Leaf	35	3.5	7	29
	Seed Fruit	5	0.5	2	4
Beans 1(7) [2]	Short Grass	63	6.3	15	22
	Tall Grass	27	2.7	6,13	10
	Broad Leaf	34	3.4	14	12
	Seed Fruit	5	0.5	2,9	2
Peanut 1(3) [4]	Short Grass	85	8.5	19	73
	Tall Grass	36	3.6	17	31
	Broad Leaf	45	4.5	17	39
	Seed Fruit	7	0.7	13	6
Soybean 0.75(3) [2]	Short Grass	64	6.4	14	46
	Tall Grass	27	2.7	10	19
	Broad Leaf	34	3.4	10	24
	Seed Fruit	5	0.5	2,5	4
Tobacco 0.67(3) [6]	Short Grass	63	6.3	24	58
	Tall Grass	27	2.7	22	25
	Broad Leaf	33	3.3	22	30
	Seed Fruit	5	0.5	2,5,18	5
Tobacco 1.33(3) [3]	Short Grass	122	12.2	17	99
	Tall Grass	52	5.2	15	42
	Broad Leaf	64	6.4	15	52
	Seed Fruit	10	1.0	10	8
Cotton 1(3) [6]	Short Grass	94	9.40	25	86
	Tall Grass	40	4.0	23	37
	Broad Leaf	50	5.0	24	46
	Seed Fruit	8	0.8	19	7

1 EEC are based on Fletcher and Kenaga nomogram using FATE first-order degradation program. The peak mean value is the highest value after the mean value from Fletcher

An analysis of the results indicate that avian chronic and acute risk, restricted use, and endangered species levels of concern (LOC) are exceeded for the degradate methamidophos from the broadcast spray of acephate from all of the use sites.

iii. Insects

Currently, EFED does not assess risk to nontarget insects. Results of acceptable studies are used for recommending appropriate label precautions. However, it should be noted that laboratory studies show acephate and the degradate methamidophos to be highly toxic to bees and other beneficial insects. When bees are placed on foliage from 2 hours to 24 hours after treatment of the foliage, more than 50% of the bees died from application as low as 0.5 lb ai/a.

b. Risk to Nontarget Aquatic Animals

EECs calculated using the GENeric Expected Environmental Concentration Program (GENEEC) are used for assessing acute and chronic risks to aquatic organisms. Acute risk assessments are performed using peak EEC values for single and multiple applications. Chronic risk assessments are performed using the 21-day EECs for invertebrates and 56-day EECs for fish. Details on the GENEEC model assumptions and the environmental fate parameters used in the model are discussed in Section 2.d.ii. EECs (in parts per million) for acephate applications to various crops are tabulated below.

Estimated Environmental Concentrations (EECs) of Acephate For Aquatic Exposure

Site	Application Method	Appl. Rate (lbs ai/a)	# of Appls./ Interval Between Apps.	Initial (PEAK) EEC (ppm)	21-day average EEC (ppm)	56-day average EEC (ppm)
GENEEC						
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Pepper	ground .... aerial..............	1	2 / 3	0.078 0.080	0.075 0.076	0.070 0.071
Pepper in Puerto Rico	ground.......... aerial........	0.5	2/7	0.031 0.032	0.030 0.031	0.028 0.029
Cranberries, Non-Bell Pepper	ground...... aerial........	1	1	0.031 0.032	0.029 0.030	0.027 0.028

Estimated Environmental Concentrations (EECs) of Acephate For Aquatic Exposure

Site	Application Method	Appl. Rate (lbs ai/a)	# of Appls./ Interval Between Apps.	Initial (PEAK) EEC (ppm)	21-day average EEC (ppm)	56-day average EEC (ppm)
Beans	ground	1	2 / 7	0.063	0.060	0.056
	aerial............			0.065	0.062	0.058
Peanut	ground.......	1	4/3	0.092	0.088	0.082
	aerial......			0.097	0.093	0.087
Soybean	ground......	0.75[1]	2/3	0.059	0.056	0.052
	aerial.....			0.060	0.057	0.053
Tobacco	ground.....	0.67[2]	6/3	0.064	0.061	0.057
		1.33 (Tn.)[3]	3/3	0.117	0.116	0.104
	aerial....	0.67	6/3	0.070	0.067	0.062
		1.33	3/3	0.121	0.116	0.107
Cotton	ground........	1	6/3	0.095	0.091	0.085
	aerial..........	1	6/3	0.104	0.100	0.093
PRZM-EXAMS[4]						
Cotton	aerial	1	6 / 3	0.071	0.014	0.006
Tobacco	aerial	1	3 / 1.33	0.015	0.004	0.002

[1] The maximum application is 1 lb and the maximum ai/lb/acre/season is 1.5; therefore EFED assumes a split application of 0.75.
[2] The maximum application is 4 lbs ai/acre/season. Since there are 6 applications in a season EFED assumes an application rate of 0.67 ai/a.
[3] The maximum lbs ai/acre/season is 4. Since there are 3 app/season, EFED assumes 1.33 ai/a. This crop is in the state of Tennessee.
[4] Values for PRZM-EXAMS were presented in Section 2.d. They are presented here for purposes of comparison.

The RQs for acute risk from acephate for both freshwater and estuarine organisms are presented below.

Acute Risk Quotients for Freshwater Fish (rainbow trout LC_{50} = 730 ppm), Aquatic Invertebrates (*Daphnia magna* LC_{50} = 1.3 ppm), Estuarine Fish (pin fish LC_{50} = 85 ppm), Oyster (LC_{50} = 5.41 ppm), and Estuarine Invertebrates (pink shrimp LC_{50} = 3.8 ppm).

Site/Application Method/ Rate in lbs ai/a (No. of Apps.)	Type of Application	Acute RQ Freshwater Fish	Acute RQ Aquatic Invertebrate	Acute RQ Estuarine fish	Acute RQ Oyster	Acute RQ Estuarine Invertebrate
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Peppers 1 (2)	ground......	< 0.05	0.06	<0.05	<0.05	<0.05
	aerial.....	< 0.05	0.06	<0.05	<0.05	<0.05
Pepper in Puerto Rico 0.5 (2)	ground.....	<0.05	<0.05	<0.05	<0.05	<0.05
	aerial....	<0.05	<0.05	<0.05	<0.05	<0.05
Cranberries, Non-Bell Peppers 1(1)	ground....	<0.05	<0.05	<0.05	<0.05	<0.05
	aerial....	<0.05	<0.05	<0.05	<0.05	<0.05

Acute Risk Quotients for Freshwater Fish (rainbow trout LC_{50} = 730 ppm), Aquatic Invertebrates (*Daphnia magna* LC_{50} = 1.3 ppm), Estuarine Fish (pin fish LC_{50} = 85 ppm), Oyster (LC_{50} = 5.41 ppm), and Estuarine Invertebrates (pink shrimp LC_{50} = 3.8 ppm).

Site/Application Method/ Rate in lbs ai/a (No. of Apps.)	Type of Application	Acute RQ Freshwater Fish	Acute RQ Aquatic Invertebrate	Acute RQ Estuarine fish	Acute RQ Oyster	Acute RQ Estuarine Invertebrate
Beans 1 (2)	ground...... aerial......	<0.05 <0.05	0.05 0.05	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05
Peanut 1(4)	ground..... aerial....	<0.05 <0.05	0.07 0.07	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05
Soybean 0.75(2)	ground.... aerial...	<0.05 <0.05	0.05 0.05	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05
Tobacco 0.67 (6) 1.33 (3)	ground..... aerial.... 0.67(6)	<0.05 <0.05	0.05 0.05	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05
	ground.... aerial... 1.33 (3)	<0.05 <0.05	0.09 0.09	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05
Cotton 1 (6)	ground...... aerial.......	<0.05 <0.05	0.07 0.08	<0.05 <0.05	<0.05 <0.05	<0.05 <0.05

For all use sites other than peppers in Puerto Rico and non-bell peppers and cranberries, the LOC for endangered species of aquatic invertebrate were exceeded. There were no exceedences for acute risk or restricted use.

The RQs for chronic risk from acephate for both freshwater and estuarine invertebrates are presented below.

Chronic Risk Quotients for Freshwater Invertebrate Life-Cycle Toxicity using *Daphnia magna* (NOAEC 0.150 ppm) and Estuarine/Marine Invertebrate Life-Cycle Acephate using *Americamysis bahia* (NOAEC 0.58 ppm).

Site/Application Method/ Rate in lbs ai/a (No. of Apps.)	Type of Application	Chronic RQ Freshwater Invert[1]	Chronic RQ Estuarine Invert.[1]
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery, Bell Peppers 1 (2)	ground...... aerial.....	0.50 0.51	0.13 0.13
Pepper in Puerto Rico 0.5 (2)	ground..... aerial....	0.20 0.21	0.05 0.05
Cranberries, Non-Bell Peppers 1(1)	ground.... aerial....	0.19 0.20	0.05 0.05

Chronic Risk Quotients for Freshwater Invertebrate Life-Cycle Toxicity using *Daphnia magna* (NOAEC 0.150 ppm) and Estuarine/Marine Invertebrate Life-Cycle Acephate using *Americamysis bahia* (NOAEC 0.58 ppm).

Site/Application Method/ Rate in lbs ai/a (No. of Apps.)	Type of Application	Chronic RQ Freshwater Invert[1]	Chronic RQ Estuarine Invert.[1]
Beans 1 (2)	ground...... aerial......	0.40 0.41	0.10 0.11
Peanut 1 (4)	ground..... aerial....	0.59 0.62	0.15 0.16
Soybean 0.75 (2)	ground.... aerial...	0.37 0.38	0.097 0.098
Tobacco 0.67 (6)	ground..... aerial	0.41 0.77	0.12 0.20
Tobacco 1.33 (3)	ground aerial...	0.45 0.77	0.12 0.20
Cotton 1 (6)	ground...... aerial.......	0.61 0.67	0.16 0.17

[1]Based on 21 day EEC.

There are no exceedences for chronic risk to freshwater or estuarine invertebrates from acephate exposure. There are no data available for assessing chronic risk to fish from acephate.

Effect of Acephate degradate Methamidophos on Aquatic Organisms

The aquatic screening EECs for methamidophos formed from the degradation of acephate when applied to various crops were calculated using the assumptions described in Section 2.c. in GENEEC.

Estimated Environmental Concentrations (EECs) For Aquatic Exposure of the Methamidophos degradate

Site	Application Method	Acephate Appl. Rate (lbs ai/a)	# of Appls./ Interval Between Apps.	Initial (PEAK) EEC (ppm)
GENEEC				
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Pepper	ground	1	2 / 3	0.056
	aerial.............	1	2 / 3	0.057
Pepper in Puerto Rico	ground..........	0.5	2/7	0.023
	aerial........	0.5	2/7	0.024
Cranberries, Non-Bell Pepper	ground......	1	1	0.020
	aerial........	1	1	0.021
Beans	ground	1	2/ 7	0.046
	aerial............	1	2/7	0.047
Peanut	ground.......	1	4/3	0.062
	aerial......	1	4/3	0.066
Soybean	ground......	0.75[1]	2/3	0.042
	aerial.....	0.75	2/3	0.043
Tobacco	ground.....	0.67[2]	6/3	0.042
		1.33 (Tn.)[3]	3/3	0.081
	aerial....	0.67	6/3	0.046
		1.33 (Tn.)[3]	3/3	0.084
Cotton	ground........	1	6/3	0.063
	aerial..........	1	6/3	0.069
PRZM-EXAMS [4]				
Cotton	aerial......	1 (parent)	6 / 3	0.071

[1] The maximum application is 1 lb and the maximum ai/lb/acre/season is 1.5; therefore EFED assumes a split application of 0.75.
[2] The maximum application is 4 lbs ai/acre/season. Since there are 6 applications in a season EFED assumes an application rate of 0.67 ai/a.
[3] The maximum lbs ai/acre/season is 4. Since there are 3 app/season, EFED assumes 1.33 ai/a. This use rate is for the state of Tennessee.
[4] Values for PRZM-EXAMS using the parent/daughter algorithm were presented in Section 2.d.ii.. They are presented here for purposes of comparison.

