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

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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Date:	June 21, 2005

MEMORANDUM

SUBJECT: **Environmental Fate and Ecological Risk Assessment for Maneb, Section 4 Reregistration for Control of Fungal Diseases on Numerous Crops, Ornamental Plantings, and Turf (Phase 3 Response).**

TO: Michael Goodis, Branch Chief
Tawanda Spears, Chemical Review Manager
Special Review and Reregistration Division (7508C)

FROM: ERB V Team for EBDCs:
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The EFED screening level Environmental Risk Assessment is attached. This RED document should be considered with the ETU document, the degradate of concern for metiram.

The following is an overview of our findings:

Risk Summary
Based on available data, EFED expects all maneb's uses to present potential chronic risks to birds and mammals. EFED relied on a referenced total foliar dissipation half-life value of 3.2 days from Willis and McDowell, 1987 to evaluate exposure to terrestrial organisms. Avian chronic LOCs are exceeded for all use patterns. RQs range from a high of 265 from the turf use to a low of 0.4 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). Mammalian chronic LOCs are exceeded for all uses patterns. RQs range from a high of 71 from the turf use to a low of 0.1 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). EFED does not calculate risk quotients to conduct risk assessments on terrestrial invertebrates. Based on the lack of acute maneb toxicity to honeybees, EFED expects a low acute risk to nontarget terrestrial

insects. Due to lack of data EFED did not assess risks to terrestrial plants or fully assess risks to aquatic plants. In the aquatic environment, EFED concludes ***maneb complex*** will present a potential acute risk to freshwater/estuarine/marine fish and invertebrates as well as nonvascular aquatic plants. EFED selected representative maneb use patterns at maximum application rates and minimum intervals between applications for aquatic modeling. Maneb is used on more than 20 different crop groupings. The representative sites selected for aquatic modeling were apples, peppers, potatoes (Maine, only) and tomatoes. The acute RQs exceeding freshwater fish acute, acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 1.13 to 4.71. The acute freshwater invertebrates' RQs exceeding acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 0.40 to 1.65. The acute estuarine/marine fish RQs exceed acute restricted use, and acute endangered species LOCs for all maneb's modeled uses with RQs ranging from 0.47 to 1.1. Estuarine/marine invertebrate acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb's modeled uses with RQs ranging from 15.87 to 65.97. Based on data for one surrogate species, maneb's modeled use patterns exceed acute risk LOCs for nonvascular aquatic plants with acute RQs ranging from 3.55 to 14.77. EFED did not assess chronic risks to freshwater invertebrates, estuarine/marine fish, or estuarine/marine invertebrates due to lack of data.

Risk to the Water Resources

Maneb is non-persistent in most of the natural environments. It is expected to decompose rapidly (to <10% of the applied within one day) by hydrolytic reactions in the main compartments of the natural environment. Among the EBDCs, maneb is characterized by the highest vulnerability to hydrolysis while metiram is the lowest. The degradate of concern in the process of maneb decomposition is ETU, a B2 carcinogen. Therefore, risk assessment for the water resource from the common EBDCs degradate ETU was performed for the application of all EBDCs including maneb. The reader is referred to the accompanied ETU chapter for this assessment.

Uncertainties

(1) Environmental Fate

EECs for ***parent maneb***[1] were estimated for water bodies using hydrolysis half-lives. The same water hydrolysis half-lives were used for soils assuming sufficient moisture is available in soil pores for hydrolysis to occur at the same rate. Uncertainty exists on whether half-lives used are applicable because of uncertainty related to soil moisture availability; soil moisture level is expected to impact resultant EECs. Lower EECs are expected in irrigated and/or rain-fed soils with high water holding capacity (WHC) and higher EECs are expected in low WHC soils under dry conditions. Given the

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[1] In this document three important abbreviations are used: ***Parent maneb***, ***maneb complex*** and ***Bound species***. ***Parent maneb*** is the polymeric parent maneb present in the active ingredient. ***Maneb complex*** is a suite of multi species residues resulting from degradation of the polymeric parent maneb. The suite includes the following: (a) species reported to be present but not specifically identified: variable/low molecular weight polymeric chains (i.e polymer fragments), monomeric species, and EBDC ligand in association with other metal ions that might be present in the environment; (b) species identified and quantified: Transient species, ETU and ETU degradates; and (c) un-identified species that bound to soil and sediment particles (referred to as ***Bound species***).

fact that maneb is highly vulnerable to hydrolysis and that it is applied to growing crops, moisture is expected to be available for parent to hydrolyze at an adjusted rate near or just below that determined from aqueous hydrolysis half-lives.

EECs for ***maneb complex*** were estimated using the physicochemical properties and hydrolysis half-lives of parent maneb in addition to aerobic soil metabolism half-lives and sorption coefficients which were assigned to this complex rather than the parent. In all aerobic soil studies two separate sets of determinations were conducted: the ***first*** was to obtain data for calculating half-lives using the CS_2-method to quantify the parent while the ***second*** was to characterize the bio-degradation process. EFED believes that half-lives calculated from the ***first*** set of determinations represent hydrolytic decomposition of ***parent maneb*** rather than bio-degradation. Rapid degradation of ***parent maneb*** produces a residue, the ***maneb complex***, which appears to be affected by slow degradation as indicated by production of CO_2. Part of this complex may contain precursor(s) for the degradate of concern, ETU. Therefore, EFED used the ***second*** set of determinations (radioactivity data) for calculating half-lives and assigned it to the ***maneb complex***. Uncertainty exists in these residue half-lives as they are conservative and affected by the validity of the assumption that the only bio-degradation of the residue was represented by evolved CO_2. Data obtained on degradates were not used as it were affected by impurities in the test materials, hydrolytic reactions and possible artificial degradation during extraction.

In this RED, aerobic soil half-lives calculated from the CS_2-method are considered to represent hydrolysis of ***parent maneb*** into its complex as modified by soil conditions (i.e. moisture content, pH and O_2 concentration). In contrast, half-lives calculated from evolved CO_2 are considered to represent bio-degradation of ***maneb complex*** left in the soil which appears to occur in parallel with hydrolytic decomposition of the parent. Likewise, calculated adsorption/desorption characteristics (K_d and K_{oc}) are thought to represent ***maneb complex*** as it were approximated from column leaching; with no 1/n value to indicate the degree of non-linearity for the Freundlich constant.

In the degradation process for maneb Mn ions/salts are expected to dissipate into the environment. Although EFED recognizes that Mn is a micronutrient, no data were presented to evaluate the risk that might be associated with this release in certain environmental settings and therefore, uncertainty exists in this aspect of risk assessment.

(2) Ecological Effects

EFED is uncertain about maneb's acute risk to nontarget terrestrial plants and needs testing performed at maneb's maximum rate of application in the environment. EFED has not received studies to evaluate the acute risk of *maneb* **complex** to vascular aquatic plants and is uncertain about this risk. EFED has received one acute study for 1 of 4 surrogate species needed to evaluate the acute risk to nonvascular aquatic plants. This one study when compared to *maneb* **complexes'** exposure showed the acute RQs exceeded LOCs. EFED needs testing performed on 3 more surrogate species to evaluate fully the acute risk to nonvascular aquatic plants. EFED has no data to evaluate the chronic risks to freshwater invertebrates or estuarine/marine organisms and is uncertain about these risks.

Endocrine Disruption
Maneb toxicity effects noted in both birds and mammals could be a result of hormonal disruptions. The avian reproductive studies reviewed by EFED noted reproductive effects. These effects in mallard duck were decreases in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a decrease in the number of 14-day old survivors as a percentage of eggs. For mammals chronic effects were noted such as male parental toxicity resulting in significant increase in lung weight (both generations) and liver weight (F1 generation) with lesions noted on these organs in the F1 generation. Chronic testing in freshwater fish showed decreased hatchability, fish survival and length of fry. When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, maneb may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption.

Data Gaps

Environmental Fate
Complete characterization of the fate of ***maneb complex*** requires more information on the various species that constitute its complex including the soil/sediment ***bound species***. Information needed are for each of these constituents and include: their physicochemical properties and the nature of their association with soil/sediment particles. Furthermore, several problems were identified in submitted fate studies for the EBDCs including maneb. These problems are presented in detail in Appendix I; the registrant is requested to address these problems.

Full characterization of the processes involved in ***parent maneb*** dissipation requires additional information on the release of Mn ions from maneb in order to evaluate possible environmental risk that might be associated with such release in specific environmental settings.

The following Table lists the status of the fate data requirements for maneb. In the Table, Hydrolysis, adsorption/desorption and leaching studies are listed as supplemental however, no new studies are required because problems found in these studies are mostly associated with the unique characteristics of this chemical in aqueous media. Not all the requirements of these guideline studies can be met due to the high susceptibility of this chemical to hydrolysis. In contrast, aerobic soil studies are classified as supplemental mainly because of incomplete characterization of the ***significant*** bound species. Without a complete characterization of this bound species, EFED was only able to estimate conservative half-lives based on complete mineralization of maneb into CO_2. The issues of the bound species and use of CS_2 data are presented in detail elsewhere in this document (section ***IV. b. iv***); the registrant is requested to address these issues. A high tier targeted monitoring study was submitted for ETU, the degradate of concern for all EBDCs including maneb, therefore, no new terrestrial field dissipation study is required at this time.

Status of environmental data requirements for maneb

Guideline Number		*Data Requirement*	*Is Data Needed?*	*MRID Number*	*Study Classification*
161-1	835.2	Hydrolysis [1]	No	453936-01	Supplemental
161-2	835.2	Photo Degradation in Water [2]	No	404656-02	Acceptable
161-3	835.2	Photo Degradation on Soil	No	404656-03	Acceptable
162-1	835.4	Aerobic Soil Metabolism	Reserved	405852-01	
				451452-02	Supplemental
162-2	835.4	Anaerobic Soil	No [3]	405852-02	Not Acceptable
162-3	835.4	Anaerobic Aquatic Metabolism	No	001633-35	Acceptable
162-4	835.4	Aerobic Aquatic Metabolism	No Studies submitted		
163-1	835.1230	Adsorption/Desorption [4]	No	050011-90	Supplemental
	835.1240	Leaching [5]	No	405852-03	Supplemental
				400472-01	
				455959-01	
				455959-02	
163-2		Laboratory Volatility	Waived; although a study was submitted (MRID 001549-86; No DER)		
164-1	835.6	Terrestrial Field Dissipation [6]	No	000889-23	Supplemental
				417430-01	
				417430-02	
201-1	840.1	Droplet Size Spectrum	A study was submitted (MRID 424343-01; No DER)		
165-4	850.2	Accumulation in Fish	Waived		

[1] Two studies were rejected (Accession No. 2552-29 and MRID 420701-01). One study was considered to contain Ancillary information (MRID 404656-01). One article on hydrolysis was submitted under MRID 000889-17.
[2] MRID 420701-02 was rejected. Two articles on photolysis were submitted under MRIDs 000889-17 and 001540-26.
[3] The study was rejected but requirement was satisfied by submitting an anaerobic aquatic study (MRID 001633-35).
[4] The same study was submitted under MRID 000658-59.
[5] No DER was found for one study submitted under two MRIDs 001428-87 and 001428-88.
[6] No DER was found for a study submitted under MRID 001619-35.

Ecotoxicity

EFED is uncertain about maneb's acute risk to aquatic and terrestrial plants because EFED lacks toxicity data for some or all surrogate species representing these groups. Because EFED lacks chronic maneb toxicity data, EFED is uncertain about the chronic risks to freshwater invertebrates and estuarine/marine organisms. EFED needs studies to evaluate these uncertainties. EFED needs whole sediment acute toxicity testing on freshwater and estuarine/marine invertebrates because maneb residue is toxic to aquatic invertebrates, binds to sediment , and may persist on sediment surfaces. In some risk evaluations EFED has used supplemental studies to make a risk determination. EFED needs core studies to confirm these findings.

The following Table lists the status of the ecological data needs for maneb.

Status of ecological data needs for Maneb.

Date: December 14, 2001 **Case No: 0643** **Chemical No: 014505**		**MANEB** **DATA NEEDS FOR THE** **ENVIRONMENTAL FATE AND EFFECTS DIVISION**				
Data Requirement	**Composition[1]**	**Use Pattern[1]**	**Does EPA Have Data To Satisfy This Need?**	**Bibliographic Citation**	**Study Classification**	**Must Additional Data Needed Under FIFRA 3(c)(2)(B)?**
§158.490 WILDLIFE AND AQUATIC ORGANISMS (6 Basic Studies in Bold)						
71-1(a) Acute Avian Oral, Quail/Duck	TGAI	1,2,3,9,11	Yes	40657001	Core	No
71-1(b) Acute Avian Oral, Quail/Duck	(TEP)	1,2,3,9,11	No	not applicable	not applicable	No
71-2(a) Acute Avian Diet, Quail	TGAI	1,2,3,9,11	Yes	00104264	Supplemental	No
71-2(b) Acute Avian Diet, Duck	TGAI	1,2,3,11	Yes	40657002 00098561	Core Supplemental	No
71-3 Wild Mammal Toxicity		1,2,3,9,11	No	not applicable	not applicable	No
71-4(a) Avian Reproduction Quail	TGAI	1,2,3,11	Yes	43586501	Supplemental	No
71-4(b) Avian Reproduction Duck	TGAI	1,2,3,11	Yes	43586502	Core	No
71-5(a) Simulated Terrestrial Field Study		1,2,3,9,11	No	not applicable	not applicable	No
71-5(b) Actual Terrestrial Field Study		1,2,3,9,11	No	not applicable	not applicable	No
72-1(a) Acute Fish Toxicity Bluegill	TGAI	1,,2,3,11	Yes	40749401 00097240 00090291	Core Supplemental Supplemental	No
72-1(b) Acute Fish Toxicity Bluegill	(TEP)	1	Yes	40749401 00052557	Core Supplemental	No[2]

MANEB
DATA NEEDS FOR THE
ENVIRONMENTAL FATE AND EFFECTS DIVISION

Data Requirement	Composition[1]	Use Pattern[1]	Does EPA Have Data To Satisfy This Need?	Bibliographic Citation	Study Classification	Must Additional Data Needed Under FIFRA 3(c)(2)(B)?
72-1(c) Acute Fish Toxicity Rainbow Trout	TGAI	1,2,3,9,11	Supplemental	40706001	Supplemental	Yes[3]
72-1(d) Acute Fish Toxicity Rainbow Trout	(TEP)	1	Supplemental	40706001	Supplemental	Yes[2,3]
72-2(a) Acute Aquatic Invertebrate	TGAI	1,2,3,9,11	Yes	40749402	Core	No
72-2(b) Acute Aquatic Invertebrate	(TEP)	1	Yes	40749402	Core	No[2]
850.1735 Whole Sediment Acute Toxicity Freshwater Invertebrates)	TGAI	1,2,3,9,11	No	Not applicable	Not applicable	Yes
72-3(a) Acute Est/Mar Toxicity Fish	TGAI	1,2,3,11	Yes	40943101	Core	No
72-3(b) Acute Est/Mar Toxicity Mollusk	TGAI	1,2,3,11	Yes	41000001	Core	No
72-3(c) Acute Est/Mar Toxicity Shrimp	TGAI	1,2,3,11	Supplemental	41000002	Supplemental	Yes[4]
850.1740 Whole Sediment Acute Toxicity Invertebrates, Est/Mar	TGAI	1,2,3,11	No	Not applicable	Not applicable	Yes
72-3(d) Acute Est/Mar Toxicity Fish	(TEP)	1	Yes	40943101	Core	No[2]
72-3(e) Acute Est/Mar Toxicity Mollusk	(TEP)	1	Yes	41000001	Core	No[2]
72-3(f) Acute Est/Mar Toxicity Shrimp	(TEP)	1	Supplemental	41000002	Supplemental	Yes[2,4]
72-4(a) Early Life Stage Fish (Freshwater)	TGAI	1,2,3,11	Yes	41346301	Core	No
72-4(a) Early Life Stage Fish (Estuarine)	TGAI	1,2,3,11	No	Not applicable	Not applicable	Yes
72-4(b) Life Cycle Invertebrate (Freshwater)	TGAI	1,2,3,11	No	Not applicable	Not applicable	Yes
72-4(b) Life Cycle Aquatic Invertebrate (Estuarine)	TGAI	1,2,3,11	No	Not applicable	Not applicable	Yes
72-5 Life Cycle Fish	TGAI	1,2,3,11	No	Not applicable	Not applicable	Yes freshwater Reserved

Date: December 14, 2001 Case No: 0643 Chemical No: 014505	MANEB DATA NEEDS FOR THE ENVIRONMENTAL FATE AND EFFECTS DIVISION					
Data Requirement	**Composition[1]**	**Use Pattern[1]**	**Does EPA Have Data To Satisfy This Need?**	**Bibliographic Citation**	**Study Classification**	**Must Additional Data Needed Under FIFRA 3(c)(2)(B)?**
72-6 Aquatic Organism Accumulation	TGAI					
72-7(1) Simulated Aquatic Field Study		1,2,3,9,11	No	not applicable	not applicable	No
72-7(b) Actual Aquatic Field Study		1,2,3,9,11	No	not applicable	not applicable	No
§158.540 PLANT PROTECTION						
122-1(a) Seed Germ./Seedling Emerg.-Tier I	(TEP)	1,2,3,11	No	not applicable	not applicable	Recommended
122-1(b) Vegetative Vigor-Tier I	(TEP)	1,2,3,11	No	not applicable	not applicable	Recommended
122-2 Aquatic Plant Growth-Tier I	(TEP)	1,2,3,11	No	not applicable	Not applicable	Yes[6]
123-1(a) Seed Germ./Seedling Emerg.-Tier II	(TEP)	1,2,3,11	No	not applicable	not applicable	Reserved
123-1(b) Vegetative Vigor-Tier II	(TEP)	1,2,3,11	No	not applicable	not applicable	Reserved
123-2 Aquatic Plant Growth-Tier II	(TEP)	1,2,3,11	Partial	40943501	Core	Yes[5]
124-1 Terrestrial Field Study		1,2,3,9,11	No	not applicable	not applicable	No
124-2 Aquatic Field Study		1,2,3,9,11	No	not applicable	not applicable	No
§158.490 NONTARGET INSECT TESTING						
141-1 Honey Bee Acute Contact	not reported	1,2,3,11	Yes	00036935	Core	No
141-2 Honey Bee Residue on Foliage	(TEP)	1,2,3,11	No	not applicable	not applicable	No
141-5 Fueld Test for Pollinators	(TEP)	1,2,3,11	No	not applicable	not applicable	No

FOOTNOTES:

1. 1=Terrestrial Food; 2=Terrestrial Feed; 3=Terrestrial Non-Food; 4=Aquatic Food; 5=Aquatic Non-Food(Outdoor);6=Aquatic Non-Food (Industrial);7=Aquatic Non-Food (Residential);8=Greenhouse Food; 9=Greenhouse Non-Food;10= Forestry; 11=Residential Outdoor; 12=Indoor Food; 13=Indoor Non-Fod; 14=Indoor Medicinal;15=Indoor Residential. TGAI=Technical grade of the active ingredient; PAIRA=Pure active ingredient, radiolabeled; TEP=Typical end-use product

2. TEP testing was required to support the cranberry use (1988 Maneb Registration Standard). The registrant requested that testing of the 80% WP formulation satisfy both TEP and TGAI testing requirements because 1) the TGAI was only 87% pure and not soluble in water; (2) the 80 WP formulated product was 80% pure and suspendable in water. EFED agreed to allow testing with the 80% WP to satisfy both TEP and TGAI tsting

requirements.

3. Study was classified supplemental because of high variability in measured test concentrations, weights of fish not given; O_2 less than recommended; study should have been conducted as a flow-through. Study must be repeated.

4. Study was classified supplemental because of high variability in measured concentrations; also analytical procedures were not able to detect concentrations below 5 ppb. Study must be repeated.

5. Suplemental study. Results were based on nominal which averaged 15% of nominal at 120 hours. Five species need to be tested.

6. Tier I or Tier II aquatic plant growth testing needs to be submitted for duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), and a freshwater diatom for maneb.

Environmental Hazards Labeling Statements for Maneb

Manufacturing Use

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

End Use Products

Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high-water mark. Do not contaminate water when disposing of equipment wash water or rinsate.

This pesticide is toxic to aquatic organisms.

Label statements for spray drift management

AVOIDING SPRAY DRIFT AT THE APPLICATION SITE IS THE RESPONSIBILITY OF THE APPLICATOR. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator is responsible for considering all these factors when making decisions. Where states have more stringent regulations, they should be observed.

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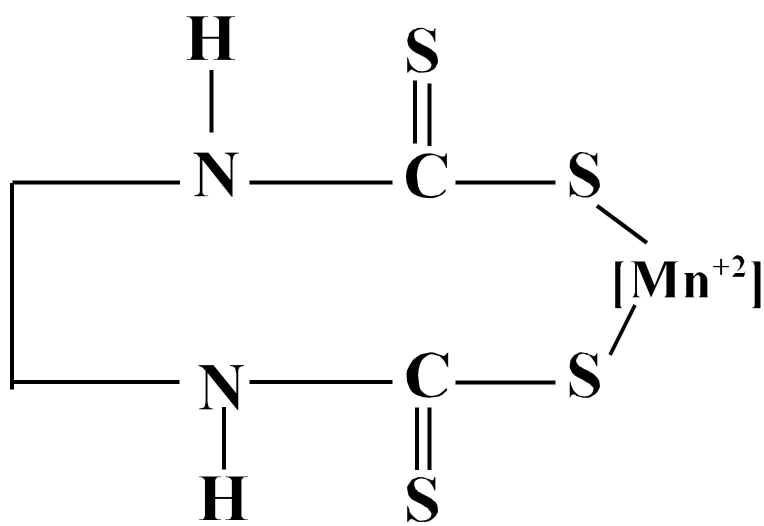
Environmental Fate and Ecological Risk Assessment for the Reregistration of Maneb

[[1,2-Ethanediylbis [carbamodithioato]]-(2-)] manganese



Maneb

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TABLE OF CONTENTS

I. Executive Summary

There are potential chronic risks to birds and mammals, acute risks to freshwater fish and estuarine/marine animals, and acute risks to aquatic nonvascular plants. These potential risks occur for all or some of maneb's uses. Because EFED lacks data, EFED is uncertain about maneb's potential acute risk to terrestrial plants, chronic risks to freshwater invertebrates, chronic risks to estuarine/marine animals and acute risks to aquatic vascular plants.

Based on available data, EFED expects all maneb's uses present potential chronic risks to birds and mammals. EFED relied on a referenced total foliar dissipation half-life value of 3.2 days to evaluate exposure to terrestrial organisms (Willis and McDowell, 1987). Avian chronic LOCs are exceeded for all use patterns. RQs range from a high of 265 from the turf use to a low of 0.4 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). Mammalian chronic LOCs are exceeded for all uses patterns. RQs range from a high of 71 from the turf use to a low of 0.1 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). EFED used a mallard duck reproductive study to calculate the RQs for this assessment. EFED based birds chronic reproductive effects on decreases in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a decrease in the number of 14-day old survivors as a percentage of eggs.. EFED based mammal reproductive effects on a 2-generation study in rats. These mammal effects were male parental toxicity resulting in significant increase in lung weight (both generations) and liver weight (F1 generation) with lesions noted on these organs in the F1 generation. EFED does not calculate risk quotients to conduct risk assessments on terrestrial invertebrates. Based on the lack of acute maneb toxicity to honeybees, EFED expects a low acute risk to nontarget terrestrial insects. Due to lack of data EFED did not assess risks to terrestrial plants or fully assess risks to aquatic plants. In the aquatic environment, EFED concludes maneb will present a potential acute risk to freshwater/estuarine/marine fish and invertebrates as well as nonvascular aquatic plants. EFED selected representative maneb use patterns at maximum application rates and minimum intervals between applications for aquatic modeling. Maneb is used on more than 20 different crop groupings. The representative sites selected for aquatic modeling were apples, peppers, potatoes (Maine, only) and tomatoes. The acute RQs exceeding freshwater fish acute, acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 1.13 to 4.71. The acute freshwater invertebrates' RQs exceeding acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 0.40 to 1.65. The acute estuarine/marine fish RQs exceed acute restricted use, and acute endangered species LOCs for all maneb's modeled uses with RQs ranging from 0.47 to 1.1. Estuarine/marine invertebrate acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb's modeled uses with RQs ranging from 15.87 to 65.97. Based on data for one surrogate species, maneb's modeled use patterns exceed acute risk LOCs for nonvascular aquatic plants with acute RQs ranging from 3.55 to 14.77. EFED did not assess chronic risks to freshwater invertebrates, estuarine/marine fish, or estuarine/marine invertebrates due to lack of data.

Maneb is a non-systematic fungicide applied to foliage and as a seed treatment for the control of fungal diseases on numerous crops, ornamental plantings, and turf. The maximum application rates for the major crops are16.0, 16.8, 9.6, and 14.4 lbs a.i/acre/crop cycle for potatoes, tomatoes, lettuce, and peppers; and 18.0 and 25.6 lbs a.i/acre/year for sweet corn and almonds, respectively. Maneb is applied as a broadcast treatment using both air and ground equipment and has numerous seed treatment uses.

Maneb is a polymer or a highly coordinated salt complex, in which the EBDC (ethylene bis dithio carbamate) ligand present in coordination with Mn^{+2}. Foliar application of maneb cause it to reach plant/soil surfaces directly and air/water bodies by drift. In the air, maneb will eventually be deposited onto soil/plant/water bodies with minimal change. On plant surfaces, it is affected by physical wash-off and abiotic hydrolytic decomposition given time and water availability. Fate of maneb reaching the soil and water/sediment systems is mainly controlled by hydrolytic decomposition and soil/sediment adsorption.

Parent maneb[2] (complete polymeric chains) is non-persistent as it is expected to decompose rapidly (reach <10% of the applied within one day) by hydrolytic reactions in the main compartments of the natural environment. Initial hydrolytic decomposition of maneb appears to be a complex process and may involve its breakdown into variable/low molecular weight polymeric chains (i.e polymer fragments), monomeric species, EBDC ligand in association with metal ions, and degradates. The final product of hydrolytic decomposition of parent maneb in water/soil pore water is a multi species residue hereinafter is refer to as the ***"maneb complex"***. ***Parent maneb*** is not expected to partition into the air from soil and water surfaces due to low vapor pressure and low Henry's Law constant. Low K_{ow} values are reported for maneb, therefore the chemical will not be significantly bio-concentrated by aquatic organisms such as fish.

In contrast, ***Maneb Complex*** consists of transient species and degradates including the degradate of concern, ETU and its degradates. In aqueous media, transient species are short-lived while ETU is persistent; unless it is subjected to rapid degradation by microbial action and/or indirect photolysis. In soils/sediments, a significant portion of the complex partitions into the soil/sediment particles (reached 70 to 90% of the applied parent within one week). In these systems, species identified in the liquid/extractable phase were similar in identity (differ in concentration) to those identified in aqueous media. Species bound to soil/sediment were poorly characterized and claimed, by the registrant, to be dominated by ethylene diamine (EDA). In the absence of experimental proof of EDA or complete characterization of these ***bound species***, EFED is concerned about the bound species as it is persistent and could contain precursors for ETU.

Conversion of ***parent maneb*** into its complex by hydrolytic decomposition appears to be eminent and

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[2] In this document three important abbreviations are used: ***Parent maneb***, ***maneb complex*** and ***Bound species***. ***Parent maneb*** is the polymeric parent maneb present in the active ingredient. ***Maneb Complex*** is a suite of multi species residues resulting from degradation of the polymeric parent maneb. The suite includes the following: (a) species reported to be present but not specifically identified: variable/low molecular weight polymeric chains (i.e polymer fragments), monomeric species, and EBDC ligand in association with other metal ions that might be present in the environment; (b) species identified and quantified: Transient species, ETU and ETU degradates; and (c) un-identified species that bound to soil and sediment particles (referred to as ***Bound species***).

rapid even at concentrations higher than those expected to reach the environment by application. Therefore, parent applied is expected to be found as residue, the ***maneb complex,*** in most natural environments. ***Maneb complex*** species in association with soil/sediment, appear to bio-degrade at a very slow rate producing maneb degradates including ETU. Residue species left in the liquid phase may continue to be affected by hydrolytic decomposition along with microbial activity (if present) producing degradates including ETU.

Submitted fate data are adequate to characterize the environmental fate and transport of the "multi species residue" of maneb as a whole. Based on submitted fate data, most of the constituents of this complex are immobile and highly persistent in the environment, with aerobic soil metabolism being the major route of its slow dissipation. As maneb and its complex dissipate in aquatic and soil/terrestrial environments, degradation products are produced including ETU.

EFED relied on a referenced total foliar dissipation half-life value of 3.2 days (Willis and McDowell, 1987) to evaluate exposure to terrestrial organisms. The stressor in this case is ***parent maneb*** although hydrolytic reactions on foliage may result in dominance of ***maneb complex*** over the parent. Terrestrial exposure was quantified as Estimated Environmental Concentrations (EECs) by modeling for the maximum application rates. For the aquatic environment, the main stressor is the ***maneb complex*** and its EECs were estimated using tier 2 PRZM/EXAMS modeling for the various crop scenarios. Drinking water assessment was performed only for ETU (refer to the accompanied ETU document); the degradate of concern present in the complex.

EFED is uncertain about maneb's risk to non-target terrestrial plants. EFED needs testing performed at maneb's maximum rate of application in the environment to evaluate this risk. EFED expects the potential chronic risks to birds and mammals from maneb's uses. RQs exceed chronic LOCs for all maneb's uses for both birds and mammals. EFED expects maneb's uses to present a low acute risk to birds, mammals, and nontarget insects because maneb is practically nontoxic to these organisms and historically there has been no incident data documenting adverse effects to these organisms.

In the aquatic environment, *maneb complex* presents a potential acute risk to freshwater fish, freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrate, and nonvascular aquatic plants with LOCs exceeded. The chronic *maneb complex* risk to freshwater fish is low with no LOCs exceeded. The data filed and reviewed to characterize *maneb complexes'* potential acute risk to aquatic animals and aquatic nonvascular plants is satisfactory. EFED has no data to evaluate *maneb complexes'* chronic risks to freshwater invertebrates or estuarine/marine organisms and is seeking data to evaluate these risks. EFED has not received studies to evaluate the risk of the *maneb complex* to vascular aquatic plants and needs studies presented to evaluate this risk. EFED needs testing performed on more aquatic nonvascular plant taxa to evaluate fully the risk to nonvascular aquatic plants.

II. Introduction

Maneb is a broad spectrum fungicide belonging to a chemical class of polymeric dithiocarbamate and a group classified as ethylene bisdithiocarbamate (EBDC) fungicides. Maneb is classified as a non-systemic contact fungicide with preventive activity. Maneb is marketed by several companies under varied names and formulations. Formulation types include dusts, water dispersible granules (dry flowables), emulsifiable concentrates, flowable concentrates, wettable powders, and liquid-ready to use.

a. Use Characterization

Maneb is applied to foliage and as seed protectant for the control of fungal diseases on numerous crops, ornamental plantings (trees, herbaceous plants, non flowering plants, woody shrubs and vines), and turf (commercial/industrial, golf course, sod farm, recreational, and residential). It is applied as a broadcast treatment using both air and ground equipment and has numerous seed treatment uses. There are 36 products registered containing maneb: 2 manufacturing-use product, 33 end-use products and 1 special local need (24-c) registration (OPP REFs data August, 2000). There are both multiple and single active ingredient products. A synopsis of the use pattern for this chemical is provided below in Table II-1.

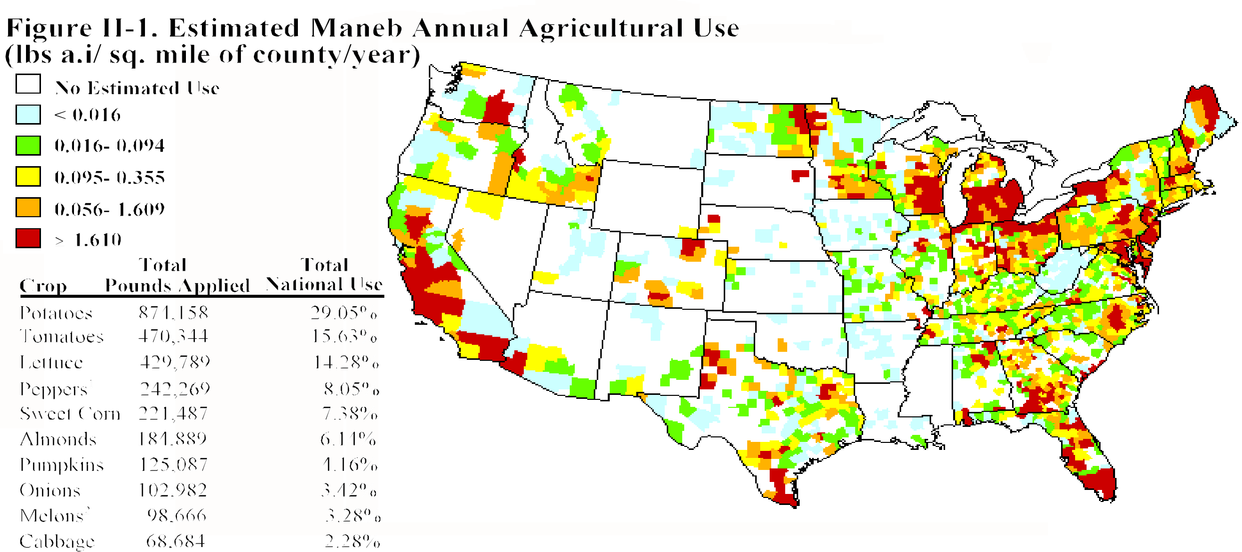
Table II-1. Maneb use patterns.

