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PC Code 129034
8/14/03

Flumioxazin: Environmental Fate and Ecological Risk Assessment: Cotton, Almonds, Grapes, Sugarcane, Container and Field Ornamentals, and Christmas and Deciduous trees

BARCODE D274658
D284048
D272504
SEC 3 - NEW USE

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ENVIRONMENTAL RISK ASSESSMENT

2008127

EXECUTIVE SUMMARY

Flumioxazin is a light-dependent peroxidizing herbicide (LDPH) which acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of photo-toxic porphyrins. This class of herbicides are known to have a photo-toxic mode of action in plants and possibly in fish. Standard toxicity testing may not include light with the same wavelength or intensity as natural sunlight. LDPHs may be more toxic when exposed to natural sunlight, such as exposure conditions in the field.

Risks to Terrestrial organisms

Most acute and chronic LOC's were not exceeded for either avian or mammalian species. Currently, EFED does not assess risk to non-target insects. Results of acceptable studies are used for recommending appropriate label precautions. As Flumioxazin is practically non-toxic to honeybees, low risk is assumed. No ecological incidents were found in the database, which was not surprising due to low use rates, low terrestrial toxicity and the current registration status of the compound.

Risks to Aquatic organisms

An analysis of the results indicate that no acute LOC's were exceeded for either freshwater or estuarine/marine fish or invertebrates. However, RQs of 1.33-2.60 exceeded the chronic LOC of 1.0 for freshwater fish and estuarine/marine invertebrates respectively, should the degradates APF and THPA enter aquatic habitats where these organisms live. These RQ values were based on the toxicity profiles of the parent due to an absence of data for the degradates.

Risks to Endangered Species

Low risk is expected for endangered terrestrial or aquatic organisms. However, there are risks to endangered terrestrial and aquatic plants, should exposure actually occur. Endangered terrestrial species RQs ranged from 0.11 to 383 for single applications (with the brunt of the risk to dicots).

For ganular applications, RQs ranged from 1.13 to 85 for endangered terrestrial plants, again with more risk to dicots. For a single broadcast application of Flumioxazin, endangered aquatic plant species levels of concern are also exceeded at maximum application rates (acute risk RQ= 1.4 to 40 for parent and degredate, respectively; RQ > LOC of 1.0), should exposure actually occur.

Risks to Plants

An analysis of the results indicate that for a single broadcast application of non-granular products, acute non-target aquatic plant species levels of concern are exceeded at maximum application rates (Acute high risk RQ= 1.4 to 40 for parent and degradate, respectively; RQ > LOC of 1.0). An analysis of the results also indicates that for single broadcast applications of Flumioxazin, non-target terrestrial and semi-aquatic plant species levels of concern are exceeded at maximum application rates (RQs ranged from 0.09 to 239.4). For granular applications, acute RQs ranged from 0.92 to 42.5. The current single maximum application rate (0.383 lbs ai/A) is 54.7 to 7,660 times higher than the least (0.007 lbs ai/A) and most (0.00005 lbs ai/A) toxic NOAEL in submitted terrestrial plant studies, respectively. Since Flumioxazin may exhibit photo- and phyto- toxicity, and RQs exceeded LOCs, non-target terrestrial plant species are potentially at risk.

Water Resources

Available environmental fate studies suggest Flumioxazin is not very mobile and quickly degrades into a number of degradation products under different environmental conditions. Two terminal major degradation products (APF and THPA) detected at pH 5 and 7 in the hydrolysis study are very mobile and appear to be highly persistent. The mobility of the major degradate detected (482-HA) at pH 9 in the hydrolysis is unknown; however, based on its chemical structure, it is believed that 482-HA is very mobile. Flumioxazin and its major degradates could potentially reach surface water via spray drift or runoff under certain environmental conditions. Although the potential for Flumioxazin to leach to groundwater is low, its two degradates (APF and THPA) may contaminate groundwater due to their high persistence and mobility.