The following table reports the RQs for aquatic organisms that are exposed to methamidophos formed as a degradate from acephate applications.

Acute Risk Quotients for Freshwater Fish (rainbow trout LC_{50} = 25 ppm), Aquatic Invertebrates (*Daphnia magna* LC_{50} = 0.026 ppm), Estuarine Fish (sheepshead minnow LC_{50} = 5.6 ppm) and mysid shrimp (LC_{50} =1.05 ppm).

		Freshwater Acute RQ		Estuarine/Marine RQ	
Site/Application Rate in lbs ai/a (No. of Apps.)	Type of Application	Fish	Aquatic Invertebrate (*Daphnia*)	Mysid Shrimp	Fish
Brussel Sprouts, Cauliflower, Head Lettuce, Mint, Celery Bell Peppers 1 (2)	ground......	< 0.05	2.15	0.05	<0.05
	aerial.....	< 0.05	2.19	0.05	<0.05
Pepper in Puerto Rico 0.5 (2)	ground.....	<0.05	0.88	<0.05	<0.05
	aerial....	<0.05	0.92	<0.05	<0.05
Cranberries, Non-Bell Peppers 1(1)	ground....	<0.05	0.77	<0.05	<0.05
	aerial....	<0.05	0.81	<0.05	<0.05
Beans 1 (2)	ground......	<0.05	1.77	<0.05	<0.05
	aerial......	<0.05	1.81	<0.05	<0.05
Peanut 1(4)	ground.....	<0.05	2.38	0.06	<0.05
	aerial....	<0.05	2.54	0.06	<0.05
Soybean 0.75(2)	ground....	<0.05	1.62	<0.05	<0.05
	aerial...	<0.05	1.65	<0.05	<0.05
Tobacco 0.67 (6)	ground.....	<0.05	1.62	<0.05	<0.05
	aerial....	<0.05	1.77	<0.05	<0.05
Tobacco (TN) 1.33 (3)	ground....	<0.05	3.12	0.08	<0.05
	aerial...	<0.05	3.23	0.08	<0.05
Cotton 1 (6)	ground......	<0.05	2.42	0.06	<0.05
	aerial.......	<0.05	2.65	0.07	<0.05

[1] LC_{50}s for these species taken from supplemental information

As acephate degrades into methamidophos, the LOCs for acute risk, endangered species, and restricted use are exceeded for freshwater invertebrates. There were no exceedences for freshwater fish.

As acephate degrades into methamidophos, only endangered species LOCs were exceeded for the mysid shrimp from brussel sprouts, cauliflower, head lettuce, mint, celery, bell peppers, peanut, tobacco in Tennessee, and cotton. There were no exceedences for estuarine fish.

Chronic risk to aquatic organisms from methamidophos cannot be assessed because of lack of chronic effects data.

c. Risk to Nontarget Plants

There are no data available to assess the risk to nontarget plants from the use of acephate.

5. Endangered Species

Endangered species LOCs are exceeded for all uses of acephate. In addition, LOCs are exceeded for endangered species of mammals, amphibians, birds, reptiles, insects, fish (estuarine and freshwater), aquatic invertebrates (estuarine and freshwater) for the degradate methamidophos which is formed from all uses of acephate.

The Agency has developed a program (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 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 through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

6. Risk Characterization

Risk characterization is a qualitative assessment of risks that expands on the environmental fate and ecological effects risk assessments. It includes discussions of other factors that may affect risk but were not considered in the quantitative risk assessments.

Use Characterization

Due to large amount of ambiguity in the current labels that were not included in the use closure memo from SRRD and the open-ended nature of the labeling (i.e. "apply as needed" in many of the application instructions), this risk characterization emphasizes the vegetables group, tobacco, and cotton, which comprise 9, 34, and 20% of the total estimated use in pounds, respectively (estimated annual U.S. usage for 1990-1993; OPP BEAD). The 3 use sites have large discrepancies between the maximum seasonal application and the typical seasonal application. These are: cotton (use closure memo states 6 lb ai/A per season vs. a reported average of 0.7 lb ai/season); and tobacco (use closure memo states 4 lb ai/A per season vs. a reported average of 0.8 lb ai/season). Please see earlier risk assessment (Section 3) for details.

Environmental fate assessment

Acephate degrades rapidly in soil (t ½ < 2 days) to methamidophos. Methamidophos then degrades rapidly in soil (t ½ < 1 day), but the final degradates are carbon dioxide and unextractable residues. Both acephate and methamidophos are very soluble (at nearly kg/L) and highly mobile (K_ds < 0.1), so they can move to aquatic environments by runoff; their persistence in surface water environments is not known, but information of marginal value suggests that acephate is more persistent in natural waters than in soil.

Ground Water

Based on environmental fate data, acephate is not persistent but is very mobile in the soil. The environmental fate characteristics of acephate and ground water modeling support the conclusion that acephate is not expected to leach to ground water. Results from the SCI-GROW screening model predicted that the maximum chronic concentration of acephate in shallow ground water is not expected to exceed 0.02 μg/L. This is considered to be an "upper bound" for residues of acephate in ground water. Acephate was modeled using a 6 lb ai/acre/season application to cotton. Typical use rates of acephate for turf and vegetables are slightly less than this amount; therefore, any acephate residues reaching ground water should be less than predicted. Any methamidophos residues formed by the degradation of acephate are not expected to leach to ground water

This prediction is supported by the ground water monitoring data for acephate, in which no detections of acephate in ground water have been reported for 1019 wells (PGWDB) and 872 wells (STORET). However, uncertainty is high for the STORET data because it is not known what the actual detection limit of the analytical method was and whether samples were taken in areas where acephate was not in use.

Surface Water

Modeling results suggest acephate and methamidophos will persist for short periods in surface waters following transport by surface runoff or spray drift. However, modeling estimates are conservative, due to the lack of acceptable data on their persistence in surface water environments. Acephate and methamidophos will be found primarily in the water column because binding to suspended and bottom sediments is not expected, due to the low K_ds (<0.1) of both chemicals. Monitoring data show that there are no records for acephate sampling from lakes, ocean, estuary, canal, or reservoir sites; there are records of 883 samples from ambient streams, but it is uncertain what the actual detection limit was and if samples were taken from an area where acephate was not in use.

The Tier 2 modeling assumes a single 10-hectare field generates runoff following pesticide application made on the entire field during a single day. This runoff is then collected in a 1-hectare pond with no outlet. Other surface water bodies may exhibit considerable flow-through (rivers, streams) or turnover (reservoirs, lakes). Acephate concentrations in such waters would be expected to be considerably less than the predicted values; however, the amount of dilution is unknown.

Risk quotients calculated for acephate alone do not indicate high acute risks to fish and invertebrates; however, under certain environmental conditions, there may be a concern for exposure to acephate because of its degradation to methamidophos. Although the acephate degradate methamidophos is only slightly toxic to fresh water fish, aquatic invertebrates are very sensitive. Furthermore, risk to freshwater invertebrates from methamidophos is greater than that for marine and estuarine invertebrates due to the apparent greater sensitivity of freshwater species.

Acephate is used in areas where runoff from agricultural fields could flow into estuaries. It is possible that acephate residues (which include methamidophos) may be diluted to insignificant amounts by the time they reached any estuaries; in addition, acephate and/or methamidophos may degrade en route. However, the lack of information on dilution volumes and on the persistence of acephate residues in aquatic environments reduces the certainty of this. Areas where there is a risk to marine and estuarine areas are the lower Rio Grande Valley in Texas, southern Florida, the Delmarva peninsula, and the North and South Carolina coasts. High amounts of rainfall in these areas exacerbate the risk to estuarine habitats in these areas.

Risk to Terrestrial Ecosystems

Birds

Nongranular Formulations

Acute Risk

The lab data and exposure indicate that there is little acute risk to birds from acephate (all RQs <0.5). Acute oral toxicity for birds from acephate is categorized as moderately toxic; subacute dietary toxicity ranges from moderately toxic to practically non toxic. In addition acephate does not show severe acute toxicity by dermal and inhalation exposure.

However, the degradate methamidophos is classified in laboratory studies as very highly toxic for oral acute, subacute dietary, dermal, and inhalation exposure. Because acephate degrades so quickly to methamidophos in the environment ($t1/2 < 2$ days), methamidophos may be the main causative agent for avian mortality from acephate applications.

Reported incidents and field studies indicate that there is high acute risk to birds. Data from field studies indicates that in applications where only acephate was applied, both acephate and methamidophos residues were found in animals and their food items. Birds have been shown to have marked brain ChE inhibition for up to at least 33 days after application of 0.5, 1.0 and 2.0 lb ai/A (Zinkl, 1977). Forestry applications at 0.5 lb ai/A cause ChE inhibition that remains at life-threatening levels for up to 26 days after application (Zinkl, 1978). After rangeland application (0.5 lb ai/A), 25% of the birds and small mammals collected have ChE depression of >20% (GS0042018). Another study also showed that 25% of the birds collected showed ChE depression with the largest ChE depression among the last birds collected (24 days post treatment) (MRID 00093909). Many field studies show that adverse effects from acephate occur not at time of application but one to-two days later, which was interpreted by the study authors as toxicity due to the acephate degradate methamidphos.

There are several incidents reported to OPP concerning an adverse impact to birds from acephate, but only 2 of those incidents were cited due to a greater certainty that acephate was the causative agent. Both incidents involved the death of birds following exposure to Orthene (acephate) from homeowner use.

The high risk attributed to birds from acephate degrading into methamidophos may have been underestimated. This is because the higly toxic acute effects to birds from dermal and inhalation exposure of methamidophos were not considered with the RQ which considered only the oral exposure route. Field studies and incidents indicate that the use of acephate is having a detrimental effect on birds, especially song birds.

Chronic risk

Laboratory data indicate that acephate affects the reproductive capacity of birds through reducing the viability of embryos and 3-week-old chicks at concentrations greater than 5 ppm. Methamidophos laboratory data indicate that the reproductive capacity of birds is also reduced by thinning of eggshells at concentration greater than 3 ppm. There are no field data available to corroborate this. Risk quotients calculated from the NOAELs for acephate and the average acephate residues predicted from FATE exceed the LOC for birds by up to 35X for tobacco, 28X for cotton and peanuts, 24X in vegetable crops, and 17X for cranberries. The laboratory data indicate that acephate presents high chronic risk to birds. It is concluded that the use of acephate poses a high chronic risk to birds.

Although methamidophos is much more acutely toxic than acephate, the chronic toxicities are comparable. Risk quotients calculated from the NOAELs for methamidophos and the average methamidophos residues predicted from FATE exceed the LOC for birds by up to 45X for tobacco, 36X for cotton and peanuts, 31X in vegetable crops, and 22X for cranberries. The laboratory data indicate that methamidophos presents high chronic risk to birds.

Granular formulations

Broadcast application of granular acephate on turf exceeds the acute LOC for song birds by 9X and equals the LOC for birds of similar size to bobwhite quail. In-furrow treatments exceed the acute LOC for song birds by 7X and do not exceed the LOC for larger birds. These RQs are higher from those calculated for liquid formulations, so the risk to birds from exposure to granular acephate is expected to be greater than that from sprays. EFED cannot estimate chronic risk from granular formulation due to uncertainty concerning long-term exposure.

The exposure from methamidophos formed from granular formulations of acephate could not be estimated due to the uncertainty about the degradation rate of acephate when formulated as a granular as well as the level of exposure from food items. However, methamidophos may be dissolved in transient water bodies (e.g.water puddles or standing water), which would increase the exposure of birds.

Other Adverse Effects

Data from the literature (Vyas, 1995) suggest that the migratory patterns of adult birds that are exposed to acephate are adversely affected. Acephate may have induced aberrant migratory orientation and behavior by affecting the memory of the adults regarding migratory routes and wintering grounds. Birds may veer off their migratory routes, become lost, and die of exhaustion which may effect population levels.