Crop	*Maximum Application Rate*		*Number of Applications*	*Minimum Application Interval (days)*
	Per Treatment	*In Total*		
Almonds	**6.4 lbs a.i/acre**	**25.6 lbs a.i/acre/crop cycle**	**4**	**7**
Apples	**4.8 lbs a.i/acre**	**19.2 lbs a.i/acre/year**	**4**	**7**
Bananas	**2.4 lbs a.i/acre**	**24 lbs a.i/acre/crop cycle**	**10**	**14**
Barley, Rice, Rye, Sorghum, Soybean & Wheat	**0.2 lbs a.i/100 lbs seed (Seed treatment)**		**1**	**NA**
Beans (dried)	**1.6 lbs a.i/acre**	**9.6 lbs a.i/acre/crop cycle**	**6**	**5**
Broccoli, Brussel Sprouts, Cabbage [a]	**1.6 lbs a.i/acre**	**9.6 lbs a.i/acre/crop cycle**	**6**	**7**
Collards & Turnip (GA & TN only)	**1.2 lbs a.i/acre**	**3.6 lbs a.i/acre/crop cycle**	**3**	**14**
Corn (field), Cotton & Oats	**0.3 lbs a.i/100 lbs seed (Seed treatment)**		**1**	**NA**
Corn (pop & sweet), East of the Mississippi River [b]	**1.2 lbs a.i/acre**	**18.0 lbs a.i/acre/year**	**15**	**3**
Corn (pop & sweet), West of the Mississippi River [c]	**1.2 lbs a.i/acre**	**6.0 lbs a.i/acre/year**	**5**	**3**
Cranberry	**4.8 lbs a.i/acre**	**14.4 lbs a.i/acre/year**	**3**	**7**
Cucumber, Melons, Pumpkin & Squash	**1.6 lbs a.i/acre**	**12.8 lbs a.i/acre/crop cycle**	**8**	**7**
Eggplant & Sugar Beets	**1.6 lbs a.i/acre**	**11.2 lbs a.i/acre/crop cycle**	**7**	**7**
Fig	**2.4 lbs a.i/acre**	**2.4 lbs a.i/acre/year**	**1**	**NA**
Flax	**0.4 lbs a.i/100 lbs seed (Seed treatment)**		**1**	**NA**
Grapes (East of the Rocky Mountains)	**3.2 lbs a.i/acre**	**19.2 lbs a.i/acre/crop cycle**	**6**	**7**
Grapes (West of the Rocky Mountains)	**2.0 lbs a.i/acre**	**6.0 lbs a.i/acre/crop cycle**	**3**	**7**

Crop	Maximum Application Rate		Number of Applications	Minimum Application Interval (days)
	Per Treatment	In Total		
Kale	1.6 lbs a.i/acre	3.2 lbs a.i/cutting	2/cutting	7
Mustard (GA and TN only)	1.2 lbs a.i/acre	2.4 lbs a.i/acre/crop cycle	2	14
Onion & Garlic	2.4 lbs a.i/acre	24.0 lbs a.i/acre/crop cycle	10	7
Onion (green) & Tomatoes (East of the Mississippi R)	2.4 lbs a.i/acre	16.8 lbs a.i/acre/crop cycle	7	7
Papaya	2.0 lbs a.i./acre	28.0 lbs a.i/acre/crop cycle	14	14
Peanuts	0.8 lbs a.i/100 lbs seed (Seed treatment)		1	NA
Pepper (East of the Mississippi River)	2.4 lbs a.i/acre	14.4 lbs a.i/acre/crop cycle	6	7
Pepper (West of the Mississippi River)	1.6 lbs a.i/acre	9.6 lbs a.i/acre/crop cycle	6	7
Potatoes (Maine only)	1.6 lbs a.i/acre	16.0 lbs a.i/acre/crop cycle	10	5
Potatoes	1.6 lbs a.i/acre	11.2 lbs a.i/acre/crop cycle	7	5
Safflower	0.1 lbs a.i/100 lbs seed (Seed treatment)		1	NA
Sunflower	0.4 lbs a.i/100 lbs seed (Seed treatment)		1	NA
Tomatoes (West of the Mississippi River)	1.6 lbs a.i/acre	6.4 lbs a.i/acre/crop cycle	4	7
Ornamentals [d]	1.2 lbs a.i/100 gal	Not specified		7
Turf [e]	17.4 lbs a.i/acre	Not specified		7

NA= Not applicable; **a=** including Cauliflower, Endive, Kohlrabi & Lettuce **b=** including AR & LA; **c=** excluding AR & LA; **d=** Trees, Herbaceous plants, Nonflowering plants & Woody shrubs and Vines; **e=** Residential, Commercial/Industrial, Gulf Course, Sod farm & Recreational.

Figure II-1, below, shows the general use areas for maneb across the US (USGS data 1990 -1993 and 1995).



EFED utilized OPP's Label Use Information System (LUIS) for maneb labels registered as of 10/31/2001, OPP's Reference Files System (REFS), the Maneb Use Closure Memo, and spot checking of currently registered maneb labels to determine what maneb use patterns posed the most significant risk to the environment. EPA use data (BEAD's Quantitative Usage Analysis for Maneb dated November 1, 2002) for the period 1992 through 2001 shows that 41% of the lettuce, 34% of the bell peppers, 34% of the sweet peppers, 39% of the pumpkins and 25% of the cabbage grown in the US are treated with maneb.

b. Approach to Risk Assessment

Maneb is a polymer or a highly coordinated salt complex, with unique properties. It is expected to be introduced to the environment at application rates resulting in soil concentration levels of <10 ppm and much lower concentrations in water bodies. When parent maneb is introduced into water bodies, by drift, at the expected low concentrations, it decomposes rapidly into the ***maneb complex*** including the degradate of concern ETU. In contrast, when parent maneb is introduced into soil or water/sediment systems, similar rapid decomposition occurs with most of the constituents of ***maneb complex*** partitioning into soil/sediment particles. ***Parent maneb*** terrestrial EECs were calculated using a spread sheet based on the slope of the 1^{st} order hydrolysis half-lives. However, Parameters determined from environmental fate studies and information on physicochemical properties were used in estimating aquatic EECs of the resultant ***maneb complex***. The major degradate of concern, ETU, was considered in the fate and exposure assessment in a separate RED document with consideration to all EBDCs (metiram, mancozeb and maneb). Normally, EFED would evaluate the risk(s) posed by a chemical's degradate(s) of concern within the risk assessment document for the chemical. However, since ethylene thiourea (ETU) is a common degradate for all the EBDCs (mancozeb, maneb and metiram) it was decided to address the environmental risk posed by ETU in a separate document and avoid repetitive references in the risk assessments for each of the EBDC chemicals. This approach to risk assessment was necessary because maneb decomposes very quickly, by hydrolytic reactions in water, into "multi species ***maneb complex***". Therefore, hydrolysis is the dominant factor in controlling ***parent maneb*** concentration and calculated hydrolysis half-lives are the parameter of choice for determining its fate. Measured parameters in fate studies were actually for ***maneb complex*** and were used to estimate the EECs for that complex.

To evaluate the potential risk to aquatic and terrestrial organisms from the use of maneb, risk quotients (RQs) are calculated from the ratio of estimated environmental concentrations (EECs) to ecotoxicity values (see Appendix IV). EECs are based on the maximum application rate of maneb for the use patterns currently registered. These RQs are then compared to the levels of concern (LOC) (see Appendix IV for these values) criteria used by EFED for determining potential risk to non-target organisms and the subsequent need for possible regulatory action.

When possible, sites having similar use patterns (application rates, timings, methods, number of applications, and intervals between applications) were grouped to evaluate the risks. Although maneb has numerous seed treatment uses (see Table 1, above) the RQs from these seed treatment uses were not calculated in this RED. Numerous seed treatment uses of mancozeb were evaluated in the mancozeb RED and no LOCs were exceeded. The avian acute LD_{50} of maneb (Bobwhite quail LD50 > 2,150 mg/kg) is practically nontoxic to birds and was greater than the avian acute LD50 for mancozeb (English sparrow LD50 ≈1,500 mg/kg). Since maneb is less toxic to birds on an acute basis than mancozeb and the exposure (rates of application) from these seed treatment uses are similar for maneb and mancozeb, EFED expects the acute risks to birds from eating maneb treated seeds is low. Since maneb is practically nontoxic to birds on an acute dietary basis (mallard duck LC50 > 5,000 ppm and bobwhite quail LC50 > 10,000 ppm) the acute dietary risks to birds eating food items exposed to spray applications of maneb is also expected to be low. Because of this EFED did not calculate RQs for acute dietary exposure. It should also be noted that maneb assessments for chronic risk to plants, acute/chronic risks to non-target insects, or chronic risk from granular/bait formulations to birds and mammals have not been evaluated because scenarios for evaluating these risks have not been developed.

EFED evaluated terrestrial exposure using EECs produced from the FATE version 5.0 model that calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. The model assumes initial concentrations on plant surfaces based on Kenaga predicted maximum and mean residues as modified by Fletcher *et al.* (1994) and assumes 1st order dissipation. Kenaga estimates and an explanation of the model with sample output are presented in Appendix II. EFED used a 3.2-day half-life as the total foliar dissipation half-life for maneb. EFED selected this half-life from the highest value provided in the half-life listing of Willis and McDowell, 1987 for maneb. This half-life value is based on total foliar residues not dislodgeable foliar residues and was determined in a study by Rhodes, 1977 performed on tomatoes. Willis and McDowell, 1987 also showed a maneb total foliar residue half-life of 2.8 days for snap beans (Rhodes, 1977). These studies, conducted in Florida, received 16.5 mm (0.6 inch) of rainfall during the measurement period. EFED uses the half-life listing values provided in Willis and McDowell, 1987 for modeling purposes to estimate total foliar residues half-lives.

EFED needs total foliar dissipation residue or total foliar residue (TFR) half-life information as a modeling input value to estimate terrestrial wildlife exposure. TFR is the total pesticide residue contained **both on the surface and absorbed into treated leaves**. EFED has no requirements for submitting such data now and relies on available half-life data chiefly from Willis and McDowell (1987). Since maneb TFR half-life information was limited from Willis and McDowell (1987), EFED reviewed half-life information from HED. EFED was initially drawn to explore HED's information because TFR half-life information was unavailable in Willis and McDowell (1987) for metiram, mancozeb, and ETU. HED receives dislodgeable foliar residue (DFR) dissipation half-life data (guideline 875.2100) to estimate exposures to individuals from working in an environment that has been treated with a pesticide (also referred to as reentry exposure). DFR is the pesticide residue **on treated leaves' surface**. For maneb and mancozeb HED (Dole and Dawson, 2003 and 2003b) provided the following (Table II-2) with MRID Nos. The Mancozeb Task Force provided the Newsome study through a literature submission (Ollinger, 2005).

Table II-2. Summary of Maneb DFR and TFR Data for Crops

MRID (Year)	CROP (Location)	Application Method	lb ai/Acre * Number of Applications	DFR Half Life	TFR Half Life
420449-04(90)	CA Grapes	Airblast	3.2 *3 (30-day intervals)	32.8 (day)	Not available

Table II-2. Summary of Maneb DFR and TFR Data for Crops

MRID (Year)	CROP (Location)	Application Method	lb ai/Acre * Number of Applications	DFR Half Life	TFR Half Life
415117-01(88)	NY Apples	Airblast	8.0 * 10 (7-day intervals)	17.8 (days)	Not available
451946-01(99)	NY Apples	Airblast	4.8 * 2 (7-day intervals)	7.2 (days)	Not available
451946-01(99)	WA Apples	Airblast	4.8 * 2 (7-day intervals)	23.6 (days)	Not available
419615-01(90)	CA Tomatoes	Ground boom	2.4 * 3 (10-day intervals)	7.5 (days)	Not available
420449-02(91)	FL Site 1 Tomatoes	Ground boom	2.4 * 9 (7-day intervals)	19.1 (days)	Not available
420449-03(91)	FL Site 2 Tomatoes	Ground boom	1.9 * 9 (7-day intervals)	9.9 (days)	Not available
Newsome, 1976	Canada Tomatoes	Groundboom	2.4 * 7 (7 days)	Not available	7.3[1,2]
Rhodes, 1977	FL Tomatoes	not available	not available	not available	3.2[3]
Rhodes, 1977	FL Snap beans	not available	not available	not available	2.8[3]
Mancozeb Study With Both DFR and TFR Data					
411339-01(86)	CA Grapes (Madera)	Airblast	3.2 * 3	15.2 (days)	14.9 (days)
411339-01(86)	CA Grapes (Fresno)	Airblast	3.2 * 3	9.6 (days)	9.3 (days)

Note 1 - Half-life values calculated by EFED from the data provided in the study.
Note 2 - TFR was from homogenized samples of the tomato fruit, only, submitted by the Mancozeb Task Force (Ollinger, 2005)
Note 3 - Source: Willis and McDowell (1987)

There were eight mancozeb, one metiram and six maneb DFR studies presented. Based on a review of all the EBDC DFR studies filed, EFED would expect a variation in DFR half-life values. This variation would be because of differences in application methods such as application rates, differences in crops such as morphology, and regional differences such as weather. HED's review showed the climate effect was a greater effect than the effect of crop morphology or application method. "The EBDC and ETU half lives were typically twice as long in the west as in the east..."(Dole and Dawson, 2003a).

Most DFR studies used the standard dislodging technique. The 1986 mancozeb study on grapes at Madera and Fresno, California (MRID 411339-01) also used the total extraction method (T. Dole, per. com., 9/13/01). Based on this mancozeb study EFED expects the EBDC's DFR half-life would be comparable to the EBDC's TFR half-life since the 1986 mancozeb study on grapes at Madera and Fresno, California showed similar DFR and TFR half-lives. EFED might not expect such a likeness if the pesticide showed systemic activity but none of the EBDCs are systemic.

Maneb's DFR half-lives range from 7.2 to 32.8 days based on the studies available from HED. Willis and McDowell (1987) shows 2 TFR maneb half-life values for 2 crops (that is, snap beans and tomatoes) . Given this limited information EFED feels it would be reasonable to use a 33-day TFR half-life for maneb as a conservative upper-bound estimate in this screening level assessment. EFED routinely uses the upper limit of TFR half-life values (that is, 35 days) provided in Willis and McDowell (1987) to perform screening level risk assessments. EFED expects maneb's DFR half-life would be comparable to the maneb's TFR half-life for most crops. The highest DFR value shown in Table II-2 is 32.8 days. It is reasonable to use this high-end estimate (that is, 33 days) in this screening level assessment. It is reasonable because it is the highest, most conservative, half-life value and the data available is limited. Maneb is used on more than 20 crop grouping (see Table II-1) or more than 40 crops. The maneb DFR studies in Table II- 2 provide half-life information on 4 crops (that is, grapes, apples, tomatoes, and turf) and TFR half-life information on 3 crops (that is, grapes, snap beans, and tomatoes).

EFED didn't find half-life values for metiram and mancozeb in Willis and McDowell, 1987. Because of this, EFED consulted HED for DFR half-life information. EFED wanted to decide if the high-end half-life value (35 days) in Willis and McDowell, 1987 was a reasonable foliar half-life estimate for metiram and mancozeb. The metiram DFR data from HED was limited. One study (MRID No.41339901, 1988) on California apples showed a 31.4-day DFR half-life. Given this limited data, EFED used a 35-day TFR half-life value for metiram's terrestrial EEC modeling. The mancozeb DFR and TFR half-life data were more robust. HED provided 15 DFR half-life values for 4 crops and 2 TFR half-life values for 1 crop. The high-end value for these mancozeb DFR and TFR half-lives was 35.4 days from a DFR half-life study done on California grapes (MRID No. 41836901, 1991). As a result, EFED used a 35-day TFR half-life value for mancozeb's terrestrial EEC modeling.

EFED used 35-day TFR half-life values for mancozeb's and metiram's terrestrial EEC modeling as high-end, conservative half-life values. EFED used a 3.2-day TFR half-life value for maneb chiefly because this value was listed in Willis and McDowell, 1987. EFED uses Willis and McDowell, 1987 as a standard source of TFR values for risk assessments. However, in retrospect, EFED should have included a 33-day TFR half-life for maneb's terrestrial EEC modeling as a conservative upper-bound estimate in this screening level assessment. EFED intends to include these extra calculations in the next revision of this RED. These new calculations for terrestrial EEC modeling will also require revisions to the RQ calculations. The RQs will increase because of these new calculations, using a 33-day TFR half-life value, because the exposure to wildlife will be greater. However, maneb's potential chronic risk to birds and mammals will remain unchanged. All maneb's uses exceed bird and mammal chronic LOCs using the 3.2 day TFR half-life value.

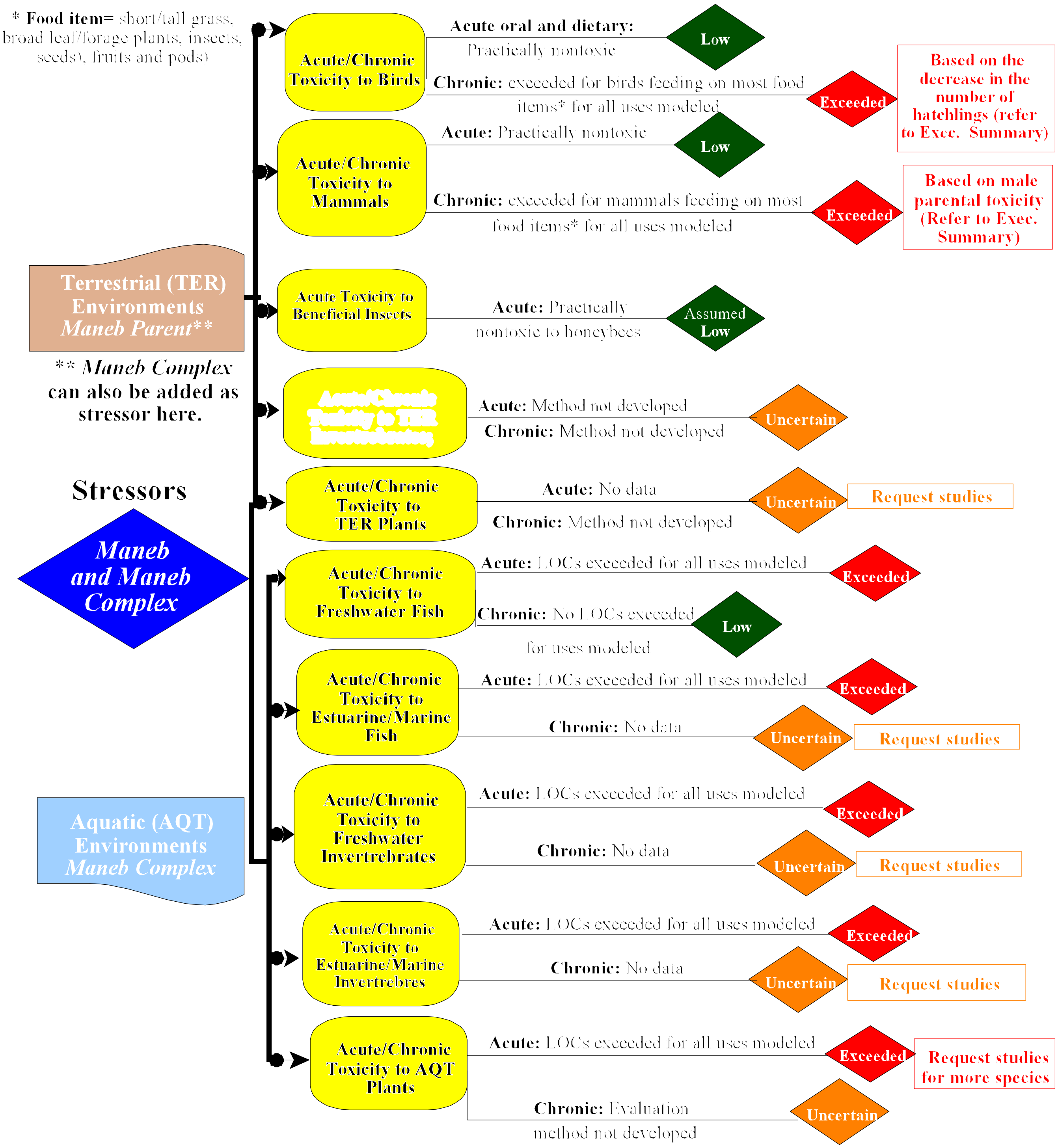
EFED assumed 3 applications of maneb to ornamentals and turf per crop cycle since the labeling did not show the number of applications that could be made. If the number of applications applied to ornamental and turf sites is greater than 3 applications then the risk to nontarget organisms would increase. The assumption of 100 gallons of finished spray per acre treated was also an assumption made for maneb applications to ornamentals. If lower finished spray rates are used then the pounds of maneb applied per acre are even greater than assumed which would increase the risk to nontarget organisms.

Monitoring data from field locations are not available for maneb. Because of this, EFED based maneb aquatic EECs on screening models. EFED modeled maneb's surface water concentrations using the Pesticide Root Zone Model version 3.1.2 beta (Carsel et al., 1997) and Exposure Analysis Modeling System version 2.98.04 (Burns, 1997) (PRZM/EXAMS) for Tier II estimates.

EFED looked specifically at the impact of EBDC usage on turf. Mancozeb and Maneb both include turf on their labels, but the actual usage is small relative to other crops. Use of fungicides is generally minimal on sod farms with mancozeb applied to 2600 acres (about 4 square miles) or about 0.9 percent of all sod grown in the United States. The average number of fungicide applications is 1.9 nationally with a maximum use rate of about 15 lbs a.i/acre applied in situations when either severe pest pressure conditions exist, or curative applications are utilized. Typical application rates are lower. Additionally, the non-systematic EBDCs serve as a rotational partner for the other systemic fungicides used in the pest management program. Therefore, risk associated with turf use pattern was not assessed for aquatic environments at this screening level risk assessment.

Conclusions based on this approach to the screening level risk assessment are summarized in Figure II-2.

Figure II-2. Summary of the screening level risk assessment for maneb in terrestrial and aquatic systems.



III. Integrated Environmental Risk Characterization

a. Overview of Environmental Risk

Based on available data, maneb use is expected to pose potential chronic risks to terrestrial birds and mammals. In the aquatic environment, it is concluded that maneb will present potential acute risk to freshwater/estuarine/marine fish and invertebrates as well as nonvascular aquatic plants. These potential risks occur for all or some of maneb's uses. Because EFED lacks data, EFED is uncertain about maneb's potential acute risk to terrestrial plants, chronic risks to freshwater invertebrates, chronic risks to estuarine/marine animals and acute risks to aquatic vascular plants.

Parent maneb is insoluble in water but is expected to decompose rather quickly, by hydrolytic reactions, into a multi species residue (***maneb complex***) consisting of transient species and degradates including the degradate of concern ETU. In dry conditions and in soils with very low water holding capacity ***parent maneb*** decomposition is slow. Maneb has low octanol/water partition coefficients (K_{ow}) suggesting that it would not be significantly bio-concentrated by aquatic organisms. Furthermore, maneb has a very low vapor pressure, thus indicating that volatilization is not an important dissipation pathway. Due to rapid hydrolytic decomposition, ***parent maneb*** is expected to exist in the natural environment for a short duration (<1 day). This rate is largely dependent on moisture availability and therefore in dry conditions and in soils with very low water holding capacity parent maneb will persist.

Most of the species present in the ***maneb complex*** are expected to partition into the soil/sediment particles; with varied strength of bonding. These soil associated materials are not largely affected by abiotic degradation but are susceptible to very slow bio-degradation further producing degradates, that might include ETU, at low concentrations and very slow rate.

Based on available data, EFED expects all maneb's uses to present potential chronic risks to birds and mammals. EFED relied on a referenced total foliar dissipation half-life value of 3.2 days to evaluate exposure to terrestrial organisms (Willis and McDowell, 1987). Maneb's DFR half-lives range from 7.2 to 32.8 days based on the studies available from HED. However, all maneb's uses exceeded bird and mammal chronic LOCs using the 3.2 day TFR half-life value. Avian chronic LOCs are exceeded for all uses patterns. RQs range from a high of 265 from the turf use to a low of 0.4 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). Mammalian chronic LOCs are exceeded for all uses patterns. RQs range from a high of 71 from the turf use to a low of 0.1 from maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only). EFED does not calculate risk quotients to conduct risk assessments on terrestrial invertebrates. Based on the lack of acute maneb toxicity to honeybees, EFED expects a low acute risk to nontarget terrestrial insects. Due to lack of data EFED did not assess risks to terrestrial plants or fully assess risks to aquatic plants. EFED is uncertain about maneb's risk to non-target terrestrial plants and needs testing performed at maneb's maximum rate of application in the environment. In the aquatic environment, EFED concludes maneb will present potential acute risk to freshwater/estuarine/marine fish and invertebrates as well as nonvascular aquatic plants. EFED selected representative maneb use patterns at maximum application rates and minimum intervals between applications for aquatic modeling. Maneb is used on more than 20 different crop groupings. The representative sites selected for aquatic modeling were apples, peppers, potatoes (Maine, only) and tomatoes. The acute RQs exceeding freshwater fish acute, acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 1.13 to 4.71. The acute freshwater invertebrates' RQs exceeding acute restricted use, and acute endangered species LOCs for all maneb's modeled uses range from 0.40 to 1.65. The acute estuarine/marine fish RQs exceed acute restricted use, and acute endangered species LOCs for all maneb's modeled uses with RQs ranging from 0.47 to 1.1. Estuarine/marine invertebrate acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb's modeled uses with RQs ranging from 15.87 to 65.97. Based on data for one surrogate species, maneb's modeled use patterns exceed acute risk LOCs for nonvascular aquatic plants with acute RQs ranging from 3.55 to 14.77. EFED has not received studies to evaluate the risk of *maneb complex* to vascular aquatic plants and needs testing performed on more aquatic nonvascular plants to evaluate fully the risk to aquatic plants. EFED did not assess chronic risks to freshwater invertebrates, estuarine/marine fish, or estuarine/marine invertebrates due to lack of data.

b. Key Issues of Uncertainty

i. Environmental Fate

EECs for ***parent maneb*** were estimated for water bodies using hydrolysis half-lives. The same water hydrolysis half-lives were used for soils assuming sufficient moisture is available in soil pores for hydrolysis to occur at the same rate. Uncertainty exists on whether half-lives used are applicable because of uncertainty related to soil moisture availability as soil moisture level is expected to impact resultant EECs. Lower EECs are expected in irrigated and/or rain-fed soils with high water holding capacity (WHC) and higher EECs are expected in low WHC soils under dry conditions. Giving the fact that maneb is applied to growing crops, moisture is expected to be available for parent to hydrolyze at an adjusted rate near or just below that determined from aqueous hydrolysis half-lives. Other factors that are known to affect hydrolytic stability of maneb include: particle size; molecular weight distribution; aqueous media pH and concentrations of O_2 [3]; and metal ions that are capable of exchanging structural Mn. However, the very low hydrolytic stability of parent maneb render consideration of such factors un-important.

EECs for ***maneb complex*** were estimated using the physicochemical properties and hydrolysis half-lives of parent maneb in addition to aerobic soil metabolism half-lives and sorption coefficients which were assigned to this complex rather than the parent. In all aerobic soil studies two separate sets of experiments/determinations were conducted: the ***first*** was to obtain data for calculating half-lives using the CS_2-method to quantify the parent while the ***second*** was to characterize the degradation process. EFED believes that half-lives calculated from the ***first*** set of experiments/determinations represent hydrolytic decomposition of ***parent maneb*** rather than bio-degradation. Rapid degradation of ***parent maneb*** produces a complex, the ***maneb complex***, which appears to be affected by slow

[3] Marshall, W.D. 1977. J. Agri. Food Chem. 25 (2), 357-361

degradation as indicated by production of CO_2. Part of this complex may contain precursor(s) for the degradate of concern, ETU. Therefore, EFED used the ***second*** set of experiments/determinations (radioactivity data) for calculating half-lives and assigned it to the ***maneb complex***. Uncertainty exists in these complex half-lives as they are affected by the validity of the assumption that the only bio-degradation of the complex was represented by evolved CO_2. Data obtained on degradates were not used as it were affected by impurities in the test materials, hydrolytic reactions and possible artificial degradation during extraction.

In this RED, aerobic soil half-lives calculated from the CS_2-method are considered to represent hydrolysis of ***parent maneb*** into its complex as modified by soil conditions (i.e. moisture content, pH and O_2 concentration). In contrast, half-lives calculated from evolved CO_2 are considered to represent bio-degradation of ***maneb complex*** left in the soil which appears to occur in parallel with hydrolytic decomposition of the parent. Likewise, calculated adsorption/desorption characteristics (K_d and K_{oc}) are thought to represent ***maneb complex*** as it were approximated from column leaching; with no 1/n value to indicate the degree of non-linearity for the Freundlich constant.

In the degradation process for maneb Mn ions/salts are expected to dissipate into the environment. No data were presented to evaluate the risk that might be associated with this release and therefore, uncertainty exists in this aspect of risk assessment.

Complete characterization of the fate of ***maneb complex*** requires more information on the various species that constitute this complex including the soil/sediment ***bound species***. Information needed are for each of these constituents and includes: their physicochemical properties and the nature of their association with soil/sediment particles.

Additional information is presented in the Appendix (Table I-B, Appendix I) detailing major problems in maneb fate studies which adds a degree of uncertainty for estimated fate parameters for ***parent maneb*** and ***maneb complex***, resultant EECs, and surface and groundwater modeling results.

ii. Ecological Effects

How does EFED expect maneb to act in the environment after it is applied? Maneb is applied to over 20 different crop groupings, with ornamental and turf uses (see Table II-1, p.6) to control plant diseases. Maneb has broad uses in the US and because of this EFED expects maneb to come in contact with non-target organisms across many taxa. EFED presumes applications of the maneb will occur when there is heavy plant disease pressure. Heavy disease pressure to plants results when there is high moisture from rains. These rains promote conditions for the growth and propagation of fungal species. EFED expects maneb applications will result in degradation of maneb to ***maneb complex*** including ETU on plant surfaces. EFED figures the hydrolysis of the maneb will be variable but rather fast, that is, about 1-day. Except for applications to dry soils in dry environments, EFED expects a rapid change of maneb into *maneb* ***complex***, including ETU.[4]

What effect does EFED expect maneb to have on non-target terrestrial species? From a short-term or acute exposure EFED expects maneb is a low risk to mammals and birds. This expectation is supported by toxicological studies and the lack of incident data. There are no incidents for maneb listed in the Ecological Incident Information System (EIIS) database dealing with adverse effects to terrestrial non-target organisms. EFED expects maneb's long-term or chronic effects on birds and mammals to be a potential concern. This belief is supported by toxicological studies. . EFED expects chronic problems that affect wildlife from the use of maneb would be largely unnoticed in the field and thus EFED would not expect incident reports, from adverse chronic exposure. Maneb's uses exceeds chronic LOCs for terrestrial animals (birds and mammals) for all maneb use patterns for all food categories in birds and for all food categories in mammals except for some seed categories. These exceedances occur on all terrestrial bird and mammal food items (that is, short grass, tall grass, broadleaf forage, insects, fruits, pods, and seeds). These chronic exceedances extend throughout the application periods for all uses ranging from 16 days for figs to 197 days for papayas (see Section VII, Terrestrial Risk Assessment, subsection d. Terrestrial Risk Assessment). In other words, there are potential reproductive risks to birds and mammals from the first application through the last application and beyond for all maneb's uses.

EFED used maneb's use on potatoes as an example (see Section VII, Terrestrial Risk Assessment, subsection d. Terrestrial Risk Assessment). Currently in Maine, up to 10 applications of maneb are allowed to be applied to potatoes every 5 days during the growing season. Pheasant, partridge, pigeon, dove, duck, geese, songbirds, antelope, and cottontail rabbits feed in potato fields. These animals feed on insects, vegetation in the treated area, or on the potato plants throughout the potato growing season (Gusey and Maturdo, 1972) which lasts 90-140 days (depending on the potato variety) from late Spring to early Fall. For birds feeding on short grass this potential chronic risk begins on Day1 and continues through Day 46 for a total exposure risk period of 46 days. For mammals, this same potential chronic risk from feeding on short grass also begins on Day1 and continues through Day 40 for a total potential chronic exposure risk period of 40 days (see Section VII, Terrestrial Risk Assessment, subsection d. Terrestrial Risk Assessment, Figure VII-5). For about 31 days after the first application to potatoes, there would be potential reproductive risks to birds and mammals feeding on short grass, broadleaf or forage plants, tall grass, and small insects. EFED used a mallard duck reproductive study to calculate the RQs for this assessment. EFED based birds chronic reproductive effects on decreases in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a decrease in the number of 14-day old survivors as a percentage of eggs.. EFED based mammal reproductive effects on a 2-generation study in rats.

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[4] Dry conditions is one circumstance that may explain the high-end (> 30 days) foliar dissipation half-life values for the EBDCs in general. EFED expects differences in application methods such as application rates, differences crops such as morphology, and regional differences such as weather also affect the foliar dissipation. Another reason that may cause longer foliar dissipation half-lives is sample analysis. Measurements quantifying the foliar dissipation half-life routinely use measurements of the evolved CS_2 in the headspace of a sealed vial. Such measurements quantify the sulfur from both the *parent EBDC* and the *EBDC complex* in the sample. This means the EBDC's foliar dissipation half-lives result from the presence over time of both the *parent EBDC* and the *EBDC complex*.

These mammal effects were male parental toxicity resulting in significant increase in lung weight (both generations) and liver weight (F1 generation) with lesions noted on these organs in the F1 generation.

Maneb is practically nontoxic to the honeybee from acute contact exposure. EFED does not perform risk quotient assessments for terrestrial insects. Based on the lack of acute maneb toxicity to honeybees, EFED expects a low acute risk to non-target terrestrial insects. EFED is uncertain about maneb's risk to non-target terrestrial plants and needs testing performed at maneb's maximum rate of application in the environment.

What effect does EFED expect maneb to have on non-target aquatic species? EFED expects maneb to reach aquatic environments through drift and runoff since maneb is not labeled for direct application to aquatic environments. Maneb's solubility was reported to range from range 6 to 200 ppm. EFED expects maneb to decompose rather quickly, by hydrolytic reactions, into a multispecies residue (*maneb complex*) consisting of transient species and degradates including the degradate of concern ETU. Once maneb reaches the aquatic environment EFED believes the *maneb complex* will be the portion of maneb that is biologically available to aquatic organisms. EFED expects most of the transient species present in the *maneb complex* to partition into the sediment particles with varied strength of bonding. Over time ETU is an important transformation product of the *maneb complex*. In aqueous media, transient species do not last long while ETU is persistent; unless it is subjected to rapid degradation by microbial and/or indirect photolysis.

Based on laboratory studies and modeled EECs, calculated RQs show that *maneb complex* is an acute risk to freshwater fish, freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrate, and nonvascular aquatic plants. EFED estimated the highest *maneb complex* aquatic EEC expected from drift and runoff would be 197.9 ppb. Based on this residue level and individual laboratory studies EFED estimated the likelihood of adverse *maneb complex* effects to individual organisms across taxa. These chance estimates show there is high likelihood (that is, 57 to 100%) of potential adverse acute effects to individual freshwater and estuarine/marine aquatic organisms from *maneb complex* (see section VI). Aquatic Exposure and Risk Assessment, subsection c. Aquatic Risk Assessment). EFED has no data to evaluate the chronic effects to freshwater invertebrates or estuarine/marine organisms. No chronic LOCs are exceeded for freshwater fish from maneb's uses. The study used to calculate the freshwater fish chronic RQs for this assessment are based on the following chronic effects: decreased hatchability; fish survival; and length of fry.

In the aquatic media, ETU is expected to be an important transformation product of all the *EBDCs* and can persist unless it is subjected to rapid degradation by microbial and/or indirect photolysis. The ETU acute RQs for nonvascular aquatic plants[5], freshwater fish and freshwater invertebrates were well below[6] the lowest LOC (endangered species LOC = 0.05) for aquatic organisms. EFED does not know how acutely toxic ETU is to estuarine/marine fish or invertebrates because no data has been

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[5] Based on green algae, (*Pseudokirchneriella subcapitata*) testing.