Endocrine Disruption

Based on available data, Flumioxazin may be an endocrine disrupting compound in mammals. Effects that may be associated with endocrine disruption were an increased incidence of reproductive organ abnormalities in rats (predominately atrophied or hypoplastic testes and/or epididymides). These effects occurred at an LOAEL of 200 ppm (NOAEL = 100 ppm). Expected environmental concentrations (maximum estimated concentration = 92 ppm for 1 application and 142 ppm for 2 applications) are below the LOAEL but above the NOAEL. Nevertheless, it is unknown if other endocrine related effects at these low concentrations may or may not occur or if the degradates will produce endocrine disrupting effects.

Use Characterization

Flumioxazin, the active ingredient of the herbicide VALOR, has been developed for control of broadleaf weeds in agricultural areas throughout the U.S. Flumioxazin (V53482) is a pre-emergence broadleaf weed herbicide. Single active ingredient formulation is a water dispersible granule containing 51% active ingredient. The pesticide may be applied by ground spray application methods. The highest application rate is on almonds, grapes and Christmas and deciduous trees at 2 applications of 12.0 oz of product per acre (0.383 lb ai/A x 2 = 0.765 total seasonal).

The herbicidal activity of Flumioxazin is due to the blocking of heme and chlorophyll biosynthesis resulting in an endogenous accumulation of photo-toxic porphyrins. This class of herbicides are known to have a photo-toxic mode of action in plants.

Label Rates For Flumioxazin

Crop	*Product*	*Max Appl. Rate (lb ai/A)*	*Max. # Appl.*	*Max Yr. Rate (lbs ai/A)*	*Min. Interv. (days)*	*Application methods*
Almonds and grapes	Chateau™ 51% WDG	0.383	2	0.765	60	ground spray
Sugarcane	Valor™ 51% WDG	0.383	1	0.383	N/A	ground spray and aerial
Cotton	Valor™ 51% WDG	0.064	2	0.128	45	ground spray and aerial

Container and field ornamentals	BroadStar™ 0.17% G	0.34	2	0.68	N/A	granules
Christmas and deciduous trees	SureGuard™ 51% WGD	0.383	2	0.765	30	ground spray and aerial

Common name: Flumioxazin (V-53482 50 WDG product and S-53482 technical)

Formulated Products: Valor™ 51% WDG (cotton and sugarcane), Chateau™ 51% WDG (almonds and grapes), SureGuard™ 51% WGD (Christmas and deciduous trees) and BroadStar™ 0.17% G (container and field grown ornamentals)

Chemical name: 7-flouro-6-[(3,4,5,6-tetrahydro)phthalimido]-4-(2-propynyl)-1,4-benzoxazin-3-(2H)-one

Chemical family: Light-dependent peroxidizing herbicide (LDPH)

Target Organism: Broadleaf weeds and trees

ENVIRONMENTAL FATE AND TRANSPORT ASSESSMENT

Summary

The following environmental fate assessment for Flumioxazin (also known as S-53482) was based on the data submitted by the registrant to support the Environmental Fate data requirements for the Terrestrial Food/Non-Food Crop uses. Based on these data, Flumioxazin can be characterized as follows:

- Flumioxazin is relatively unstable to hydrolysis, especially in alkaline media (half-lives = 4.2, 1, and 0.01 days, respectively). The three major degradates detected in the hydrolysis study are APF, THPA, and 482-HA.
- Flumioxazin photodegrades very rapidly in water and on soil (half-lives = 1 and 5.8 days, respectively).
- Flumioxazin degrades very rapidly under the aerobic soil metabolism and anaerobic aquatic metabolism conditions (half-lives = 15 and 0.2 days, respectively).
- Flumioxazin is classified as having a medium soil mobility potential.
- its two major degradates (APF and THPA) are expected to be more mobile than the parent compound in the environment (Koc = 410 and 155, respectively)
- Although no mobility information on 482-HA were available, based on its chemical structure, this degradate is expected to be very mobile, especially in the alkaline environment.
- Flumioxazin is relatively volatile in water and on soil.
- Flumioxazin is not expected to bioaccumulate in fish (Kow = 355).