Mammals

Liquid formulations
Acute risk

The lab data and exposure indicate that, although levels of concern are exceeded for mammals, all acute RQs are less than 0.5. Acute oral toxicity for small mammals from acephate is categorized as moderately toxic; acephate does not show severe acute toxicity from dermal and inhalation exposure. Mammals are comparatively less sensitive to organophosphate insecticides than birds; however, field studies do show mortality and depressed ChEs in mammals.

The degradate methamidophos is classified in laboratory studies as highly toxic for oral acute, dermal, and inhalation exposure. Because acephate degrades so quickly to methamidophos in the environment (t1/2 <2 days), methamidophos may be the main causative agent for mammalian mortality from acephate applications. RQs show that the LOCs for acute risk to mammals from exposure to the methamidophos degradate are exceeded, whereas the RQs from acephate show minimal acute risk.

There are several incidents reported to OPP concerning an adverse impact to mammals from acephate, but only 3 of those incidents were cited due to a greater certainty that acephate was the causative agent. All incidents involved the ingestion of Orthene (acephate); the monkey and the dog recovered with minor effects but the rodent/lagomorph died (see Section 3.e for details on these incidents).

Field studies show that squirrels and deer mice were adversely affected by acephate applications; brain ChEs were depressed 15% (00093909, 40329701) from 0.09 lb ai/A application. This is a much lower exposure than found in labeled acephate applications (0.5 lb ai/A).

The high risk attributed to mammals from acephate degrading into methamidophos may have been underestimated. This is because the highly toxic acute effects to mammals from dermal and inhalation exposure of methamidophos were not considered with the RQ which considered only the oral exposure route. Field studies and incidents indicate that the use of acephate is having a detrimental effect on mammals, especially small mammals.

Chronic Risk to Mammals

Laboratory data indicates that acephate affects the reproductive capacity of mammals through reducing the viability of pups and body weight at concentrations greater than 50 ppm. Methamidophos laboratory data indicate that the reproductive capacity of mammals is also affected by reducing the viability of pups and body weight at concentrations greater than 10 ppm. There are no field data available to corroborate this. The chronic RQs show similar results to mammals as described in the bird section above. It is concluded that the use of acephate poses a high chronic risk to mammals.

The environmental fate assessment clearly indicates that acephate is not persistent in the environment, which decreases the concern for chronic risk. Laboratory studies indicate that acephate is mobile and rapidly degrades, and field dissipation studies confirmed that acephate residues will not persist in soil (half-lives were < 6 days). Exposures would therefore be more likely on an acute basis for both acephate and its degradate. However, because of the uncertainity of the amount of methamidophos available on soil and foliar food items the chronic risk to terrestrial animals is therefore considered potentially high.

Granular formulations

Broadcast application of granular acephate on turf exceeds the acute LOC for mammals by 2X (turf) and 1.3X for pepper, cotton, and peanuts (in-furrow treatments). These RQs are higher from those calculated for liquid formulations, so the risk to mammals from exposure to granular acephate is expected to be greater than that from sprays. EFED cannot estimate chronic risk from granular formulation due to uncertainty concerning long-term exposure.

The exposure from methamidophos formed from granular formulations of acephate could not be estimated due to the uncertainty about the degradation rate of acephate when formulated as a granular as well as the level of exposure from food items. However, methamidophos may be dissolved in transient water bodies (e.g.water puddles or standing water), which would increase the exposure of mammals.

Risk to Beneficial Insects and Other Arthropods

Acephate is highly toxic to honey bees and beneficial predatory insects. In acute residue toxicity studies on bees, different species of bees exhibited >50% mortality when exposed to acephate residues on foliage from 2 hours to 24 hours after a treatment equivalent to 1 lb/A acephate (00014715; 05000837). In laboratory studies, acephate was more toxic to the beneficial green lacewing and parasitic wasp than to the pest species tobacco budworm that it was to control (05004012).

Studies show that acephate can be transferred to honey bee queens from nurse bees that have fed on crops that have surface residues of >1 ppm acephate (Stoner, 1984). In addition, acephate is taken up by plants and honey bees can be exposed to acephate through the nectar (Stoner, 1984). Honey bee colonies fed on honey dosed with acephate had their brood cycles broken, effectively killing the colony. Measured seed and fruit production in various native plants was decreased in areas served by the broken colonies when complared to control (untreated) colonies (00099762).

Yellow jacket wasps and ants were severely affected by acephate applied to forests at 1 and 2 lb/A. Effects were more severe when temperatures increased to 59°F from 39°F, because increased foraging activity at higher temperature increased exposure (00099763). In another study, twenty days following a single application of 0.5 ai/A, 74% mortality was observed in spiders (05020212). These species are generalized predators of other arthropods and are therefore beneficial.

There are several incidents reported to OPP concerning an adverse impact to bee colonies from acephate. (see Section 3.e for details on these incidents).

Risk to Aquatic Ecosystems

Freshwater environments

Agency guideline laboratory studies indicate that acephate does not pose a high risk to freshwater ecosystems from acute toxicity; however under certain environmental conditions (high exposures in combination with elevated temperatures), the use of acephate may cause significant mortalities to freshwater bi-valves, invertebrates and indirectly to fish.

Acephate is categorized as moderately toxic to slightly toxic to freshwater fish and practically nontoxic to moderately toxic for freshwater aquatic invertebrates. Additional laboratory information for salamander and frogs shows acephate to be practically nontoxic. Laboratory data from the open literature show minimal acute effects to rainbow trout.

Brain ChE depression greater than 70% has been observed (Zinkl, 1987)in rainbow trout. ChE depression causes sublethal effects such as inability to sustain physical activity in search of food, in eluding predators, or in maintaining position in flowing water. Fish would die as an indirect effect of such sublethal toxicity. Field data from a forestry study in Maine did not show adverse effects on brook trout and land-locked salmon; however, there were ChE depression in bottom feeding suckers (00014547).

There have been documentation of mussel die-offs in North Carolina during August. An estimated 1,000 mussels of several species were found dead or moribund, including about 111 Tar spinymussels (Elliptio steinstansana), a federally listed endangered species. The die-off occurred during a period of low flow and high water temperature in a stream reach dominated by forestry and agriculture. The mussels all showed signs of severe ChE inhibition but no actual residues were detected. Although no OPs were detected, the authors attributed the die-offs to OP insecticides used in the area where the die-offs occurred (Fleming, 1995).

To further investigate the effects of OP insecticides on freshwater mussels and estuarine clams, acephate at 5 ppm depressed ChE in the adductor muscle up to 96% (Moulton, 1996). Recovery periods were 12 to 24 days after exposure under cooler temperatures (21°C) with no adverse effects noted; however, when temperature was increased (30°C) during the recovery period, significant mortalities appeared. However, uncertainty surrounding acephate's involvement in mussel die-offs is high because we do not expect to see concentrations as high as 5 ppm in the environment and acephate has not been directly linked to incidents, but it cannot be discounted.

The acephate degradate methamidophos ranges from moderately toxic to slightly toxic for freshwater fish; risk quotients indicate that there would be minimal effects to freshwater fish.

Laboratory studies show methamidophos to be very highly toxic to freshwater invertebrates (Daphnid); LOCs calculated using Tier I EECs are exceeded by 1.5X to >5X. However, supplemental information from a laboratory study conducted in Mexico (Juarez and Sanchez, 1989) on a commercial variety of freshwater prawns produced an LC_{50} of 42 ng/L (42 parts per trillion). If this value were used to calculate an RQ, the LOC would be exceeded by 4000X. However, there is some uncertainty associated with the level of risk posed by the acephate degradate methamidophos to fresh water invertebrates because the other species of freshwater invertebrates tested do not appear to be as sensitive. In addition, the study conditions (static renewal) may have adversely affected the species tested. Therefore, the risk to freshwater invertebrates cannot be discounted and may be higher than indicated from the RQs.

Chronic effects

No data on the chronic effects of acephate to freshwater fish are available. The data on aquatic invertebrates show minimal chronic risk. Since aquatic invertebrates is more sensitive than fish, no chronic data will be requested for the freshwater fish. There are no chronic data for freshwater fish or aquatic invertebrates available for the methamidophos degradate. Chronic data for the aquatic invertebrates using methamidophos are outstanding; therefore an assessment on the chronic risk to freshwater aquatic invertebrates is incomplete.

Estuarine environments

Acute Risk

Agency guideline laboratory studies indicate that acephate does not pose a high risk to estuarine ecosystems from acute toxicity; however, under certain environmental conditions (high exposures in combination with elevated temperatures), the use of acephate may cause significant mortalities to estuarine bi-valves (clams and oysters).

Acephate is categorized as slightly to practially non-toxic to estuarine fish and moderately toxic to practically nontoxic to estuarine aquatic invertebrates in the Agency's guideline laboratory studies. There are no LOC exceedences for acephate, no incidents have been reported, and no field studies were conducted.

As described in the freshwater section above, acephate at 5 ppm on asiatic clams depressed ChE in the adductor muscle up to 96% (Moulton, 1996). Recovery periods were 12 to 24 days after exposure under cooler temperatures (21°C) with no adverse effects noted; however, when temperature was increased (30°C) during the recovery period, significant mortalities appeared. Although freshwater mussels were seen in the die-offs, estuarine bi-valves can also be at similar risk. However, uncertainty surrounding acephate's involvement in mussel die-offs is high because we do not expect to see concentrations as high as 5 ppm in the environment and acephate has not been directly linked to incidents, but it cannot be discounted.

The acephate degradate methamidophos is moderately toxic to estuarine fish; risk quotients indicate that there would be minimal effects to estuarine fish from methamidophos formed from acephate.

Although methamidophos is moderately toxic to very highly toxic to estuarine invertebrates, LOCs calculated using Tier I EECs were not exceeded for mysid shrimp. However, supplemental information from a laboratory study conducted in Mexico (Juarez and Sanchez, 1989) on a commercial variety of blue shrimp produced an LC_{50} of 160 ng/L (160 parts per trillion). If this value were used to calculate an RQ, the LOC would be exceeded by 1000X. However, there is some uncertainty associated with the level of risk posed by the acephate degradate methamidophos to estuarine invertebrates because the other species of estuarine invertebrate (mysid shrimp) tested does not appear to be as sensitive. In addition, the study conditions (static renewal) may have adversely affected the species tested. Therefore, the risk to estuarine invertebrates cannot be discounted and may be higher than indicated from the RQs. However, since shrimp nurseries are located in shallow estuaries that could receive runoff from fields treated with acephate, the risk to commercial shrimp production in Florida, North Carolina, and the Gulf areas from the acephate degradate methamidophos cannot be discounted.

Chronic Risk

No data on the chronic effects of acephate to estuarine fish is available. The data on estuarine invertebrates show minimal chronic risk. Since aquatic invertebrates is more sensitive than fish, no chronic data will be requested for the estuarine fish. There are no chronic data for estuarine fish or invertebrates are available for the methamidophos degradate. Chronic data for the estuarine invertebrates using methamidophos are outstanding; therefore an assessment on the chronic risk to estuarine invertebrates is incomplete.

Plants

Three incidents (including a lawsuit with a $12,000 damages award) were reported for plant injury (see Section 3.e for details on these incidents).

Non-guideline supplemental data in the files and the incident database indicate that plants are injured by the application of acephate. There are no phytotoxicity studies on plants available; these studies are outstanding (GLN 122-1a and b).

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APPENDICES / SUPPORTING DOCUMENTATION FOR EFED ACEPHATE RED CHAPTER

APPENDIX A

PRZM 3.1 and EXAMS 2.97.5 Chemical-Specific Input Parameters

Chemistry

Aerobic soil metabolism is the main degradative process for acephate. Observed half-lives are less than two days under the nominal or expected use conditions, producing the intermediate degradate methamidophos, which is itself rapidly metabolized by soil microorganisms to carbon dioxide and microbial biomass (half-life of 14 hours). Acephate is stable against hydrolysis except at high pH's and does not photodegrade. Acephate is not persistent in anaerobic clay sediment:creek water systems in the laboratory, with a half-life of 6.6 days. The major degradates under anaerobic conditions were carbon dioxide and methane, comprising > 60% of the applied after 20 days of anaerobic incubation. No other anaerobic degradates were present at > 10% during the incubation. There are no acceptable data for the aerobic aquatic metabolism of acephate; supplemental information indicates that acephate degrades more rapidly in aquatic systems when sediment is present.