[6] The highest ETU RQ is 0.00014 (see EFED's ETU chapter).

reviewed for evaluating this hazard. This means the *maneb complex*, other than ETU, is responsible for the acute toxicity to freshwater fish, freshwater invertebrates, and nonvascular aquatic plants. EFED expects the acute toxicity to freshwater fish, freshwater invertebrates, estuarine/marine fish and nonvascular aquatic plants, from exposure to the *maneb complex*, will not last long. The acute fish studies have a duration of 96 hours, while the acute invertebrate studies last 48 hours and the nonvascular aquatic plant studies are 120 hours in duration. Acceptable aquatic half-life data is unavailable for most products of the *maneb complex*. EFED expects maneb to hydrolyze quickly (that is, within hours) to its residues. Based on this information, EFED expects the *maneb complexes'* acute toxicity to these aquatic organisms will last for 120 hours but suspects this toxicity will rapidly decline after this time period as these residues degrade to ETU. However, EFED expects there will still be enough *maneb complex* to present an acute risk to estuarine/marine invertebrates. EFED expects the acute risk to estuarine/marine invertebrates will persist because *maneb complexes* are very highly toxic to these organisms (mysid shrimp EC_{50} = 3 ppb). Modeled *maneb complex* EECs for selected sites range from 2.1 to 9.2 ppb 21 days after maneb applications (see section V. Water Resource Assessment, Table V.2). This combination of exposure and toxicity suggests acute LOCs would still be triggered for estuarine/marine invertebrates 21 days after maneb is applied.

EIIS reported maneb in three fish kill incidents (see Section VI, Incidents). One incident occurred in 1973, another in June,1994 and the latest occurred in August,1994. In the 1973 and June,1994 incidents, EFED classified maneb as unlikely to have been responsible for the these fish kills. The final maneb related incident, occurring in August, 1994, was reported by the Maine Department of Agriculture. In this incident roughly 10,000 newly released brook trout were killed in a pond that borders New Brunswick, Canada and Maine. Three pesticides (maneb, esfenvalerate, and chlorothalonil) recently applied to potatoes surrounding this pond were suspected in this fish kill. Tissue samples of the fish confirmed the presence of all three pesticides (maneb at 169 ppb, esfenvalerate at 4.2 ppb, and chlorothalonil at 20 ppb) in the fish. These fish samples were taken from both the pond and brooks feeding the pond. All three of these pesticides are very highly toxic to freshwater fish. Maneb's rainbow trout LC_{50} is 42.0 ppb, esfenvalerate's rainbow trout LC_{50} is 0.26 ppb (Hicks, L. May, 1995) and chlorothalonil's rainbow trout LC_{50} is 42.3 ppb (US EPA. 1998)]. The submitter of the incident report pointed out there were severe thunderstorms in the area preceding the fish kill which suggest pesticide runoff was a cause in this kill. Based on sampling evidence, EFED believes maneb was a contributory cause in this fish kill.

c. Endangered Species Conclusions

Based on available screening level information there is a concern for maneb's potential acute effects on listed freshwater and estuarine/marine animals and potential chronic effects on listed birds and mammals should exposure actually occur. EFED expects maneb poses a low acute risk to nontarget insects because maneb is practically nontoxic to honeybees, (acute contact LD_{50} > 12 µg/bee). Also, there is no incident data reporting adverse effects to honeybees from maneb's use. However, EFED does not assess risk to bees using RQs because a screening level RQ assessment method for estimating the risk to bees is not available. EFED has not developed an exposure design for bees to estimate the risk using a risk quotient method. The Agency does not currently have enough data to perform a screening level assessment for maneb's effects on listed nontarget terrestrial plants or vascular aquatic plants. EFED did not assess chronic risks to freshwater invertebrates, or estuarine/marine fish due to lack of data. There are no nonvascular aquatic plants or estuarine/marine invertebrate species on the endangered species list.

d. Endocrine Disruption Concerns

The Federal Food, Drug, and Cosmetic Act (FFDCA) requires EPA, as amended by the Food Quality Protection Act (FQPA), to develop a screening program. This program is to decide whether certain substances (including all pesticide active and other ingredients) “may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate.” Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined there was scientific basis for including, as part of the program, the androgen and thyroid hormone systems, as well as the estrogen hormone system. EPA also adopted EDSTAC’s recommendation including in the Program evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and FFDCA authority to require the wildlife evaluations. EPA will use FFDCA authority to evaluate effects in wildlife from tests that Food and Drug Administration uses to discover effects in humans. As the science develops and allows, EPA may add screening of more hormone systems to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and or testing protocols being considered under the Agency’s Endocrine Disruptor Screening Program have been developed, maneb may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption. The avian reproductive studies reviewed by EFED noted reproductive effects. These effects in mallard duck were decreases in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a decrease in the number of 14-day old survivors as a percentage of eggs. For mammals chronic effects were noted such as male parental toxicity resulting in significant increase in lung weight (both generations) and liver weight (F1 generation) with lesions noted on these organs in the F1 generation. See Appendix III for a detailed listing of the studies and results. These effects noted in both birds and mammals could be a result of hormonal disruptions. Chronic testing in freshwater fish showed decreased hatchability, fish survival and length of fry. See Appendix III for a detailed listing of the studies and results. These effects noted in freshwater species may be a result of hormonal disruptions.

EFED recommends that when appropriate screening and/or testing protocols being considered under the Agency’s EDSP have been developed, maneb be subjected to more definitive testing to better characterize effects related to its potential endocrine disruptor activity. EFED bases this recommendation on the the potential chronic effects in freshwater fish, birds and mammals.

IV. Environmental Fate Assessment

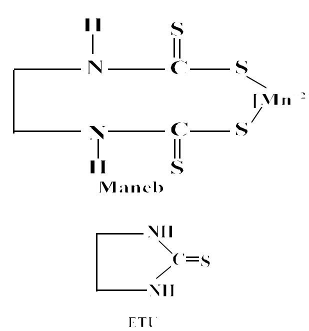
The fate of ***parent maneb*** was evaluated by considering data on its hydrolytic stability. Practically, ***parent maneb*** is short-lived, therefore it was important to evaluate the fate and transport of resultant ***maneb complex*** by its degradation processes in aqueous phases as well as soil and field environments. Transformation products identified in fate studies were also given the required emphasis here and in the accompanied RED chapter for ETU.

a. Chemical Identity and Physicochemical Properties

Maneb is a high molecular weight coordination polymer or a highly coordinated salt complex that is usually represented by one unit of the polymer; a monomeric Mn^{+2} ethylene bis-dithiocarbamate (EBDC). For maneb and related chemicals, the metal is bonded, by bridging, to the EBDC ligand through the sulfur atoms. Information pertaining to the chemical identity of maneb and its physicochemical characteristics are listed in table IV-1. Maneb water solubility was reported to range from range 6 to 200 ppm resulting in complete hydrolytic destruction of maneb into its multi species complex. Variations in reported solubilities were reported, by the registrant, to be related to uncertainties associated with each specific analytical procedure used for its determination (e.g. efficiency of sampling, energy supplied to promote solubilization and filtration procedure).

Volatilization from water and/or dry/moist soil surfaces is not expected to be an important dissipation process based upon vapor pressure and calculated Henry's Law constant. Maneb has a low K_{ow} suggesting that it will not be significantly bio-concentrated by aquatic organisms such as fish or aquatic invertebrates.

Table IV-1. Nomenclature and physical chemical identity of the maneb complex and ETU.

CAS	[[1,2-Ethanediylbis [carbamodithioato]]-(2-)]manganese	***Structure of Maneb and its Main Degradate ETU***
CAS Registry No.	12427-38-2	
PC Code	014505	
Molecular Weight	265.28 (C4-H6-Mn-N2-S4; monomeric unit)	
Formulated Products	liquid flowable; flowable suspension; wettable powder	
K_{ow}	5; based on its reported log of 0.69	
Vapor Pressure	< 9.97×10^{-11} atm @ 20 ^{0}C [1]	
Water Solubility	Rapidly decomposes in water [2]	

[1] US Dept Agric; The Pesticide Properties Database: http://wizard.arsusda.gov/rsml/textfiles/Maneb

[2] Registrant reported solubility in water to range frm 150 to 200 ppm (Pennwalt Corporation data with no MRID number assigned); Also reported to be 200 ppm (MRID 455959-01). In a new hydrolysis study (MRID 453936-01), no solubility data was submitted but the authors described maneb to be "a polymer that is insoluble in a wide variety of non-polar and polar solvents, including water". This contradicts with the 150-200 ppm values reported earlier by the registrant. In another reference an "estimated water solubility" was reported to equal 6 ppm (Wauchope R. D *et al*. 1991. Res Environ Contam. Toxicol. 123: 1-36).

b. Fate Processes

Table IV-2 contains a summary of data obtained from guideline studies conducted on maneb. Submitted guideline studies suggest that under typical application rates into natural environment, ***parent maneb*** is expected to decompose (within one day) by hydrolytic reactions and resists both water/soil photolysis or volatilization. Therefore, hydrolytic reactions are extremely important in the fate of ***parent maneb*** and its decomposition to ***maneb complex***.

Maneb complex consists of transient species, degradates and other unidentified materials. Based on data summarized in Table IV-2, the main process involved in ***parent maneb*** dissipation is hydrolysis. In contrast, the main processes involved in the fate of resultant ***maneb complex*** is its strong affinity for adsorption to the soil/sediment followed by limited biotic degradation. As a result of bio-degradation of the residue, slow and continuous release of transient species and degradates including ETU, at low concentrations, is expected to occur over time.

Mobility of ***maneb complex*** in the natural environment is expected to be limited because of its strong affinity to adsorption. In contrast, the degradate of concern (ETU) is predicted to be susceptible to leaching due to its high solubility and mobility. In the soil environment, ETU lacks stability which can limit its leaching, however, its slow and steady formation from ***maneb complex*** can overcome the lack of stability and make it available for leaching at low concentrations.

Table IV-2. Environmental fate data summary for maneb.

Parameter	*Value*	*Source (MRID)*
Hydrolysis	**Half-lives,** for the process of decomposition by hydrolytic reactions in water, depends on the pH of the aqueous media as follows: **Acidic:** $t_{1/2=}$ **4 Hours** @ pH 5; **Neutral:** $t_{1/2=}$ **3 Hours** @ pH 7; **Basic:** $t_{1/2=}$ **3 Hours** @ pH 9.	**453936-01**
Photo lysis	**Not important** in water (***direct photolysis)***, No data for ***indirect photolysis***	**404656-02**
	Not important on soil	**404656-03**
Aerobic Soil Metabolism	**Half-lives were calculated by EFED based on evolved CO_2:** $t_{1/2}$**= 145 days** Speyer loamy sand soil; Germany (54% sand, 41% silt, 5% clay, pH 5.7, 2.11% organic carbon, and CEC of 9 meq/100g soil).	**405852-01**
	$t_{1/2}$**= 075 days** Speyer sandy loam soil; Germany (37% sand, 57% silt, 6% clay, pH 5.8, 0.82% organic carbon, and CEC of 7 meq/100g soil).	**405852-01**
	$t_{1/2}$**= 270 days** Collamer silt loam, a silt loam soil (29% sand, 61% silt, 10% clay, pH 6.1, 2.09% organic carbon, and CEC of 13 meq/100g soil).	**451452-02**

Parameter	Value	Source (MRID)
Anaerobic Soil; Aerobic Aquatic Metabolism; and Bio-accumulation Factor : No acceptable studies.		
Anaerobic Aquatic Metabolism	Complete degradation within one Hour for ***parent maneb***; The sediment bound part of ***maneb complex*** appears to be persistent and ***maneb complex*** appears to be practically stable based on evolved CO_2 (Maximum of 2.75% at 275 days)	**001633-35**
Adsorption Coefficients for maneb *complex (L Kg^{-1})**	**Loamy Sand:** K_d = 35.70 and $\mathbf{K_{OC}}$ **= 1,692** (a.i. used)	**405852-03**
	Sand: K_d = 7.46 and $\mathbf{K_{OC}}$ **= 6,412** (a.i. used) **Sandy Loam:** K_d = 9.10 and $\mathbf{K_{OC}}$= **978** (a.i. used) **Clay Loam:** K_d = 6.97 and $\mathbf{K_{OC}}$ = **428** (a.i. used) **Silt Loam:** K_d = 2.23 and $\mathbf{K_{OC}}$ = **400** (a.i. used)	**400472-01**
	Sand: K_d = 3.18 and $\mathbf{K_{OC}}$ = **454** (a.i. used)	**455959-01**
	Sand: K_d = 10.21 and $\mathbf{K_{OC}}$ **= 1,459** (formulation used) **Loamy Sand:** K_d= 25.96 and $\mathbf{K_{OC}}$ **= 1,133** (formulation used) **Sandy Loam**: K_d= 13.72 and $\mathbf{K_{OC}}$= **1,024** (formulation used)	**455959-02**

***** A suite of maneb degradation products and transient species.

i. Aqueous Solutions

Maneb is a non-homogenous or a highly coordinated salt complex, with variable molecular weight. When suspended in water it decomposes rapidly by hydrolytic reactions into transient species and degradates including ETU. The amount affected by hydrolytic reactions appears to depend on particle size distribution and molecular weight distribution of the maneb polymer as well as temperature, metal ions present, and available oxygen. Hydrolytic decomposition results from detachment of the coordinated EBDC ligand from the metal by oxidation. In turn, the water soluble free ligand reacts with water to produce predominantly transient species and ETU.

Two supplemental hydrolysis studies were submitted for maneb. In the first study, ^{14}C-maneb was used at levels of 22- 40 ppm while in the second study the concentration level was 10 ppm. In the first study (MRID 404656-01), the parent decomposes rather quickly (preventing determination of half-lives) resulting in EBIS (5,6-Dihydro-3H-imidazo[2,1-c]-1,2,4-dithiazole-3-thione; a transient species), un-identified degradate, ETU (4,5-Dihydro-1H-imidazol-2-thione), EU (2-Imidazolidinone) and low quantities of glycine (only at pH 3). The second study consisted of two identical hydrolysis experiments: one was for identifying/quantifying degradation products while the other was for calculating hydrolysis kinetics (MRID 453936-01). Major identified degradates, at all pHs, included the transient EBIS and the degradates ETU, EU and one unknown compound. Minor degradates were Jaffe's base "J.B= [3-(2-Imidzaolin-2-yl)-2-imidazolidinethione]" and un-identified others. Registrant calculated first order half-lives at 25 ^{O}C were 4, 3, and 3 hours at pH 5, 7, and 9, respectively.

Direct photolysis studies on maneb were complicated by its rapid degradation upon suspension in water at concentration levels used (22 ppm in MRID 404656-02 and 10 ppm in MRID 420701-02). Identified degradation products were similar to those formed in hydrolysis studies with the exception of formation of minor amounts of ETT (4,5-Dihydro-1H-imidazol-2-thione-1-thiocarboxamide). It appears that although the degradation of maneb suspensions in water is primarily dominated by hydrolysis, there is a small contribution of photo-reactions likely to be linked to reactions related to transient chemical species.

ii. Soil

A 30-day photo-degradation study on a loamy sand soil showed no significant difference between samples exposed to simulated sunlight and those kept in the dark in the product pattern, the relative amounts of degradation products and their formation/decline (MRID 404656-03). Although maneb was never detected (^{14}C-maneb used was 8.6 ppm), a suite of degradates were detected in the extractable fraction (24- 19% of the applied radioactivity by methanol and 9-14% of the applied radioactivity by water) included EU, ETU, EBIS, carbimid, and an un-identified polar fraction. This indicates that photolysis appear not to be an important processes in dissipation of maneb in soils.

Two supplemental aerobic soil studies were submitted for maneb (MRID 451452-02 and 405852-01). Many reasons were sited for the assigned classification for these studies. Some of these reasons are related to the nature of the test substance (may not be able to control) including: impurity (purity ~ 84.8%) and instability of the test substance (in the rejected study parent was never detected even at time zero). However, reasons that may have controlled included: non-determination of mass balance, exclusion of un-extracted bound species, incomplete characterization of degradation products, insufficient duration (for example, on day 60, 81% of the total residues remained in the soil with substantial degradation appeared to start between days 30 and 60), and inadequacy/uncertainty of the procedures used in quantifying the parent maneb and degradates (CS_2 and TLC methods).

One soil was used in the first study with fortification level of 15-21 ppm (MRID 451452-02) while two soils were used in the second study with fortification level of 9 ppm of ^{14}C maneb (MRID 405852-01). DT_{50} of <1 day was estimated for the first soil (MRID 451452-02) while parent was never detected in the other two soils (MRIDs 405852-01). As shown for EBDCs, parent degradation in aerobic soils can be attributed to chemical hydrolysis rather than bio-degradation. Furthermore, EFED suggests a second process to be involved in maneb degradation in aerobic soil; a very slow bio-degradation occurring in parallel with the first very rapid hydrolysis. In this scheme, the *first* process transforms ***parent maneb*** into a multi species residue (***maneb complex***) while the *second* process transforms ***maneb complex*** into further degradates and CO_2. Therefore, a second set of half-lives were calculated by EFED for the ***maneb complex*** as species present in this complex can be precursors for the degradate of concern, ETU. For this purpose, EFED used the mass balance data (radioactivity data) from both studies and assumed that the only bio-degradation of the complex was represented by evolved CO_2. EFED calculated first order half-lives for ***maneb complex*** are summarized in Table IV-2 and indicate that the complex is moderately persistent (half-lives in the range of 75-270 days). It is important to note that these estimated half-lives are conservative as it is based on complete mineralization of the ***maneb complex*** into CO_2.

Transformation products in the supplemental aerobic soil study (MRID 451452-02) were identified/ quantified only in the basified acetonitrile:water extract by HPLC/MS. The list of metabolites included:

ETU (Ethylenethiourea; 2-imidazolidinethione): was 5-6% of the applied at time 0, a maximum 7-8% at 1 day post-treatment, 2-3% at 4 days, and <1% at 30 days.

EBIS or DIDT (5,6-dihydro-3H-imidazo-[2,1,-c]-1,2,4-dithiazole-3-thione): was 14-18% of the applied at time 0, 10-11% at 2 days, 5-6% at 4 days, and <1 at 30 days.

EU (Ethyleneurea; 2-imidazolidone): was a maximum of 1% of the applied at 2 days and decreased to <1% at 30 days.

iii. Sediment/Water Systems

In an anaerobic aquatic soil study (MRID 001633-35), the natural lake Mendota sediment (55% sand, 40% silt, 5% clay, 8.3% organic matter, 7.9 pH and 14 meq/100g CEC) and water (pH 7.9 and dissolved oxygen 9 ppm) were fortified with ethylene-labeled ^{14}C-maneb at ≈ 9 ppm level. Maneb was never identified, however, radioactivity partitioned into the water and the sediment with the latter being mainly non-extractable. Total radioactivity partitioned into the soil increased steadily to reach a plateau of nearly 70% within 100 days of application with most being bound un-extractable. Under the aquatic anaerobic conditions of the experiment, maneb degraded by hydrolysis into the transient EBIS, two major degradates ETU and EU, and one minor un-identified degradate. Although EBIS was equally divided between the soil extractable and water phases, both ETU and EU were more prominent in the water phase reflecting their high solubility compared to EBIS. No aerobic aquatic metabolism studies have been submitted.

iv. Bound Species, CS_2-data and Half-life Determination for EBDCs

The registrant claims that the CS_2-method quantitatively determines sulfur containing dithiocarbamates (parent EBDCs and EBDCs species formed by hydrolytic reactions) in aqueous media, soil and water/sediment systems including ***bound species*** to soil/sediment. In support, the registrant stated that CS_2 based methods were used early in the discovery of EBDCs [7] and later with improvements in safety and methods employed in CS_2 determination [8]. It was also argued that

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[7] Clark, D.G., Bauam, H., Stanley, E.L., and Hester, W.F. 1951. Anal. Chem. 23, 1842.
Lowen, W.K. 1951. Anal. Chem. 23, 1846-1850. And in 1953. J. AOAC 36, 484-492.
Pease, JL. 1957. J. AOAC 40, 1113-1118.

[8] Gordon, C.F., Schuckert, R.J. and Bornal, W.E. 1967. AOAC 50 (5), 1102-1108.
Bighi, C.J. 1961. J. Chromatog. 14, 348-354.
Bighi, C.J. 1961. J. Chromatog. 17, 13-22.
McLeod, H.A. and McCulley, K.A. 1969. AOAC 52 (5), 1226.

classical chemistry suggests that the dithiocarbamate functionality would not be stable under the acid hydrolytic conditions used by the CS_2-method to release CS_2. Many literature examples were cited to indicate method reliability including: demonstration of rapid EBDCs degradation at elevated temperatures and acidic conditions in aqueous media[9]; recommendation, after careful review, of a similar method for analysis of dithiocarbamate residues by a Panel set up by the Committee for Analytical Methods for Residues of Pesticides and Veterinary Products in Foodstuffs of the Ministry of Agriculture, Fisheries, and Food (MAFF) in 1977[10]; obtaining a recovery of 98.0 ± 15.8% for mancozeb in *freshly fortified* control *soil* samples[11]; and the extensive use of the method for over 10 years with the greatest effort towards *crop residue* analysis. Therefore, the registrant argues that the appropriate method for calculating half-lives of EBDCs in fate studies is the use of CS_2-method data rather than the evolved CO_2-data. Half-lives obtained for parent EBDCs are expected to be conservative due to the fact that CS_2 is expected to evolve not only from parent but also from EBDC species/degradates containing structural sulfur (e.g EBIS and ETU).

With one exception, EFED agrees with conclusions stated above and therefore, the use of CS_2-data was acceptable for calculating conservative ***parent EBDCs*** half-lives in aqueous hydrolysis studies. In addition, EFED suggests that calculated half-lives, on the basis of CS_2-data, are acceptable as parent hydrolysis half-lives in soil and water/sediment systems. The exception is that EFED can not consider the significant ***bound species***, in aerobic and aquatic studies, to be included as part of the species determined by the CS_2-method in the absence of their complete characterization. Quantitative generation of CS_2 from largely *known EBDC species* in aqueous media and possibly in *plant residue* and *freshly* fortified *soil* may not necessarily be comparable to *unknown EBDCs species* in *aged soil/sediment*. In the absence of characterization data on the significant ***bound species***, EFED has no other way to calculate bio-degradation half-lives other than the use of evolved CO_2-data. EFED recognizes that resultant bio-degradation half-lives would be conservative as it represents complete mineralization of the EBDCs complex as a whole. Giving the fact that ***parent EBDCs*** are short-lived, it was necessary to assign these half-lives to all of the hydrolytic products which were referred to as the ***EBDCs complex***. EFED believes that it is justified to use the term ***EBDCs complex*** and to use CO_2 for calculating its half-lives in soil and water/sediment systems.

In few of the submitted fate studies, only limited data were provided on the significant ***bound species*** found in soil and water/sediment studies. Fractionation of the bound species was performed into fulvic and humic fractions with no further determination of identity/quantity of species present. Without presenting direct evidence, the registrant stated that consistent with current mechanistic studies, "bound EBDC' is significantly comprised of short-chain polar degradates such as

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9 Marshall, W. D. 1977. J. Agri. Food Chem. 25(2): 357-361.

10 Panel on: *Determination of Dithiocarbamate Residue* of the Analytical Methods for Residues of Pesticides and Veterinary Products in Foodstuffs of the Ministry of Agriculture, Fisheries, and Food (MAFF). 1981. Analyst 106: 782-787.

11 MRID 451452-02: Aerobic Soil Metabolism of [14C] Mancozeb in Soil, Xenobiotic Laboratories Inc., XBL Report No. RPT006055, 06/09/00.

ethylenediamine "EDA". In support of this suggestion, the registrant stated that EBDCs may degrade via two different[12], routes with both routes eventually forming EDA, which in turn transformed into glycine[13]. Other cited literature include: a report that the EDA has a Freundlich adsorption coefficient range of 15-238 suggesting that it binds strongly to soil[14]; and low levels of EDA were identified in soil samples from at least one cropped field treated with maneb, at normal commercial rates, in Ottawa, Canada[15].

As stated above, the registrant is proposing two possible theories that may explain the nature of the bound species, namely: EDA and polar natural products. However, in the soil/sediment studies, sulfur balance appears to decrease with time coinciding with the observed increase in ***bound species*** which would suggest that the bound species contain sulfur. EDA has no structural sulfur and its presence as a major part of the ***bound species*** can not explain the observed sink in sulfur balance. This sink may, however, be explained by the presence of EBDC species with high affinity to soil/sediment and in which structural sulfur resists being evolved, as CS_2, by reagents/heat used in the CS_2-method. Therefore, EFED is proposing that the ***bound species*** are probably sulfur containing compounds that can be "ETU precursors". In absence of data on the identity of the significant and persistent ***bound species***, EFED suggests that the "ETU precursor" theory has more relevance than the EDA because the former can explain the observed sink in sulfur balance. Additional reasons include: EDA was identified at ***low levels in only one*** hydrolysis study and this identification was carried out by the TLC method without confirmation; the rapid degradation predicted for EDA in water/soils using US EPA EPI suite program v3.10; and the non-detection (possibly because they were not tracked) of any form of sulfur bearing compounds (such as: elemental sulfur, sulfates, CS_2, H_2S and others) that may have formed in any of the submitted fate studies.

In order to solve the problem of the identity of ***bound species***, EFED proposes that the registrant conduct one complete aerobic soil study. In the proposed study, greater efforts should be exercised to try to characterize ***bound species***. In addition, EDA; and ETU, EBIS, and all types of sulfur bearing compounds should be tracked (possibly by labeling structural sulfur in ***parent EBDC***). A sterile soil treatment should also be included in order to determine the relative importance of the active dissipation/degradation processes in aerobic soils (binding to soil/hydrolysis compared to bio-degradation).

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12 Marshall, W. D. 1977. J. Agri. Food Chem. 25(2): 357-361.

13 Caldwell, J., and Cotgreave, I. A. 1984. Methodol. Surv. Biocchem. Anal. 14, 47; and van Dijken, J. P. 1981. Bos. Arch. Micobiol. 128, 320.

14 Davis, J. 1993. Env. Tox. & Chem. 12:27-35.

15 Newsome, W. H., *et al.* 1975. J. Agric. Food Chem. 23(4): 756-758.

c. Mobility

Mobility in soil studies were complicated by the instability of the parent as maneb was not identified at time zero in the TLC procedure nor after aging in soil column leaching. Therefore, mobility as indicated by R_f or K_d /K_{oc} values do not represents maneb but rather ***maneb complex*** formed as a result of the observed rapid hydrolysis. Five studies were submitted on mobility of maneb (MRIDs 00658-59, 405852-03, 400472-01, 455959-01 and 455959-02) and all were classified as supplemental due to non-detection of maneb (fortification in the range of 9 to 24 ppm) and non-characterization of the test substance at time zero, use of wettable powder formulations as source for radiolabeled parent, incomplete identification/ quantification of the degradates, and the use of unacceptable methods for the analysis of parent (i.e bioassay). Most of the listed procedural deficiencies are probably related to parent instability and may not be possible to avoid, however, some may contribute to uncertainty in the results. For example, the use of formulation instead of pure active ingredient increased estimated K_{oc} for the same sandy soil from 454 to 1,459; formulated products were used to increase stability.

In TLC plates, determined R_f values ranged from 0.0 to 0.43 (Table IV-2). These values were taken to indicate immobility to medium mobility of ***maneb complex*** in a muck soil and four soils with varied clay and organic matter content. Results from soil column leaching studies were similar as it indicated immobility to medium mobility from estimated K_d /K_{oc} with no apparent relationship between estimated mobility and clay or organic carbon contents. Furthermore, column leaching profiles indicated that most of the radioactivity remained in the top 3-4" of the soil column (65-93%). Leached radioactivity varied from <5% in half of the soil column while it ranged from 10-32% in the other half with no apparent relationship to soil texture or organic matter. It is interesting to note that leached radioactivity were <5% in soils fortified with wettable powder formulations. Leached radioactivity increased from 4% to 12% when one of these soils were fortified with the active ingredient.

In submitted studies, soil residues were not fully characterized as data were only reported for some soils. Reported data show no parent was present and that the dominant constituents of the residue were ETU, EBIS and carbimid in the soil column and ETU and EU in the leachate.

d. Field Dissipation

Field dissipation for ^{14}C-parent maneb, at a rate of 2 lb a.i/acre, was studied using in situ soil columns of Keyport silt loam soil (Clay= 21%, O.C= 1.34%, pH= 5.4, and CEC= 9 meq/100g) isolated by 12" sections of 4" diameter stainless steel tubing. The study was conducted for 52 weeks and received a total of 51" of rainfall (MRID 000889-23). Half life of 1-2 months ($DT_{50} \approx$ 48 days) was estimated from the "total radioactivity" remained in the whole 12" soil column. EFED calculated first order half-life from the same data gave a t½ of 301 days (R^2= 0.73). This terrestrial dissipation t½ is not far from the aerobic soil t½ of 270 days (r^2=0.9595) determined for ***maneb complex*** based on evolved CO_2. The study was classified as "supplemental" because it was not conducted under actual use conditions, test substance was not a typical end use product, half-life was based on radioactive residues, radioactive residues were not characterized (i.e. maneb was never identified), degradation products were not addressed and field test data were not reported.

Two terrestrial field dissipation studies were conducted using maneb flowable formulation applied in seven applications of 2.4 lb a.i/acre each in one-week intervals. According to the study authors maneb dissipated with a calculated first order half-life ($t_{1/2}$) of 12 days in Hanford loamy sand plots planted with tomatoes in California (MRID 417430-01) and 40 days in a Norfolk sandy loam plots planted with snap beans in Georgia (MRID 417430-02). Although, problems were associated with these two studies, the results indicate that substantial amounts of maneb can be intercepted/persist on plant surfaces. Disc incorporation of tomato plant residues into the top 6" one month after the last application returned enough maneb residue to raise/sustain the concentration of maneb in the top 3" of the soil for more than two months. Determined levels of maneb in the top 3" of the soil increased to levels higher than any single soil concentration determined after each of the seven applications. In these studies, the only monitored degradate was ETU which was detected mainly during the application period in the top 3" of the soil and in the range of 0.01 and 0.053 ppm (near its detection limit of 0.01 ppm which corresponds to degradation of only 1% of the applied parent). In California, ETU was detected too infrequently and at a maximum level of 0.015 ppm (corresponds to degradation of only 1.6% of the applied parent). In contrast, ETU levels in Georgia ranged from 0.014 to 0.053 ppm corresponding to degradation of only 1.5 to 5.5% of the applied parent. Parent depth profile suggested evidence of leaching to a maximum depth of 6" following the first application in California plots and to a maximum depth of 24" following the first and second applications in Georgia plots; leaching to 24" was attributed to vegetative matter being disked under. At the analytical sensitivity of the method ().01 ppm), ETU showed no evidence of leaching below the top 3" of the soil in either California or Georgia.

e. Bio-accumulation

The fish bio-accumulation study was waived based on reported low K_{ow} value of 5 for maneb. K_{ow} value indicates low potential for bio-concentration in aquatic organisms such as fish.

V. Water Resource Assessment

Parent maneb is not expected to be present in significant amounts in the environment except for short duration because it will hydrolyze rather quickly into its complex. More details about ***parent maneb*** EECs are presented in Appendix I (section *b. i*).

This water resource assessment is for ***maneb complex***; the resultant complex from expected rapid hydrolysis of ***parent maneb*** in the natural environment. ***Maneb complex*** was determined to consist of a suite of chemical species: transient species (EBIS, carbimid and TDIT), ETU, ETU degradates (EU, hydantoine and others), and the significant unknown ***bound species*** (suspected of containing persistent precursors for ETU). Among the constituents of ***maneb complex***, ETU is the species of concern. Therefore, a complete water resource assessment was performed for ETU while only surface water modeling was necessary for ***maneb complex***. The resultant EECs were used in the ecological risk assessment of ***maneb complex***.

a. Surface Water Monitoring and Modeling

EFED is not aware of surface-water monitoring data for maneb. Monitoring data were submitted to the Agency by the EBDC Task Force only for the degradate of concern ETU, this data will be discussed separately in the accompanied RED chapter for ETU. The surface water assessment of ***maneb complex*** is therefore based upon computer modeling.

Screening assessments for ***maneb complex*** were completed using the linked PRZM and EXAMS models. PRZM/EXAMS input values are listed in Table V-1 and the results in Table V-2. This data were used for estimating EECs necessary for the ecological risk assessment of ***maneb complex***.

Table V-1. PRZM/EXAMS Input Parameters for ***maneb complex****.

Input Parameter	*Value*	*Reference*
Molecular Weight (grams)	265.36	Registrant data
Vapor Pressure (torr)	7.577 e-8	Registrant data
Bacterial Bio-lysis in the water column (days)	0 (Stable)	Guidance** because: No aerobic aquatic metabolism study/significant hydrolysis
Bacterial Bio-lysis in benthic sediment (days)	0 (Stable)	MRID 001633-35
Aerobic Soil Metabolism Half-life (days)	271	Upper confidence bound on the mean for three soils (MRIDs 405852-01 and 451452-02).
Application Method	Aerial	Product Label
Depth of Incorporation (inches)	0	Product Label
Application Efficiency (fraction)	0.95	Guidance**
Spray Drift (fraction)	0.05	Guidance**

Input Parameter	*Value*	*Reference*
Solubility (mg/L or ppm)	150	Registrant data
K_{oc} (L Kg^{-1})	946	Average for eight soils (MRIDs 405852-03, 400472-01, 455959-01, and 455959-02)
pH 7 Hydrolysis Half-life (days)	0.13	MRID 453936-01
Photolysis Half-life(days)	0 (Stable)	MRID 404656-02

* Parent maneb Parameters for Molecular Weight (grams); Vapor Pressure (torr); Solubility (mg/L or ppm); and pH 7 Hydrolysis Half-life were used.
** Guidance for Chemistry and Management Practice Input Parameters For Use in Modeling the Environmental Fate and Transport of Pesticides, Version 2/November 7, 2000.

Table V.2. PRZM/EXAMS output EECs for ***maneb complex****

Crop	*Rate (lbs/Acre)*	*Number of Applications*	*Interval*	*Peak*	*96 Hour*	*21 Day*	*60 Day*	*Annual Average*
Apples (NC)	4.8	4	7	84.0	14.4	4.1	1.8	0.3
Peppers (FL)	1.6	6	7	113.0	16.7	5.4	2.1	0.4
Potatoes (ME)	1.6	7	5	47.6	6.7	2.1	1.0	0.2
Tomatoes (FL)	1.6	7	7	197.9	31.6	9.2	4.0	0.7

b. Ground Water Monitoring and Modeling

EFED is not aware of ground water monitoring data for maneb. Monitoring data were submitted to the Agency by the EBDC only for the degradate of concern ETU, this data will be discussed separately in the accompanied RED chapter for ETU. No ground water modeling was performed for maneb complex because the only species of concern is ETU for which modeling can be found in the accompanied ETU RED chapter.

c. Drinking Water Assessment

Assessments for surface/ground drinking water were only performed for the degradate of concern, ETU. This assessment can be found in the accompanied chapter for ETU.