Physico-chemical properties of Flumioxazin are listed in the table below. Based on the environmental fate properties for Flumioxazin, with consideration of the product formulation and application rates, EFED believes that the parent compound does not have the physical/chemical characteristics in common with pesticides that are known to leach to ground water or to move offsite to surface water. It should be noted that the Kd and Koc used in the water assessment for the parent compound were generated from the column leaching study (instead from the batch equilibrium study) due to the unstable nature of the parent compound in water.

Physical-chemical properties of Flumioxazin.

Parameter	Value
Molecular Weight	354 g/mole
Melting Point	203 °C
Solubility (25°C)	1.8 mg/L
Vapor Pressure (22 °C)	2.4×10^{-6} mmHg
Octanol-Water Partition Coefficient (K_{ow}) (20 °C)	355

The following table summarizes the available fate information for Flumioxazin.

Half-lives and Koc estimated from the environmental fate laboratory studies for Flumioxazin and its two hydrolysis degradates (APF and THPA).

Fate Property	Status	Half-life or Koc
Hydrolysis	pH 5	4.2 days
	pH 7	1 day
	pH 9	0.01 days
Aqueous photolysis (pH 5)		1 day
Soil photolysis		3.2 and 8.4 days
Aerobic soil metabolism		11.9 and 17.5 days
Anaerobic aquatic metabolism		0.2 and 0.2 days
Adsorption-Flumioxazin (based on column leaching studies)		112, 271, 656, 1190
Adsorption-APF (based on adsorption study)		201, 336, 391, 502, 620
Adsorption-THPA (based on adsorption study)		13, 66, 75, 191, 248, 339

Degradation and Metabolism

Hydrolysis (MRID 42697501 and 42684905)
Flumioxazin hydrolyzes very rapidly. The hydrolysis rate increases as the pH of the solution increases. Two

hydrolysis studies were submitted. The average half-lives from the [Ph-^{14}C]-S-53482 (uniformly ring labeled), and [THP-^{14}C]-S-53482 (labeled at the 1- and 2- positions of the 3,4,5,6-tetrahydro-phthalimide moiety) hydrolysis studies were 4.2 days, 23 hours, and 18.3 minutes for the pH 5, 7, and 9 buffered solutions, respectively. Four degradates were observed; 7-Fluoro-6[(2-carboxy-cyclohexenoyl)amino]-4-(2-propynyl)-1,4-benzoxazin-3(2H)-one (482-HA), 6-Amino-7-fluoro-4-(2-propynyl)-1,4,-benzoxazin-3(2H)-one (APF), 3,4,5,6-tetrahydrophthalic acid (THPA), and3,4,5,6-Tetrahydrophthalic acid anhydride (Δ-TPA). Degradate 482-HA was found at high concentrations (97.3% of the applied) in the pH 9 solution. APF and THPA were not detected in the pH 9 solutions, but were important components in the pH 5 and 7 solutions. Δ-TPA was a minor component (≤8.8% of the applied) in the pH 5 and 7 solutions. The following table lists the major degradates detected in the hydrolysis study at pH 5, 7, and 9.

Major degradates detected at the end of 30-day hydrolysis study for Flumioxazin

	% of Applied Radioactivity		
Chemical	pH 5	pH 7	pH 9
Flumioxazin	negligible	4.7	negligible
482-HA	negligible	9.3	97.3
APF	41.8	40.0	negligible
THPA	47.7	41.8	negligible

Aqueous Photolysis (MRID 44295036, 44295037, and 45914601)
Flumioxazin photodegrades very rapidly in water. Two aqueous photolysis studies (MRID 44295036 and 44295037) were fully reviewed whereas the third study (MRID 45914601) is still under review. Results from the first two studies are summarized below:

In the first study, uniformly phenyl ring-labeled [^{14}C]Flumioxazin, at 0.1 ppm, degraded with a half-life of 20.9 hours (r^2 = 0.99; 0-48 hour data) in sterilized pH 5 aqueous buffer solution which was irradiated with a xenon lamp (12 hour light/dark cycle) and maintained at 25 ± 1°C for up to 720 hours. An unidentified major degradate (designated as Unknown 1), was initially 8.9% of the applied radioactivity at 2 hours post-treatment, was a maximum of 74.6% at 96 hours, and was 23.7% at 720 hours. Another unidentified major degradate (designated as Unknown 3) reached a maximum of 16.8% at 720 hours post-treatment. The minor degradate APF was detected twice, at 0.6% of the applied radioactivity at 8 hours post-treatment and at 3.1% at 24 hours. Uncharacterized origin material initially (48 hours) accounted for 10.4% of the applied and was a maximum of 41.3% at 720 hours post-treatment.

In the second study, tetrahydrophthalimido ring-labeled [1,2-^{14}C]Flumioxazin, at 0.1 ppm, degraded with a half-life of 26.3 hours (r^2 = 0.94; 0-48 hour data) in sterilized pH 5 aqueous buffer solution which was irradiated with a xenon lamp (12 hour light/dark cycle) and maintained at 25 ± 1°C for up to 720 hours. The major degradate THPA was initially (5 hours) 3.7% of the applied radioactivity, was a maximum of 23.0% at 264 hours, and was 13.4% at 720 hours post-treatment. An unidentified major degradate (designated as Area

1) was initially (2 hours) 25.2% of the applied radioactivity, was a maximum of 54.1% at 48 hours, and was 6.8% at 720 hours post-treatment. Another unidentified major degradate (designated as Area 3) was initially (408 hours) 19.4% of the applied radioactivity, and was a maximum of 35.1% at 720 hours post-treatment. Uncharacterized origin material initially accounted for 13.7% of the applied radioactivity at 48 hours post-treatment, increased to a maximum of 40.4% by 504 hours, and was 35.2% at 720 hours.

Soil Photolysis (MRID 44295038 and 44295039)
In contrast to aqueous photolysis, Flumioxazin photodegrades relatively slowly on the soil surface. Two soil photolysis studies were submitted. In the first study, uniformly phenyl ring-labeled [^{14}C]Flumioxazin, at a nominal application rate of 2.5 μg/g (dry soil), degraded with a half-life of 3.2 days ($r^2 = 0.96$) in sandy loam soil maintained at 25 ± 1°C and irradiated with a xenon arc lamp on a 12-hour light/dark cycle for up to 6 days. In the irradiated soil samples, the parent compound was initially 96.9% of the applied, decreased to 55.3% by 2 days and 34.5% by 4 days post-treatment, and was 29.1-29.8% at 5-6 days. The minor degradate IMOXA was initially (time 0) 0.8% of the applied radioactivity, and increased to 3.1% by 6 days post-treatment (the last sampling interval). The combined minor degradates APF and 482-HA were initially (time 0) 1.4% of the applied radioactivity the irradiated samples, and were 0.6% at 6 days post-treatment. Nonextractable [^{14}C]residues were initially (time 0) 3.0% of the applied radioactivity, increased to 16.4% by 1 day post-treatment, and were 43.3% at 6 days. Evolved $^{14}CO_2$ and [^{14}C]organic volatiles were negligible for the irradiated samples.

In the second study, tetrahydrophthalimido ring-labeled [1,2-^{14}C]Flumioxazin, at 2.5 μg/g (dry soil), degraded with a half-life of 8.4 days ($r^2 = 0.95$) in sandy loam soil maintained at 25 ± 1°C and irradiated with a xenon arc lamp on a 12-hour light/dark cycle for up to 14 days. In the irradiated soil samples, the parent compound was initially 99.2% of the applied radioactivity, decreased to 82.2% by 7 days post-treatment, and was 36.9-37.0% at 9-14 days. In the irradiated soil, the major degradate Δ-TPA was initially (day 1) 0.3% of the applied radioactivity, was a maximum of 21.6% at 9 days post-treatment, and was 8.6% at 14 days. The major degradate THPA was initially (day 2) 2.7% of the applied radioactivity, increased to 7.4% by 9 days post-treatment, and was a maximum of 12.9% at 14 days. The minor degradate 1-OH-HPA was detected twice, at 3.0% of the applied radioactivity at 9 days post-treatment and 4.4% at 14 days. Uncharacterized residual radioactivity in the irradiated samples was initially (day 4) detected at 1.2% of the applied radioactivity, was a maximum of 17.3% at 9 days, and was 15.1% at 14 days. Evolved $^{14}CO_2$ and [^{14}C]organic volatiles were not detected during the incubation period.