Acephate is very soluble (80.1-83.5g/100 mL) and very mobile (K_{ads} = 0.090) in the laboratory. Only one K_{ads} value is available, because acephate was adsorbed in only one of the five soils (a clay loam) used in the batch equilibrium studies. When tested in the same soils, methamidophos was determined to be more mobile than acephate; again, only one K_{ads} value is available (K_{ads} = 0.029 in the clay loam soil).

Field studies conducted in Mississippi (tobacco on silt loam soil), California (bell peppers on silt loam soil), Florida (cauliflower on sand soil) and Iowa (soybeans on loam soil) produced half-lives of 2 days or less with no detections of parent or the degradate methamidophos below a depth of 50 cm.

Based upon both the laboratory and field data, ground water effects are expected to be minimal. In surface waters, in the absence of acceptable aerobic aquatic metabolism, degradation is assumed to proceed at a rate slower than aerobic soil metabolism, thus acephate is predicted to persist over a longer interval. Unlike acephate, the degradate methamidophos is persistent under anaerobic aquatic conditions (DT_{50} = 51 days), which indicates that it is more stable in deep waters or anaerobic sediments.

Laboratory studies showed that bioaccumulation of acephate in bluegill sunfish was insignificant. A maximum bioaccumulation factor of 10x occurred after 14 days' exposure to acephate at 0.01 and 1.0 ppm. Methamidophos did not bioaccumulate in bass, *Daphnia magna*, or the marine diatom *Cylindrotheca fusiformis*; bioaccumulation factors were less than 2.

The data in Tables 1a, 2a, and 3a were used for input into the PRZM-EXAMS modeling for **Parent Acephate**. The data in Tables 1b, 2b, and 3b were used for input into the PRZM-EXAMS modeling for the acephate degradate **Methamidophos**.

Below is a brief discussion of how the fate information was integrated.

Degradation: For PRZM-EXAMS environmental fate parameters from the submitted studies for acephate were used as inputs according to approved parameter selection criteria[2]. Hydrolysis and soil and aqueous photolysis half-life were not incorporated because the studies indicated that acephate was essentially stable to these processes. The 90th percentile of the metabolism half-lives were found using three values from an acceptable study. The 90th percentile half-life for metabolism were converted to a daily rate constant for PRZM using the formula Ln 2/(3 x $T_{1/2}$). The water solubility of 801000 mg/L was used as an upper bound.

Hydrolysis and soil and aqueous photolysis half-lives for methamidophos were incorporated, and the single acceptable soil metabolism half-life was multiplied by 3 according to approved parameter selection criteria. The half-lives were converted to a daily rate constant for PRZM using the formula Ln 2/(3 x $T_{1/2}$). The water solubility of 200000 mg/L was used as an upper bound.

Soil-Water Partition Coefficient. Data on soil adsorption and desorption are reported in Tables 3a and 3b. The Freundlich K_{ads} values of 0.9 and 0.029 for acephate and methamidophos, respectively, were used because only a single soil (clay loam soil) showed any adsorption.

Soil Volatilization. The soil volatilization routines in PRZM 3.1 were deactivated by setting the relevant parameters (Vapor diffusion rate, Henry's Law Constant and the enthalpy of Vaporization) to zero. The ability to estimate some of the necessary parameters, particularly the enthalpy of vaporization for acephate and its metabolite, is very poor, and there is lack of confidence in the validity of the PRZM 3.1 volatilization routines.

Table 1a. Environmental fate parameters for Acephate

Fate Parameter	Value	Source	Quality of Data
Molecular Mass	183.16 g·mol^{-1}	EFGWB One-Liner	Good
Aerobic Soil Metabolism Rate Constant	0.301 d^{-1}	MRID 00014991	Good
K_f, n (adsorption)	0.09 (clay loam), n=1.06	MRID 40504811	Good - Fair
Solubility	801000 mg L^{-1}	MRID 40390601	Good
Vapor Pressure	1.7 x 10^{-6} torr	MRID 40645901	Good
Hydrolysis Rate Constant at pH 7	Stable	MRID 41081604	Good
Aqueous Photolysis Constant	Stable	MRID 41081603	Good
Soil Photolysis Constant	Stable	MRIDs 00015202 and 40504810	Fair

[2]Draft Internal Guidance: Model Parameter Selection Criteria for PRZM and EXAMS, Environmental Fate and Effects Division, August 5, 1997.

Table 1b. Environmental fate parameters for Methamidophos			
Fate Parameter	**Value**	**Source**	**Quality of Data**
Molecular Mass	141.14 $g \cdot mol^{-1}$	EFGWB One-Liner	Good
Aerobic Soil Metabolism Rate Constant	0.396 d^{-1}	MRID 41372201	Good - Fair
K_f, n (adsorption)	0.029 (clay loam), n=0.64	MRID 40504811	Good - Fair
Solubility	> 200000 mg L^{-1}	MRID 43661003	Good
Vapor Pressure	1.725 x 10^{-5} torr	MRID 43661003	Good
Hydrolysis Rate Constant at pH 7	2.53 x 10^{-2} d^{-1}	MRID 00150609	Good
Aqueous Photolysis Constant	3.46 x 10^{-4} d^{-1}	MRID 00150610	Fair
Soil Photolysis Constant	0.266 d^{-1}	MRID 00150611	Fair

Table 2a. PRZM 3.1 input parameters for Acephate			
Input Parameter	**Value**	**Source**	**Quality of Data**
Foliar Volatilization (PLVKRT)	0 d^{-1}		Poor
Foliar Decay Rate (PLDKRT)	0 d^{-1}		Poor
Foliar Washoff Extraction Coefficient (FEXTRC)	0.5 cm^{-1}		Poor
Plant Uptake Fraction (UPTKF)	0		Poor
Soil-Water Partition Coefficient (KD) for all crops	0.09 L kg^{-1}	MRID 40504811	Good - Fair
Dissolved Phase Decay Rate: Upper Horizons (DWRATE)	0.301 d^{-1}	MRID 00014991	Fair
Adsorbed Phase Decay Rate: Upper Horizons (DSRATE)	0.301 d^{-1}	MRID 00014991	Fair
Dissolved Phase Decay Rate: Lower Horizons (DWRATE)	0.301 d^{-1}	MRID 00014991	Fair
Adsorbed Phase Decay Rate: Lower Horizons (DSRATE)	0.301 d^{-1}	MRID 00014991	Fair
Vapor Phase Decay Rate (DGRATE) (all horizons)	0 d^{-1}		Poor

Table 2b. PRZM 3.1 input parameters for Methamidophos			
Input Parameter	Value	Source	Quality of Data
Foliar Volatilization (PLVKRT)	0 d^{-1}		Poor
Foliar Decay Rate (PLDKRT)	0 d^{-1}		Poor
Foliar Washoff Extraction Coefficient (FEXTRC)	0.5 cm^{-1}		Poor
Plant Uptake Fraction (UPTKF)	0		Poor
Soil-Water Partition Coefficient (KD) for all crops	0.029 L kg^{-1}	MRID 40504811	Good
Dissolved Phase Decay Rate: Upper Horizons (DWRATE)	0.396 d^{-1}	MRID 41372201	Fair
Adsorbed Phase Decay Rate: Upper Horizons (DSRATE)	0.396 d^{-1}	MRID 41372201	Fair
Dissolved Phase Decay Rate: Lower Horizons (DWRATE)	0.396 d^{-1}	MRID 41372201	Fair
Adsorbed Phase Decay Rate: Lower Horizons (DSRATE)	0.396 d^{-1}	MRID 41372201	Fair
Vapor Phase Decay Rate (DGRATE) (all horizons)	0 d^{-1}		Poor

Table 3a. EXAMS 2.97.5 Input parameters for Acephate			
Input Parameter	Value	Source	Quality
Aerobic Aqueous Metabolism Constant (KBACW)	1.26×10^{-2} h^{-1}	MRID 00014991	poor
Sediment Metabolism Constant (KBACS)	0		poor
Neutral Hydrolysis Rate Constant (KNH)	stable	MRID 41081604	good
Partition Coefficient (KPS) for all modeled crops	0.09 mL g^{-1}	MRID 40504811	fair
Molecular Mass (MWT)	183.16 g $\cdot mol^{-1}$	EFGWB One-Liner	excellent
Solubility (SOL)	801000 mg$\cdot$ L^{-1} (25° C)	MRID 40390601	good
Vapor Pressure (VAPR)	1.7×10^{-6} torr	MRID 40645901	good
Henry's Law Constant (calculated)	5.1×10^{-13} Atm.M^3 $Mole^{-1}$	EFGWB One-Liner	fair
Q10 For The water Column (QTBAW)	0		poor
Q10 For Sediment (QTBAS)	0		poor

Table 3b. EXAMS 2.97.5 Input parameters for Methamidophos			
Input Parameter	Value	Source	Quality
Aerobic Aqueous Metabolism Constant (KBACW)	1.65×10^{-2} h^{-1}	MRID 41372201	good
Sediment Metabolism Constant (KBACS)	0		poor
Neutral Hydrolysis Rate Constant (KNH)	9.8×10^{-4} h^{-1}	MRID 00150609	good
Partition Coefficient (KPS) for all modeled crops	0.029 mL g^{-1}	MRID 40504811	fair
Molecular Mass (MWT)	141.14 g $\cdot mol^{-1}$	EFGWB One-Liner	excellent
Solubility (SOL)	>200000 mg· L-1	MRID 43661003	good
Vapor Pressure (VAPR)	1.725×10^{-5} torr	MRID 43661003	good
Henry's Law Constant (calculated)	1.6×10^{-11} Atm.M^3 $Mole^{-1}$	EFGWB One-Liner	fair
Q10 For The water Column (QTBAW)	0		poor
Q10 For Sediment (QTBAS)	0		poor

Models Used

The EECs were calculated using two models: PRZM 3.1, (Carsel, et.al., undated; executable dated October 17, 1997), to simulate the transport of the pesticide off the field, and EXAMS 2.97.5, (Burns, L.A., 1997; executable dated June 19, 1997), to simulate the fate of the chemical in the water body. The PRZM version used is an interim release that has been modified to provide improved pesticide extraction into runoff and additional application capacity. All post-processing analysis were handled by Table20 (executable dated May 27, 1998).

Procedure

All PRZM 3.1 simulations were run from January 1 through December 31 for each year of meteorological data available for the Major Land Resource Areas (MLRA). EXAMS was run for all the scenarios. The 10 year return EECs (or 10% yearly exceedence EECs) listed in Table 4 were calculated by linear interpolation between the third and fourth largest values using the Table20 program. The upper 90% confidence bound of the overall means were estimated by Table20.

Scenarios

The scenarios chosen represent high exposure sites for acephate. The weather data and agricultural practices are simulated at each site over multiple (36) years so that the probability of an EEC occurring at that site can be estimated. The modeled sites are 10 hectare fields draining into a 1 hectare pond, 2 m deep with no outlet (20,000,000 liter volume). The site was selected so as to generate exposures to aquatic organisms greater than for most sites (about 90%) used for growing the modeled crops. Table 4 provides a summary of the scenario for each modeled crop. The simulations were made with maximum application rates ranging from 1.0-1.33 lbs a.i./acre with the maximum number of yearly applications being six. Intervals between applications were

3 days for cotton and tobacco, based on the reapplication intervals specified in the LUIS report. The EECs have been calculated so that in any given year there is a 10% probability the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. The Loring silt loam soil was classified as a Group C, which is more prone to runoff than leaching. Norfolk loamy sand soil (Group B) was used for the North Carolina tobacco scenario because it is one of the major benchmark soils and a major soil in tobacco production.