VI. Aquatic Exposure and Risk Assessment

a. Hazard Summary (Acute/Chronic)

Acutely, maneb is very highly toxic to cold water (freshwater) fish (LC_{50} = 42 ppb), highly toxic to slightly toxic to warm water (freshwater) fish (LC_{50} = 170 - 68,000 ppb) and highly toxic to estuarine/marine fish (LC_{50} = 180 ppb). Early life-stage chronic freshwater fish NOAEC and LOAEC values were determined to be 6.1 and 12 ppb, respectively, with reduced hatchability, fish survival and length of fry being the endpoints affected. EFED needs a freshwater fish life cycle test using the TGAI for maneb. EFED needs this testing because the end-use product is expected to be transported to water from the intended use site and EECs are greater than one-tenth of the NOAEC in the fish early life-stage. The PRZM-EXAMS modeled peak EECs for selected sites in maneb's current use patterns range from 47.6 ppb for potato applications to 197.9 ppb for tomato applications. Acute toxicity values for aquatic invertebrates suggest that maneb is highly toxic to freshwater invertebrates (Daphnia EC_{50} = 120 ppb) and highly to very highly toxic to estuarine/marine invertebrates (oyster EC_{50} = 280 ppb and mysid shrimp EC_{50} = 3 ppb). No acceptable data has been filed to assess the chronic effects of maneb to freshwater invertebrates, estuarine/marine invertebrates, or estuarine/marine fish. EFED needs toxicity tests to fulfill these needs (see Appendix III). A supplemental Tier II aquatic plant growth study reviewed on maneb showed the EC_{50} was 13.4 ppb and the NOAEC was 5 ppb. The endpoint affected was growth inhibition. The test species in the study was green algae *(Selenastrum capricornutum*), a freshwater nonvascular plant. There was no data filed to evaluate the affects maneb has on the additional aquatic test species: duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), and a freshwater diatom. Also, EFED needs a core study for a freshwater green alga (*Selenastrum capricornutum*). Aquatic plant growth studies at the Tier I or Tier II level (guidelines 123-1 or 123-2, respectively) needs to be submitted for these species (see Appendix III). Toxicological Endpoints Used to Determine Aquatic Risk Quotients (RQs) for Maneb are presented in Table VI-1.

Table VI-1: Toxicological Endpoints Used to Determine Aquatic Risk Quotients (RQs) for Maneb

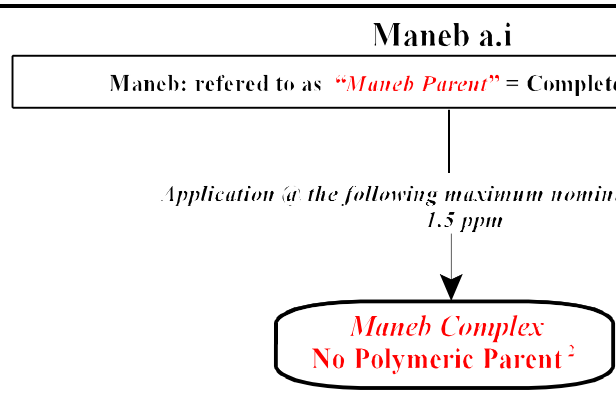
Type of Toxicity	*Organism*	*Species*	*Toxicological Endpoint*
Acute	Freshwater fish	rainbow trout (Oncorhynchus mykiss)	LC_{50} = 42 ppb
Chronic		fathead minnow *(Pimephales promelas)*	NOAEC = 6.1 ppb[1]
Acute	Freshwater invertebrate	waterflea *(Daphnia magna)*	LC_{50} = 120 ppb
Chronic		no data	no data
Acute	Estuarine/marine fish	Atlantic silverside *(Menidia menidia)*	LC_{50} = 180 ppb
Chronic		no data	no data

1. Based on hatchability, fish survival and length of fry
2. Estimated level because of high variability in measured concentrations; analytical procedures were not able to detect maneb below 5 ppb.

The EDBCs (metiram, mancozeb, and maneb), unlike most pesticide active ingredients are not well-defined monomeric substances. The EBDCs are polymeric complexes and are nearly insoluble in water with a high affinity to adsorption by soil or sediment particles. The EBDC portion that dissolves in water and breaks up into a suite of transient species and degradates, is the EBDC complex. This complex is not the parent material by itself. Over time ETU is the dominant transformation product of the EDBCs.

Studies provided estimates of the Parent EBDC material in test concentrations used for evaluating the toxicity to aquatic organisms. These studies showed low recoveries of the test substance. For example, measuring carbon disulfide (CS_2) containing residues, using gas chromatography, one study found roughly a 40% ± 10% average of nominal levels of the "parent complexes". Through filtering and measuring the treatment water, the recovery of "parent complexes" was around 15% ± 10% average of nominal levels (MRID No. 43525001). Filtering of the test solution before analytical measurement increases the accurate measurement of the test material in solution because this removes the undissolved material in the solution. This remaining, soluble portion of the chemical is more biologically available to aquatic organisms and represents a more conservative estimate of the toxicity to these organisms. These filtered and measured "parent complexes", is the portion of the parent material that is available to aquatic organisms in the environment (see Figure VI-1).

Figure VI-1. Identity of various species expected to exist upon application of the active ingredient maneb into aquatic experiments submitted/examined to date.



[1] Amount depends on particle size/molecular weight distribution. And length/conditions of storage

[2] Polymeric parent is not expected to be present due to expected complete decomposition as a result of One or more of the following: Low concentration; Use of water containing metal ions (i..e., fresh water, filtered sea water, and estuarine marine water); and addition of EDTA EDTA salts).

Maneb Complex = Multi species consisating of varied molecular weight polimer chains, Monomeric Chains, EBDC ligand in coordination with other metal ions; Transient species; ETU and its degradates.

The EPA's Rejection Rate Analysis determined that studies, testing materials having poor water solubility, were to use measured as opposed to nominal concentrations. Studies were to use measured concentrations for fixing aquatic toxicological endpoints for compounds with poor solubility (US EPA. December, 1994). EFED believes filtered and measured samples provide a more conservative estimate of the EBDCs' toxicity to aquatic organisms. Also, EFED believes the filtered and measured samples provide a more true estimate of aquatic organism exposure to the EBDC complexes in the environment.

Modeling estimates using PRZM-EXAMS are also estimating EBDC complexs by predicting the EECs using the physicochemical properties of the EBDC, parent aerobic soil metabolism half-lives and sorption coefficients. Appendix VI shows the toxicity to aquatic organisms found from the various EBDC aquatic toxicological studies. These endpoints are an **estimate** of the **EBDC complex** that fixes the toxicities (that is, LC_{50}s, EC_{50}s, and NOAECs). The modeling EECs are also estimates. Influences such as particle size, conditions of storage, degree of decomposition, pH, and the presence of other cations (see Figure VI-1) would always cause difficulty in providing definite aquatic toxicological endpoints for the EBDCs.

b. Exposure and Risk Quotients

Tier II modeling (PRZM/EXAMS) was performed for selected sites for which EFED currently has modeling scenarios. EFED decided to perform Tier II modeling for maneb to remain consistent with the modeling platform used for the other EBDCs and their common degradate, ETU. Also, EFED expects Tier II modeling provides a more refined EEC estimate. Below (Figure VI-2) are graphs representing *maneb complexes'* aquatic risks to non-target organisms. EFED selected representative maneb use patterns at maximum application rates and minimum intervals between applications. For a more detailed listing and explanation of maneb's risk, see Appendix IV. EFED does not have a method to evaluate chronic risks to non-target aquatic plants.

The results show:
1) The acute RQs exceed freshwater fish acute, acute restricted use, and acute endangered species LOCs for all maneb uses (acute RQ ranges from 1.13 to 4.71). No chronic LOCs are exceeded for freshwater fish from maneb's uses..
2) The freshwater invertebrates' acute RQs exceed acute, acute restricted use, and acute endangered species LOCs for maneb's use on apples, tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.4 to 1.65).
3) The estuarine/marine fish acute RQs exceed acute, acute restricted use, and acute endangered species LOCs for maneb uses on tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.26 to 1.1).
4) The estuarine/marine invertebrate acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb uses (acute RQ ranges from 15.87 to 65.97). There are currently no estuarine/marine invertebrates listed as endangered species.
5) All maneb's use patterns exceed acute risk LOCs for nonvascular aquatic plants (acute RQ ranges from 3.55 to 14.77). There are no nonvascular aquatic plants listed as endangered species.

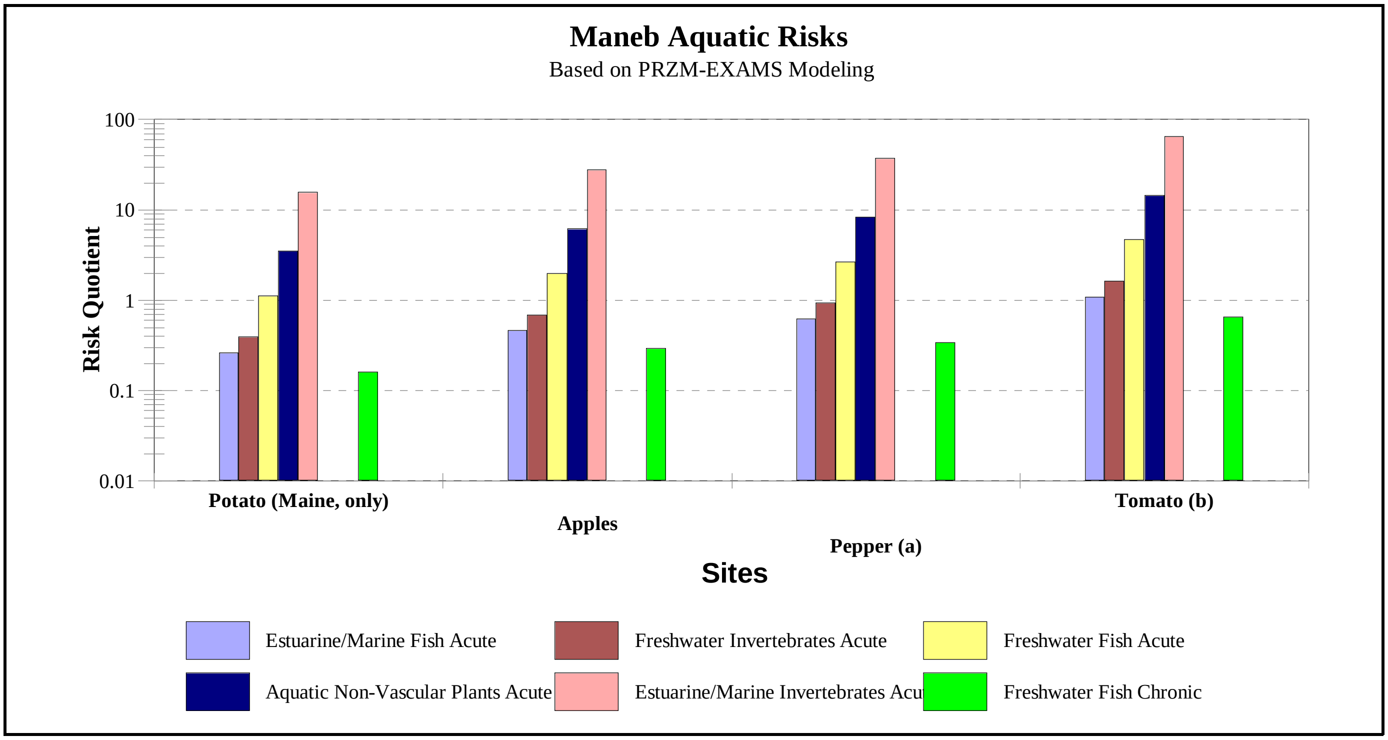


Figure VI-2

RQ greater or equal to 1.0 exceeds aquatic plant acute and acute endangered species LOCs.
RQ greater or equal to 0.5 exceeds aquatic animal acute, acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.1 exceeds aquatic animal acute restricted use and acute endangered species LOCs
RQ greater or equal to 0.05 exceeds aquatic animal acute endangered species LOCs
RQ greater or equal to 1 exceeds aquatic animal chronic LOCs.
There are currently no estuarine/marine invertebrates or non-vascular aquatic plant species listed as endangered species.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)

b East of the Mississippi River

c. Aquatic Risk Assessment

Dose/response slope values for the toxicological endpoints (see Table V-1) used to calculate aquatic RQs for *maneb complex* were reported in the studies used to determine these endpoints. EFED estimated the highest *maneb complex* aquatic EEC expected from drift and runoff would be 197.9 ppb. Based on this residue level and individual laboratory studies EFED estimated the likelihood of adverse *maneb complex* effects to individual organisms across taxa. These chance estimates show there is high likelihood (that is, 57 to 100%) of adverse acute effects to individual freshwater and estuarine/marine aquatic organisms from *maneb complex*. EFED calculated this range using Equation VI-1. For the highest peak *maneb complex* the results show:

$$\text{probit } k = (\log LC_k - \log LC_{50}) * \text{slope} + \text{probit } 50\%$$

k = new percentage mortality

Equation VI-1

1) The acute RQs exceed freshwater fish acute, acute restricted use, and acute endangered species LOCs for all maneb uses (acute RQ ranges from 1.13 to 4.71). The highest peak *maneb complex* aquatic EEC expected from drift and runoff is 197.9 ppb. This value is the estimated aquatic concentrations based on maneb's applications to tomatoes. At this concentration the likelihood of adverse *maneb complex* effects to individual freshwater fish is 1 in 1 or 100%. EFED calculated this chance estimate using a freshwater fish acute LC_{50} = 42 ppb and slope = 2.8 from MRID No. 40706001 and LC_k = 197.9 ppb using equation VI-1. No chronic LOCs are exceeded for freshwater fish from maneb's uses.

2) The freshwater invertebrates' acute RQs exceed acute, acute restricted use, and acute endangered species LOCs for maneb's use on apples, tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.4 to 1.65). At the peak *maneb complex* aquatic EEC expected from drift and runoff of 197.9 ppb, the likelihood of adverse *maneb complex* effects to individual freshwater invertebrates is 4 in 5 or 80%. EFED calculated this chance estimate using a freshwater invertebrate acute LC_{50} = 120 ppb and slope = 4.2 from MRID No. 40749402 and LC_k = 197.9 ppb.

3) The estuarine/marine fish acute RQs exceed acute, acute restricted use, and acute endangered species LOCs for maneb uses on tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.26 to 1.1). At the peak *maneb complex* aquatic EEC expected from drift and runoff of 197.9 ppb, the likelihood of adverse *maneb complex* effects to individual estuarine/marine fish is more than 1 in 2 or 57%. EFED calculated this chance estimate using a estuarine/marine fish acute LC_{50} = 180 ppb and slope = 4.2 from MRID No. 40943101 and LC_k = 197.9 ppb.

4) The estuarine/marine invertebrate acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb uses (acute RQ ranges from 15.87 to 65.97). There are currently no estuarine/marine invertebrates listed as endangered species. At the peak *maneb complex* aquatic EEC expected from drift and runoff of 197.9 ppb, the likelihood of adverse *maneb complex* effects

to individual estuarine/marine invertebrate is 1 in 1 or 100%. EFED calculated this chance estimate using a estuarine/marine invertebrate acute LC_{50} = 3 ppb and slope = 3.5 from MRID No. 41000002 and LC_k = 197.9 ppb.

5) All maneb's use patterns exceed acute risk LOCs for nonvascular aquatic plants (acute RQ ranges from 3.55 to 14.77).. There are no nonvascular aquatic plants listed as endangered species. At the peak *maneb complex* aquatic EEC expected from drift and runoff of 197.9 ppb, the likelihood of adverse *maneb complex* effects to individual nonvascular aquatic plants is 1 in 1 or 100%. EFED calculated this chance estimate using a nonvascular aquatic plants LC_{50} = 13.4 ppb; LC_k = 197.9 ppb; and slope = 4.8 from MRID No. 40943501.

These chance estimates show there is high likelihood (that is, $\geq$57 %) of adverse acute effects to individual freshwater and estuarine/marine aquatic organisms. EFED expects adverse effects to these aquatic organisms at maximum predicted *maneb complex* aquatic exposure levels. Incident reported data supports this expectation in at least one report from EIIS (see below). EFED does not have acute toxicity data to estimate the likelihood of adverse effects to vascular aquatic plants.

i. Incidents

The Ecological Incident Information System (EIIS) (see Appendix V for background information) reported maneb in three fish kill incidents. An incident (Incident No. B000-223), occurring in August, 1973, reported by the Oregon Department of Agriculture showed some fish in a 15 acre pond had been killed. Presumably drift from an aerial application of maneb and endosulfan to potatoes caused the kill. No analyzes of the dead fish was provided. Both maneb and endosulfan are very highly toxic to freshwater fish [maneb rainbow trout LC50 = 42.0 ppb and endosulfan rainbow trout LC50 = 0.37 ppb (US EPA. 2001)] and both pesticides could have been responsible for the fish kill, if in fact the kill was pesticide related. However, the inadequate information provided with this reported incident and the lack of laboratory analyzes makes it difficult to charge this fish kill to either pesticide.

The second maneb related incident (Incident No. I003826-030) occurred in June, 1994 and was reported by the North Carolina Department of Agriculture. The owner of a 2.5 acre commercial fishpond filed a complaint of a fish kill in the pond because of drift from applications of maneb, trifluralin, imazaquin, pendimethalin, and acephate aerially applied to corn and soybean fields near the pond. The owner felt the fish kill was a result of drift from these pesticides. The North Carolina Department of Agriculture investigated this complaint and took samples for analyzes but the sampling evidence did not confirm the presence of maneb or the other pesticides listed in the samples taken. Based on the investigation and the analysis of samples, it is unlikely that maneb contributed to this fish kill.

The final maneb related incident (Incident Nos. I002200-001 and I003596-001), occurring in August, 1994, was reported by the Maine Department of Agriculture. In this incident roughly 10,000 newly released brook trout were killed in a pond that borders New Brunswick, Canada and Maine. Three pesticides (maneb, esfenvalerate, and chlorothalonil) recently applied to potatoes surrounding this pond were suspected in this fish kill. Tissue samples of the fish confirmed the presence of all three pesticides (maneb at 169 ppb, esfenvalerate at 4.2 ppb, and chlorothalonil at 20 ppb) in the fish. These fish samples were taken from both the pond and brooks feeding the pond. Again, as in the first incident, all three of these pesticides are very highly toxic to freshwater fish. Maneb's rainbow trout LC50 is 42.0 ppb, esfenvalerate's rainbow trout LC50 is 0.26 ppb (Hicks, L. May, 1995) and chlorothalonil's rainbow trout LC50 is 42.3 ppb (US EPA. 1998)]. The submitter of the incident report pointed out there were severe thunderstorms in the area preceding the fish kill which suggest pesticide runoff was a cause in this kill. Based on sampling evidence, EFED believes maneb was contributory cause in this fish kill.

ii. Endocrine Disruptors

Chronic testing in freshwater fish showed reduced hatchability, fish survival and length of fry being the endpoints affected in fathead minnow. See Appendix III for a detailed listing of the study and results. These effects noted in a freshwater fish species may be a result of hormonal disruptions. Based on these effects in freshwater fish, EFED recommends maneb be subjected to more definitive testing to better characterize effects related to its potential endocrine disruption. This testing should occur when EPA develops suitable screening and testing protocols, considered under the Agency's EDSP.

iii Endangered Species

Based on available screening level information there is a potential concern for maneb's acute effects on listed freshwater and estuarine/marine animals should exposure actually occur. There are no nonvascular aquatic plant or estuarine/marine invertebrate species on the endangered species list. EFED does not have toxicological data to evaluate the chronic endangered/threatened species risk to freshwater invertebrates or estuarine/marine fish from maneb's use. Based on EFED's *maneb complex* calculated RQs, EFED expects the chronic risks to endangered and threatened species of freshwater fish to be low. The highest freshwater fish chronic RQ calculated is 0.66 which is below the chronic LOC of 1.

VII. Terrestrial Exposure and Risk

a. Hazards Summary (Acute/Chronic)

Maneb is categorized as practically nontoxic to avian species on an acute oral basis (Northern bobwhite quail LD_{50} >2,150 mg/kg). Avian subacute dietary tests were conducted using Northern bobwhite quail and mallard duck as test species. The maneb dietary LC_{50} for birds ranged from greater than 5,000 ppm in mallard ducks to greater than 10,000 ppm in bobwhite quails. This categorizes maneb as practically nontoxic to avian species on a subacute dietary basis. In a maneb avian reproduction study using the mallard duck, chronic toxic effects were seen which included: a reduction in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a reduction in the number of 14-day old survivors as a percentage of eggs set. The reproduction NOAEC/LOAEC is 20/100 ppm. A Northern bobwhite quail reproduction study was classified as supplemental because a LOAEC was not determined. At the highest dose tested (500 ppm) no adverse effects were noted. Collectively, the mallard is the more sensitive species for the EBDC's, and will be used for risk assessment purposes. Mallard duck reproduction NOAECs for mancozeb and metiram are 10 ppm and 50 ppm, respectively. Bobwhite quail NOAECs for mancozeb and metiram are 125-300 ppm and >500 ppm, respectively.

Maneb is practically nontoxic to small mammals on an acute oral basis with LD_{50} > 5,000 mg/kg in tests done on laboratory rats. Results from chronic 2-generation reproduction study for maneb show a parental and fetal toxicity at a LOAEL of 300 ppm (NOAEL = 75 ppm) with paternal parental toxicity resulting in significant increase in lung weight (both generations) and liver weight in F1 (one generation removed from the original parent generation) and an increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia (lesions on the organs' surfaces) in F1. Fetal toxicity, at this test concentration (300 ppm), was also noted based on a slight delay in the startle response in the offspring (NOAEL = 75 ppm).

Currently, EFED does not assess risk to non-target insects using risk quotient methodology. Results of acceptable studies are used for recommending appropriate label precautions. Since maneb was determined to be practically nontoxic to honey bees (LD_{50} > 12 µg/bee) no bee precautionary labeling is required on maneb product labeling.

EFED has not received any non-target terrestrial plant studies and is unable to assess the risk to non-target terrestrial plants as a result of maneb's uses. The submission of Tier I seedling emergence and vegetative vigor studies for a TEP are being recommended to evaluate this risk.

For a more detailed listing and explanation of maneb's hazards to all terrestrial organisms, see Appendix III.

Table VII-1: Toxicological Endpoints Used to Determine Risk Quotients (RQs) for Maneb

Type of Toxicity	Organism	Species	Toxicological Endpoint
Chronic	Bird	mallard duck *(Anas platyrhynchos)*	NOAEC = 20 ppm
Chronic	Mammal	laboratory rat (*Rattus norvegicus*)	NOAEL = 75 ppm

b. Exposure Summary

Terrestrial exposure was evaluated using estimated environmental concentrations generated from the FATE version 5.0 model that calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. The model assumes initial concentrations on plant surfaces based on Kenaga predicted maximum and mean residues as modified by Fletcher *et al.* (1994) and assumes 1st order dissipation. Kenaga estimates and an explanation of the model with sample output are presented in Appendix II. A 3.2-day half-life was used as the foliar dissipation half-life for maneb. The selection of this half-life was based on the highest value provided in the half-life listing of Willis and McDowell, 1987 for maneb. This half-life value is based on total foliar residues not dislodgeable foliar residues and was determined in a study by Rhodes, 1977 performed on tomatoes. EFED use the half-life listing values provided in Willis and McDowell, 1987 for modeling purposes to estimate total foliar residues half-lives.

c. Risk Quotients

The acute risk to terrestrial animals from maneb's use are a low risk concern since maneb has been determined to be practically nontoxic to birds and mammals on an acute basis. Acute RQs were not generated for birds or mammals. Chronic concerns to terrestrial animals are exceeded when the RQ reaches 1.0. Below (figures VII-1 through VII-4) are graphs representing maneb's potential chronic risks to non-target terrestrial birds and mammals. These graphs show the chronic RQs EFED expects from terrestrial animals feeding on the food items listed.

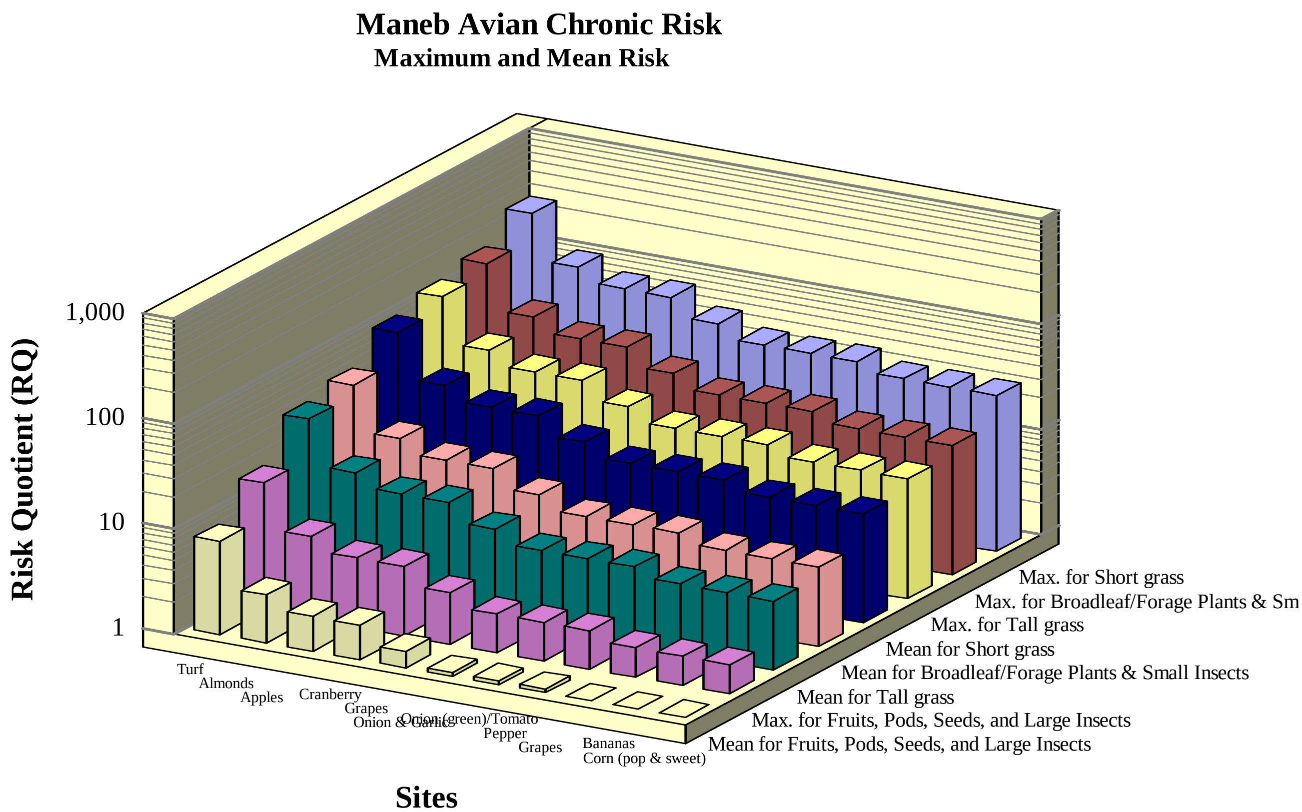

Maneb Avian Chronic Risk
Maximum and Mean Risk
Risk Quotient (RQ)
1,000
100
10
1
Turf
Almonds
Apples
Cranberry
Grapes
Onion & Garlic
Onion (green)/Tomato
Pepper
Grapes
Bananas
Corn (pop & sweet)
Sites
Max. for Short grass
Max. for Broadleaf/Forage Plants & Sm
Max. for Tall grass
Mean for Short grass
Mean for Broadleaf/Forage Plants & Small Insects
Mean for Tall grass
Max. for Fruits, Pods, Seeds, and Large Insects
Mean for Fruits, Pods, Seeds, and Large Insects

Figure VII-1

These chronic RQs are derived from EECs based on the maximum and mean residue estimates (see Appendix II) EFED expects on these food items following maneb's applications to various sites shown. For example, the chronic RQ for birds feeding on short grass as a result of maneb being applied to turf is over 200 at maximum residue levels and over 90 at mean residue levels (see figure VII-1). As can be seen from these graphs, all maneb's uses exceed chronic LOCs for birds and for mammals. As a result of maneb's applications to turf, the chronic exceedances to birds range from a high RQ of 265 (figure VII-1) from birds feeding on short grass low of 8 (figure VII-1) from birds feeding on fruits, pods, seeds and large insects.

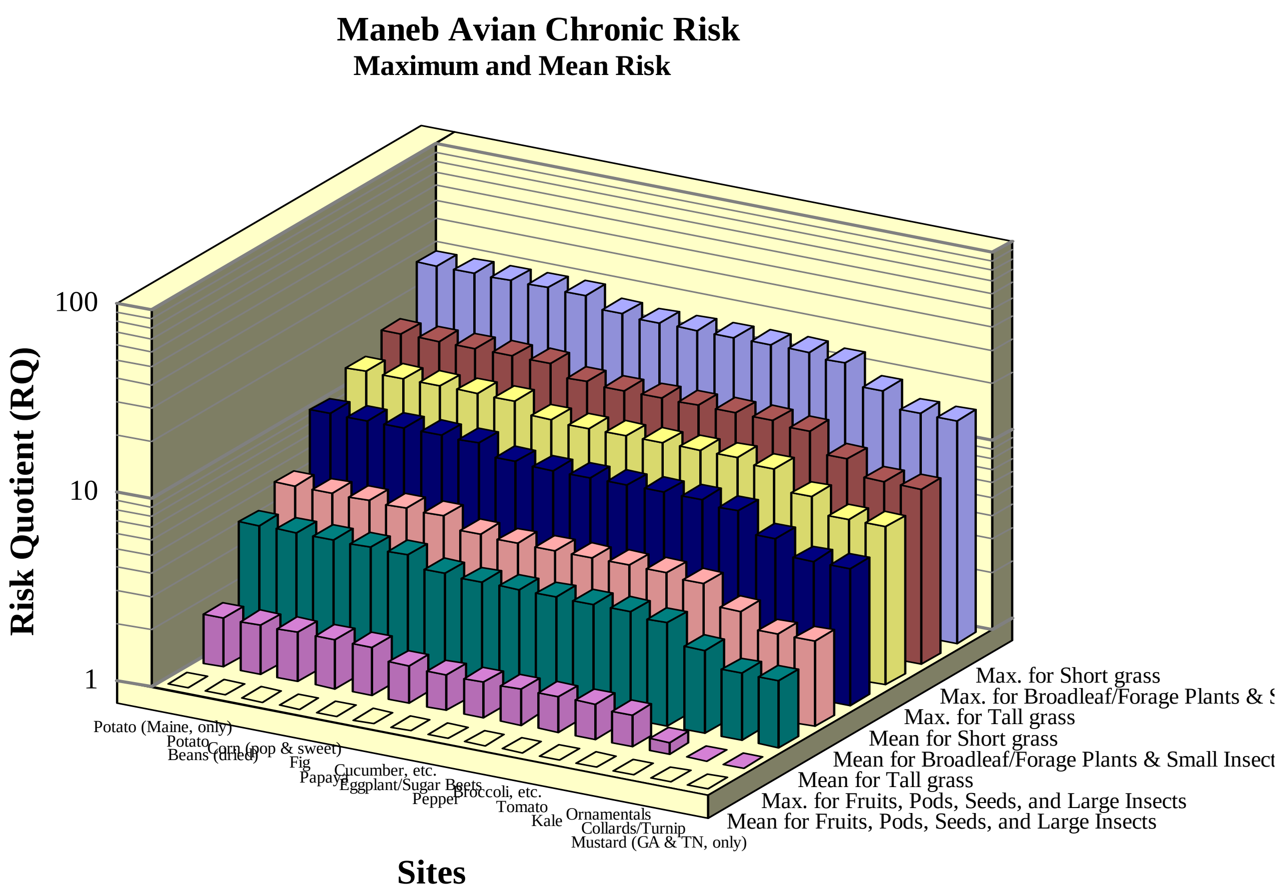


Figure VII-2

For mammals, the range of RQ exceedances, from maneb turf applications, is from a high of 71 (figure VII-3) from birds feeding on short grass to a low of 2 (figure VII-3) from birds feeding on fruits, pods, seeds and large insects. These potential risks are based on maneb's current use patterns at maximum application rates and minimum intervals between applications. It should also be noted that the applications of maneb to ornamentals and turf assumed 3 applications per crop cycle since the labeling did not indicate the number of applications that could be made. Even at this relatively low number of applications chronic LOC exceedances are high.

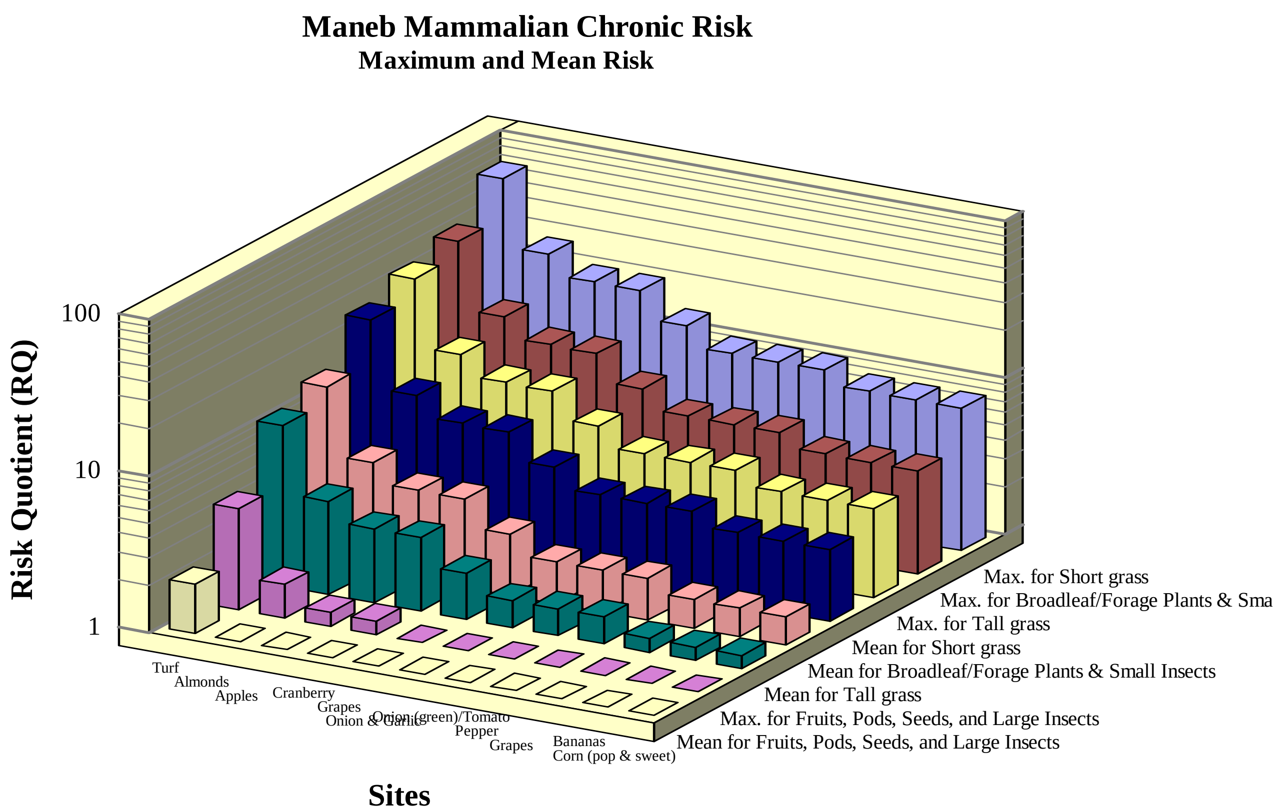


Figure VII-3

The assumption of 100 gallons of finished spray per acre treated was also an assumption made for the application of maneb to ornamentals. If lower finished spray rates are used then the pounds of maneb applied per acre are even greater than assumed which would increase the potential risk to non-target organisms. For some sites, there are geographic limitations on the use pattern. For example, the charts (figures VII-1 through VII-4) will provide two use patterns for maneb's application to grapes. One use pattern pertains to applications of maneb to grapes east of the Rocky Mountains at higher application rates providing greater risk and the other listing of grapes pertains to maneb applications west of the Rocky Mountains. Please refer to Table II-1, above, for additional geographic limitations.