Metabolism
Parent Flumioxazin degraded relatively rapidly in soil under aerobic conditions and very rapidly in sediment/natural water systems under anaerobic conditions (half-lives varied from 4.2 hours in the anaerobic aquatic metabolism study to 14.7 days in the aerobic soil metabolism study). Three radioactive studies were submitted.

Aerobic Soil Metabolism (MRID 42684906, 42884009 and 44295040)
[^{14}C]-Flumioxazin (uniformly phenyl ring labeled), at 0.26 μg/g, degraded with a half-life of 11.9 days in a California sandy loam soil incubated in the dark at 22-26°C. Flumioxazin was 92.9% of the applied at day 0 and decreased to 18.0% by day 28 and was ≤3.7% of the applied from day 89 post-treatment. Four minor degradates were detected (482-CA, 482-HA, APF, and IMOXA). $^{14}CO_2$ comprised 2.3% of the applied at day 0 and 11.5% of the applied at day 181 post-treatment. Soil-bound residues increased from 0.7% of the applied at

day 0 to 52.7% by day 28 and 73.6% of the applied by day 181. The humic acid, fulvic acid, and humin fractions in the soil-bound residues ranged from 3.1-12.9%, 2.3-7.6%, and 7.4-24.9% of the applied, respectively. Material balances ranged from 88.9% to 104.5% of the applied throughout the study.

[^{14}C]-Flumioxazin (THP-ring labeled), at 0.245 μg/g, degraded with a half-life of 17.5 days in a California sandy loam soil incubated in the dark at 24-26°C. Flumioxazin was 97.3% of the applied at day 0 and decreased to 28.9% by day 30 and was 11.8% of the applied at day 91 post-treatment. $^{14}CO_2$ comprised 0.2% of the applied at day 1 and 55.1% of the applied at day 91 post-treatment. Four minor degradates were isolated and identified: 3,4,5,6-tetrahydrophthalic acid (THPA), 3,4,5,6-tetrahydrophthalic anhydride (Δ-TPA), 7-fluoro-6-(3,4,5,6-tetrahydrophthalimido)-2H-1,4-benzoxazin-3(4H)-one (IMOXA), and 2-[7-fluoro-3-oxo-6-(3,4,5,6-tetrahydrophthalimido)-2H-1,4-benzoxazin-4-yl]propionic acid (482-CA). These compounds were present at concentrations ≤6.6% of the applied. Soil-bound residues increased from 2.7% of the applied at day 0 to 20.0% by day 30 and 29.0% of the applied by day 91. The humic acid, fulvic acid, and humin fractions in the soil-bound residues ranged from 0.9-7.0%, 3.5-8.0%, and 2.5-13.1% of the applied, respectively. Material balances ranged from 96.4% to 101.3% of the applied throughout the study.

Nonradiolabeled Flumioxazin, at a nominal application rate of 0.1 ppm, degraded with half-lives of 5.0 days (r^2 = 0.96) in Wheeling sandy loam, 18.6 days (r^2 = 0.98) in Drummer clay loam, 18.9 days (r^2 = 0.88) in Dothan sand, and 15.6 days (r^2 = 0.96) in Webster loam soils incubated in darkness at 25.1 °C for up to 44 days. Soil samples were adjusted to 79-84% of 0.33 bar moisture content and homogenized by stirring, and the test vessels were capped. In the sandy loam soil, the parent was initially 0.1 ppm, decreased to 0.054 ppm by 6 days and 0.023 ppm by 13 days post-treatment, and was below the LOQ by 16 days. In the clay loam soil, the parent was initially 0.098 ppm, decreased to 0.051 ppm by 16 days post-treatment, was 0.046 ppm at 21 days, and was 0.017 ppm at 44 days. In the sand soil, the parent was initially 0.097 ppm, decreased to 0.053 ppm by 9 days and 0.043 ppm by 13 days post-treatment, and was last detected at 0.034 ppm at 28 days. In the loam soil, the parent was initially 0.097 ppm, was 0.054 ppm at 9 days post-treatment, and was last detected at 0.026 ppm at 28 days. Degradate compounds were not monitored.