Table 6. Usage Practices used for modeling Acephate on various crops.		
Crop	Location, (Soil), Hydrologic Group, and (MLRA)	Maximum Labeled Rate (lb ai/A), App. Dates, Pre-Harvest Interval (PHI)
Cotton	Yazoo County, MS (Loring silt loam), Group C, (MLRA 134)	1.0 lb (6 x 1.0 lbs ai) at 3 day interval July 1 - 16; PHI=NA
Tobacco	Wake County, NC (Norfolk loamy sand), Group B, (MLRA 133a)	1.33 lb (3 x 1.33 lbs ai) at 3 day interval June 1 - 7; PHI=NA

The PRZM 3.1 scenario parameters for each site are provided in Appendix B. The EXAMS non-chemical specific parameters describing the pond are listed in Appendix C.

PRZM-EXAMS RESULTS

Crop specific consecutive PRZM-EXAM simulations were conducted to evaluate the cumulative probability distribution for peak, 4-day, 21 day, 60 day, and 90 day EECs. The one-in-10 year PRZM-EXAMS Peak EECs for parent acephate for the two scenarios modeled are presented in Table 5. No accumulation in water bodies is expected.

Table 5. Tier II upper tenth percentile EECs for Acephate (μg/L)**							
Crop	Peak	4-Day	21-Day	60-day	90-day	Over-all Mean	90% CB Mean*
Cotton, Mississippi	71	42	14	6.5	4.3	1.4	0.75
Tobacco, North Carolina	15	11	3.7	1.7	1.1	0.3	0.20

*Upper 90th percent confidence bound on the overall mean concentration.
**EECs rounded to 2 significant figures.

The acephate degradate methamidophos is also toxic to wildlife, so the algorithms included in PRZM were used to simulate the parent/daughter relationship of acephate/methamidophos. Tier II upper tenth percentile EECs for Methamidophos formed as a consequence of acephate applications to cotton in Mississippi are reported in Table 6.

Table 6. Tier II upper tenth percentile EECs for Methamidophos formed as a consequence of acephate applications ($\mu g/L$)**							
Crop	Peak	4-Day	21-Day	60-day	90-day	Over-all Mean	90% CB Mean*
Cotton, Mississippi	71	49	18	8.2	5.5	1.7	0.75

* Upper 90th percent confidence bound on the overall mean concentration.
** EECs rounded to 2 significant figures.

The model simulations use historical precipitation as an input, and did not take into account irrigation which is often used in dry (e.g., California) regions to supplement rainfall. Virtually all pond residues were associated with the aqueous phase. Aerobic aquatic metabolism data were not available for input into the model, and therefore the aerobic soil metabolism data were used as input in EXAMS. Laboratory studies for aerobic soil metabolism and anaerobic aquatic metabolism indicate that acephate is not persistent.

The acephate degradation product methamidophos was formed in significant quantities in the laboratory studies (up to 23%). Therefore, the parent:daughter capabilities of PRZM-EXAMS were used to estimate the concentrations of parent acephate and the daughter methamidophos. However, there is some uncertainty in the potential impact to water quality long-term from both the parent and the metabolite because of insufficient aerobic aquatic dissipation data. Therefore, if a more complete environmental fate assessment for acephate and methamidophos is required, an aerobic aquatic metabolism study for each compound will be needed to assess potential water quality problems for both.

Runoff is the source of acephate loading to aquatic environments in all of these scenarios. Transport with eroded sediment was only a small source of loading for acephate. Mitigation strategies need to consider the relative risks of ground water versus surface water contamination, and the relative risks of alternative pesticides to aquatic, and terrestrial environments, as well as human health.

It should be remembered in interpreting these results that they represent the upper limit for possible exposure from these use patterns to aquatic environments at a single high exposure site. In actual practice, the true environmental concentrations will probably be less than indicated by this analysis because most sites will produce less loading to aquatic environments than these scenarios.

Appendix B
PRZM 3.1 Scenario Parameters

This section provides a brief description of each crop site used to produce the Tier II EECs for acephate. The soils descriptions are summaries of the Official Soil Series Descriptions provided on-line by Iowa State University[3]. The PRZM 3.1 parameters that describe each site more fully are provided in Tables B-1 through B-6.

Scenario Sites

The field used to grow Mississippi cotton is located in Yazoo County, Mississippi. The soil is a Loring silt loam, a fine-silty, mixed, mesic Thermic Typic Fragiudalf, in MLRA O-134. The Loring silt loam is a moderately well drained soil with a fragipan formed in loess on level to strongly sloping upland and stream terraces on slopes of 0-20 percent. The Loring silt loam is a Hydrologic Group C soil with SCS curve numbers that were measured on a real field in Yazoo County, Mississippi under cotton culture. There are approximately 101,000 acres of cotton grown in Yazoo County, which is the most of any county in Mississippi and among the top 10 percent in the U.S. (US Department of Commerce, 1994a). USLE C Factors were developed by George Foster at the University of Mississippi in consultation with Ronald Parker of the US EPA to represent a cotton field with one year tilled followed by two years under conservation tillage using RUSLE. The weather data used was for MLRA 134.

The field used to grow North Carolina tobacco is located in Wake County. The soil is a Norfolk loamy sand, a fine-loamy, kaolinitic, thermic, Typic, Kandiudults in MLRA P-133A. Norfolk loamy sand is a very deep, well drained, moderately permeable soil that formed on loamy marine sediments of the Coastal Plains. Runoff is slow to medium. These soils have seasonally apparent water tables at 4-6 feet. The series is located on level to gently sloping uplands with slopes of 0-10 percent. The MAP is 49 inches and the MAT is 62°F. The soils are mostly cleared for general farm crops such as corn, cotton, peanuts, tobacco, and soybeans. The soil is characterized as a Group B hydrologic soil. The series is of large extent from Texas to Maryland along the Coastal Plan. The series was established in Cecil County, Maryland in 1900. The weather data used was for MLRA 134.

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[3]Official Soil Series Descriptions, USDA-NRCS Soil Survey Division; Iowa State University; WEB Page: http://www.statlab.iastate.edu/soil/osd. 1998.

Table B-1 PRZM 3.1 climate and time parameters for North Carolina tobacco and Mississippi cotton.

	Mississippi Cotton	North Carolina Tobacco		
Parameter	Value	Value	Source	Quality
Starting Date*	January 1, 1948	January 1, 1948		
Ending Date*	December 31, 1983	December 31, 1983		
Pan Evaporation Factor (PFAC)	0.74	0.770	PIC	good
Snowmelt Factor (SFAC)	0.150 cm · K^{-1}	0.150 cm · K^{-1}	PIC	good
Minimum Depth of Evaporation (ANETD)	17.0 cm	27.5 cm	PIC	good
Average Duration of Runoff Hydrograph (TR)	5.8 h	6.2 h	PIC	good

* These values are in the RUN file rather than the INP file.

Table B-2. PRZM 3.1 model state flags for modeled scenarios.

Parameter	Value
Pan Factor Flag (IPEIND)	0
Foliar Application Model Flag (CAM); foliar application	2
Bulk Density Flag (BDFLAG)	0
Water Content Flag (THFLAG)	0
Kd Flag (KDFLAG)	0
Drainage model flag (HSWZT)	0
Method of characteristics flag (MOC)	0
Irrigation Flag (IRFLAG)	0
Soil Temperature Flag (ITFLAG)	0
Thermal Conductivity Flag (IDFLAG)	0
Biodegradation Flag (BIOFLAG)	0
Erosion Calculation Flag (ERFLAG)	4

Table B-3. Erosion and landscape parameters for Mississippi cotton and North Carolina tobacco				
	Mississippi Cotton	North Carolina Tobacco		
Parameter	Value	Value	Source	Quality
USLE K Factor (USLEK)	0.49 tons EI^{-1*}	0.24 tons EI^{-1*}	PIC	good
USLE LS Factor (USLELS)	0.40	0.33	PIC	fair
USLE P Factor (USLEP)	1.00	1.0	**	fair
Field Area (AFIELD)	10 ha	10 ha	standard	
NRCS Hyetograph (IREG)	3	3		good
Slope (SLP)	6%	6.0%		fair
Hydraulic Length (HL)	354 m	354 m		good
* EI = 100 ft-tons * in/ acre*hr ** P Factor represent compromise for 1 year of conventional tillage and two years of no till.				

Table B-4. PRZM 3.1 crop parameters for Mississippi cotton and North Carolina tobacco.				
	Mississippi Cotton	North Carolina Tobacco		
Parameter	Value	Value	Source	Quality
Initial Crop (INICRP)	1	1	PIC	good
Initial Surface Condition (ISCOND)	3	3	PIC	fair
Number of Different Crops (NDC)	3	1	**	fair - good
Number of Cropping Periods (NCPDS)	36	36	Standard	
Maximum rainfall interception storage of crop (CINTCP)	0.2	0.20	PIC	fair
Maximum Active Root Depth (AMXDR)	125 cm	45.0 cm	PIC	fair
Maximum Canopy Coverage (COVMAX)	98	80	PIC	fair
Soil Surface Condition After Harvest (ICNAH)	3	3	PIC	fair
Date of Crop Emergence (EMD, EMM, IYREM)	5/01	4/11		fair - good
Date of Crop Maturity (MAD, MAM, IYRMAT)	9/07	7/06		fair - good
Date of Crop Harvest (HAD, HAM, IYRHAR)	9/22	7/16		fair - good
Maximum Dry Weight (WFMAX)	0.0	0.0	PIC	fair
SCS Curve Number (CN)	92-99 (Year 1) 83-94 (Years 2,3)	78-86	PIC	fair
Manning's N Value (MNGN)	0.02	0.023	PRZM Manual	good
USLE C Factor (USLEC)	0.63,0.16,0.18 (Year 1) 0.16,0.13,0.13 (Year 2) 0.16,0.13,0.09 (Year 3)	0.41	PIC	fair

Table B-5. PRZM 3.1 soil parameters for a cotton field in Yazoo County, Mississippi.			
Parameter	Value	Source	Quality
Total Soil Depth (CORED)	125 cm	PIC	good
Number of Horizons (NHORIZ)	3	PIC	good
First, Second and Third Soil Horizons (HORIZN = 1, 2)			
Horizon Thickness (THKNS)	10 cm (HORIZN = 1, 2) 105 cm (HORIZN = 3)	PIC	good
Bulk Density (BD)	1.60 g $\cdot cm^{-3}$ (HORIZN = 1, 2) 1.80 g $\cdot cm^{-3}$ (HORIZN = 3)	PIC	good
Initial Water Content (THETO)	0.294 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 1) 0.294 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 2) 0.147 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 3)	PIC	good
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2.0 cm (HORIZN = 2) 5.0 cm (HORIZN = 3)	standard	
Field Capacity (THEFC)	0.191 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 1, 2) 0.249 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 3)	PIC	good
Wilting Point (THEWP)	0.086 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 1, 2) 0.109 cm^3-H_2O $\cdot cm^3$-soil (HORIZN = 3)	PIC	good
Organic Carbon Content (OC)	1.16% (HORIZN = 1, 2) 0.174% (HORIZN = 3)	PIC	good

Table B-6. PRZM 3.1 soil parameters for a tobacco field in Wake County, North Carolina.			
Parameter	Value	Source	Quality
Total Soil Depth (CORED)	150 cm	PIC	good
Number of Horizons (NHORIZ)	4	PIC	good
First, Second and Third Soil Horizons (HORIZN = 1, 2,3, 4)			
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 35 cm (HORIZN = 2) 55 cm (HORIZN = 3) 50 cm (HORIZN = 4)	PIC	good
Bulk Density (BD)	1.55 g $\cdot$cm^{-3} (HORIZN = 1, 2) 1.3 g $\cdot$cm^{-3} (HORIZN = 3) 1.1 g $\cdot$cm^{-3} (HORIZN = 4)	PIC	good
Initial Water Content (THETO)	0.199 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 1, 2) 0.406 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 3) 0.396 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 4)	PIC	good
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5.0 cm (HORIZN = 2, 3, 4)	standard	
Field Capacity (THEFC)	0.199 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 1, 2) 0.406 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 3) 0.396 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 4)	PIC	good
Wilting Point (THEWP)	0.089 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 1, 2) 0.206 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 3) 0.246 cm^3-H_2O $\cdot$cm^3-soil (HORIZN = 4)	PIC	good
Organic Carbon Content (OC)	2.90% (HORIZN = 1, 2) 0.116% (HORIZN = 3) 0.058% (HORIZN = 4)		

Appendix C
EXAMS Scenario Input Parameters

The pond used to generate the Tier II EECs for acephate is modified for generic use from the Richard Lee pond that was distributed with EXAMS and is the standard pond used for all EEC calculations. Modifications were made to convert the pond from 1 acre, 6 ft deep to 1 ha, 2 m deep. Additionally, adjustments were made to the standard pond by changing the water temperature to that which was more appropriate for the region being simulated. The temperature in the pond each month was set to the average monthly air temperature over all years calculated from the meteorological file that was used in the simulation. Additionally, the latitude and longitude were changed for each pond to values appropriate for the site selected. Finally, all transport into and out of the pond has been set to zero.