For a more detailed listing and explanation of maneb's risk to all terrestrial organisms, see Appendix IV.

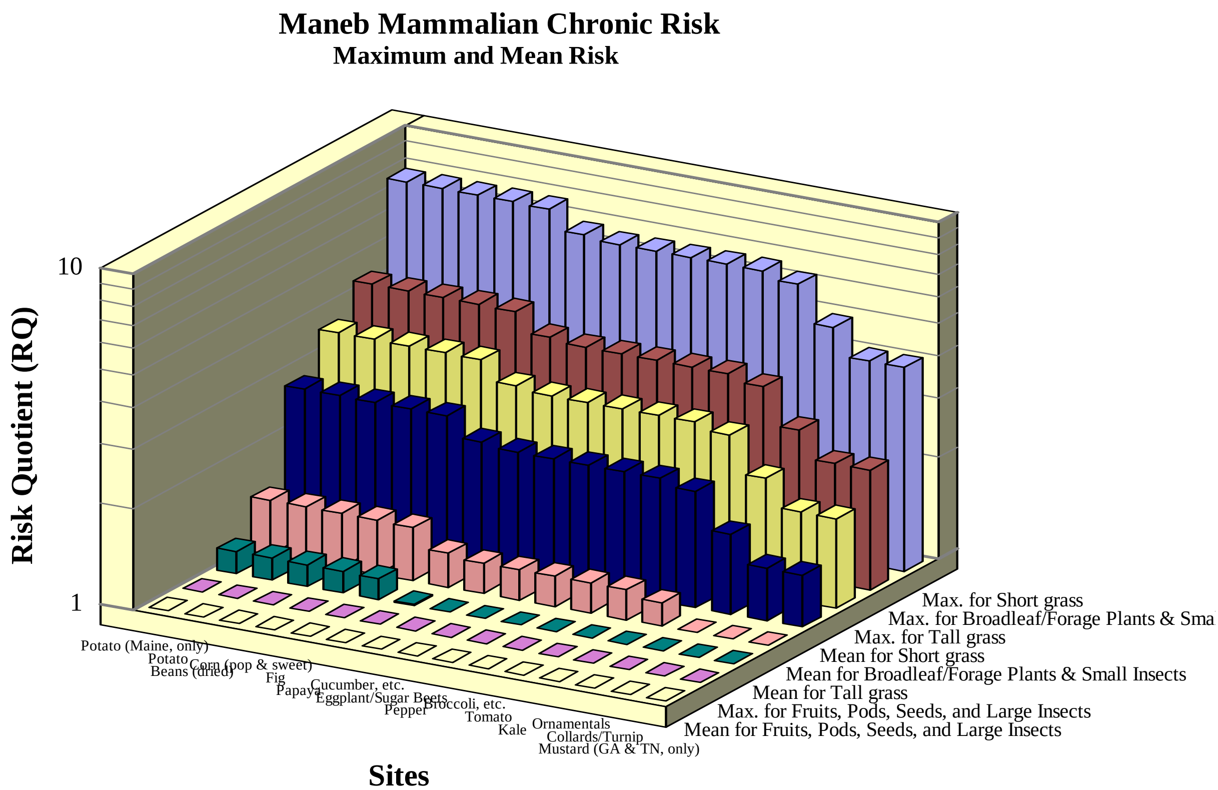


Figure VII-4

d. Terrestrial Risk Assessment

The annual estimate of maneb total domestic usage averaged approximately 2,500,000 pounds active ingredient (a.i.) for over 600,000 US acres treated. Approximately 550,000 lbs ai of maneb is applied annually to 120,000 acres of US potatoes. (EPA use data 1987-1996) (BEAD's Quantitative Usage Analysis for Maneb dated 10/1/1998). Maneb can be applied at the maximum rate of 1.6 lb ai/A, 7 times per season every 5 days during the foliar stages of potatoes. In the state of Maine, maneb can be applied at the maximum rate of 1.6 lb ai/A, 10 times per season every 5 days during the foliar stages of potatoes (see table 1, above). Pheasant, partridge, pigeon, dove, duck, geese, songbirds, antelope, and cottontail rabbits feed in potato fields on insects, vegetation in the treated area, or on the potato plants throughout the potato growing season (Gusey and Maturdo, 1972) which lasts 90-140 days (depending upon the potato variety) from late Spring to early Fall. Figure VII-5, based on the maximum application rate of 1.6 lb ai/A, applied 7 times per season every 5 days, represents an example of the maneb residues that can be expected on various avian and mammalian food items over time after an initial maneb application to potatoes on Day 1 and six subsequent application at 5 day intervals. Maneb's avian and mammalian reproductive NOAEC (20 ppm) and NOAEL (75 ppm), respectively, are also indicated in Figure VII-5 as horizontal lines. Residue levels above these lines pose a potential risk of adverse reproductive effects to the birds and/or mammals feeding on these food items. For birds feeding on short grass this potential risk begins on Day1

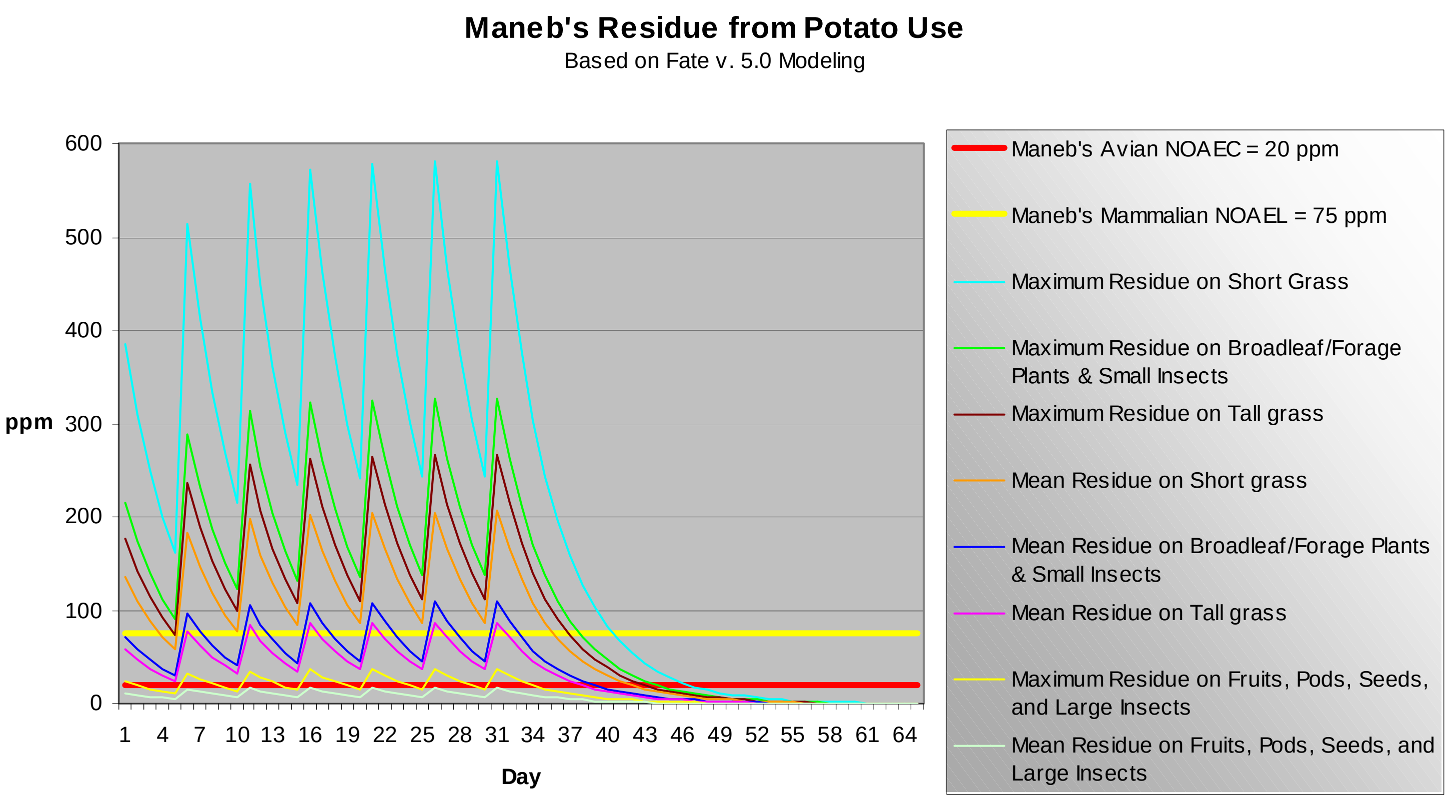


Figure VII-5

(maneb residues = 384 ppm) and continues through Day 46 (maneb residues = 23 ppm) for a total exposure risk period of 46 days. For mammals, this same potential risk from feeding on short grass also begins on Day1 and continues through Day 40 (maneb residues = 83 ppm) for a total chronic exposure risk period of 40 days.

Maneb's use on potatoes is one example of the potential chronic risk posed by maneb's use to wildlife. Figure VII-6 provides the potential chronic risk to birds and mammals from maneb's use on turf which can be applied at a maximum single application rate of 17.4 lb ai/A (~ 11 times higher than the potato rate) every 7 days. The number of applications of maneb to turf is not specified on the labeling and as a result an assumption of 3 applications per season is being made although this could be an under estimate. For birds feeding on short grass this potential risk begins on Day1 (maneb residues = 4,176 ppm) and continues through Day 40 (maneb residues = 24 ppm) for a total exposure risk period of 40 days. For mammals, this same potential risk from feeding on short grass also begins on Day1 and continues through Day 34 (maneb residues = 86 ppm) for a total exposure risk period of 34 days.

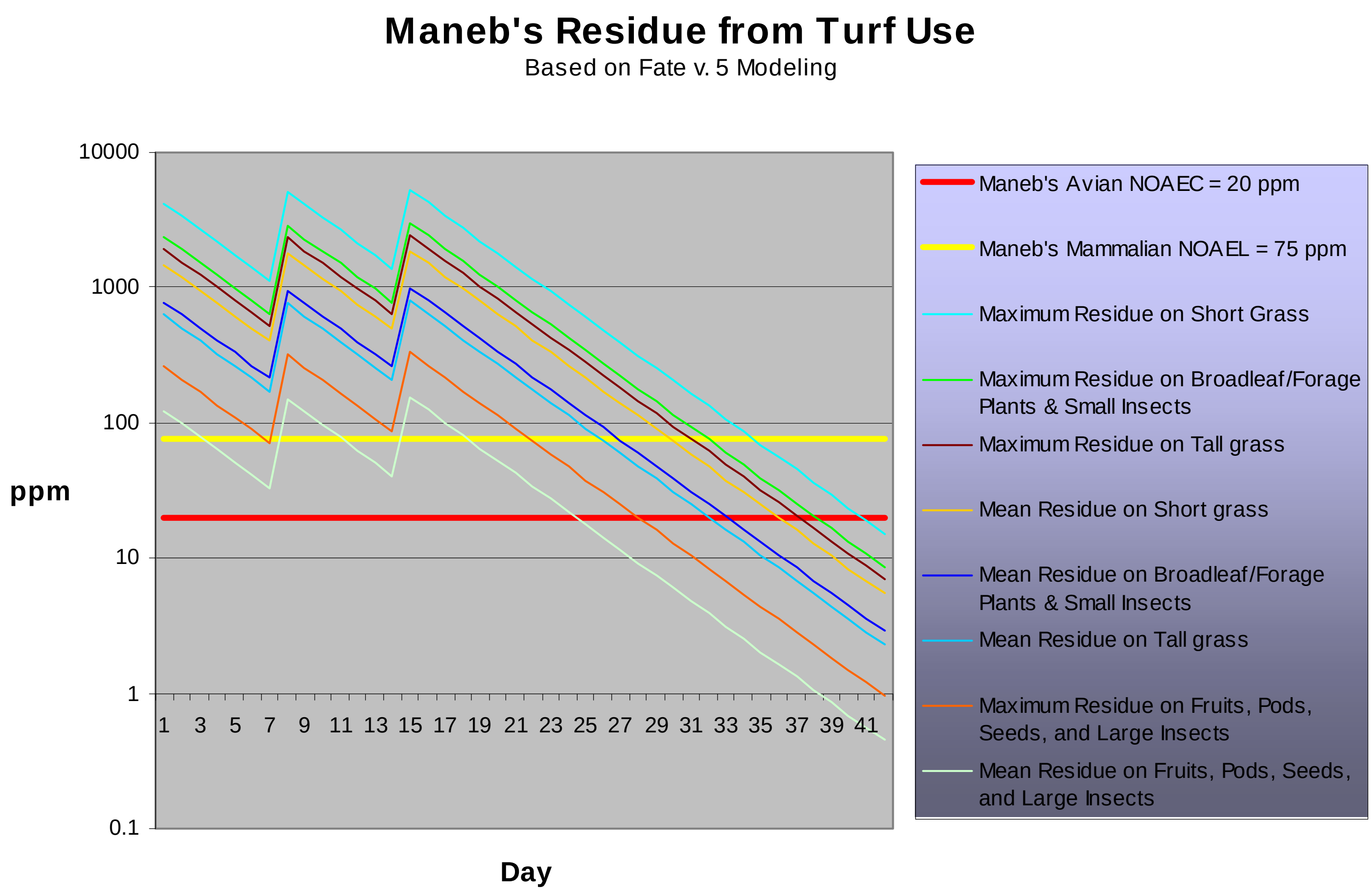

Maneb's Residue from Turf Use
Based on Fate v. 5 Modeling
10000
1000
100
10
1
0.1
ppm
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
Day
Maneb's Avian NOAEC = 20 ppm
Maneb's Mammalian NOAEL = 75 ppm
Maximum Residue on Short Grass
Maximum Residue on Broadleaf/Forage Plants & Small Insects
Maximum Residue on Tall grass
Mean Residue on Short grass
Mean Residue on Broadleaf/Forage Plants & Small Insects
Mean Residue on Tall grass
Maximum Residue on Fruits, Pods, Seeds, and Large Insects
Mean Residue on Fruits, Pods, Seeds, and Large Insects

Figure VII-6

Although potatoes and turf are used as examples of the wildlife exposure that can be expected from maneb's registered uses, all the sites maneb is currently being used on (see Table II-1) would have comparable exposure levels with similar potential risks to wildlife.

In this screening level assessment, maneb's high application rates combined with repeat applications are a major reason why avian and mammalian LOCs are exceeded. Single application rates range from 1.2 lb ai/A on collards, turnips, and mustard to 17.4 lb ai/A on turf. Labeling allows repeat applications at these maximum rates for all maneb's uses. These high applications rates with repeat applications increases the exposure of maneb to nontarget organism. High exposure is the reason for high RQs. One way to grasp the impact of the high exposure is to use modeling to estimate the reductions needed to reduce the EECs below the LOCs. Using modeling to calculate EECs below LOCs is simply a rough estimate but does provide some insight into the extent maneb's application rates contributes to potential chronic risk to birds and mammals.

To reduce the exposure risk to birds and mammals from manebs's use on potatoes, the maximum single application rate would need to be reduced from the current 1.6 lb ai/A to 0.05 lb ai/A (see figure VII-7)[16]. This calls for a 32-fold decrease in the maximum application rate of maneb on potatoes. A combination of rate drops with a decrease in the number of applications per growing season could also be used to lessen the EECs. However, to reduce the potential chronic EEC exposure risk, essentially only 1 maneb application could be made to potatoes at a maximum application rate of 0.08 lb ai/A (see figure VII-8). This translates to a 20-fold application rate decrease and cuts out all multiples applications. Current labeling allows seven maneb applications on potatoes.

16 Rate reductions determined by randomly imputing application rates into ELL- Fate spreadsheet program until the avian chronic risk to birds from maneb residues on short grass is less than or equal to 1.

Figure VII-7: Maneb Estimated Reduction in Application Rate to Potatoes. (Libelo. 1999)

Chemical Name:	Maneb
Use	Potatoes
Formulation	non-granular

Inputs

Application Rate	0.05	lbs a.i./acre
Half-life	3.2	days
Application Interval	5	days
Maximum # Apps./Year	7	

Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)
Short Grass	18.13	7.70
Tall Grass	8.31	3.53
Broadleaf plants/Insects	10.20	4.33
Seeds	1.13	0.48

Avian

Acute LC_{50} (ppm)	5000
Chronic NOAEC (ppm)	20

	Acute RQ	Chronic RQ (Max. res. mult. apps.)
Short Grass	**0.00**	**0.91**
Tall Grass	**0.00**	**0.42**
Broadleaf plants/Insects	**0.00**	**0.51**
Seeds	**0.00**	**0.06**

Mammalian

Acute LD_{50} (mg/kg)	5000
Chronic NOAEL (mg/kg)	75

	15 g mammal		35 g mammal		1000 g mammal	
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)
Short Grass	0.00	0.23	0.00	0.16	0.00	0.04
Tall Grass	0.00	0.11	0.00	0.07	0.00	0.02
Broadleaf plants/Insects	0.00	0.13	0.00	0.09	0.00	0.02
Seeds	0.00	0.01	0.00	0.01	0.00	0.00

Figure VII-8: Maneb Estimated Reduction in Application Rate and Number of Applications to Potatoes. (Libelo. 1999)

Chemical Name:	Maneb
Use	Potatoes
Formulation	non-granular

Inputs

Application Rate	0.08	lbs a.i./acre
Half-life	3.2	days
Application Interval	5	days
Maximum # Apps./Year	1	

Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)
Short Grass	19.20	1.76
Tall Grass	8.80	0.81
Broadleaf plants/Insects	10.80	0.99
Seeds	1.20	0.11

Avian

Acute LC_{50} (ppm)	5000
Chronic NOAEC (ppm)	20

	Acute RQ	Chronic RQ (Max. res. mult. apps.)
Short Grass	**0.00**	**0.96**
Tall Grass	**0.00**	**0.44**
Broadleaf plants/Insects	**0.00**	**0.54**
Seeds	**0.00**	**0.06**

Mammalian

Acute LD_{50} (mg/kg)	5000
Chronic NOAEL (mg/kg)	75

	15 g mammal		35 g mammal		1000 g mammal	
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)
Short Grass	0.00	0.24	0.00	0.17	0.00	0.04
Tall Grass	0.00	0.11	0.00	0.08	0.00	0.02
Broadleaf plants/Insects	0.00	0.14	0.00	0.10	0.00	0.02
Seeds	0.00	0.02	0.00	0.01	0.00	0.00

In addition to maneb's use on potatoes, maneb is also use on numerous other sites (see Table II-1, above). Each of these groupings represent a unique use pattern based on rates of application, number of applications allowed per crop cycle or season, and minimum intervals between applications. The above risk assessment, using potatoes as an example, could be extended to each of these separate crop groupings but the conclusions for these other crop groupings would be similar to the conclusions drawn from the example of maneb's use on potatoes. In other words, all maneb's uses represent an extended potential chronic risk to birds and mammals and maneb's exposure in the environment is a major part of this risk concern.

As another example, showing the potential temporal chronic risks to birds and mammals from maneb's current uses is provided in Figure VII-9. Figure VII-9 shows the number of days maneb residues on short grass would exceed chronic LOCs for birds and mammals. For example, the maneb residues on short grass resulting from maneb's use pattern on potatoes would present a potential chronic risk to birds feeding on short grass for 46 days after the first application. This same potato use would present a potential chronic risk for 40 days to mammals feeding on short grass.

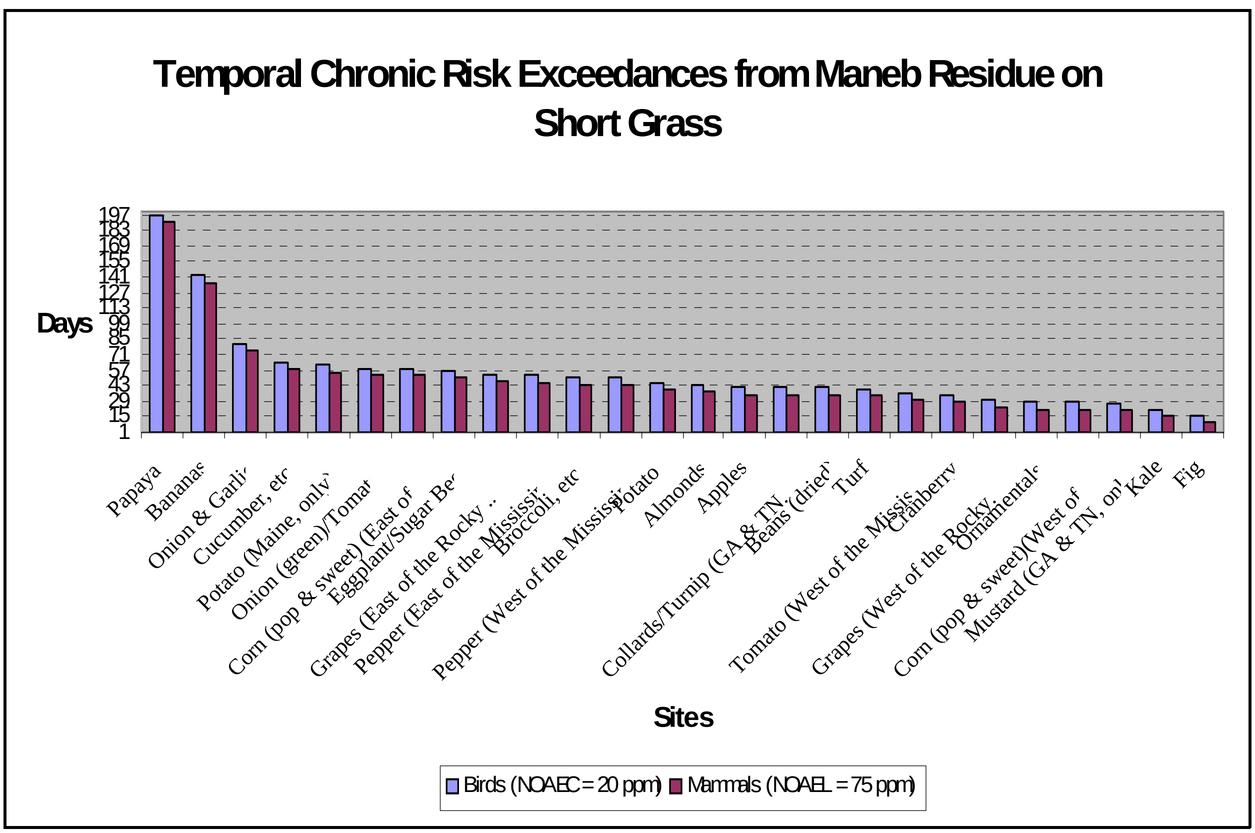


Figure VII-9

i. Incidents

There are no incidents for maneb listed in the Ecological Incident Information System (EIIS) data base dealing with adverse effects to terrestrial non-target organisms. Even though maneb, on an acute basis, appears to pose a low risk to terrestrial animals, the chronic LOCs for terrestrial animals (birds and mammals) are exceeded for all maneb use patterns. The incident reports submitted to EPA primarily deal with field mortality of wildlife. Chronic problems that affect wildlife from the use of maneb and it's degradate, ETU, would be expected to be largely unnoticed in the field and thus incident reports, as a result of chronic exposure, would not be anticipated.

ii. Endocrine Disruptors

The avian reproductive studies reviewed by EFED noted maneb reproductive effects. EFED noted effects such as a decreases in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a decrease in the number of 14-day old survivors as a percentage of eggs. HED noted maneb mammalian effects, from a reproductive study. Effects noted in rats were male parental toxicity resulting in significant increase in lung weight (both generations) and liver weight (F1 generation) with lesions noted on these organs in the F1 generation. These effects noted in both birds and mammals may be a result of hormonal disruptions. Based on these effects in birds and mammals, EFED recommends subjecting maneb to more definitive testing to better characterize effects related to its potential endocrine disruptor activity when the Agency's EDSP develops screening and testing methods.

iii. Endangered Species

Based on available screening level information there is a potential concern for maneb's chronic effects on listed birds and mammals should exposure actually occur. EFED expects maneb poses a low acute risk to nontarget insects because maneb is practically nontoxic to honeybees, (acute contact LD_{50} > 12 µg/bee). Also, there is no incident data reporting adverse effects to honeybees from maneb's use. However, EFED does not assess risk to bees using RQs because a screening level RQ assessment method for estimating the risk to bees is not available. EFED has not developed an exposure design for bees to estimate the risk using a risk quotient method. The Agency does not currently have enough data to perform a screening level assessment for maneb's effects on listed nontarget terrestrial plants. Tier I seedling emergence [guideline 122-1(a)] and vegetative vigor [guideline 122-1(b)] studies have not been submitted for a maneb. EFED recommends these studies be submitted for review to evaluate the acute toxicity of maneb to endangered/threatened species of terrestrial plants. Currently, EFED does not perform assessments for chronic risk to plants.

APPENDIX I: Notes on Fate Studies and Modeling & Additional Fate Data

a. Notes on Fate Studies

i. Aqueous medium studies

Guidance for hydrolysis and aqueous photolysis require ***Parent EBDC*** to be applied at concentrations within the solubility range. It was established that any part of ***Parent EBDC*** that goes into solution will completely decompose, by hydrolytic reactions, into a suite of multi species residue; the ***EBDC complex***. Reported levels of Parent EBDCs that decompose in water were near 2 ppm for metiram and in the range of 6-22 ppm for mancozeb and 6-200 ppm for maneb. Additionally, particle size reduction (i.e. sonication) is believed to cause an increase in the level susceptibility of parent EBDCs to decomposition. In most studies, levels used in aqueous media studies were near this critical range of susceptibility, parent was determined by CS_2 and suspensions were prepared using ultrasonic. Therefore, calculated hydrolysis and/or photolysis half-lives are affected by:

(1) Occurrence of hydrolytic decomposition during preparation of stock solution; indicated by the presence of high concentrations of transient species and degradates at time zero. Use of accurately measured nominal concentration can overcome this problem as it can be considered as time-zero concentration of the test substance.

(2) An increase of hydrolytic reactions caused by reduction of particle size by sonication; and

(3) Nonspecificity of CS_2-determination for Parent EBDC in the presence of its hydrolytic residue because it was experimentally proven that CS_2 evolves from at least one of its constituents; EBIS.

(4) influence of the presence of metal ions on solubility of ***Parent EBDC*** (i.e decomposition to ***EBDC complex***). These metal ions are introduced to the system from chemicals present in buffer solutions.

In studies were the solvent DMSO is used, no half-life could be calculated for EBDCs because no ***Parent EBDC*** would be present at time zero. This solvent appears to cause complete breakage of the EBDC complex into various transformation products dominated by ETU. This means that such studies can only be used to identify effects of pH or photon energy and aging on the suite of EBDC ***complex*** present at time zero.

ii. Soil/sediment studies

Problems associated with soil sediment/studies include:

(1) Degradation of ***Parent EBDC***, by decomposition in water, before time zero and when the application suspension is prepared. In most cases, resultant application suspensions were dominated by ***EBDC complex***. Analysis was not always performed for suspensions just before application.

(2) Extraction systems (i.e., acetonitrile/water or methanol/water) appear to affect the integrity of

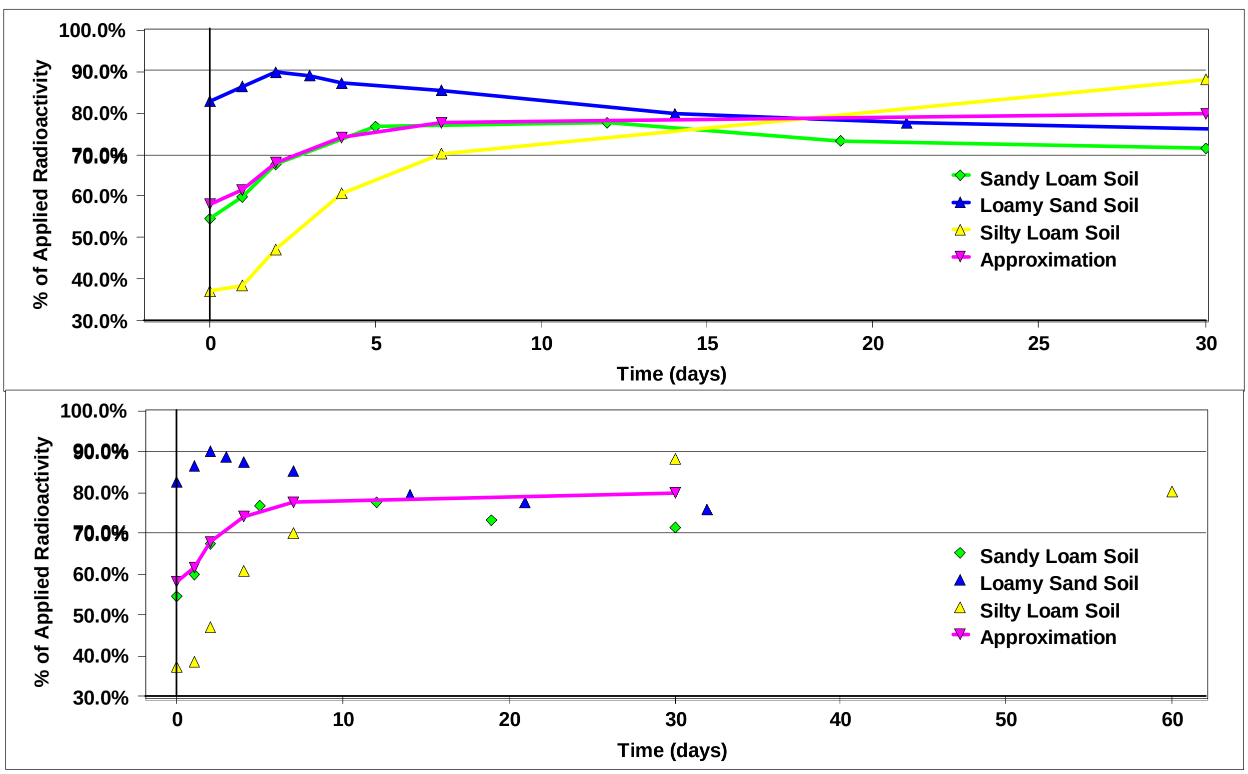
the parent. Therefore, resultant suite of ***EBDC complex***(in the extraction solution) was at least partly artificial and can not be used to represent the suite that might form in the environment. The use of different extraction systems made it difficult to compare results obtained from different soils.

(3) ***EBDC complex*** has high affinity to soil and no characterization was conducted for the resultant bound species. Therefore, ***bound species*** are suspicious of containing active species that can be precursors for the degradate of concern ETU. For example, In maneb aerobic soil studies, bound species degraded after reaching a plateau in the range of 70- 90%. Production of degradates and CO_2, increased after the bound species reach the described plateau. Figure 1 shows bound radioactivity distribution with time as reported for soils in three aerobic soil studies. Definitive trend for degradation of the bound species is not apparent and is probably related to the short duration of the experiments.

(4) Nonspecificity of CS_2-determination for ***Parent EBDC*** in the presence of its hydrolytic complex because it was experimentally proven that CS_2 evolves from at least one of its constituent; EBIS.

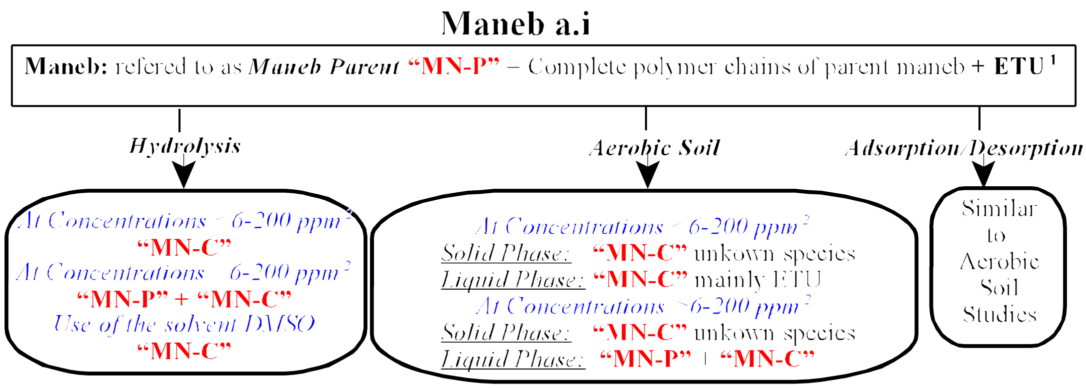
(5) Chromatographic separation between ***Parent EBDC*** and various species in its residue was not conclusive and solvents used appear to affect the integrity of parent and some degradates and/or transient species.

Figure 1. Change of bound radioactivity with time in four aerobic soils treated with maneb.



After considering the difficulties stated above, it is expected that species present in fate studies are those shown in Figure 2. Consequently, species expected to be present in compartments of the natural environment are those shown in Figure 3.

Figure 2. Identity of various species expected to exist in various laboratory experiments.