Anaerobic Soil/Aquatic Metabolism (MRID 44295041 and 45914602)
The first study (MRID 44295041) was fully reviewed whereas the second study (MRID 45914602) is still under review. Results from the first study are summarized below:

Uniformly phenyl ring-labeled [^{14}C]Flumioxazin and tetrahydrophthaloyl ring-labeled [1,2-^{14}C]Flumioxazin, at a nominal concentration of 50 ng/g, degraded with half-lives of 4.2 hours (r^2 = 0.88; 0-6 hour data) and 4.3 hours (r^2 = 0.77; 0-6 hour data) in flooded sandy loam soil incubated anaerobically in darkness at 25 ± 1 °C for up to 182 days, respectively.

Uniformly phenyl ring-labeled [^{14}C]Flumioxazin, in the total system, was initially 90.2% of the applied, decreased to 48.1% by 2 hours and 32.9% by 6 hours post-treatment, was 2.8-11.1% from 24 hours to 120 days, and was not detected following 120 days. In the water phase, the parent was initially 82.4% of the applied, decreased to 43.2% by 2 hours post-treatment, was 4.8% at 24 hours, and was last detected at 1.2% at 7 days. In the water phase, the major degradate 482-HA was initially 6.8% (time 0) of the applied, increased to 26.8% by 2 hours post-treatment, was a maximum of 45.4% at 24 hours, was 14.4% at 42 days, and generally decreased to 0.8% by 182 days. The major degradate SAT-482-HA-2 was initially (hour 48) 0.6% of the applied, increased to 8.3% by 56 days post-treatment, and was a maximum of 16.2% at 182 days.

Uncharacterized radioactivity (designated as the PH-polar fraction) was initially (hour 2) 21.6% of the applied radioactivity, was a maximum of 46.6% at 48 hours post-treatment, and generally decreased to 11.6% (5.6 ppb) by 182 days. Non-extractable [^{14}C]residues in the soil were 10.6% of the applied at 7 days post-treatment, were 26.5% of the applied at 28 days, and increased to 60.4% by 182 days. Same degradates were detected in the second study in which tetrahydrophthaloyl ring-labeled [1,2-^{14}C]Flumioxazin was used.

Mobility

Mobility of Flumioxazin (MRID 42684907, 42684908, 42684909 and 42884010)
The potential for the parent compound to migrate into ground water and to move with surface runoff water is very low. Based on the organic carbon adsorption coefficients (K_{oc}) obtained from the column leaching study, Flumioxazin is classified as a chemical with "medium" soil mobility potential (mean K_{oc} = 557) (see table below).

Adsorption coefficients for Flumioxazin, estimated from column leaching studies

Soil	Kd	Koc
Plainfield sand	0.5	271
California College sandy loam	0.8	112
Mississippi silt loam	7.7	1,190
Kewaunee clay loam	19.3	656

Flumioxazin is relatively volatile in water and on soil (vapor pressure=2.4×10^{-6} mmHg at 22°C). Since this chemical is applied to the soil surface by the band or broadcast method without subsequent incorporation, volatilization could play a role in the dissipation of the chemical in the environment.

Mobility of APF and THPA (MRID 45303201 and 453032202)
According to these two adsorption studies, Degradates APF and THPA appear to be mobile (see table below).