Table C-1. EXAMS II pond geometry for standard pond.

	Littoral	Benthic
Area (AREA)	10000 m^2	10000 m^2
Depth (DEPTH)	2 m	0.05 m
Volume (VOL)	20000 m^3	500 m^3
Length (LENG)	100 m	100 m
Width (WIDTH)	100 m	100 m

Table C-2. EXAMS II dispersive transport parameters between benthic and littoral layers in each segment for standard pond.

Parameter	Pond*	Stream 1**	Stream 2***
Turbulent Cross-section (XSTUR)	10000 m^2	300 m^2	1200 m^2
Characteristic Length (CHARL)	1.01, 1.025 m	0.275 m	0.275 m
Dispersion Coefficient for Eddy Diffusivity (DSP)	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}

* JTURB = 1, ITURB = 2; ** JTURB = 3, ITURB = 4; *** JTURB = 5, ITURB = 6

Table C-3. EXAMS II sediment properties for standard pond.

	Littoral	Benthic
Suspended Sediment (SUSED)	30 mg L^{-1}	
Bulk Density (BULKD)		1.85 g cm^{-3}
Per cent Water in Benthic Sediments (PCTWA)		137%
Fraction of Organic Matter (FROC)	0.04	0.04

Table C-4. EXAMS II external environmental parameters for standard pond.	
Precipitation (RAIN)	90 mm $\cdot$month^{-1}
Atmospheric Turbulence (ATURB)	2.00 km
Evaporation Rate (EVAP)	90 mm $\cdot$month^{-1}
Wind Speed (WIND)	1 m $\cdot$sec^{-1}
Air Mass Type (AMASS)	Rural (R)

Table C-5. EXAMS II biological characterization parameters for standard pond.

Parameter	Limnic	Benthic
Bacterial Plankton Population Density (BACPL)	1 cfu $\cdot$cm^{-3}	
Benthic Bacteria Population Density (BNBAC)		37 cfu $\cdot$(100 g)$^{-1}$
Bacterial Plankton Biomass (PLMAS)	0.40 mg $\cdot$L^{-1}	
Benthic Bacteria Biomass (BNMAS)		6.0x10^{-3} g $\cdot$m^{-2}

Table C-6. EXAMS water quality parameters for standard pond.

Parameter	Value
Optical path length distribution factor (DFAC)	1.19
Dissolved organic carbon (DOC)	5 mg $\cdot$L^{-1}
chlorophylls and pheophytins (CHL)	5x10^{-3} mg $\cdot$L^{-1}
pH (PH)	7
pOH (POH)	7

Table C-7. EXAMS mean monthly water temperatures and location parameters for a field pond in Yazoo County, Mississippi.	
Month	Temperature (Celsius)
January	6
February	9
March	12
April	16
May	20
June	24
July	26
August	28
September	25
October	18
November	13
December	10
Latitude	34° N
Longitude	83° W

Appendix D
Input File Names

Table D-1. Input files archived for Acephate Tier 2 EECs.		
File Name	Date	Description
MET134.MET	March 22, 1991	MLRA 134 weather data for Mississippi cotton
MET133A.MET	March 22, 1991	MLRA 133A weather data for North Carolina tobacco
Input Data File Sets*		
COTTMS6a	July 23, 1998	File set for Acephate on cotton in Mississippi, 6 aerial applications of 1 lb/A at 3 day intervals, starting July 1 each year
COTTMS6d	July 20 , 1998	Files set for Acephate on cotton, as above, but including parent acephate degrading to daughter methamidophos
NCTOBAC3	August 31, 1998	File set for Acephate on tobacco in North Carolina, 3 aerial applications of 1.33 lb/A at 3 day intervals, starting June 1 each year

APPENDIX E

ACEPHATE USE CLOSURE MEMO

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

23

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Memorandum

To: Margaret Stasikowski, Director, Health Effects Division
Joe Merenda, Director, Environmental Fate and Effects Division

From: Lois Rossi, Director
Special Review and Reregistration Division

RMcNally for

Subject: Acephate Use Closure Memo

This memo serves as the acephate use closure memo and clarifies acephate uses for the RED risk assessment.

Background

The SMART meeting for acephate was held on September 18, 1997 as scheduled. The usage information provided by this chemical's main registrant, Valent, was deemed unsatisfactory by the Agency, as site-specific maximum use values were not supported by similar statements in the products' labels. At the same time, Valent questioned the accuracy of some use sites in the LUIS report.

Following several preliminary informal communications, SRRD sent a letter to Valent on November 7 to request that the registrant provide the Agency with information on (1) use sites that Valent intended to delete or for which there was a record of a prior deletion and (2) use sites for which Valent was willing to indicate maximum application rates and maximum numbers of applications, as well as the dates by which these would be included in label amendments.

Valent submitted its response on November 17. SRRD followed up to clarify and resolve remaining issues and to address how Valent's commitments could be adequately captured in a timeframe consistent with the RED schedule. The other two major manufacturers, Micro Flo and Drexel, also agreed to take the same actions as Valent.

Accordingly, all three registrants have submitted requests for amending the terms and conditions of registration, which require them to amend their labels and include certain maximum use rates by March 1, 1998. Formal requests for deleting all forestry and pastureland/rangeland uses are being sent by the registrants.

All acephate team members were kept informed on developments and were frequently consulted as to Agency actions and registrants' responses at all stages of this process.

<u>Supplemental Use Information for the RED</u>

The following information supplements that provided in the LUIS report, which continues to form the basis for the RED risk assessments:

1. The risk assessment for acephate will be based on the use sites included in the LUIS report, except for the forestry and rangeland/pastureland which are being voluntarily deleted by the registrants.

2. Similarly, the risk assessment for food uses will be based on baseline residue data used to set up tolerances, to be provided by HED, except for those sites for which the registrants will include maximum rates in their labels, in which case the maximum values shown in Appendix 1 will be used.

3. With BEAD's support, HED and EFED will jointly decide which non-food sites and use rates will be considered in the risk assessment.

4. BEAD will, to the extent possible, verify the reliability of the information provided by the registrants for non-food uses. In cases where reliable data are lacking, BEAD will provide EFED with best estimate values for both agricultural and non-agricultural non-food uses.

Based on our understanding, this information will allow work on the RED to proceed as scheduled for a December 1998 RED completion date.

cc: Stephanie Syslo, EFED
Felecia Fort, HED
Alan Halvorson, BEAD
Marilyn Mautz, RD

Appendix 1

Crop	Proposed maximum number of application restrictions for food crops treated with acephate
Beans (snap, dry, Lima)	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Brussels Sprouts	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Cauliflower	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Celery	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Cotton	Apply no more than 6.0 lbs a.i. (8 lbs formulated 75% product or 6⅔ lbs 90% formulated product) per acre per crop cycle.
Cranberries	Apply no more than 1.0 lb a.i. (1⅓ lbs formulated 75% product) per acre per crop cycle.
Head lettuce	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Peanut	Apply no more than 4.0 lbs a.i. (5⅓ lbs formulated 75% product) per acre per crop cycle.
Pepper (non-Bell)	Apply no more than 1.0 lb a.i. (1⅓ lbs formulated 75% product) per acre per crop cycle.
Pepper (Bell)	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Peppermint/ spearmint	Apply no more than 2.0 lbs a.i. (2⅔ lbs formulated 75% product) per acre per crop cycle.
Soybean	Apply no more than 1.5 lbs a.i. (2 lbs formulated 75% product) per acre per crop cycle.
Tobacco	Apply no more than 4.0 lbs a.i. (5⅓ lbs formulated 75% product) per acre per crop cycle.

APPENDIX F
Examples of FATE Runs and Graphs

Chemical Name	....	Methamidophos from Acephate applied to tobacco
Initial Residue Concentration (ppm)	.....	33.0000
Half-life (day)	....	1.7500
Number of Application(s)	....	6
Application Interval (day)	....	3
Length of Simulation (day)	....	22

Day	Residue (ppm)
0	33.0000
1	22.2074
2	14.9444
3	43.0569
4	28.9751
5	19.4988
6	46.1217
7	31.0376
8	20.8868
9	47.0558
10	31.6662
11	21.3098
12	47.3404
13	31.8577
14	21.4387
15	47.4271
16	31.9161
17	21.4779
18	14.4536
19	9.7265
20	6.5455
21	4.4048
22	2.9642

Maximum Residue ... 47.4271
Average Residue ... 25.7415

Chemical Name	....	Methamidophos from Acephate applied to tobacco
Initial Residue Concentration (ppm)	.....	63.0000
Half-life (day)	....	1.7400
Number of Application(s)	....	6
Application Interval (day)	....	3
Length of Simulation (day)	....	24

Day	Residue (ppm)
0	63.0000
1	42.2995
2	28.4007
3	82.0688
4	55.1026
5	36.9970
6	87.8405
7	58.9779
8	39.5989
9	89.5875
10	60.1508
11	40.3865
12	90.1163
13	60.5059
14	40.6249
15	90.2763
16	60.6133
17	40.6970
18	27.3248
19	18.3464
20	12.3181
21	8.2706
22	5.5531
23	3.7284
24	2.5034

Maximum Residue ... 90.2763
Average Residue ... 45.0954

Chemical Name	Methamidophos from Acephate applied to tobacco
Initial Residue Concentration (ppm)	5.0000
Half-life (day)	1.7500
Number of Application(s)	6
Application Interval (day)	3
Length of Simulation (day)	18