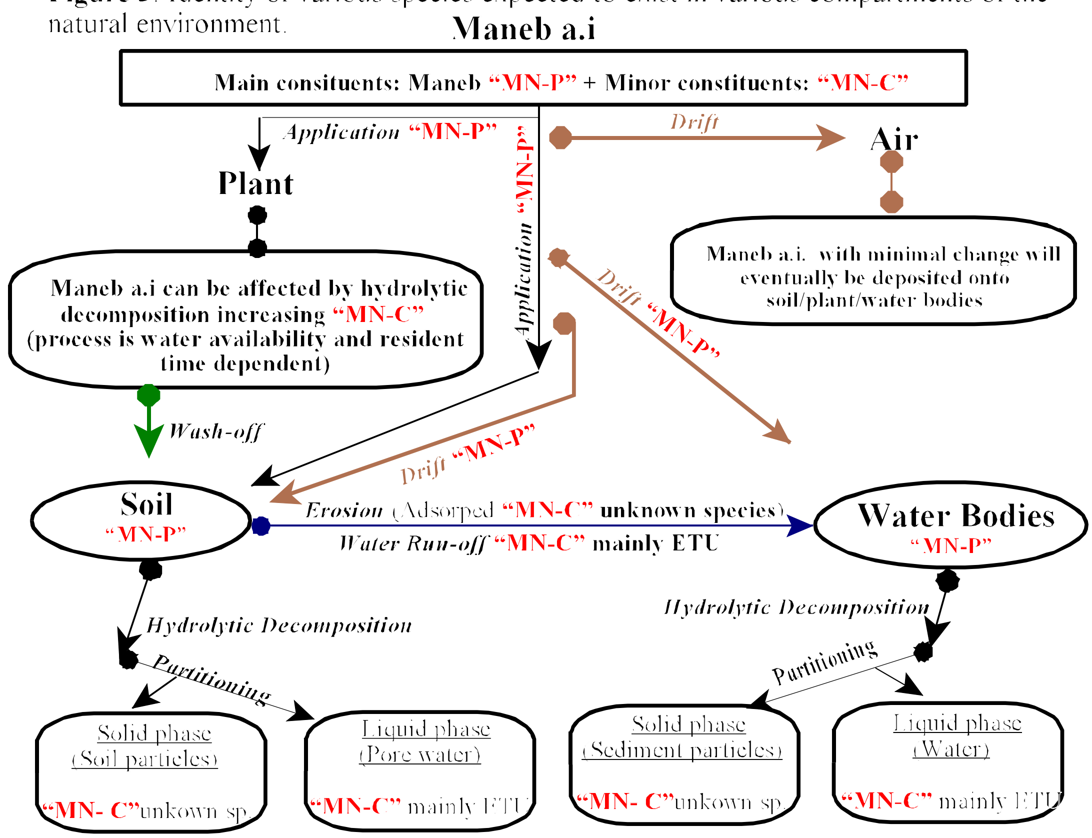


[1] Amount depends on particle size/molecular weight distribution and length/conditions of storage.

[2] The 6-200 ppm concentration range is the reported solubility.

"MN-C" – the ***maneb residue*** – multi species consisting of varied molecular weight polymer chains, monomeric chains, EBDC ligand in coordination with other metal ions, transient species and ETU and its degradates

Figure 3. Identity of various species expected to exist in various compartments of the natural environment.



b. Notes on Modeling

i. EECs for Parent maneb

EECs for ***Parent maneb*** are presented in the Figure 4. Data for EECs were calculated using the slope of the line for 0.1 day (Table IV.2); the estimated hydrolysis half. Other assumptions included:

- Application rate of 4.8 lbs a.i/Acre applied four times at 7-day intervals;

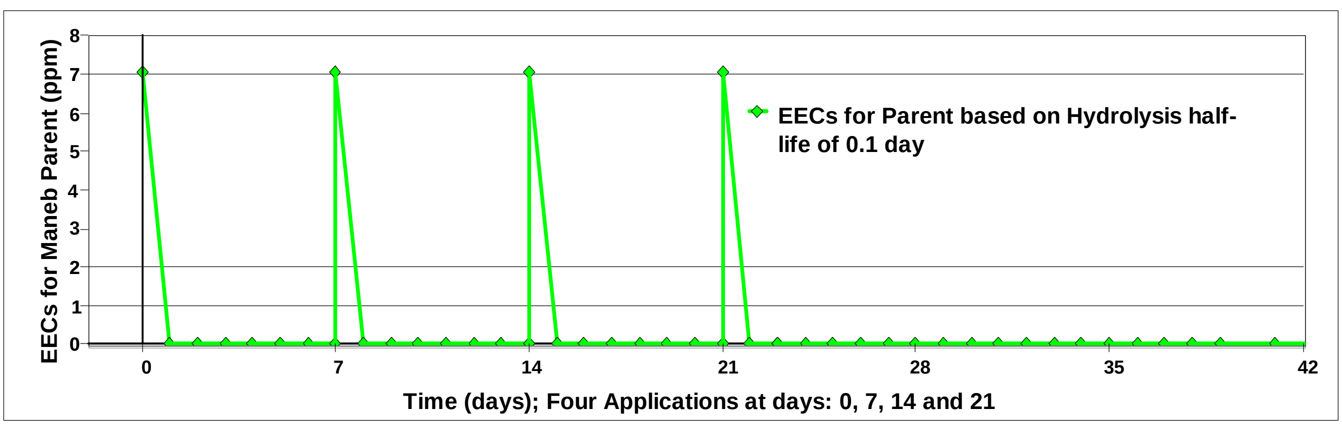
- All applied material reached the soil and mixed with top 2" giving a zero time concentration of 7.1 ppm.

- Enough moisture is present to complete hydrolytic reactions.

Data indicate that soil EECs of ***parent maneb*** are expected to be below 0.1 ppm (≈ 1.4% of the applied) within one day of the first application and to completely degrade just before the second application. The same is repeated after each of the four application with negligible amounts being left within one day from the last application. This data are believed to represent concentrations in soil environments where most of the pesticide is applied. However, higher EECs is expected in dry conditions and in soils with very low water holding capacity.

Considering that only a small fraction of the applied material would reach water bodies by drift, maneb complex, not parent, is the species expected to be found in water bodies affected by drift.

Figure 4. EECs for ***parent maneb*** following four applications of 4.8 lbs a.i/acre applied four times at 7-day intervals.



ii. Background Information on the PRZM and EXAMS models & the Index Reservoir Scenario

The linked PRZM and EXAMS models are used in this case as a second tier screen designed to estimate the pesticide concentrations found in water for use in drinking water assessments. They provide high-end values on the concentrations that might be found in a small drinking water reservoir due to the use of pesticide. The Drinking Water Index Reservoir scenario includes a 427 acres field immediately adjacent to a 13 acres reservoir, 9 feet deep, with continuous site-specific flow. This amount can be reduced due to degradation in field and the effect of binding to soil. Spray drift is equal to 6.4% of the applied concentration from the ground spray application and 16% for aerial applications.

The PRZM/EXAMS modeling system with the Index Reservoir scenario also makes adjustments for the percent cropped area. While it is assumed that the entire watershed would not be treated, the use of a PCA is still a screen because it represents the highest percentage of crop cover of any large watershed in the US, and it assumes that the entire crop is being treated. Various other conservative assumptions of this scenario include the use of a small drinking water reservoir surrounded by a runoff-prone watershed, the use of the maximum use rate and no buffer zone.

iii. Background Information on SCIGROW

SCI-GROW is a screening model which the Office of Pesticide Programs (OPP) in EPA frequently uses to estimate pesticide concentrations in vulnerable ground water. The model provides an exposure value which is used to determine the potential risk to the environment and to human health from drinking water contaminated with the pesticide. The SCI-GROW estimate is based on environmental fate properties of the pesticide (aerobic soil degradation half-life and linear adsorption coefficient normalized for soil organic carbon content), the maximum application rate, and existing data from small-scale prospective ground-water monitoring studies at sites with sandy soils and shallow ground water.

Pesticide concentrations estimated by SCI-GROW represent conservative or high-end exposure values because the model is based on ground-water monitoring studies which were conducted by applying pesticides at maximum allowed rates and frequency to vulnerable sites (i.e., shallow aquifers, sandy, permeable soils, and substantial rainfall and/or irrigation to maximize leaching). In most cases, a large majority of the use areas will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate. SCIGROW provides a groundwater screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. SCIGROW estimates likely groundwater concentrations if the pesticide is used at the maximum allowable rate in areas where groundwater is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have groundwater that is less vulnerable to contamination than the areas used to derive the SCIGROW estimate.

c. Additional Fate Data

The following are additional fate data maneb complex mobility:

<u>First study (MRID 000658-59):</u>

^{14}C-maneb mobility was investigated by the TLC method in which determined R_f values ranged from 0.0 to 0.43 (Table1). These values were taken to indicate immobility to medium mobility of the test substance which is believed to be a mixture of maneb degradation products (maneb was not identified even at time zero).

Table 1. Soil characteristics and the adsorption parameters of the soils used in the 1st adsorption/desorption study.

Soil Name	Celeryville muck	Lakeland SL	Barnes CL	Hagerstown SiCL	Norfolk SL
Textural Class	Muck soil	Sandy Loam	Clay Loam	Silty Clay Loam	Sandy Loam
Clay	Not determined	12%	34.4%	39.5%	11%
pH (water)	5.0	6.4	7.4	6.8	5.1
Field Capacity	113.0%	8.5%	28.5	25.8%	6.5%
Organic Carbon	52.56%	0.52%	4.01%	1.45%	0.08%
R_f	0.00		0.10	0.17	0.42
Mobility Class	Immobile		Slight		Medium

Second study (MRID 405852-03):

A 30-day aged ^{14}C-maneb complexs were slightly mobile in a column (30-cm length, 5-cm diameter) of loamy sand soil leached with 51 cm (20 inches, 1 L) of water for 24 hours. The radioactivity profile was used, for this RED, to calculate K_d (35.7) and K_{oc} (1,692). Only 2.6% of the applied radioactivity was recovered in the leachate. ETU and EU (present in the 30-day aged soil in un-quantified amounts) exhibited mobility and were the major components in the leachate; ETU, EU, and three unidentified degradates were isolated in the leachate at 1.8, 0.2, and <0.6% of the radioactivity applied to the soil column, respectively. The majority of the radioactivity (93.3% of radioactivity applied to the column) remained in the upper 10 cm (4 inches) of the soil column. In the soil column, ETU, EBIS, carbimid, and five unidentified degradates were isolated.

Third study (MRID 400472-01):

^{14}C-maneb complex exhibited variable mobility in four different texture soils in columns (12" long, 3'' diameter) leached with constant/simulated 20" rainfall using de-ionized water. The radioactivity profile was used, for this RED, to calculate the K_d and K_{oc} values presented in Table2. Data indicate that maneb complexes (a mixture of degradates not parent) can be classified as immobile, low, and medium mobile in sand, sandy loam, and clay loam/silty loam, respectively. The radioactivity depth profile showed that most of the applied radioactive residues were found at the top one inch segment of the soil columns. Radioactivity found in the leachate ranged from 9.5 to 32% of the applied. Neither maneb nor its known two degradate ETU/EU were identified in any of the leachates as radioactivity in these leachates were left unidentified.

Table 2. Soil characteristics and the adsorption parameters of the soils used in the 3rd study.

Source	Georgia	Georgia	Pennsylvania	Mississippi
Soil Textural Class	Sand	Sandy Loam	Clay Loam	Silt Loam
Clay	4%	14%	28%	10%
pH (water)	6.5	5.8	7.0	7.7
Field Capacity	7.8%	14.1%	29.1%	17.4%
C.E.C (meq/100 g)	3.8	9.1	15.7	7.6
Organic Carbon	0.12%	0.93%	1.63%	0.58%
K_{ad}	7.46	9.10	6.97	2.23
K_{oc}	6,412	978	428	400
Mobility Class	Immobile	Low	Medium	

Fourth/fifth study (MRID 455959-01/02):

In the 4th study, ^{14}C-maneb, aged for five hours in the application solution, was studied in duplicate Speyer 2.1 soil columns that were leached with 200 mm (393 ml) of water over a period of two days. Each 30 cm. soil column was purged with CO_2 to remove oxygen and was fortified with 0.621 mg of the aged ^{14}C-maneb. Total ^{14}C-residues were not identified but were nearly 54% of the applied radioactivity in the top 6 cm soil layer and ranged from 9- 2%, in the four segments below the top layer. Total [^{14}C]residues recovered in the leachate accounted for nearly 13% of the applied. In this leachate, ^{14}C-maneb was not detected but two of its transformation products EU (3.5-3.8%) and ETU (0.1-0.2%) were identified. Additionally, five unknown radioactive fractions were detected in the leachate, with the metabolite with the highest concentration totaling 2.7-2.9% of the applied. None of the other four degradates exceeded 1.0% of the applied. Estimated K_{ad}/K_{oc} and related soil characteristics for this soil are included in Table 3.

Soil column leaching experiments were conducted in the 5th study using three soils (Speyer 2.1/2.2 and 2.3) and the same procedure used in the *fourth* study. However, the source of ^{14}C-maneb was from the active ingredient of a wettable powder formulation (MRID 455959-02). Following leaching, total [^{14}C]residues in the soil (all layers) ranged from 76.6 to 84.3% of the applied from each duplicate soil column and total [^{14}C]residues in the leachate ranged from 1.5 to 4.7%.

In the Speyer 2.1 soil, total [^{14}C]residues were 71.6-73.8% of the applied radioactivity in the top 6 cm soil layer and were 4.9%, 2.7-3.0%, 1.4-1.7%, and 0.9-1.2%, respectively, in the four segments below the top layer proceeding from top to bottom. [^{14}C]Residues in the soil were not identified. A total of 3.4-4.7% of the applied was recovered in the leachate. Radioactivity detected in the leachate was comprised of seven unknown fractions, with no single fraction detected at greater than

1.5% of the applied. The material balance was 85.3% and 89.0% of the applied for the duplicate columns.

In the Speyer 2.2 soil, total [^{14}C]residues were 70.5-74.5% of the applied radioactivity in the top 6 cm soil layer and were 2.5-4.2%, 1.1-1.2%, 0.4-0.6%, and 0.3%, respectively, in the four segments below the top layer proceeding from top to bottom. [^{14}C]Residues in the soil were not identified. A total of 1.5-1.6% of the applied was recovered in the leachate. Radioactivity detected in the leachate was comprised of seven unknown fractions, with no single fraction detected at greater than 0.6% of the applied. The material balance was 78.2% and 80.5% of the applied for the duplicate columns.

In the Speyer 2.3 soil, total [^{14}C]residues were 67.5-67.9% of the applied radioactivity in the top 6 cm soil layer and were 4.8-6.9%, 3.5-4.4%, 1.6-2.4%, and 0.8-1.7%, respectively, in the four segments below the top layer proceeding from top to bottom. [^{14}C]Residues in the soil were not identified. A total of 2.1-3.9% of the applied was recovered in the leachate. Radioactivity detected in the leachate was comprised of seven unknown fractions, with no single fraction detected at greater than 2.5% of the applied. The material balance was 83.3% and 84.1% of the applied for the duplicate columns.

Estimated K_{ad}/K_{oc} and related soil characteristics for the three German soils are included in Table 3.

Table 3. Soil characteristics and the adsorption parameters of the soils used in the 4^{th}/5^{th} studies.

Soil Name	Speyer 2.1		Speyer 2.2	Speyer 2.3
Soil Textural Class	Sand		Loamy sand	Sandy loam
^{14}C-maneb source	Pure a.i	(a.i) from a wettable powder formulation		
Clay	4%		5%	8%
pH (water)	6.1		6.0	6.9
C.E.C (meq/100 g)	4.9		9.7	9.5
Organic Carbon	0.70%		2.29%	1.34%
K_{ad}	3.18	10.21	25.96	13.72
K_{oc}	454	1,459	1,133	1,024
Mobility Class	Medium	Low		

APPENDIX II: Hoerger-Kenaga Estimates & Fate v. 5.0 Model

a. Hoerger-Kenaga Estimates

EFED uses Hoerger and Kenaga estimates (1972) as changed by Fletcher and other researchers (1994) to estimate the residues on plants and insects. Hoerger-Kenaga categories represent preferred foods of various terrestrial vertebrates. Upland game birds prefer fruits and bud and shoot tips of leafy crops. Hares and hoofed mammals consume leaves and stems of leafy crops. Rodents consume seeds, seedpods and grasses; and various birds, mammals, reptiles and terrestrial-phase amphibians consume insects. Terrestrial vertebrates also may contact pesticides applied to soil by swallowing pesticide granules or pesticide-laden soil when foraging. Rich in minerals, soil comprises 5 to 30% of dietary intake by many wildlife species (Beyer and Conner).

Hoerger and Kenaga based pesticide environmental concentration estimates on residue data correlated from more than 20 pesticides on more than 60 crops. These estimates are representative of many geographic regions (7 states) and a wide array of cultural practices. Hoerger-Kenaga estimates also considered differences in vegetative yield, surface to mass ratio and interception causes. In 1994, Fletcher, Nellessen and Pfleeger reexamined the Hoerger-Kenaga simple linear model ($y=B^1x$, where x=application rate and y=pesticide residue in ppm) to decide whether the terrestrial EEC's were accurate. They compiled a data set of pesticide day-0 and residue-decay data involving 121 pesticides (85 insecticides, 27 herbicides, and 9 fungicides from 17 different chemical classes) on 118 species of plants. After analyzes, their conclusions were that Hoerger-Kenaga estimates needed only minor changes to increase the predictive values. They recommended an increase for forage and fruit categories from 58 to 135 ppm and from 7 to 15 ppm, respectively. Otherwise, the Hoerger-Kenaga estimates were accurate in predicting the maximum residue values after a 1 lb ai/acre application. Mean values represent the arithmetic mean of values from samples collected the day of pesticide treatment. The values in the table below are the predicted 0-day maximum and mean residues of a pesticide that may occur on selected avian, mammalian, reptilian or terrestrial-phase amphibian food items. These predicted residues occur immediately following a direct single application at a 1 lb ai/acre application rate. For pesticides applied as a nongranular product (for example, liquid or dust), EFED compared the estimated environmental concentrations (EECs) on food items following product application to LC_{50} values to assess risk. EFED based the estimated environmental concentrations of ETU on food items on Kenaga maximum and mean predicted values.

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).

b. Fate v. 5.0 Model Terrestrial Exposure Values

The model assumes a first order decay to fix the concentration at each day after first application based on the concentration resulting from the first and more applications. The model calculates decay from the first order rate equation:

$CT = Ci e^{-kT}$
or in integrated form:
$\ln (CT/Ci) = -kT$
Where:

CT = concentration at time T on day zero

C*i* = concentration in parts per million (ppm) present initially (on day zero) on the surfaces. The model calculates C*i* based on Kenaga and Fletcher by multiplying the application rate, in pounds active ingredient per acre. The model multiplies the application rate by 240 (mean of 85) for short grass, 110 (mean of 36) for tall grass, and 135 (mean of 45) for broad-leaf plants and insects and 15 (mean of 7) for seeds. The model converts extra applications from pounds active ingredient per acre to PPM on the plant surface and the addition mass added to the mass of the chemical still present on the surfaces on the day of application.

k= degradation rate constant determined from studies of hydrolysis, photolysis, microbial degradation, etc. Since degradation rate is reported by half-life, the model calculates the rate constant from the half-life (k = ln 2/T1/2). Choosing the degradation rate and half-life to use in terrestrial exposure calculations is open for debate and should be done by a qualified scientist.

T= time, in days, since the start of the simulation. The first application is on day 0. The simulation runs for the number of days entered by the modeler.

The program calculates concentration on each surface on a daily interval for the number of days entered by the modeler. The modeler chooses the days based on the guidance provided in Urban, 2000. The modeler uses the following formula with acute exposure addition of 30 days or the chronic exposure addition of 60 days:

$$\frac{\text{maximum number of applications}}{\text{crop cycle or season}} * \text{minimum interval between applications (days)} + \text{30 or 60 days}$$

The model calculates maximum and mean EECs based on the maximum and mean Kenaga-Fletcher values listed in Table 1 above. These EECs are the maximum amounts collecting on each day during the interval chosen. The model calculates these EECs for the different food item groupings.

c. Fate v. 5.0 Model Sample Outputs for Maneb

RUN No. 2 FOR maneb ON apples *** INPUT VALUES ***

RATE(#/AC) ONE(MAX)	APPLICATIONS NO.-INTERVAL		HALF-LIFE (DAYS)	AVIAN(ppm) LC50	AVIAN(ppm) NOAEC	MAMMALIAN(mg/kg) LD50	MAMMALIAN(mg/kg) NOAEL
4.800(6.136)	4	7	3.2	*******	20.000	*******	75.000

MAXIMUM & 58 DAY AVERAGE KENAGA/FLETCHER RESIDUES: 95th% (mean) in ppm

	SHORT GRASS	BROADLEAF & INSECTS	TALL GRASS	SEED FRUIT
MAX	1472.61(521.55)	828.34(276.11)	674.95(220.89)	92.04(42.95)
AVE	144.46(229.44)	76.48(186.95)	61.18(25.49)	11.90(

ENDPOINT	SHORT GRASS RQ	BR LEAF&INS RQ	TALL GRASS RQ	SEED FRUIT RQ
AV CHRON	73.63(26.08)	41.42(13.81)	33.75(11.04)	4.60(2.15)
MA CHRON	19.63(6.95)	11.04(3.68)	9.00(2.95)	1.23(.57)

Below are lists of daily Kenaga-Flether pesticide residue values
for four avian/mammalian food groupings for maneb use on turf
Values are in parts per million (ppm).

	SHORT GRASS DAILY VALUES		BROADLEAF & INSECTS DAILY VALUES		TALL GRASS DAILY VALUES		SEED FRUIT DAILY VALUES	
DAY	95%	MEAN	95%	MEAN	95%	MEAN	95%	MEAN
1	4176.00	1479.00	2349.00	783.00	1914.00	626.40	261.00	121.80
2	3362.70	1190.96	1891.52	630.51	1541.24	504.41	210.17	98.08
3	2707.80	959.01	1523.14	507.71	1241.08	406.17	169.24	78.98
4	2180.44	772.24	1226.50	408.83	999.37	327.07	136.28	63.60
5	1755.79	621.84	987.63	329.21	804.74	263.37	109.74	51.21
6	1413.84	500.74	795.29	265.10	648.01	212.08	88.37	41.24
7	1138.49	403.22	640.40	213.47	521.81	170.77	71.16	33.21
8	5092.76	1803.69	2864.68	954.89	2334.18	763.91	318.30	148.54
9	4100.92	1452.41	2306.77	768.92	1879.59	615.14	256.31	119.61
10	3302.25	1169.55	1857.51	619.17	1513.53	495.34	206.39	96.32
11	2659.12	941.77	1495.75	498.58	1218.76	398.87	166.19	77.56
12	2141.24	758.36	1204.45	401.48	981.40	321.19	133.83	62.45
13	1724.23	610.66	969.88	323.29	790.27	258.63	107.76	50.29
14	1388.42	491.73	780.99	260.33	636.36	208.26	86.78	40.50
15	5294.02	1874.97	2977.89	992.63	2426.43	794.10	330.88	154.41
16	4262.99	1509.81	2397.93	799.31	1953.87	639.45	266.44	124.34
17	3432.75	1215.77	1930.92	643.64	1573.34	514.91	214.55	100.12
18	2764.20	978.99	1554.87	518.29	1266.93	414.63	172.76	80.62
19	2225.86	788.33	1252.05	417.35	1020.19	333.88	139.12	64.92
20	1792.36	634.80	1008.21	336.07	821.50	268.85	112.02	52.28
21	1443.29	511.17	811.85	270.62	661.51	216.49	90.21	42.10

22	1162.20	411.61	653.74	217.91	532.68	174.33	72.64	33.90
23	935.86	331.45	526.42	175.47	428.94	140.38	58.49	27.30
24	753.60	266.90	423.90	141.30	345.40	113.04	47.10	21.98
25	606.83	214.92	341.34	113.78	278.13	91.02	37.93	17.70
26	488.65	173.06	274.86	91.62	223.96	73.30	30.54	14.25
27	393.48	139.36	221.33	73.78	180.35	59.02	24.59	11.48
28	316.85	112.22	178.23	59.41	145.22	47.53	19.80	9.24
29	255.14	90.36	143.52	47.84	116.94	38.27	15.95	7.44
30	205.45	72.76	115.57	38.52	94.16	30.82	12.84	5.99
31	165.44	58.59	93.06	31.02	75.83	24.82	10.34	4.83
32	133.22	47.18	74.94	24.98	61.06	19.98	8.33	3.89
33	107.27	37.99	60.34	20.11	49.17	16.09	6.70	3.13
34	86.38	30.59	48.59	16.20	39.59	12.96	5.40	2.52
35	69.56	24.64	39.13	13.04	31.88	10.43	4.35	2.03
36	56.01	19.84	31.51	10.50	25.67	8.40	3.50	1.63
37	45.10	15.97	25.37	8.46	20.67	6.77	2.82	1.32
38	36.32	12.86	20.43	6.81	16.65	5.45	2.27	1.06
39	29.25	10.36	16.45	5.48	13.40	4.39	1.83	.85
40	23.55	8.34	13.25	4.42	10.79	3.53	1.47	.69
41	18.96	6.72	10.67	3.56	8.69	2.84	1.19	.55
42	15.27	5.41	8.59	2.86	7.00	2.29	.95	.45
43	12.30	4.35	6.92	2.31	5.64	1.84	.77	.36
44	9.90	3.51	5.57	1.86	4.54	1.49	.62	.29
45	7.97	2.82	4.48	1.49	3.65	1.20	.50	.23
46	6.42	2.27	3.61	1.20	2.94	.96	.40	.19
47	5.17	1.83	2.91	.97	2.37	.78	.32	.15
48	4.16	1.47	2.34	.78	1.91	.62	.26	.12
49	3.35	1.19	1.89	.63	1.54	.50	.21	.10
50	2.70	.96	1.52	.51	1.24	.40	.17	.08
51	2.17	.77	1.22	.41	1.00	.33	.14	.06

APPENDIX III: Ecological Hazards Assessment

a. Overview

The toxicity testing required does not test all species of birds, fish, mammals, invertebrates, and plants. EFED uses only two surrogate species for birds (Bobwhite quail and mallard ducks) to represent all bird species (over 900 in the US). EFED uses three species of freshwater fish (rainbow trout, bluegill sunfish and fathead minnow) to act as surrogate test species for all freshwater fish species (over 900 in the US). One estuarine fish species (sheepshead minnow) serves as surrogate for all estuarine and marine fish (over 300 in the US). The surrogate species for terrestrial invertebrates is the honeybee. For freshwater invertebrates the surrogate species is usually the waterflea (*Daphnia magna*). For estuarine and marine invertebrates the surrogate species are mysid shrimp and eastern oyster. EFED uses these four species to represent all invertbrates species (over 10,000 in the US). For plants, there are ten surrogate species used for all terrestrial plants and five surrogate species used for all aquatic plants. There are over 20,000 plant species in the US which includes flowering plants, conifers, ferns, mosses, liverworts, hornworts and lichens. There are over 27,000 species of algae worldwide.

The surrogate species testing scheme used in this assessment assumes that a chemical's method of action and toxicity found for avian species is similar to that in all reptiles (over 300 species in the US). The same assumption applies to amphibians (over 200 species in the US) and fish. EFED assumes the tadpole stage of amphibians has the same sensitivity as a fish. Therefore, EFED considers the results from toxicity tests on surrogate species are applicable to other member species within their class and extrapolates this toxicity to reptiles and amphibians. EFED got the US species numbers noted in this section from: http://www.natureserve.org/summary (NatureServe: An online encyclopedia of life [web application].2000) and the worldwide species number from Ecological Planning and Toxicology, Inc.1996.

b. Toxicity to Terrestrial Animals

i. Birds, Acute, Subacute and Chronic

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of maneb to birds. The avian oral LD_{50} is an acute, single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of birds. The preferred test species is either the Mallard Duck, a waterfowl, or Bobwhite quail, an upland gamebird. The TGAI is administered by oral intubation to adult birds, and the results are expressed as LD_{50} milligrams (mg) active ingredient (a.i.) per kilogram (kg). Toxicity category descriptions are as follows (Brooks, 1973):

If the LD_{50} is *less than 10 mg a.i./kg*, then the test substance is *very highly toxic*.
If the LD_{50} is *10-to-50 mg a.i./kg*, then the test substance is *highly toxic*.
If the LD_{50} is *51-to-500 mg a.i./kg*, then the test substance is *moderately toxic*.
If the LD_{50} is *501-to-2,000 mg a.i./kg*, then the test substance is *slightly toxic*.

If the LD_{50} is *greater than 2,000 mg a.i./kg*, then the test substance is *practically nontoxic.*

Study results are in the table below.

Table 1. Avian Acute Oral Toxicity - Maneb

Species	% ai	LD_{50} (mg/kg)	Toxicity Category	MRID/ Author/Year	Classification
Northern bobwhite *(Colinus virginianus)*	86 (doses were adjusted to 100% ai)	>2,150	practically nontoxic	40657001/ D. Fletcher/1988	Core

The avian acute oral toxicity of maneb is >2150 mg/kg, categorizing maneb as slightly to practically nontoxic to birds. The guideline 71-1(a) is fulfilled (MRID 40657001).

Two dietary studies using the TGAI are required to establish the toxicity of maneb to birds. These avian dietary LC_{50} tests, using the Mallard Duck and Bobwhite Quail, are acute, eight-day dietary laboratory studies designed to estimate the quantities of toxicant required to cause 50% mortality in the two respective test populations of birds. The TGAI is administered by mixture to juvenile birds' diets for five days followed by three days of "clean" diet, and the results are expressed as LC_{50} parts per million (ppm) active ingredient (a.i.) in the diet. Toxicity category descriptions are as follows (Brooks, 1973):

If the LC_{50} is *less than 50 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *50-to-500 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *501-to-1,000 ppm a.i.*, then the test substance is *moderately toxic.*
If the LC_{50} is *1001-to-5,000 ppm a.i.*, then the test substance is *slightly toxic.*
If the LC_{50} is *greater than 5,000 ppm a.i.*, then the test substance is *practically nontoxic.*

Study results are tabulated below.

Table 2. Avian Subacute Dietary Toxicity - Maneb

Species	% ai	LC50 (ppm)	Toxicity Category	MRID/Author/ Year	Study Classification
Bobwhite Quail *(Colinus virginianus*)	assumed to be 100%	>10,000	practically nontoxic	00104264/R. Fink/ 1975	Supplemental[1]
Mallard Duck *(Anas platyrhynchos*)	assumed to be 100%	>10,000	practically nontoxic	00098561/Truslow Farms, Inc../1975	Supplemental[2]
Mallard Duck *(Anas platyrhynchos*)	86 (doses were adjusted to 100% ai)	>5,000	practically nontoxic	40657002/D. Fletcher/ 1988	Core

[1] Although classified supplemental, the study was found to fulfill the guideline requirement (see Maneb 1988 Registration Standard).
[2] Study was classified supplemental, but upgradeable if growth data and dose mortality could be provided.

With LC50 values ranging from greater than 5,000 ppm for mallard ducks to greater than 10,000 ppm for bobwhite quail, maneb is considered to be practically nontoxic to birds. Guideline 71-2(a) for bobwhite is fulfilled (MRID 00104264). Guideline 71-2(b) for mallard duck is also considered fulfilled (MRID 40657002).

Avian reproduction studies using the Bobwhite Quail and Mallard Duck are laboratory tests designed to estimate the quantity of toxicant required to adversely affect the reproductive capabilities of a test population of birds. The TGAI is administered by mixture to breeding birds' diets throughout their breeding cycle. Test birds are approaching their first breeding season and, generally, are 18-to-23 weeks old. The onset of the exposure period is at least 10 weeks prior to egg laying. Exposure period during egg laying is generally 10 weeks with a withdrawal period of three additional weeks if reduced egg laying is noted. Results are expressed as No Observed Adverse Effect Concentration (NOAEC) and various observable effect levels, such as the Lowest Observable Adverse Effect Concentration (LOAEC), quantified in units of parts per million of active ingredient (ppm) in the diet. Study results are tabulated below .

Table 3. Avian Reproduction - Maneb

Species/ Study Duration	% ai	NOAEC/ LOAEC (ppm)	LOAEC Endpoints	MRID/Author/ Year	Classification
Northern bobwhite *(Colinus virginianus)* /22 weeks	91.0	>500 (highest dose tested)/LAOEC not determined	not determined	43586501/Beavers *et. al*./1995	Supplemental[1]
Mallard Duck *(Anas platyrhynchos)* /22 weeks	91.0	20/100	Reduction in the number of hatchlings as percentages of eggs laid, eggs set, and live 3-week old embryos, and a reduction in the number of 14-day old survivors as a percentage of eggs set.	43586502/Beavers *et. al*./1995	Core

1 study was classified supplemental because a NOAEC was not established.

The avian reproduction study using mallard duck resulted in a LOAEC of 100 ppm based on a reduction in the: (1) number of hatchlings as percentages of eggs laid, (2) number of eggs set; (3) number of live 3-week old embryos; and (4) number of 14-day old survivors as a percentage of eggs set when compared to the control. The NOAEC is 20 ppm. The guideline 71-4(b) is fulfilled (MRID 43586502).

The avian reproduction study using bobwhite resulted in a NOAEC greater than 500 ppm, the highest dose tested. This study was classified supplemental because an NOAEC was not established. Although a core study is not available, the mallard has been shown to be more the more sensitive of the two species, and will be used for risk assessment purposes. Additional reproductive testing is not required. Guideline 71-4(a) is considered fulfilled (MRID 43586501).

ii. Mammals, Acute and Chronic

1. Acute Oral Toxicity Testing

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. The toxicity values used in this assessment were taken from HED's Tox One-Liner, and the final Hazard Identification Assessment Review Committee (HIARC) reports on maneb (dated 11/15/99 and 11/27/01). The results indicate that maneb is practically nontoxic to mammals on an acute oral basis with LD_{50} value greater than 5,000 mg /kg (see Table 4, below). The toxicity values (LD_{50} and NOAEL) appearing in the shaded areas of the tables will be used to calculate the acute and chronic mammalian risk quotients (RQ's) in subsequent sections. Toxicity category descriptions are the following (Brooks, 1973):

If the LD_{50} is *less than 10 mg a.i./kg*, then the test substance is *very highly toxic*.
If the LD_{50} is *10-to-50 mg a.i./kg*, then the test substance is *highly toxic*.
If the LD_{50} is *51-to-500 mg a.i./kg*, then the test substance is *moderately toxic*.
If the LD_{50} is *501-to-2,000 mg a.i./kg*, then the test substance is *slightly toxic*.
If the LD_{50} is *greater than 2,000 mg a.i./kg*, then the test substance is *practically nontoxic*.

Table 4. Mammalian Acute Toxicity - Maneb

Species	% ai	Test Type	LD_{50} (mg/kg)	Toxicity Category)	Affected Endpoints	MRID
			Technical			
laboratory rat (Rattus norvegicus) laboratory	not reported	oral - single dose	>5,000	practically nontoxic	mortality	41975601

2. Acute Dermal and Inhalation Toxicity Testing

In addition to acute oral routes of exposure, terrestrial vertebrates entering treatment area may be acutely exposed to maneb through other routes of exposure. Results of toxicological testing indicate maneb is a Category III toxicant to rats via the inhalation route (LC50> 1.3 mg/L; MRID 41975603) and to rabbits via the dermal route of exposure (LD50 > 2000 mg/kg; MRID 41975602).