Soil Type (Soil number)	APF		THPA	
	Kd	Koc	Kd	Koc
Sandy loam	2.8	336	0.1	13
Loam	4.2	391	2.7	248
Sandy loam	6.0	502	0.8	66
Sandy loam	1.6	620	0.9	339
Loam (sediment)	4.9	201	1.8	75
Clay	n/a	n/a	5.3	191

The mobility of phenyl ring-labeled [U-^{14}C]6-amino-7-fluoro-4-(2-propynyl)-2H-1,4-benzoxazin-3(4H)-one (APF), a degradate of Flumioxazin, at nominal concentrations of 0.047-0.048, 0.13, 0.24-0.25, and 0.48-

0.51 µg/mL, was investigated in four soils (three sandy loam and one loam) and one sediment that were equilibrated for 4, 16 or 17 hours (soils) or 24 hours (sediment) at 25 ± 1°C. Freundlich K_{ads} values were 1.6110-5.9704 for the sandy loam soils, 4.2179 for the loam soil, and 4.9068 for the sediment; corresponding 1/n values ranged from 0.7800 to 0.9883. K_{oc} values were 336-620 for the sandy loam soils, 391 for the loam soil, and 201 for the sediment. Freundlich K_{des} values were 5.3150-18.6724 for the sandy loam soils, 6.3343-7.6085 for the loam soil, and 10.2141 for the sediment; corresponding l/n values ranged from 0.6089 to 0.9334. Reviewer-calculated coefficients of determinations (r^2) values for K_{ads} vs. percent organic matter, K_{ads} vs. pH, and K_{ads} vs. percent clay content were 0.2208, 0.4082, and 0.0278, respectively. Freundlich K_{des} values were 5.3150-18.6724 for the sandy loam soils, 6.3343-7.6085 for the loam soil, and 10.2141 for the sediment; corresponding 1/n values ranged from 0.6089 to 0.9660. Reviewer-calculated coefficients of determination (r^2) values for K_{ads} *vs.* percent organic matter, K_{ads} *vs.* pH, and K_{ads} *vs.* percent clay content were 0.2208, 0.4082, and 0.0278, respectively. [^{14}C]APF was stable in the soil/sediment slurries during the adsorption equilibration phase, but degraded in two sandy loam soils and the loam soil during the desorption equilibration phase, comprising 54.5-89.2% of the radioactivity recovered.

The mobility of [1,2-^{14}C]THPA, at nominal concentrations of 0.026-0.027, 0.06-0.07, 0.13, and 0.26-0.27 µg/mL, was investigated in five soils (three sandy loam, one loam, and one clay) and one sediment that were equilibrated for 4-8 or 48 hours at 25 ± 1°C. The soil:solution ratios were 2:7 for the sandy loam soils, 1:8 for the loam and clay soils, and 1:7.9 for the sediment. Freundlich K_{ads} values were 0.1078-0.8658 for the sandy loam soils, 2.6884 for the loam soil, 5.2614 for the clay soil, and 1.8357 for the sediment; corresponding 1/n values ranged from 0.8950 to 1.0147. K_{oc} values were 13-339 for the sandy loam soils, 248 for the loam soil, 191 for the clay soi;l, and 75 for the sediment. ranged from 13 to 339 for all soil/sediment types and 1/n values ranged from 0.8950 to 1.0147. Freundlich K_{des} values were 0.1790-1.1350 for the sandy loam soils, 4.1860 for the loam soil, 6.9711 for the clay soil, and 2.8701 for the sediment; corresponding l/n values ranged from 0.6413 to 0.9486. Reviewer-calculated coefficients of determinations (r^2) values for K_{ads} vs. percent organic matter, K_{ads} vs. pH, and K_{ads} vs. percent clay content were 0.4465, 0.365, and 0.2052, respectively.

Bioconcentration/Bioaccumulation
The Agency granted the registrant's waiver request because: 1) The observed octanol/water partition coefficient is smaller than 1,000 (log Kow = 2.55); and 2) Degradation is quick in water with a half-life of about one day at pH 7 and about 20 minutes at pH of 9. Based on the low octanol water partition coefficient (K_{ow} =355), Flumioxazin is not expected to accumulate in fish. The Agency has waived this data requirement.