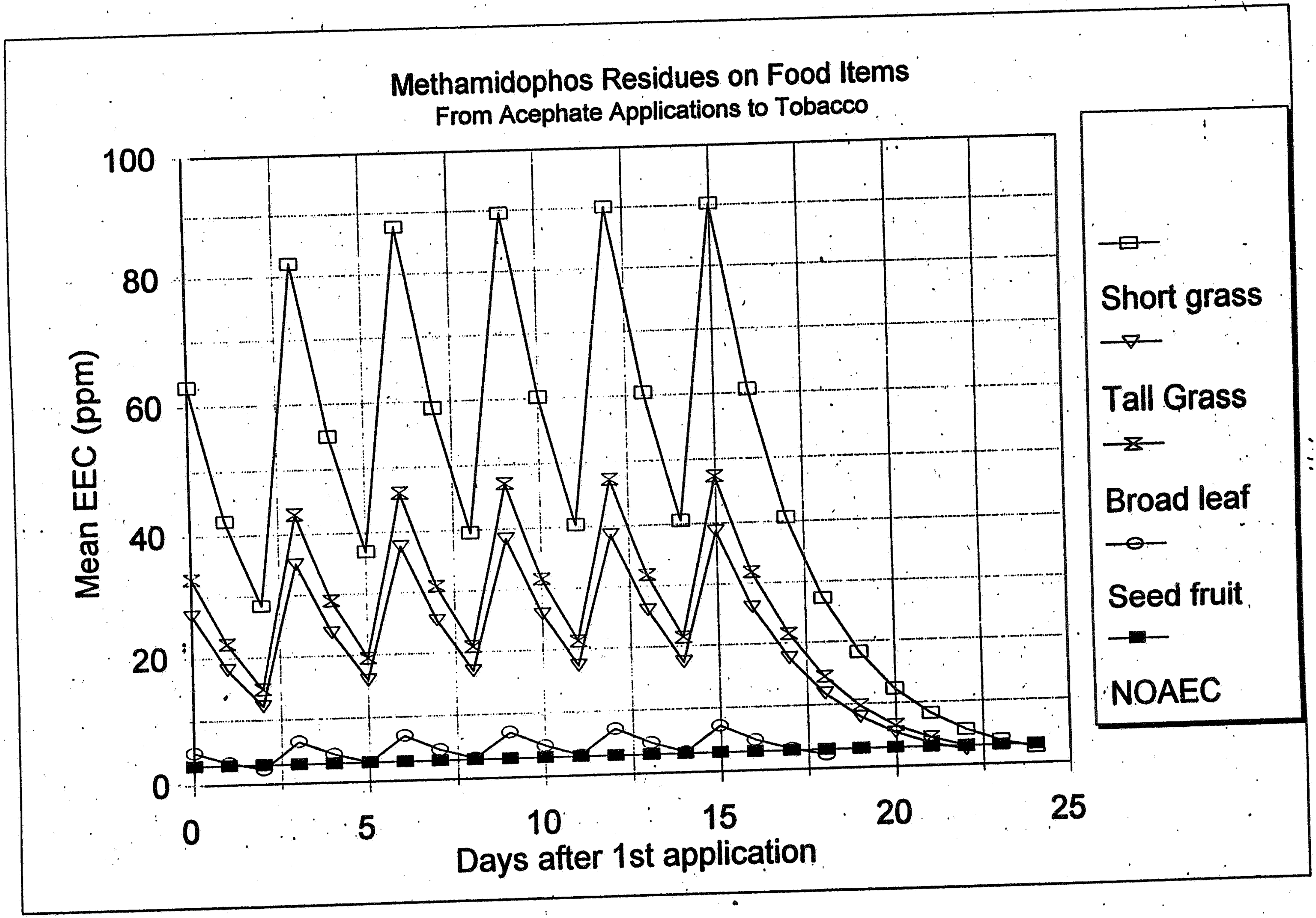
Day	Residue (ppm)
0	5.0000
1	3.3648
2	2.2643
3	6.5238
4	4.3902
5	2.9544
6	6.9881
7	4.7027
8	3.1647
9	7.1297
10	4.7979
11	3.2288
12	7.1728
13	4.8269
14	3.2483
15	7.1859
16	4.8358
17	3.2542
18	2.1899

Maximum Residue ... 7.1859
Average Residue ... 4.5679

Chemical Name	Methamidophos from Acephate applied to tobacco
Initial Residue Concentration (ppm)	27.0000
Half-life (day)	1.7500
Number of Application(s)	6
Application Interval (day)	3
Length of Simulation (day)	22

Day	Residue (ppm)
0	27.0000
1	18.1697
2	12.2273
3	35.2283
4	23.7069
5	15.9536
6	37.7360
7	25.3944
8	17.0892
9	38.5002
10	25.9087
11	17.4353
12	38.7331
13	26.0654
14	17.5407
15	38.8040
16	26.1132
17	17.5729
18	11.8257
19	7.9581
20	5.3554
21	3.6039
22	2.4253

Maximum Residue ... 38.8040
Average Residue ... 21.0612



Methamidophos Residues on Food Items
From Acephate Applications to Tobacco
Mean EEC (ppm)
100
80
60
40
20
0
0
5
10
15
20
25
Days after 1st application
Short grass
Tall Grass
Broad leaf
Seed fruit
NOAEC

Chemical Name .... Methamidophos fr
Initial Residue Concentration (ppm) 94.0000
Half-life (day) 1.7500
Number of Application(s) 6
Application Interval (day) 3
Length of Simulation (day) 25

Day	Residue (ppm)
0	94.0000
1	63.2573
2	42.5690
3	122.6468
4	82.5352
5	55.5421
6	131.3770
7	88.4102
8	59.4956
9	134.0376
10	90.2006
11	60.7005
12	134.8484
13	90.7463
14	61.0677
15	135.0955
16	90.9125
17	61.1796
18	41.1708
19	27.7059
20	18.6447
21	12.5469
22	8.4435
23	5.6820
24	3.8237
25	2.5732

Maximum Residue ... 135.0955
Average Residue ... 65.0085

Chemical Name	Methamidophos fr
Initial Residue Concentration (ppm)	40.0000
Half-life (day)	1.7500
Number of Application(s)	6
Application Interval (day)	3
Length of Simulation (day)	23

Day	Residue (ppm)
0	40.0000
1	26.9180
2	18.1145
3	52.1901
4	35.1214
5	23.6349
6	55.9051
7	37.6214
8	25.3173
9	57.0373
10	38.3832
11	25.8300
12	57.3823
13	38.6154
14	25.9863
15	57.4874
16	38.6862
17	26.0339
18	17.5195
19	11.7897
20	7.9339
21	5.3391
22	3.5930
23	2.4179

Maximum Residue ... 57.4874
Average Residue ... 29.9503

Chemical Name	Methamidophos fr
Initial Residue Concentration (ppm)	50.0000
Half-life (day)	1.7500
Number of Application(s)	6
Application Interval (day)	3
Length of Simulation (day)	24

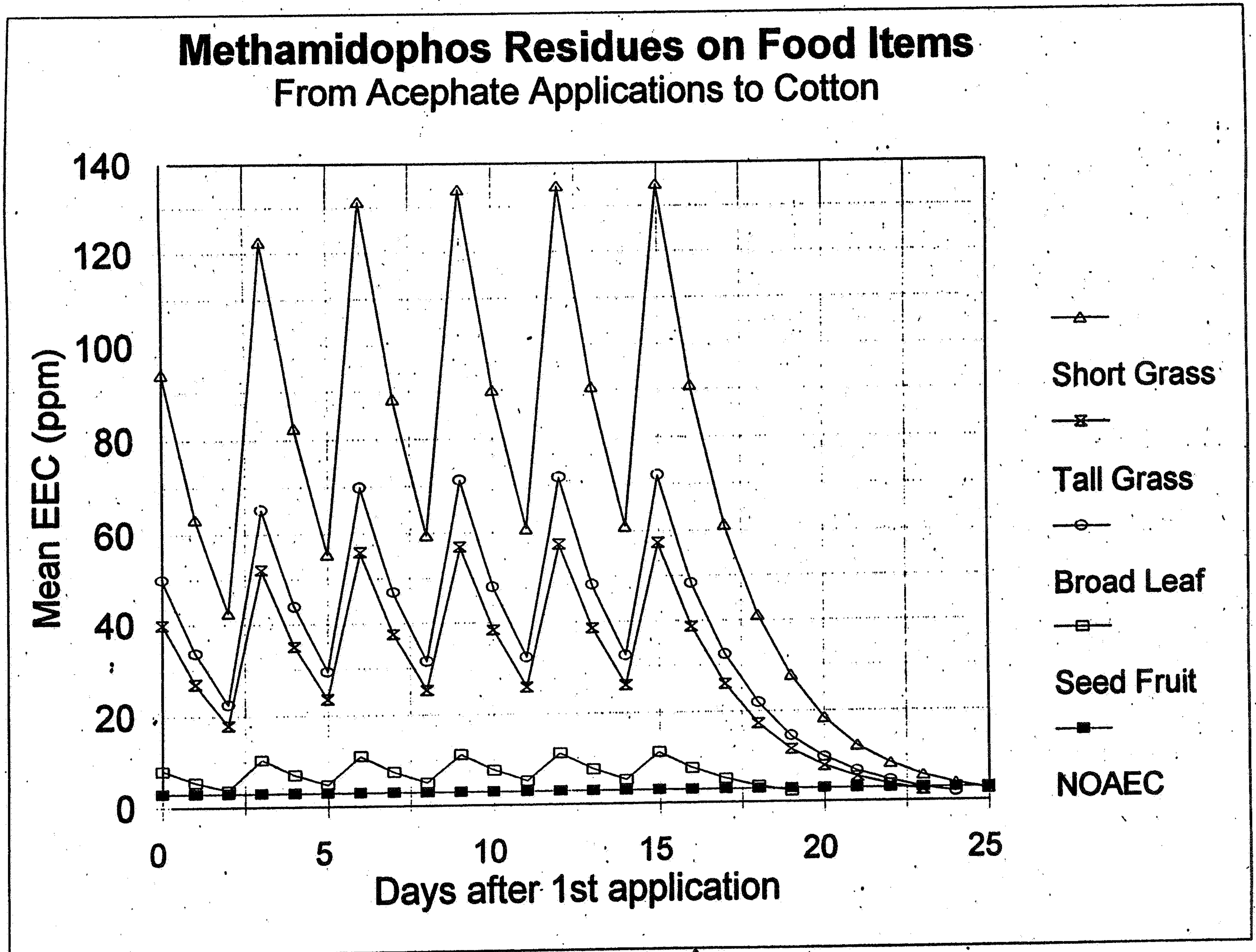
Day	Residue (ppm)
0	50.0000
1	33.6475
2	22.6431
3	65.2377
4	43.9017
5	29.5437
6	69.8814
7	47.0267
8	31.6466
9	71.2966
10	47.9790
11	32.2875
12	71.7279
13	48.2693
14	32.4828
15	71.8593
16	48.3577
17	32.5423
18	21.8994
19	14.7372
20	9.9174
21	6.6739
22	4.4912
23	3.0224
24	2.0339

Maximum Residue ... 71.8593
Average Residue ... 35.9628

Chemical Name	Methamidophos fr
Initial Residue Concentration (ppm)	8.0000
Half-life (day)	1.7500
Number of Application(s)	6
Application Interval (day)	3
Length of Simulation (day)	19

Day	Residue (ppm)
0	8.0000
1	5.3836
2	3.6229
3	10.4380
4	7.0243
5	4.7270
6	11.1810
7	7.5243
8	5.0635
9	11.4075
10	7.6766
11	5.1660
12	11.4765
13	7.7231
14	5.1973
15	11.4975
16	7.7372
17	5.2068
18	3.5039
19	2.3579

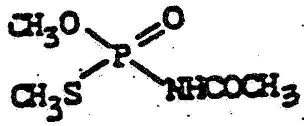
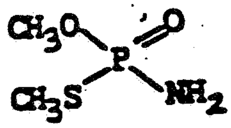
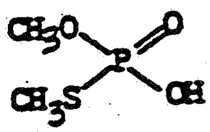
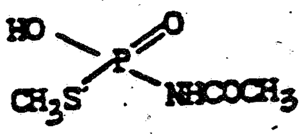
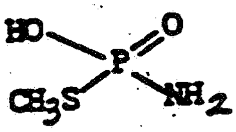
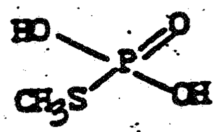
Maximum Residue ... 11.4975
Average Residue ... 7.0481


Methamidophos Residues on Food Items
From Acephate Applications to Cotton
Mean EEC (ppm)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
Days after 1st application
Short Grass
Tall Grass
Broad Leaf
Seed Fruit
NOAEC

APPENDIX G
Structures of Acephate and Major Degradates

TABLE II

CHEMICAL NAMES, DESIGNATIONS and STRUCTURES

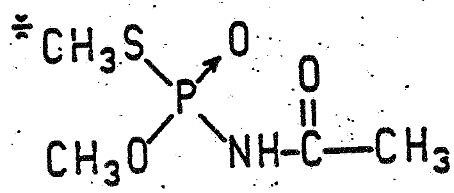
DESIGNATION	STRUCTURE	CHEMICAL NAMES
Acephate		O,S-dimethyl acetylphophoramidothioate
Methamidophos		O,S-dimethylphosphoramidothioate
DMDS	CH_3SSCH_3	dimthyl disulfide
MSH	CH_3SH	methyl mercaptan
DMS	CH_3SCH_3	dimethyl sulfide
DMPT		O,S-dimethyl phosphothioate
RE-17245		S-methyl acetylphosphoramidophothioate
S-MPAT		S-methyl phosphoramidophothioate
RE-4527		S-methyl phosphothioate