Toxicity category descriptions associated with inhalation routes of exposure include the following (US EPA CFR. Part 156):

If the LC_{50} is *less than or equal to 0.05 mg/liter*, then the test substance is *in Toxicity Category I*.
If the LC_{50} is *greater than 0.05 mg/liter through 0.5 mg/liter*, then the test substance is in *Toxicity Category II*.
If the LC_{50} is *greater than 0.5 mg/liter through 2.0 mg/liter*, then the test substance is *in Toxicity Category III*
If the LC_{50} is *greater than 2.0 mg/liter*, then the test substance is *in Toxicity Category IV*.

Toxicity category descriptions associated with dermal routes of exposure include the following (US EPA CFR. Part 156):

If the LD_{50} is *less than or equal to 200 mg/kg,* then the test substance is *in Toxicity Category I.*
If the LD_{50} is *greater than 200 through 2,000 mg/kg,* then the test substance is in *Toxicity Category II.*
If the LD_{50} is *greater than 2,000 through 5,000 mg/kg,* then the test substance is *in Toxicity Category III*
If the LD_{50} is *greater than 5,000 mg/kg,* then the test substance is *in Toxicity Category IV.*

3. Mammalian Feeding, Reproductive and Developmental Toxicity Testing

Based on a 13-week maneb feeding study in rats (see Table 5), thyroid effects, namely, increased thyroid weights and follicular cell hyperplasia (abnormal increase) in males and decreased thyroxine (a thyroid hormone) levels in both sexes were noted at a LOAEL of 400 ppm (NOAEL = 80 ppm) (MRID No. 40982601). In a maneb developmental study on rats, treatment-related developmental effects caused by maneb resulted in increased post-implantation (embedding of fertilized egg in uterine lining) loss, increased resorption (total and resorption per dam), and decreased fetal viability at a LOAEL of 1,000 ppm (NOAEL = 200 ppm) (MRID No. 42520001). A two-generation reproductive study on rats using maneb provided a LOAEL of 300 ppm (NOAEL = 75 ppm) for paternal toxicity causing an increase in lung weight in both generations (F0, parent and F1, first generation of offspring) and liver weight in F1. An increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia was also noted in F1. Fetal effects based on slight delay in the startle response in the offspring were also noted at a LOAEL of 300 ppm (NOAEL = 75 ppm) in this two-generation reproductive study (MRID No. 42049401).

Table 5. Mammalian Feeding, Developmental and Reproductive Chronic Toxicity - Maneb Technical

Species/ Study Duration	% ai	Test Type	NOAEL/LOAEL Toxicity (mg/kg/day)	Affected Endpoints	MRID
laboratory rat (Rattus norvegicus) /13 weeks	77.9	Feeding	5/24 (80/400 ppm) male 6/30 (80/400 ppm) female	Based on thyroid effects (increased thyroid weights and follicular cell hyperplasia in males) and decreased T_4 (thyroxine, a thyroid hormone).	40982601
laboratory rat (Rattus norvegicus) /gestation (days 6-15)	90.4	Developmental	20/100 (400/2,000 ppm)[1] (maternal) 20/100 (200/1,000 ppm)[1] (developmental)	mat. - based on increased clinical signs (soft stool), decreased body-weight gain and decreased food consumption dev. -based on increased post-implantation (embedding of fertilized egg in uterine lining) loss, increased resorption (total and resorption per dam), and decreased fetal viability	42520001
laboratory rat (Rattus norvegicus) /2-generation	87.3	Reproductive	(75/300 ppm)[2] (parental) (300/1,200 ppm)[2] (reproductive) (75/300 ppm)[2] (fetal)	parental (paternal) - based on a significant increase in lung (both generations) and liver (F1) weight and an increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia (F1) parental (maternal) - based on decreased body weight/body-weight gain and food consumption reproductive - based on delayed vaginal opening in the F1 female offspring fetal - based on slight delay in the startle response in the offspring	42049401

1 ppm conversion based on:
1 mg/kg/day = 20 ppm in adult rats, and 10 ppm in younger rats. (Nelson, 1975)
2 ppm value provided in study review

iii. Insect Acute Contact

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

If the LD_{50} is *less than 2* μg a.i./bee, then the test substance is *highly toxic*.
If the LD_{50} is *2 to less than 11* μg a.i./bee, then the test substance is *moderately toxic.*
If the LD_{50} is *11* μg a.i./bee or *greater*, then the test substance is *practically nontoxic*

Study results are tabulated below.

Table 6. Non-target Insect Acute Contact Toxicity - Maneb

Species	% ai	LD50 (μg/bee)	Toxicity Category	MRID/Author/ Year	Study Classification
Honey bee (Apis mellifera)	not reported	> 12.09	practically nontoxic	00036935/Atkins *et. al*./1975	Core

The LD_{50} for maneb is greater than 12.09 μg per bee, classifying maneb as practically nontoxic to bees. Guideline (141-1) is fulfilled (MRID 00036935).

iv. Insect Residual Contact

Honey bee toxicity of residues on foliage study is required on an end-use product for any pesticide intended for outdoor application when the proposed use pattern indicates that honey bees may be exposed to the pesticide and when the formulation contains one or more active ingredients having an acute contact honey bee LD_{50} which falls in the moderately toxic or highly toxic range. Since maneb is practically nontoxic to honey bees a honey bee toxicity of residues on foliage (Guideline 141-2) is not required.

v. Terrestrial Field Testing

No studies were submitted and no studies are required.

c. Aquatic Organism Toxicity

i. Toxicity to Freshwater Animals

1. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of maneb to fish. The preferred test species are rainbow trout (a coldwater fish; Guideline 72-1c) and bluegill sunfish (a warmwater fish; Guideline 72-1a). End-use product testing was required to support the cranberry use (see Maneb 1988 Registration Standard). EFED subsequently allowed TEP testing (with 80% WP) to fulfill TGAI testing requirements. Justification provided by the registrant was that the end-use product had greater solubility in water than the TGAI.. The toxicity values (LC_{50}) appearing in the shaded area of the tables will be used to calculate the acute aquatic risk quotients (RQ's) in subsequent sections. Toxicity category descriptions are as follows (Brooks, 1973):

If the LC_{50} is *less than 0.1 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *0.1-to-1.0 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *greater than 1 and up through 10 ppm a.i.*, then the test substance is *moderately toxic*.
If the LC_{50} is *greater than 10 and up through 100 ppm a.i.*, then the test substance is *slightly toxic*.
If the LC_{50} is *greater than 100 ppm a.i.*, then the test substance is *practically nontoxic*.

Study results are tabulated below.

Table 7. Freshwater Fish 96-hr Acute Toxicity - Maneb

Species/ Flow-through or Static	% ai	LC_{50} (ppm)/ (measured/ nominal)	Toxicity Category	MRID /Author/ Year	Study Classification
		End-Use Product			
Bluegill sunfish *(Lepomis macrochirus)* /static	80.0 WP	0.27 (mean measured) 0.17 (lowest measured	highly toxic	40749401/R. Sugatt/ 1988	Core
Rainbow Trout *(Oncorhynchus mykiss)* /static	80.0 WP	0.052 (lowest measured 0.042 (based on active ingredient) slope = 2.8 ($p < 0.05$)	very highly toxic	40706001/R.Sugatt/ 1988	Supplemental[1]
Bluegill sunfish *(Lepomis macrochirus)* /static	80.0 (Dithane M-22)	0.979 (nominal)	highly toxic	00097240/McCann. & Pitcher/1973	Supplemental[2]
Bluegill sunfish *(Lepomis macrochirus)* /static	5.6 Tide Maneb	68 (nominal)	slightly toxic	00052557/J. McCann/ 1968	Supplemental[2]
Bluegill sunfish *(Lepomis macrochirus)* /static	80.0 (DuPont Mannate)	0.99 (nominal)	highly toxic	00090291/McCann & Pitcher/1973	Supplemental[2]

[1] Study classified supplemental because high variability in measured concentrations; weights of fish not given; O_2 less than recommended; study should have been flow-through.

[2] The McCann studies were not conducted according to acceptable protocols: the toxicity end points were not based on measured concentrations and/or the information was provided as a reference source with no supporting data or statistical analysis.

Since one of the LC_{50} values (for rainbow trout) falls below 0.1 ppm, maneb is characterized very highly toxic to fish on an acute basis. In the studies conducted by Sugatt, a substantial decrease in test substance between the beginning and the end of the tests was noted. For example, in the rainbow trout study the concentration of maneb decreased as much as 55% of the nominal at the zero hour measurement, and the final measurements only averaged 13.1% of the nominal value (range was 9.6% to 22.5%). Because estimation of the actual exposures of the fish was not possible, EFED based the study results on final (lowest) measurement concentrations. Guidelines 72-1(a) for the TGAI and 72-1(b) for the TEP of maneb are fulfilled (MRID 40749401). Guidelines 72-1(c) for the TGAI and 72-1(d) for the TEP of maneb are not fulfilled. A core study is required to fulfill these guideline requirements and, as mentioned above, testing with the 80% WP formulation can fulfill the requirements for both TGAI and TEP testing.

2. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for maneb because the end-use product may be transported to water from the intended use site, and acute aquatic toxicity values are less than 1 ppm. Acceptable freshwater test species are rainbow trout, brook trout, coho salmon, Chinook, bluegill, brown trout, lake trout, northern pike, fathead minnow, white sucker and channel catfish. The fish early life-stage is a laboratory test designed to estimate the quantity of toxicant required to adversely effect the reproductive capabilities of a test population of fish. The TGAI is administered into water containing the test species, providing exposure throughout a critical life-stage, and the results are expressed as a No Observed Adverse Effect Concentration (NOAEC) and LOAEC (Lowest Observed Adverse Effect Concentration). The toxicity value (NOAEC) appearing in the shaded area of the table will be used to calculate the chronic aquatic risk quotients (RQ's) in subsequent sections. The guideline 72-4(a) for early life-stage fish testing is fulfilled (MRID 41346301). Testing results are summarized below.

Table 8. Freshwater Fish Early Life-Stage Toxicity - Maneb

Species/Static or Flow-through Study Duration	% ai	NOAEC/LOAEC (ppb)/ (measured/nominal)	Endpoints Affected	MRID/Author/ Year	Study Classification
Fathead minnow *(Pimephales promelas)* /flow-through/35 days	87.3	6.1/12 (mean measured) [1]	Hatchability, fish survival and length of fry	41346301/W.A. McAllister./1989	Core

[1] mean values ranged 58 to 77% of the nominal. The authors reported that due to the low water and organic solvent solubility of maneb, as well as its rapid hydrolysis rate, an electronically controlled toxicant delivery apparatus was developed to automatically provide fresh test stock solutions at six hour intervals.

A freshwater fish life-cycle test using the TGAI is required for maneb because the end-use product is expected to be transported to water from the intended use site and any EEC is equal to or greater than one-tenth of the NOAEC in the fish early life-stage or invertebrate life-cycle test. The PRZM-EXAMS modeled peak EECs for selected sites in maneb's current use patterns range from 47.6 ppb for potato applications to 197.9 ppb for tomato applications. The preferred test species is fathead minnow. The freshwater fish life-cycle test (Guideline 72-5) has not been fulfilled. A core study for this guideline is required to be submitted.

3. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of maneb to aquatic invertebrates. The preferred test organism is Daphnia magna, but early instar amphipods, stoneflies, mayflies, or midges may also be used. End-use product testing was required to support the cranberry use (see Maneb 1988 Registration Standard). EFED subsequently allowed TEP testing (with 80% WP) to fulfill TGAI testing requirements. The toxicity value (EC_{50}) appearing in the shaded area of the table will be used to calculate the acute risk quotients (RQ's) in subsequent sections. Study results are tabulated below.

Table 9. Freshwater Invertebrate Acute Toxicity - Maneb

Species/Static or Flow-through/Duration	% ai	EC_{50} (ppm)/ (nominal/measured)	Toxicity Category	MRID/Author/ Year	Study Classification
Daphnid *(Daphnia magna)*/ static (48 hr.)	80 WP	0.31(mean measured) 0.12 (lowest measured) slope = 4.2 ($p < 0.05$)	highly toxic	40749402/R. Sugatt/1988	Core

Since the EC_{50} is less than 1 ppm maneb is categorized very highly toxic to freshwater aquatic invertebrates on an acute basis. Since a substantial decrease in test substance concentration was noted between the beginning and end of the test (final values averaged 34% of nominal), test results were based on final measured concentrations. Guideline 72-2 (a and b) are considered fulfilled (MRID 40749402).

4. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI was reserved in the 1988 Registration Standard pending results of environmental fate data such as hydrolysis, photplysis and aquatic field dissipation and studies on technical maneb. This study is required because the end-use product is expected to be transported to water from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent, (2) the aquatic acute LC_{50} or EC_{50} is less than 1.0 ppm, and (3) the EEC in water is equal to or greater than 0.01 of any acute EC50 or LC50 value. The preferred test species is *Daphnia magna*. The guideline (72-4) is not fulfilled.

5. Freshwater Field Studies

No studies were submitted and no studies are required.

ii. Toxicity to Estuarine and Marine Animals

1. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine and marine fish using the TGAI is required for maneb because the end-use product is expected to reach the marine/estuarine environment because of its use in coastal counties. The preferred test organisms are the sheepshead minnow. End-use product testing was required to support the cranberry use (see Maneb 1988 Registration Standard). EFED subsequently allowed TEP testing (with 80% WP) to fulfill TGAI testing requirements. Justification provided by the registrant was that the end-use product had greater solubility in water than the TGAI. The toxicity value (LC_{50}) appearing in the shaded area of the table will be used to calculate the acute risk quotients (RQ's) in subsequent sections. Study results are tabulated below.

Table 10.   Summary of acute 96-hr toxicity tests for Estuarine/Marine Fish - Maneb

Species/static or flowthrough	% a.i.	LC_{50}) ppm/ (measured/nominal)	Toxicity Category	MRID/Author/ Year	Classification
		End-Use Formulation			
Atlantic Silverside/ *(Menidia menidia)*/ flowthrough	84.8 (80% WP)	0.23(mean measured) 0.18 (lowest measured) slope = 4.2	highly toxic	40943101/S. Manning/1988	Core

Based on the results of this test, maneb is categorized highly toxic to estuarine fish. The study authors noted that measured concentrations were variable (69 to 89% of the nominal), and attributed this to the poor solubility of the test material in sea water. The study fulfills Guideline 72-3(a and d) (MRID 40943101).

2. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using the TGAI is required for maneb because the end-use product is expected to be transported to the estuarine/marine environment from the intended use site, and the following conditions are met: the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent and the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value. The preferred test species is sheepshead minnow. The guideline (72-4a) estuaine/marine fish is not fulfilled. A core study is required to be submitted for this guideline.

3. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for maneb because the end-use product is expected to reach the marine/estuarine environment because of it use in coastal counties. The preferred test species are mysid shrimp and eastern oyster. End-use product testing was required to support the cranberry use (see Maneb 1988 Registration Standard). EFED subsequently allowed TEP testing (with 80% WP) to fulfill TGAI testing requirements. The toxicity value (EC_{50}) appearing in the shaded area of the table will be used to calculate the acute risk quotients (RQ's) in subsequent sections. Study results are tabulated below.

Table 11 .   Estuarine/Marine Invertebrate Acute Toxicity - Maneb

Species/Static or Flow-through	% a.i.	96-hour EC50 (ppm)/ (measured/nominal)	Toxicity Category	MRID/Author/Yea r	Study Classification
		End-Use Formulation			
Eastern oyster *(Crassostrea virginica)*/flow-through (shell deposition)	84.8 (80% WP)	0.64 (mean measured) 0.28 (lowest measured)	highly toxic	41000001/S. Manning/1989	Core

Table 11 . Estuarine/Marine Invertebrate Acute Toxicity - Maneb

Species/Static or Flow-through	% a.i.	96-hour EC50 (ppm)/ (measured/nominal)	Toxicity Category	MRID/Author/Year	Study Classification
Mysid *(Americamysis bahia)*/flow-through	84.8 (80% WP)	0.003(estimated) slope = 3.5	very highly toxic	41000002/S. Manning/1988	Supplemental[1]

1 high variability in measured concentrations; analytical procedures were not able to detect maneb below 5 ppb..

Since the mollusc EC_{50} is less than 1 ppm, maneb is considered to be highly toxic to the mollusc on an acute basis. Guideline 72-3(b) for the TGAI acute toxicity to estuarine/marine organism-mollusk is fulfilled (MRID No. 41000001). Since the nominal to measured concentrations varied significantly in this test (authors attributed to low solubility of material), EFED based the study results on the lowest measured concentrations. The study fulfills Guideline 72-3(b and e) (MRID 41000001).

Based on a supplemental study with mysid shrimp, maneb may be characterized as very highly toxic to estuarine invertebrates. There was high variability in measured concentrations in this study (estimated at 13 to 17% of nominal); the study authors attributed this to the poor solubility of the test material. Since three of the four actual measured concentrations were only estimates (not verified by recovery methods), the only assumption that could be drawn from the study was that the LC50 value is below 5 ppb, and probably about 3 ppb. Guideline 72-3 (c and f) is not fulfilled.

4. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity test (Guideline 72-4b) using the TGAI is required for maneb because the end-use product is expected to be transported to the estuarine/marine environment from the intended use site, the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent, any aquatic acute LC_{50} or EC_{50} is less than 1.0 ppm, and the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value. The preferred test species is mysid shrimp. This guideline has not been fulfilled and a core study for this guideline is required to be submitted.

5. Estuarine and Marine Field Studies

No studies were submitted and no studies are required.

iii. Toxicity to Plants

1. Terrestrial Plants

Terrestrial plant Tier I seedling emergence and vegetative vigor testing of a maneb TEP is currently recommended for all pesticides having outdoor uses. For seedling emergence and vegetative vigor testing the following plant species and groups should be 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*). Tier I tests measure the response of plants, relative to a control, at a test level that is equal to the highest use rate (expressed as lbs ai/A). Tier II studies are required if the Tier I studies indicate any of the test species, when exposed to the test material, displayed a $\geq$25% inhibition of various growth parameters as compared to the control. Tier I seedling emergence [guideline 122-1(a)] and vegetative vigor [guideline 122-1(b)] studies have not been submitted for a maneb and it is recommended that these studies be submitted for review.

2. Terrestrial Plant Field Studies

No studies were submitted and no studies are required.

3. Aquatic Plants

Aquatic plant testing is recommended for all pesticides having outdoor uses (Keehner. July 1999). The tests are performed on species from a cross-section of the non-target aquatic plant population. The preferred test species are duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), freshwater green alga (*Selenastrum capricornutum*), and a freshwater diatom. Tier I aquatic plant testing is a maximum dose test designed to quickly evaluate the toxic effects to the test species in terms of growth and reproduction and to determine the need for additional aquatic plant testing. Tier II aquatic plant testing is a multiple dose test of the plants species that showed a phytotoxic effect to the pesticide being tested at the Tier I level. Tier II testing is aimed to determine the detrimental effect levels of the chemical on the aquatic plants which showed a greater than 50% detrimental effect in Tier I testing.

One study (see Table 12, below) has been submitted for a maneb technical formulation using the freshwater green algae. *S. capricornutum* (MRID 40943501). The EC_{50} for *S. capricornutum* was 13.4 ppb based on growth inhibition; the NOAEC was 5 ppb. Results were based on nominal concentrations, even though the study author reported that maneb was unstable in the test media (at 120 hours it averaged 15% of the nominal). The toxicity value (EC_{50}) appearing in the shaded area of the table will be used to calculate the acute risk quotients (RQ's) in subsequent sections. Guideline 123-2 (Tier II) is not fulfilled. Guideline 122-2 (Tier I) or Guideline 123-2 (Tier II) aquatic plant growth testing needs to be submitted for duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), and a freshwater diatom.

Table 12: Non-target Aquatic Plant Toxicity (Tier II) - Maneb

Species/duration	% A. I.	EC_{50}/NOAEC (ppb ai)	MRID No. Author/year	Classification[1]
Nonvascular Plants				
frreshwater green algae (*Selenastrum capricornutum*) /120 hrs.	87.3	13.4/5.0 (nominal) slope = 4.8 ($p < 0.05$)	40943501/Forbis, A./1988	Core

4. Aquatic Plant Field Studies

No studies are available. In 1989 EFED recommended a Tier II study be conducted based results of the green algae toxicity coupled with expected aquatic EECs resulting in anticipated adverse effects to freshwater algae from a typical application. The study was subsequently reserved.

APPENDIX IV: Environmental Exposure Assessment

a. Overview of Risk Quotients (RQs)

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The Agency calls this integration the quotient method. The Agency calculates risk quotients (RQs) by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE/TOXICITY

EFED compares RQs to OPP's levels of concern (LOCs). OPP uses these LOCs to analyze potential risk to non-target organisms and the need to consider regulatory action. This method signals that a pesticide used as directed has the potential to cause adverse effects on non-target organisms. LOCs currently address the following risk presumption categories: (1) acute risks - the risks warrant regulatory action as well as restricted use classification; (2) acute restricted use - the potential for acute risk exists, but the restricted use classification may mitigate the risk; (3) acute endangered species - the risk may adversely affect endangered species; and (4) chronic risk - the risk may warrant regulatory action because there is a potential for chronic risk. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to non-target insects, or chronic risk from granular or bait formulations to birds or mammals.

The Agency gets ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients from required studies. Examples of ecotoxicity values gathered from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds); (2) LD_{50} (birds and mammals); (3) EC_{50} (aquatic plants and aquatic invertebrates); and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels drawn from the results of long-term laboratory studies that assess chronic effects are: (1) LOAEL or LOAEC (birds, fish, and aquatic invertebrates) and (2) NOAEL or NOAEC (birds, fish and aquatic invertebrates). For birds, mammals, fish and aquatic invertebrates, the Agency uses the NOAEL or NOAEC as the ecotoxicity test value in assessing chronic effects, although the Agency may use other values when justified. Tabulated below are risk presumptions and the matching RQs and LOCs.

Risk quotients are index or reference values used to show potential ecological risk. There are limits with the use of risk quotients in assessing the risk to non-target animals and plants. The likelihood of an adverse effect does not increase with the size of the risk quotient. (Urban, 2000). An LOC defined as 1 (see table below) provides the reference point for estimating the exposure to toxicity risk (that is, risk quotient). Values at or above this reference point trigger risk concerns. A risk quotient value of 100 compared to a value of 50 does not suggest a greater risk or a risk that is more likely to occur. Both these values are above the reference point for risk of 1. The risk quotient value of 100 reflects an exposure level that is twice has high as the risk quotient value of 50. The “exposure” in the “RQ = Exposure/Toxicity” ratio is twice has high for RQ of 100 as for the RQ of 50. Risk quotients are nonprobabilistic and have numerical and dichotomous results. The numerical result drawn from the calculation either exceeds a fixed LOC or does not exceed it. (US EPA. June 30, 1995).

Table 1. Risk presumptions for terrestrial animals based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
	Birds	
Acute Risk	EEC^1/LC_{50} or LD_{50}/ft^2 or LD_{50}/day^3	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
	Wild Mammals	
Acute Risk	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items
[2] mg/ft^2
[3] mg of toxicant consumed/day
LD_{50} * wt. of bird
LD_{50} * wt. of bird

Table 2. Risk presumptions for aquatic animals based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
Acute Risk	EEC^1/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1

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

Table 3. Risk presumptions for plants based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
Terrestrial and Semi-Aquatic Plants		
Acute Risk	EEC^1/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1
	Aquatic Plants	
Acute Risk	EEC^2/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1

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

b. Exposure and Risk to Terrestrial Animals

i. Birds

Since maneb is practically nontoxic to birds on an acute basis (acute oral LD50 > 2,150 mg/kg and acute dietary LC50 > 5,000 ppm) the acute risks to birds are expected to be low from maneb's uses and acute RQs have not been calculated. The chronic RQs for multiple broadcast applications of nongranular maneb products are tabulated below. Analysis of the results indicate that for multiple applications of maneb nongranular products, avian chronic LOCs are exceeded for all uses patterns with RQs ranging from a high of 265 from the turf use to a low of 0.4 from the maneb's uses on collards, turnips, and mustard (Georgia and Tennessee, only).

Table 4: Avian Chronic Risk Quotients for Multiple Broadcast Applications of Nongranular Maneb based on a Mallard Duck (*Anas platyrhynchos*) NOAEC of 20 ppm.

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Almonds ground & aerial	6.4/4 7-day interval	Short grass	1,963	695	98	34.8
		Tall grass	900	295	45	14.7
		Broadleaf plants/Insects	1,104	368	55	18.4
		Seeds	123	57	6	2.9
Apples ground & aerial	4.8/4 7-day interval	Short grass	1,473	522	74	26.1
		Tall grass	675	221	34	11.0
		Broadleaf plants/Insects	828	276	41	13.8
		Seeds	92	43	5	2.1
Bananas ground & aerial	2.4/10 14-day interval	Short grass	605	214	30	10.7
		Tall grass	277	91	14	4.5
		Broadleaf plants/Insects	340	113	17	5.7
		Seeds	38	18	2	0.9
Beans (dried) ground & aerial	1.6/6 5-day interval	Short grass	580	205	29	10.3
		Tall grass	266	87	13	4.3
		Broadleaf plants/Insects	326	109	16	5.4
		Seeds	36	17	2	0.8
Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Endive, Kohlrabi, & Lettuce ground & aerial	1.6/6 7-day interval	Short grass	492	174	25	8.7
		Tall grass	225	74	11	3.7
		Broadleaf plants/Insects	277	92	14	4.6
		Seeds	31	14	2	0.7
Collards & Turnip (GA & TN, only) ground & aerial	1.2/3 14-day interval	Short grass	303	107	15	5.4
		Tall grass	139	45	7	2.3
		Broadleaf plants/Insects	170	57	9	2.8
		Seeds	19	9	1	0.4
Corn (pop & sweet) [a] (including AR & LA) ground & aerial	1.2/15 3-day interval	Short grass	603	213	30	10.7
		Tall grass	276	90	14	4.5
		Broadleaf plants/Insects	339	113	17	5.7
		Seeds	38	18	2	0.9
Corn (pop & sweet) [b] (excluding AR & LA) ground & aerial	1.2/5 3-day interval	Short grass	579	205	29	10.3
		Tall grass	266	87	13	4.3
		Broadleaf plants/Insects	326	109	16	5.4
		Seeds	36	17	2	0.8

Table 4 (continued): Avian Chronic Risk Quotients for Multiple Broadcast Applications of Nongranular Maneb based on a Mallard Duck (*Anas platyrhynchos*) NOAEC of 20 ppm.

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Cranberry	4.8/3	Short grass	1,460	517	73	25.9
ground & aerial	7-day interval	Tall grass	669	219	33	11.0
		Broadleaf plants/Insects	821	274	41	13.7
		Seeds	91	43	5	2.1
Cucumber, Melons,	1.6/8	Short grass	492	174	25	8.7
Pumpkin & Squash	7-day interval	Tall grass	226	74	11	3.7
ground & aerial		Broadleaf plants/Insects	277	92	14	4.6
		Seeds	31	14	2	0.7
Eggplant & Sugar Beets	1.6/7	Short grass	492	174	25	8.7
ground & aerial	7-day interval	Tall grass	226	74	11	3.7
		Broadleaf plants/Insects	277	92	14	4.6
		Seeds	31	14	2	0.7
Fig	2.4/1	Short grass	576	204	29	10.2
ground & aerial	not applicable	Tall grass	264	86	13	4.3
		Broadleaf plants/Insects	324	108	16	5.4
		Seeds	36	17	2	0.8
Grapes[c]	3.2/6	Short grass	984	348	49	17.4
ground & aerial	7-day interval	Tall grass	451	148	23	7.4
		Broadleaf plants/Insects	553	184	28	9.2
		Seeds	61	29	3	1.4
Grapes[d]	2.0/3	Short grass	609	216	30	10.8
ground & aerial	7-day interval	Tall grass	279	91	14	4.6
		Broadleaf plants/Insects	342	114	17	5.7
		Seeds	38	18	2	0.9
Kale	1.6/2	Short grass	468	166	23	8.3
ground & aerial	7-day interval	Tall grass	215	70	11	3.5
		Broadleaf plants/Insects	263	88	13	4.4
		Seeds	29	14	1	0.7
Mustard (GA & TN, only)	1.2/2	Short grass	302	107	15	5.3
ground & aerial	14-day interval	Tall grass	138	45	7	2.3
		Broadleaf plants/Insects	170	57	8	2.8
		Seeds	19	9	1	0.4

Table 4 (continued): Avian Chronic Risk Quotients for Multiple Broadcast Applications of Nongranular Maneb based on a Mallard Duck (*Anas platyrhynchos*) NOAEC of 20 ppm.

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Onion & Garlic ground & aerial	2.4/10 7-day interval	Short grass	738	261	37	13.1
		Tall grass	338	111	17	5.5
		Broadleaf plants/Insects	415	138	21	6.9
		Seeds	46	22	2	1.1
Onion (green) & Tomato [a] ground & aerial	2.4/7 7-day interval	Short grass	738	261	37	13.1
		Tall grass	338	111	17	5.5
		Broadleaf plants/Insects	415	138	21	6.9
		Seeds	46	22	2	1.1
Papaya ground & aerial	2/14 14-day interval	Short grass	504	179	25	8.9
		Tall grass	231	76	12	3.8
		Broadleaf plants/Insects	284	95	14	4.7
		Seeds	32	15	2	0.7
Pepper [a] ground & aerial	2.4/6 7-day interval	Short grass	738	261	37	13.1
		Tall grass	338	111	17	5.5
		Broadleaf plants/Insects	415	138	21	6.9
		Seeds	46	22	2	1.1
Pepper [b] ground & aerial	1.6/6 7-day interval	Short grass	492	174	25	8.7
		Tall grass	225	74	11	3.7
		Broadleaf plants/Insects	277	92	14	4.6
		Seeds	31	14	2	0.7
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	Short grass	581	206	29	10.3
		Tall grass	266	87	13	4.4
		Broadleaf plants/Insects	327	109	16	5.4
		Seeds	36	17	2	0.8

Table 4 (continued): Avian Chronic Risk Quotients for Multiple Broadcast Applications of Nongranular Maneb based on a Mallard Duck (*Anas platyrhynchos*) NOAEC of 20 ppm.

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Potato ground & aerial	1.6/7 5-day interval	Short grass	580	206	29	10.3
		Tall grass	266	87	13	4.4
		Broadleaf plants/Insects	326	109	16	5.4
		Seeds	36	17	2	0.8
Tomato [b] ground & aerial	1.6/4 7-day interval	Short grass	491	174	25	8.7
		Tall grass	225	74	11	3.7
		Broadleaf plants/Insects	276	92	14	4.6
		Seeds	31	14	2	0.7
Ornamentals [e] ground	1.2/3 [f] 7-day interval	Short grass	365	129	18	6.5
		Tall grass	167	55	8	2.7
		Broadleaf plants/Insects	205	68	10	3.4
		Seeds	23	11	1	0.5
Turf [g] ground & aerial	17.4/3 [f] 7-day interval	Short grass	5,294	1,875	265	93.7
		Tall grass	2,426	794	121	39.7
		Broadleaf plants/Insects	2,978	993	149	49.6
		Seeds	331	154	17	7.7

1 Assumes degradation using FATE version 5.0 program with a foliar dissipation (total residue) half-life of 3.2 days.

2 RQ greater or equal to 1.00 exceeds chronic LOC.

a East of the Mississippi River

b West of the Mississippi River

c East of the Rocky Mountains

d West of the Rocky Mountains

e Trees, Herbaceous Plants, Non Flowering Plants, & Woody Shrubs and Vines

f The maximum number of applications per crop cycle was not specified on the labeling. Three (3) applications per crop cycle are assumed for modeling purposes.

g. Residential, Commercial/Industrial, Golf Course, Sod Farm, & Recreational

Maneb has numerous seed treatment uses (see Table 1, above) the RQs from these seed treatment uses were not were calculated in this RED. Numerous seed treatment uses of mancozeb were evaluated in the mancozeb RED and no LOCs were exceeded. The avian acute LD50 of maneb (Bobwhite quail LD50 > 2,150 mg/kg) is practically nontoxic to birds and was greater than the avian acute LD50 for mancozeb (English sparrow LD50 ~ 1,500 mg/kg). Since maneb is less toxic to birds on an acute basis than mancozeb and the exposure (rates of application) from these seed treatment uses are similar for maneb and mancozeb, EFED has determined that the acute risks to birds from eating maneb treated seeds are low.

ii. Mammals

As identified in Appendix III, maneb is practically nontoxic (rat LD50 > 5,000 mg/kg) to mammals on an acute basis. Because of this, the acute exposure to maneb presents a low risk to mammals so RQs for acute exposure were not determined. The chronic mammalian risk quotients for multiple broadcast applications of nongranular products are tabulated below in table 5. The results indicate that chronic mammalian LOCs are exceeded for all maneb use patterns listed.