From MRID 40504810

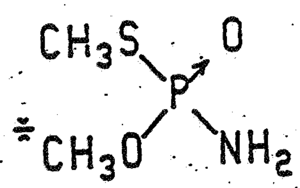
MRID 40504811

FIGURE 1

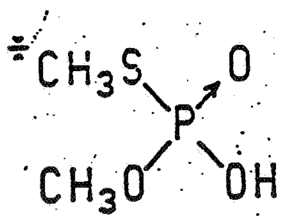
1. [S-METHYL-^{14}C]ACEPHATE:



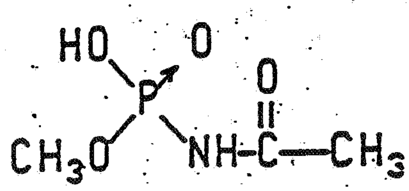
2. [O-METHYL-^{14}C]METHAMIDOPHOS:



3. [S-METHYL-^{14}C]-O,S-DIMETHYL PHOSPHOROTHIOATE:



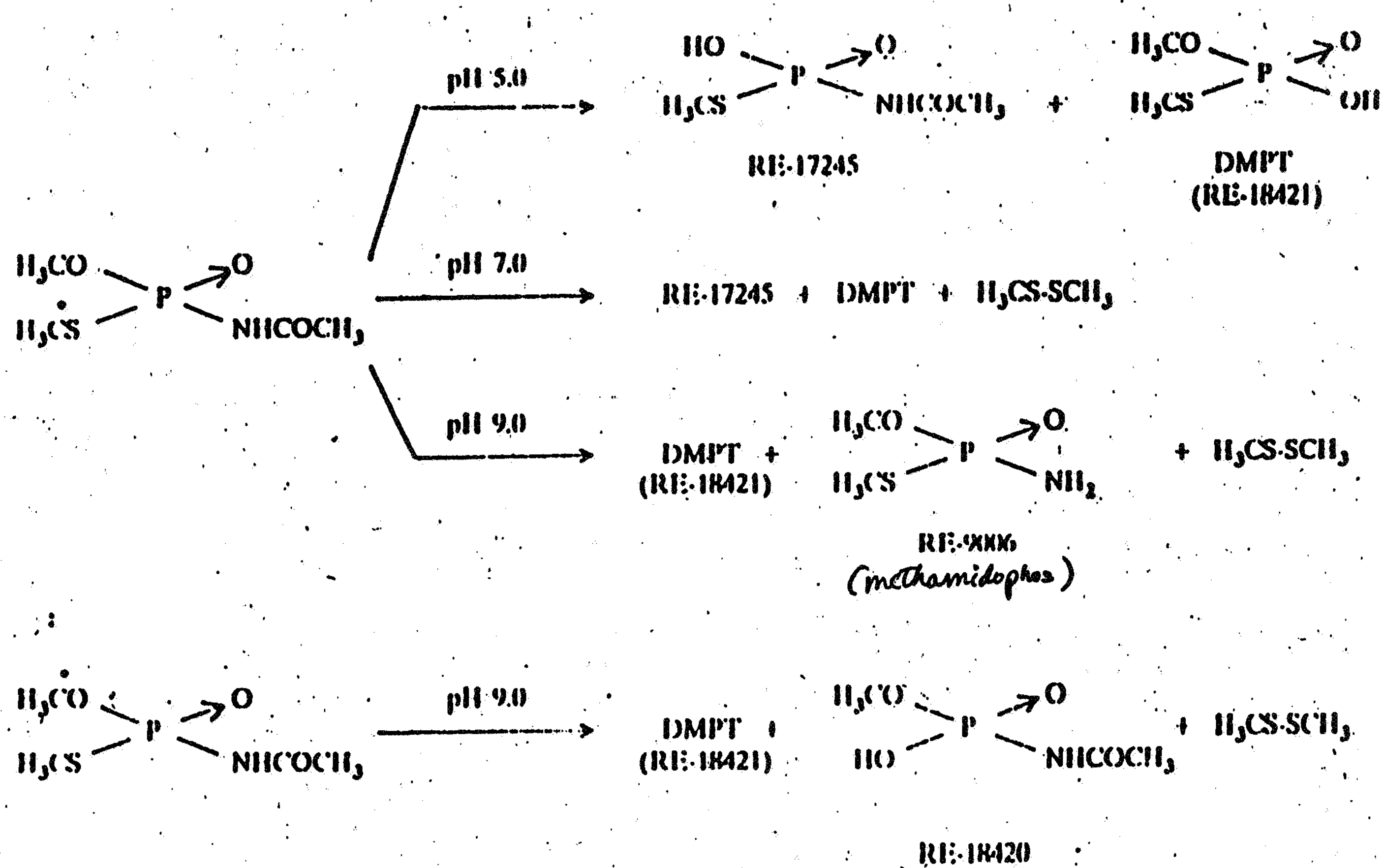
4. O-METHYL N-ACETYLPHOSPHORAMIDATE:



(Location of C-14 label is denoted by an asterisk.)

APPENDIX H
Proposed Degradation Pathways for Acephate

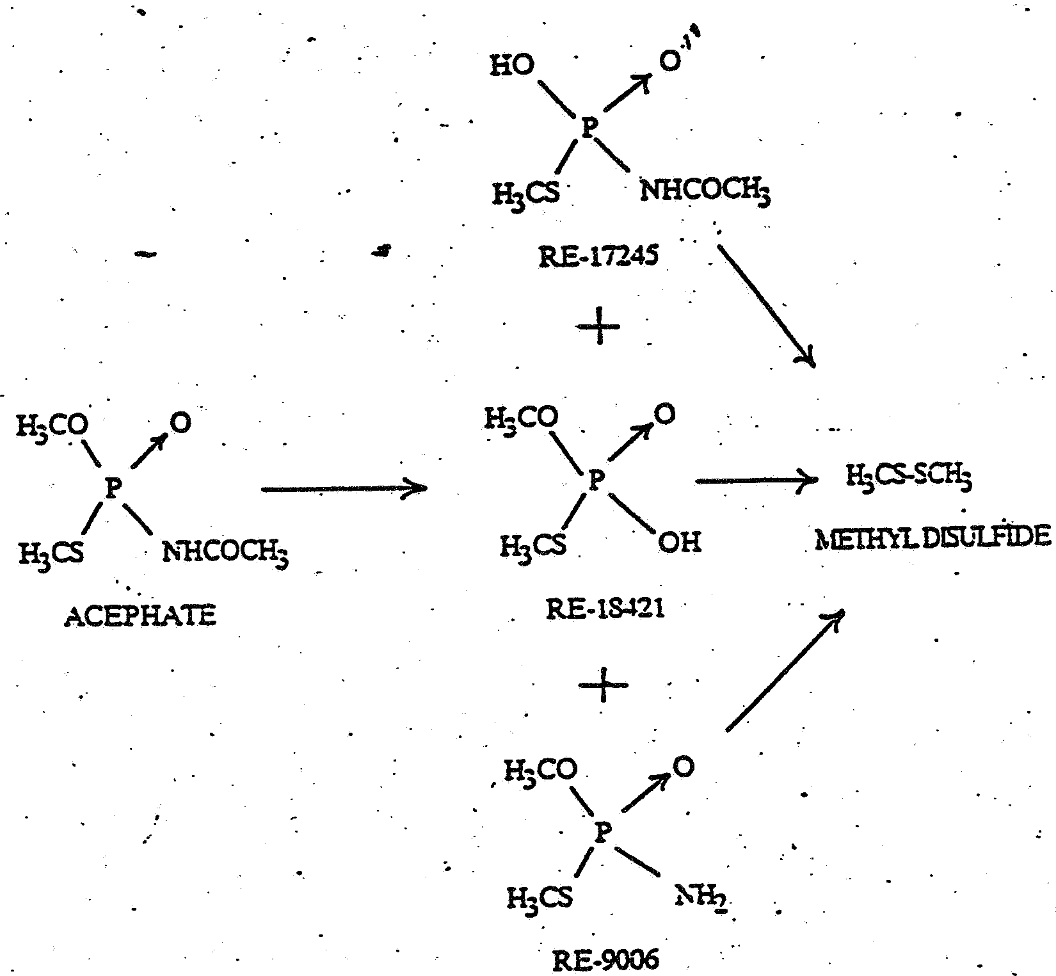
Figure 20. Hydrolysis Pathways of [14]C Acephate at pH 5.0, 7.0 and 9.0



* Indicates location of ^{14}C labelling.

MRID 41081603

Figure 18. Hydrolysis.Photolysis Pathways of ^{14}C Acephate at pH 7



MRID 43971601

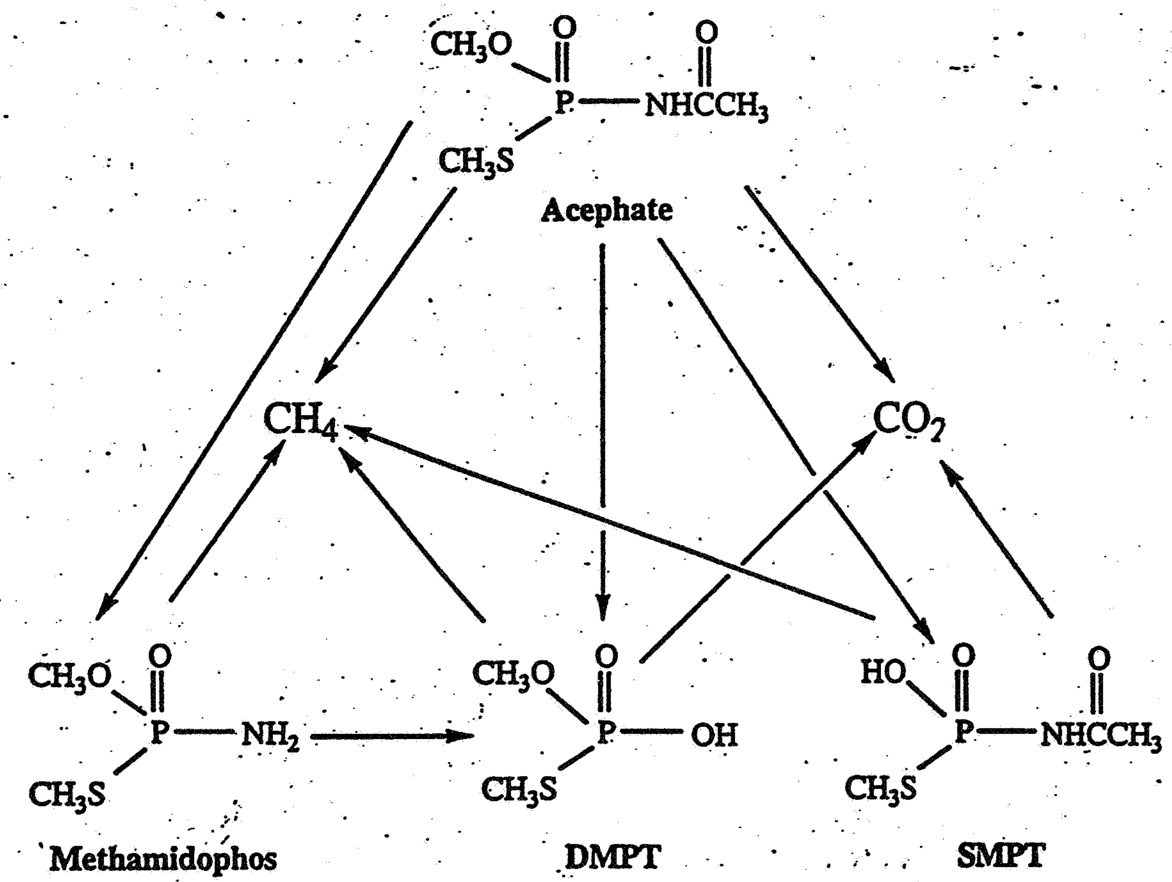


Figure 26. Proposed Anaerobic Aquatic Metabolic Pathways for Acephate.