Table 5: Mammalian Chronic Risk Quotients for Multiple Applications of Maneb Nongranular (Broadcast) Based on a labaratory rats (*Rattus norvegicus*) NOAEL of 75 ppm [h]

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Almonds ground & aerial	6.4/4 7-day interval	Short grass	1,963	695	26	9.3
		Tall grass	900	295	12	3.9
		Broadleaf plants/Insects	1,104	368	15	4.9
		Seeds	123	57	2	0.8
Apples ground & aerial	4.8/4 7-day interval	Short grass	1,473	522	20	7.0
		Tall grass	675	221	9	2.9
		Broadleaf plants/Insects	828	276	11	3.7
		Seeds	92	43	1	0.6
Bananas ground & aerial	2.4/10 14-day interval	Short grass	605	214	8	2.9
		Tall grass	277	91	4	1.2
		Broadleaf plants/Insects	340	113	5	1.5
		Seeds	38	18	0.5	0.2
Beans (dried) ground & aerial	1.6/6 5-day interval	Short grass	580	205	8	2.7
		Tall grass	266	87	4	1.2
		Broadleaf plants/Insects	326	109	4	1.4
		Seeds	36	17	0.5	0.2
Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Endive, Kohlrabi, & Lettuce ground & aerial	1.6/6 7-day interval	Short grass	492	174	7	2.3
		Tall grass	225	74	3	1.0
		Broadleaf plants/Insects	277	92	4	1.2
		Seeds	31	14	0.4	0.2
Collards & Turnip (GA & TN, only) ground & aerial	1.2/3 14-day interval	Short grass	303	107	4	1.4
		Tall grass	139	45	2	0.6
		Broadleaf plants/Insects	170	57	2	0.8
		Seeds	19	9	0.3	0.1
Corn (pop & sweet) [a] (including AR & LA) ground & aerial	1.2/15 3-day interval	Short grass	603	213	8	2.8
		Tall grass	276	90	4	1.2
		Broadleaf plants/Insects	339	113	5	1.5
		Seeds	38	18	0.5	0.2
Corn (pop & sweet) [b] (excluding AR & LA) ground & aerial	1.2/5 3-day interval	Short grass	579	205	8	2.7
		Tall grass	266	87	4	1.2
		Broadleaf plants/Insects	326	109	4	1.4
		Seeds	36	17	0.5	0.2

Table 5 (continued): Mammalian Chronic Risk Quotients for Multiple Applications of Maneb Nongranular (Broadcast) Based on a labaratory rats (*Rattus norvegicus*) NOAEL of 75 ppm [h]

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Cranberry	4.8/3	Short grass	1,460	517	19	6.9
ground & aerial	7-day interval	Tall grass	669	219	9	2.9
		Broadleaf plants/Insects	821	274	11	3.7
		Seeds	91	43	1	0.6
Cucumber, Melons,	1.6/8	Short grass	492	174	7	2.3
Pumpkin & Squash	7-day interval	Tall grass	226	74	3	1.0
ground & aerial		Broadleaf plants/Insects	277	92	4	1.2
		Seeds	31	14	0.4	0.2
Eggplant & Sugar Beets	1.6/7	Short grass	492	174	7	2.3
ground & aerial	7-day interval	Tall grass	226	74	3	1.0
		Broadleaf plants/Insects	277	92	4	1.2
		Seeds	31	14	0.4	0.2
Fig	2.4/1	Short grass	576	204	8	2.7
ground & aerial	not applicable	Tall grass	264	86	4	1.2
		Broadleaf plants/Insects	324	108	4	1.4
		Seeds	36	17	0.5	0.2
Grapes[c]	3.2/6	Short grass	984	348	13	4.6
ground & aerial	7-day interval	Tall grass	451	148	6	2.0
		Broadleaf plants/Insects	553	184	7	2.5
		Seeds	61	29	0.8	0.4
Grapes[d]	2.0/3	Short grass	609	216	8	2.9
ground & aerial	7-day interval	Tall grass	279	91	4	1.2
		Broadleaf plants/Insects	342	114	5	1.5
		Seeds	38	18	0.5	0.2
Kale	1.6/2	Short grass	468	166	6	2.2
ground & aerial	7-day interval	Tall grass	215	70	3	0.9
		Broadleaf plants/Insects	263	88	4	1.2
		Seeds	29	14	0.4	0.2
Mustard (GA & TN, only)	1.2/2	Short grass	302	107	4	1.4
ground & aerial	14-day interval	Tall grass	138	45	2	0.6
		Broadleaf plants/Insects	170	57	2	0.8
		Seeds	19	9	0.3	0.1

Table 5 (continued): Mammalian Chronic Risk Quotients for Multiple Applications of Maneb Nongranular (Broadcast) Based on a labaratory rats (*Rattus norvegicus*) NOAEL of 75 ppm [h]

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Onion & Garlic ground & aerial	2.4/10 7-day interval	Short grass	738	261	10	3.5
		Tall grass	338	111	5	1.5
		Broadleaf plants/Insects	415	138	6	1.8
		Seeds	46	22	0.6	0.3
Onion (green) & Tomato [a] ground & aerial	2.4/7 7-day interval	Short grass	738	261	10	3.5
		Tall grass	338	111	5	1.5
		Broadleaf plants/Insects	415	138	6	1.8
		Seeds	46	22	0.6	0.3
Papaya ground & aerial	2/14 14-day interval	Short grass	504	179	7	2.4
		Tall grass	231	76	3	1.0
		Broadleaf plants/Insects	284	95	4	1.3
		Seeds	32	15	0.4	0.2
Pepper [a] ground & aerial	2.4/6 7-day interval	Short grass	738	261	10	3.5
		Tall grass	338	111	5	1.5
		Broadleaf plants/Insects	415	138	6	1.8
		Seeds	46	22	0.6	0.3
Pepper [b] ground & aerial	1.6/6 7-day interval	Short grass	492	174	7	2.3
		Tall grass	225	74	3	1.0
		Broadleaf plants/Insects	277	92	4	1.2
		Seeds	31	14	0.4	0.2
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	Short grass	581	206	8	2.7
		Tall grass	266	87	4	1.2
		Broadleaf plants/Insects	327	109	4	1.5
		Seeds	36	17	0.5	0.2

Table 5 (continued): Mammalian Chronic Risk Quotients for Multiple Applications of Maneb Nongranular (Broadcast) Based on a labaratory rats (*Rattus norvegicus*) NOAEL of 75 ppm [h]

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Potato	1.6/7	Short grass	580	206	8	2.7
ground & aerial	5-day interval	Tall grass	266	87	4	1.2
		Broadleaf plants/Insects	326	109	4	1.5
		Seeds	36	17	0.5	0.2
Tomato [b]	1.6/4	Short grass	491	174	7	2.3
ground & aerial	7-day interval	Tall grass	225	74	3	1.0
		Broadleaf plants/Insects	276	92	4	1.2
		Seeds	31	14	0.4	0.2
Ornamentals [e]	1.2/3 [f]	Short grass	365	129	5	1.7
ground	7-day interval	Tall grass	167	55	2	0.7
		Broadleaf plants/Insects	205	68	3	0.9
		Seeds	23	11	0.3	0.1
Turf [g]	17.4/3 [f]	Short grass	5,294	1,875	71	25.0
ground & aerial	7-day interval	Tall grass	2,426	794	32	10.6
		Broadleaf plants/Insects	2,978	993	40	13.2
		Seeds	331	154	4	2.1

1 Assumes degradation using FATE version 5.0 program with a foliar dissipation (total residue) half-life of 3.2 days.

2 RQ greater or equal to 1.00 exceeds chronic LOC.

a East of the Mississippi River

b West of the Mississippi River

c East of the Rocky Mountains

d West of the Rocky Mountains

e Trees, Herbaceous Plants, Non Flowering Plants, & Woody Shrubs and Vines

f The maximum number of applications per crop cycle was not specified on the labeling. Three (3) applications per crop cycle are assumed for modeling purposes.

g. Residential, Commercial/Industrial, Golf Course, Sod Farm, & Recreational

h. Reproductive study, based on parental (paternal) effects resulting in a significant increase in lung (both generations) and liver (F1) weight and an increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia (F1) and fetal effects resulting in a slight delay in the startle response in the offspring.

iii. Insects

Currently, EFED does not assess risk to non-target insects. Results of acceptable studies are used for recommending appropriate label precautions. Since maneb was determined to be practically nontoxic to honey bees (LD50 > 12 µg/bee) no bee precautionary labeling is required on maneb product labeling.

c. Aquatic Organisms

i. Overview

Because monitoring data from field locations are not available for maneb, EFED based the surface water exposure EECs of maneb on screening models. EFED used Tier II modeling, the Pesticide Root Zone Model version 3.1.2 beta (Carsel and others., 1997) and Exposure Analysis Modeling System version 2.98.04 (Burns, 1997) (PRZM/EXAMS), to estimate aquatic EECs.

The PRZM/EXAMS modeling tools used by EFED are designed to be conservative tools; with 90% of simulated sites expected to have environmental concentrations lower than the Tier II estimates. EFED uses environmental fate and transport computer models to calculate refined EECs. PRZM simulates pesticide surface water runoff on daily time steps, incorporating runoff, infiltration, erosion, and evaporation. The model calculates foliar dissipation and runoff, pesticide uptake by plants, soil microbial transformation, volatilization, and soil dispersion and retardation. EXAMS simulates pesticide fate and transport in an aquatic environment (one hectare body of water, two meters deep with no outlet). The EECs have been calculated so 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 Tier II model uses a single site which represents a high exposure scenario for the use of the pesticide on a particular crop use site. The model simulates weather and agricultural practice at the site over multiple years so the probability of an EEC occurring at that site can be estimated. The PRZM/EXAMS modeling approach is an uncertain predictor of water concentrations in estuarine/marine systems. EFED suspects, though it hasn't been empirically proved, that flushing and exchange rates within these systems may differ from those assumed in the existing surface water modeling. Sometimes, flushing and exchange may be greater than accounted for in the EXAMS model and true estuarine/marine water concentrations may be lower. In other cases tidal entrapment of pollutants may contribute to higher effective pesticide concentrations than predicted by the model.

EFED uses the EECs for assessing acute and chronic risks to aquatic organisms. EFED uses peak EEC values to calculate acute RQs for single and multiple applications. EFED uses 21-day EECs for invertebrates and 60-day EECs for fish to calculate chronic RQs.

EFED selected boundaries used in Tier II (PRZM/EXAMS) modeling using Agency guidance (WQTT/EFED/OPP. August, 2000) and EFED calculated degradation rate constants from review of registrant filed environmental fate studies.

ii. Freshwater Fish

Tabulated below in Table 6 are maneb's acute and chronic risk quotients for freshwater fish. The results show all maneb uses exceed acute, acute restricted use, and acute endangered species LOCs (acute RQ ranges from 1.13 to 4.71). No chronic LOCs are exceeded for freshwater fish from maneb's uses. EFED modeled on representative maneb uses. EFED has not developed PRZM/EXAMS schemes for modeling all maneb uses.

Table 6: Maneb Acute and Chronic Risk Quotients for Freshwater Fish Based On a Rainbow Trout (*Salmo gairdneri*) LC50 of 42.0 ppb and a Fathead Minnow (*Pimephales promelas*) NOAEC of 6.1 ppb.

Site/ Application Method/	Application Rate (lbs ai/A)/ Number of Applications/ Interval	EEC Peak (ppb) [1]	EEC 60-Day Average (ppb) [1]	Acute RQ (Peak EEC/LC50) [2]	Chronic RQ (60-Day EEC/NOAEC) [3]
Apples ground & aerial	4.8/4 7-day interval	84	1.8	2.00	0.30
Pepper [a] ground & aerial	1.6/6 7-day interval	113	2.1	2.69	0.34
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	47.6	1	1.13	0.16
Tomato [b] ground & aerial	2.4/7 7-day interval	197.9	4	4.71	0.66

1 Based on PRZM version 3.12/EXAMS version 2.97.5 modeling.
2 RQ greater or equal to 0.5 exceeds acute high risk, acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.1 exceeds acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.05 exceeds acute endangered species LOCs.
3 RQ greater or equal to 1.00 exceeds chronic LOC.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)
b East of the Mississippi River

iii. Freshwater Invertebrates

Tabulated below in Table 7 are maneb's acute risk quotients for freshwater invertebrates. The results show that acute, acute restricted use, and acute endangered species RQs exceed LOCs for maneb's use on apples, tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.40 to 1.65).

Table 7: Maneb Acute Risk Quotients for Freshwater Invertebrate Based On a Waterflea (*Daphnia magna*) LC50 of 120 ppb.

Site/ Application Method/	Application Rate (lbs ai/A)/ Number of Applications/ Interval	EEC Peak (ppb)[1]	Acute RQ (Peak EEC/LC50)[2]
Apples ground & aerial	4.8/4 7-day interval	84	0.70
Pepper[a] ground & aerial	1.6/6 7-day interval	113	0.94
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	47.6	0.40
Tomato[b] ground & aerial	2.4/7 7-day interval	197.9	1.65

1 Based on PRZM version 3.12/EXAMS version 2.97.5 modeling.
2 RQ greater or equal to 0.5 exceeds acute high risk, acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.1 exceeds acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.05 exceeds acute endangered species LOCs.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)
b East of the Mississippi River

iv. Estuarine/Marine Fish

Tabulated below in Table 8 are maneb's acute risk quotients for esturarine/marine fish. The results show that acute, acute restricted use, and acute endangered species RQs exceed LOCs for maneb's use on tomatoes and peppers. Restricted use and acute endangered species LOCs are exceeded for all maneb uses (acute RQ ranges from 0.26 to 1.1).

Table 8: Maneb Acute Risk Quotients for Estuarine/Marine Fish Based On a Atlantic silverside (*Menidia menidia*) LC50 of 180 ppb.

Site/ Application Method/	Application Rate (lbs ai/A)/ Number of Applications/ Interval	EEC Peak (ppb)[1]	Acute RQ (Peak EEC/LC50)[2]
Apples ground & aerial	4.8/4 7-day interval	84	0.47
Pepper[a] ground & aerial	1.6/6 7-day interval	113	0.63
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	47.6	0.26
Tomato[b] ground & aerial	2.4/7 7-day interval	197.9	1.10

1 Based on PRZM version 3.12/EXAMS version 2.97.5 modeling.

2 RQ greater or equal to 0.5 exceeds acute high risk, acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.1 exceeds acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.05 exceeds acute endangered species LOCs.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)

b East of the Mississippi River

v. Estuarine/Marine Invertebrates

Tabulated below in Table 9 are maneb's acute risk quotients for esturarine/marine invertebrates. The results show that acute RQs exceed acute, acute restricted use, and acute endangered LOCs for all maneb uses (acute RQ ranges from 15.87 to 65.97). There are currently no estuarine/marine invertebrates listed as endangered species.

Table 9: Maneb Acute Risk Quotients for Estuarine/Marine Invertebrates Based On a Mysid Shrimp (*Americamysis bahia*) LC50 of 3.0 ppb.

Site/ Application Method/	Application Rate (lbs ai/A)/ Number of Applications/ Interval	EEC Peak (ppb) [1]	Acute RQ (Peak EEC/LC50) [2]
Apples ground & aerial	4.8/4 7-day interval	84	28.00
Pepper [a] ground & aerial	1.6/6 7-day interval	113	37.67
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	47.6	15.87
Tomato [b] ground & aerial	2.4/7 7-day interval	197.9	65.97

1 Based on PRZM version 3.12/EXAMS version 2.97.5 modeling.
2 RQ greater or equal to 0.5 exceeds acute high risk, acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.1 exceeds acute restricted use and acute endangered species LOCs.
RQ greater or equal to 0.05 exceeds acute endangered species LOCs.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)
b East of the Mississippi River

d. Exposure and Risk to Non-target Plants: Aquatic Plants

Exposure to non-target aquatic plants may occur through runoff or spray drift from adjacent treated sites or directly from such uses as aquatic weed or mosquito larvae control. EFED assesses an aquatic vascular plant risk for acute risk from the surrogate duckweed *Lemna gibba*. EFED makes nonvascular aquatic plant acute risk assessments using either algae or a diatom, whichever is the most sensitive species. So far, there are no known nonvascular plant species on the endangered species list. Runoff and drift exposure is computed from PRZM/EXAMS. EFED calculates the risk quotient by dividing the pesticide's initial or peak concentration in water by the plant EC_{50} value.

Shown in Table 10 are the acute risk quotients for freshwater, nonvascular green alga (*Selenastrum capricornutum)*. All maneb's use patterns exceed acute risk LOCs for nonvascular aquatic plants (acute RQ ranges from 3.55 to 14.77).

Table 10: Maneb Acute Risk Quotients for Aquatic Non-Vascular Plants Based On a Green Algae (*Selenastrum capricornutum*) LC50 of 13.4 ppb.

Site/ Application Method/	Application Rate (lbs ai/A)/ Number of Applications/ Interval	EEC Peak (ppb) [1]	Acute RQ (Peak EEC/LC50) [2]
Apples ground & aerial	4.8/4 7-day interval	84	6.27
Pepper [a] ground & aerial	1.6/6 7-day interval	113	8.43
Potato (Maine, only) ground & aerial	1.6/10 5-day interval	47.6	3.55
Tomato [b] ground & aerial	2.4/7 7-day interval	197.9	14.77

1 Based on PRZM version 3.12/EXAMS version 2.97.5 modeling.

2 RQ greater or equal to 1.0 exceeds acute high risk LOCs.

a East of the Mississippi River (1.6 lb ai/A is a W. of Miss. R. rate for peppers. 2.4 lb ai/A 6 times every 7 days is the E. of Miss. R. rate – the scenario is FL)

b East of the Mississippi River

e. Endangered Species

Based on available screening level information there is a potential concern for maneb's acute effects on listed freshwater and estuarine/marine animals and chronic effects on listed birds and mammals should exposure actually occur. EFED expects maneb poses a low acute risk to nontarget insects because maneb is practically nontoxic to honeybees, (acute contact LD_{50} > 12 µg/bee). Also, there is no incident data reporting adverse effects to honeybees from maneb's use. However, EFED does not assess risk to bees using RQs because a screening level RQ assessment method for estimating the risk to bees is not available. EFED has not developed an exposure design for bees to estimate the risk using a risk quotient method. The Agency does not currently have enough data to perform a screening level assessment for maneb's effects on listed nontarget terrestrial plants or vascular aquatic plants. EFED did not assess chronic risks to freshwater invertebrates, or estuarine/marine fish due to lack of data. There are no nonvascular aquatic plants or estuarine/marine invertebrate species on the endangered species list.

f. Ecological Incidents

The Ecological Incident Information System (EIIS) (see Appendix V for background information) reported maneb in three fish kill incidents. An incident (Incident No. B000-223), occurring in August, 1973, reported by the Oregon Department of Agriculture showed some fish in a 15 acre pond had been killed. Presumably drift from an aerial application of maneb and endosulfan to potatoes caused the kill. No analyzes of the dead fish was provided. Both maneb and endosulfan are very highly toxic to freshwater fish [maneb rainbow trout LC50 = 42.0 ppb and endosulfan rainbow trout LC50 = 0.37 ppb (US EPA. 2001)] and both pesticides could have been responsible for the fish kill, if in fact the kill was pesticide related. However, the inadequate information provided with this reported incident and the lack of laboratory analyzes makes it difficult to charge this fish kill to either pesticide.

The second maneb related incident (Incident No. I003826-030) occurred in June, 1994 and was reported by the North Carolina Department of Agriculture. The owner of a 2.5 acre commercial fishpond filed a complaint of a fish kill in the pond because of drift from applications of maneb, trifluralin, imazaquin, pendimethalin, and acephate aerially applied to corn and soybean fields near the pond. The owner felt the fish kill was a result of drift from these pesticides. The North Carolina Department of Agriculture investigated this complaint and took samples for analyzes but the sampling evidence did not confirm the presence of maneb or the other pesticides listed in the samples taken. Based on the investigation and the analysis of samples, it is unlikely that maneb contributed to this fish kill.

The final maneb related incident (Incident Nos. I002200-001 and I003596-001), occurring in August, 1994, was reported by the Maine Department of Agriculture. In this incident roughly 10,000 newly released brook trout were killed in a pond that borders New Brunswick, Canada and Maine. Three pesticides (maneb, esfenvalerate, and chlorothalonil) recently applied to potatoes surrounding this pond were suspected in this fish kill. Tissue samples of the fish confirmed the presence of all three pesticides (maneb at 169 ppb, esfenvalerate at 4.2 ppb, and chlorothalonil at 20 ppb) in the fish. These fish samples were taken from both the pond and brooks feeding the pond. Again, as in the first incident, all three of these pesticides are very highly toxic to freshwater fish. Maneb's rainbow trout LC50 is 42.0 ppb, esfenvalerate's rainbow trout LC50 is 0.26 ppb (Hicks, L. May, 1995) and chlorothalonil's rainbow trout LC50 is 42.3 ppb (US EPA. 1998)]. The submitter of the incident report pointed out there were severe thunderstorms in the area preceding the fish kill which suggest pesticide runoff was a cause in this kill. Based on sampling evidence, EFED believes maneb was contributory cause in this fish kill.

APPENDIX V: US EPA Ecological Incident Information System

The Office of Pesticide Programs (OPP) has tracked incidents reports, given to EPA since about 1994, by assigning identification number in an Incident Data System (IDS) and microfiching the reports. The Environmental Fate and Effects Division (EFED) then enters the ecological related incident reports into a second database, the Ecological Incident Information System (EIIS). This second database has some 85 fields for potential data entry. EFED has also made an effort to enter information into EIIS on incident reports received before establishment of current databases. Although EFED has added many of these reports, EIIS does not yet provide a listing of all incident reports received by EPA. OPP does not receive incident reports in a consistent format. For example, states and various labs usually have their own report formats. The incidents reports may involve multiple incidents involving multiple chemicals in one report, and may report on only part of an incident investigation (for example, residues). EFED has made some progress in recent years, both in getting incident reports sent and entered. However, there has never been enough staff time and effort assigned to recording incidents. For example, the staff time and effort assigned to tracking and reviewing laboratory toxicity studies are greater than those assigned to tracking incidents.

EFED classifies EIIS entered incidents into one of several certainty levels: highly probable, probable, possible, unlikely, or unrelated. In brief, "highly probable" incidents usually need carcass residues, show large cholinesterase inhibition (for chemicals such as organophosphates that depress brain and blood cholinesterase), or clear circumstances about the exposure. "Probable" incidents include those where residues were not available or circumstances were less clear than for "highly probable." "Possible" incidents include those where multiple chemicals may have been involved and it is not clear what the contribution was of a given chemical. OPP uses the "unlikely" category, for example, where a given chemical is almost nontoxic to the category of organism killed or the chemical was tested for but not detected in samples. "Unrelated" incidents are those that OPP confirms was not pesticide-related.

EFED also classes EIIS entered incidents as use or misuse. Unless specifically confirmed by a state or federal agency to be misuse, or there was clear misuse such as intentional baiting to kill wildlife, EFED would not typically consider incidents to be misuse. For example, data entry personnel often do not have a copy of the specific label used in a given application, and would not usually be able to detect various label-specific violations.

EFED believes the number pesticide related incidents reported in EIIS, while large, are a small fraction of pesticide incidents. EIIS entered incidents requires that mortality incidents be seen, reported, examined, and have investigation reports sent to EPA. Incidents often are not seen, because of scavenger removal of carcasses, decay in a field, or simply because carcasses may be hard to see on many sites. Poisoned wildlife may also move off-site to less visible areas before dying. Incidents often are not seen because few people are systematically looking. Finders, seeing incidents, may not report incidents to suitable authorities to examine the incident. The finder may not know that it is important to report incidents or may not know who to contact. He or she may not feel they have the time or wish to make a telephone call, may hesitate to call because of their own involvement in the kill, or the call may be long-distance which may discourage the caller. Incidents reported may not get examined if time or people are limited or may not get examined thoroughly, with residue and cholinesterase analyzes, for example. Also, if kills are not reported and examined at once, there will be little chance of documenting the cause, since tissues and residues may decay quickly. States often do not send reports of examined incidents to EPA, since reporting by states is voluntary and some investigators may believe that they don't have the time or people to send incident reports to EPA. (Felkel. 2000)

APPENDIX VI: EBDC Aquatic Studies

EBDC Aquatic Studies Used for Calculating Risk Quotients With Associated Study Parameters - 3/13/2003

MRID No.	Chemical	Species Tested	Water type	Water Analysis (cations, anions, EC)	Test Type[1]	Nominal Test Concentrations Range (ppm)	Measured (unfiltered) Test Concentrations Range (ppm)	Measured (filtered) Test Concentrations Range (ppm) and Filter Size (µm)	Test Aquaria Size (L)	Chemical Analyses (Parent or Other?)	Toxicity Endpoint (ppm)	Exposure Time (hours)	Study Categorization
43525001	metiram	Rainbow trout	fresh-water	mixture of tap water, unchlorinated water, deionized water (chemical analysis - not reported)	F	0.01 - 1.0	ND[2] - 0.527	ND[2] - 0.233 filter size = 0.05	60	GC[3] for CS_2	LC_{50} = 0.229[4]	96	core
44301101	metiram	water flea	fresh-water	deionized water, EDTA free, and HCL fortified samples for analysis	S	0.1 - 1.0	0.051 - 0.511	Not applicable	0.25	GC[3] for CS_2	EC_{50} > 0.358[6] (highest concentration tested)	48	supplemental
43199601	metiram	green algae	fresh-water	Na_2EDTA	S	0.001 - 1.0	Not applicable	Not applicable	0.1	Not applicable	EC_{50} = 0.077[5]	72	supplemental
40706001	maneb	Rainbow trout	fresh-water	softwater and well water (chemical analysis - not reported)	S	0.08 -1.0	0.009 - 0.225	Not applicable	30	GC[3] for CS_2	LC_{50} = 0.0416[6]	96	supplemental
41346301	maneb	fathead minnow	fresh-water	EDTA	F	0.0013 - 0.020	0.00096 - 0.012	Not applicable	11.5	GC[3] for CS_2	NOAEC = 0.0061[6]	35 days	core
40749402	maneb	water flea	fresh-water	softwater and well water	S	0.08 - 1.0	ND[2] - 0.39	Not applicable	0.1	GC[3] for CS_2	LC_{50} = 0.12[6]	48	core

EBDC Aquatic Studies Used for Calculating Risk Quotients With Associated Study Parameters - 3/13/2003

MRID No.	Chemical	Species Tested	Water type	Water Analysis (cations, anions, EC)	Test Type[1]	Nominal Test Concentrations Range (ppm)	Measured (unfiltered) Test Concentrations Range (ppm)	Measured (filtered) Test Concentrations Range (ppm) and Filter Size (µm)	Test Aquaria Size (L)	Chemical Analyses (Parent or Other?)	Toxicity Endpoint (ppm)	Exposure Time (hours)	Study Categorization
40943101	maneb	Atlantic silverside	Estuarine/marine	filtered (0.5 µm) seawater (salinity ~ 20%) & EDTA	F	0.12 - 1.5	ND[2] - 1.10	Not applicable	9	GC[3] for CS_2	LC_{50} = 0.18[6]	96	core
41000002	maneb	mysid shrimp	Estuarine/marine	filtered (0.5 µm) seawater (salinity ~ 20%) & EDTA	F	0.005 - 0.060	ND[2] - 0.0064	Not applicable	6.4	GC[3] for CS_2	LC_{50} = 0.003[6]	96	supplemental
40943501	maneb	green algae	fresh-water	Na_2EDTA	S	0.0026 - 0.040	0.0004 - 0.006[7]	Not applicable	0.25	GC[3] for CS_2	EC_{50} = 0.0134[8]	120	core
40118502	mancozeb	Rainbow trout	fresh-water	Not reported	S	0.22 - 4.5	Not applicable	Not applicable	Not reported	Not applicable	LC_{50} = 0.46[5]	96	core[9]
43230701	mancozeb	fathead minnow	fresh-water	EDTA added	F	0.0003 - 0.02	0.000236 - 0.019[10] ND[2] - 0.00797[3]	Not applicable	~12.2	GC[3] for CS_2 & LSC[10] for ^{14}C	NOAEC = 0.00219[6] for GC & 0.00237 for LSC	28 days	core
40118503	mancozeb	water flea	fresh-water	Not reported	S	0.026 - 2.0	Not applicable	Not applicable	Not reported	Not applicable	EC_{50} = 0.58[5]	48	core[9]
40953802	mancozeb	water flea	fresh-water	EDTA added	F	0.003 - 0.05	0.0029 - 0.053	Not applicable	1.0	GC[3] for CS_2 & LSC[10] for ^{14}C	NOAEC = 0.0073[6] for LSC	21 days	core
41844901	mancozeb	sheepshead minnow	Estuarine/marine	filtered seawater with well water (salinity ~ 20%) Na_3EDTA added	F	0.6 - 7.7	0.28 - 3.7	Not applicable	9	GC[3] for CS_2	LC_{50} = 1.6[6]	96	supplemental

EBDC Aquatic Studies Used for Calculating Risk Quotients With Associated Study Parameters - 3/13/2003

MRID No.	Chemical	Species Tested	Water type	Water Analysis (cations, anions, EC)	Test Type[1]	Nominal Test Concen-trations Range (ppm)	Measured (unfiltered) Test Concentra-tions Range (ppm)	Measured (filtered) Test Concentra-tions Range (ppm) and Filter Size (µm)	Test Aquaria Size (L)	Chemical Analyses (Parent or Other?)	Toxicity Endpoint (ppm)	Ex-posure Time (hours)	Study Cate-gorization
41822901	mancozeb	mysid shrimp	Estuarine/marine	filtered seawater with well water (salinity ~ 20%) Na_3EDTA added	F	0.003 - 0.04	0.0034 - 0.017	Not applicable	6	GC[3] for CS_2	LC_{50} = 0.0105[6]	96	supplemental
43664701	mancozeb	green algae	fresh-water	Na_2EDTA	S	0.033 - 0.50	0.022 - 0.376	Not applicable	0.1	GC[3] for CS_2	EC_{50} = 0.047	120	core

1. For aquatic organisms (fish, zooplankton, and phytoplankton), tests are carried out using either **static** (**S**) or **flow-through** (**F**) methods. In the static method, the pesticide and test organisms are added to the test solution and kept there for the remainder of the study time. In the flow-through method, a freshly prepared, pesticide-spiked test solution flows through the test chamber continuously for the duration of the test. The flow-through method provides a higher continuous dose of the pesticide; however, the static method does not remove waste products and may accumulate toxic pesticide breakdown products and metabolites. Neither method exactly mimics a natural system. (http://docs.pesticideinfo.org/documentation4/ref_ecotoxicity4.html) Flow-through system allows the testing of volatile and instable chemicals, problematic in static test systems.

2. None detected

3. Gas chromatography

4. Based on filtered and measured concentration.

5. Based on nominal concentration.

6. Based on measured (unfiltered) concentration.

7. Measured estimate is based on 15% of nominal test concentrations remaining at end of test. No actual values were provided in DER and the limits of detection at lower values is questionable. Measured EC_{50} was based on actual mean green algae cell counts at end of study. Aquatic plant studies base the test concentrations on the 0-hour concentrations because the plants will take-up test material during the study period and loss of test material is not necessarily due to instability of test material.

8. Based on actual cell counts, not on measured concentration levels.

9. Categorization based on acceptance in 1987 Mancozeb Standard

EBDC Aquatic Studies Used for Calculating Risk Quotients With Associated Study Parameters - 3/13/2003

MRID No.	Chemical	Species Tested	Water type	Water Analysis (cations, anions, EC)	Test Type[1]	Nominal Test Concen-trations Range (ppm)	Measured (unfiltered) Test Concentra-tions Range (ppm)	Measured (filtered) Test Concentra-tions Range (ppm) and Filter Size (µm)	Test Aquaria Size (L)	Chemical Analyses (Parent or Other?)	Toxicity Endpoint (ppm)	Ex-posure Time (hours)	Study Cate-gorization

10. LSC detection. The process by which radioactive decay energy is converted to visible light and measured in an organic liquid environment is called LIQUID SCINTILLATION COUNTING (LSC). In Liquid Scintillation Counting, the amount of light produced is proportional to the amount of radiation present in the sample and the energy of the light produced is proportional to the energy of the radiation that is present in he sample. This makes LSC a very convenient tool to measure radioactivity. http://www.sfu.ca/~rsafety/APPEND9.pdf

APPENDIX VII: Maneb Revised Risk Quotients for Almonds & Turf Uses

This appendix reflects the registrant's proposed use pattern changes for almonds and turf. For almonds, the registrant intends to reduce the maximum number of applications per crop cycle from 4 to 3. For turf, the registrant intends to reduce the maximum application rate from 17.4 lb ai/A to 8.7 lb ai/A and set the maximum number of applications per crop cycle at 4. Tables 1 and 2 show the new maneb avian and mammalian RQs resulting from these use pattern revisions to almonds and turf. Although the RQs are less they still exceed chronic LOCs for birds and mammals.

Previously maneb's chronic avian RQs on almond ranged from 98 (maximum EEC exposure) for birds feeding on short grass to 2.9 (mean EEC exposure) for birds feeding on seeds. The proposed change reduces the chronic avian RQs on almonds ranging from 97 (maximum EEC exposure) for birds feeding on short grass to 2.8 (mean EEC exposure) for birds feeding on seeds. Previously maneb's chronic avian RQs on turf ranged from 265 (maximum EEC exposure) for birds feeding on short grass to 7.7 (mean EEC exposure) for birds feeding on seeds. The proposed change reduces the chronic avian RQs on turf ranging from 133 (maximum EEC exposure) for birds feeding on short grass to 3.9 (mean EEC exposure) for birds feeding on seeds. Avian chronic LOCs are still exceeded for maneb's almond and turf use patterns.

Table 1: Avian Chronic Risk Quotients for Multiple Broadcast Applications of Nongranular Maneb based on a Mallard Duck (*Anas platyrhynchos*) NOAEC of 20 ppm.

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Almonds ground & aerial	6.4/3 7-day interval	Short grass	1,947	690	97	34.5
		Tall grass	892	292	45	14.6
		Broadleaf plants/Insects	1,095	365	55	18.3
		Seeds	122	57	6	2.8
Turf[a] ground & aerial	8.7/4 7-day interval	Short grass	2,669	945	133	47.3
		Tall grass	1,223	400	61	20.0
		Broadleaf plants/Insects	1,501	500	75	25.0
		Seeds	167	78	8	3.9

1 Assumes degradation using FATE version 5.0 program with a foliar dissipation (total residue) half-life of 3.2 days.

2 RQ greater or equal to 1.00 exceeds chronic LOC.

a. Residential, Commercial/Industrial, Golf Course, Sod Farm, & Recreational

Previously maneb's chronic mammalian RQs on almonds ranged from 26 (maximum EEC exposure) for mammals feeding on short grass to 0.8 (mean EEC exposure) for mammals feeding on seeds. The proposed change doesn't reduce the chronic mammalian RQs on almonds. The new RQs still range from 26 (maximum EEC exposure) mammals feeding on short grass to 0.8 (mean EEC exposure) for mammals feeding on seeds. Previously maneb's chronic mammalian RQs on turf ranged from 71 (maximum EEC exposure) for mammals feeding on short grass to 2.1 (mean EEC exposure) for mammals feeding on seeds. The proposed change reduces the chronic mammalian RQs on turf ranging from 36 (maximum EEC exposure) for mammals feeding on short grass to 1.0 (mean EEC exposure) for mammals feeding on seeds. Mammalian chronic LOCs are still exceeded for maneb's almond and turf use patterns.

Table 2: Mammalian Chronic Risk Quotients for Multiple Applications of Maneb Nongranular (Broadcast) Based on a labaratory rats (*Rattus norvegicus*) NOAEL of 75 ppm [b]

Site/ Application Method	Application Rate (lbs ai/A)/ Number of Applications/ Interval	Food Items	Maximum EEC (ppm)[1]	Mean EEC (ppm)[1]	Chronic RQ Based on Maximum EECs (Max. EEC/NOAEC)[2]	Chronic RQ Based on Mean EECs (Mean EEC/NOAEC)[2]
Almonds ground & aerial	6.4/3 7-day interval	Short grass	1,947	690	26	9.2
		Tall grass	892	292	12	3.9
		Broadleaf plants/Insects	1,095	365	15	4.9
		Seeds	122	57	2	0.8
Turf [a] ground & aerial	8.7/4 7-day interval	Short grass	2,669	945	36	12.6
		Tall grass	1,223	400	16	5.3
		Broadleaf plants/Insects	1,501	500	20	6.7
		Seeds	167	78	2	1.0

1 Assumes degradation using FATE version 5.0 program with a foliar dissipation (total residue) half-life of 3.2 days.

2 RQ greater or equal to 1.00 exceeds chronic LOC.

a. Residential, Commercial/Industrial, Golf Course, Sod Farm, & Recreational

b. Reproductive study, based on parental (paternal) effects resulting in a significant increase in lung (both generations) and liver (F1) weight and an increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia (F1) and fetal effects resulting in a slight delay in the startle response in the offspring.

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