Field Dissipation
Based on the findings in the environmental fate laboratory studies, the major routes of dissipation of Flumioxazin in the environment appear to be rapid hydrolysis, photolysis, and metabolism of the parent compound.

Six field dissipation studies were included in the evaluation of the fate of Flumioxazin in the environment.

Mississippi Field Dissipation Study in 1996 (MRID 44295045)
Flumioxazin (Sumisoya®; V-53482 WDG, 50.9% a.i.), broadcast applied once as a spray at a nominal application rate of 42.5 g a.i./A, dissipated with a half-life of 10.3 days (r^2 = 0.97) on a plot of silt loam soil planted with soybeans (the day after application) in Mississippi. In the 0- to 7.5-cm depth, the parent was 0.070-0.071 ppm at 0-1 day post-treatment, decreased to 0.051 ppm by 5 days, was 0.031-0.032 ppm from 8 to

14 days, and was last detected at 0.011 ppm at 28 days. The parent compound was not detected below the 0- to 7.5-cm depth. Samples were not analyzed for degradates of Flumioxazin.

Illinois Field Dissipation Study in 1996 (MRID 44295044)
Flumioxazin (VP-53482 WP, 51.4% a.i.), broadcast applied once as a spray at a nominal application rate of 43.2 g a.i./A, dissipated with a half-life of 12.5 days (0-28 day data; $r^2 = 0.85$) on a no-till bare ground plot (containing crop residues) of silt loam soil in Illinois. The observed first half-life occurred between 3 and 7 or 14 days post-treatment. The parent compound was initially present in the 0- to 7.5-cm depth at 0.069 ppm, decreased to 0.064 ppm by 3 days and 0.025 ppm by 7 days (the next sampling interval), was 0.029 ppm at 14 days, was 0.014-0.021 ppm from 21 to 59 days, and was not detected above the limit of quantitation following 59 days with the exception of 0.011 ppm (one of three replicates) at 122 and 241 days. The parent compound was not detected above the limit of quantitation below the 0- to 7.5-cm depth. Samples were not analyzed for degradates of Flumioxazin.

Iowa Field Dissipation Study in 1996 (MRID 44295046)
Flumioxazin (VP-53482 WDG, 50.9% a.i.), broadcast applied once as a spray at a nominal application rate of 42.5 g a.i./A, dissipated with a half-life of 42.0 days (0-112 day data; $r^2 = 0.94$) on a plot of silt loam soil planted with soybeans in Iowa. However, dissipation was observed to be biphasic and the apparent first half-life of the parent occurred between 21 and 28 days post-treatment; data were variable over time. In the 0- to 7.5-cm depth, the parent compound was initially 0.062-0.066 ppm at 0-1 day post-treatment, was 0.054-0.057 ppm from 3 to 7 days, decreased to 0.044 ppm by 14 days, then was 0.060 ppm at 21 days, was 0.029-0.020 ppm from 28 to 56 days, was 0.013 ppm (two of three replicates) at 112 days, and was not detected following 112 days with the exception of 0.014 ppm (one of three replicates) at 336 days. The parent compound was only detected once (day 14) in the 7.5- to 15-cm depth, at 0.012 ppm (one of three replicates), and was not detected above the LOQ at any other sampling interval or depth. Samples were not analyzed for degradates of Flumioxazin.

North Carolina Field Lysimeter/Dissipation Study in 1996 (MRID 44295043)
Uniformly phenyl ring-labeled [^{14}C]Flumioxazin, applied at a nominal application rate of 43.4 g a.i./A (0.348 mg/lysimeter) to lysimeter-enclosed bareground plots of Dothan loamy sand soil in Clayton, NC, dissipated with a half-life of 27 days (0-111 day data; $r^2 = 0.97$); the half-life was determined from the parent compound detected in the 0- to 3-inch depth only. However, the observed first half-life occurred between 17 and 27 days; only 32.4% of the applied remained as parent at 27 days. Dissipation was observed to be biphasic with the more rapid phase occurring through 111 days. Residue data were reported as parent equivalents. The parent compound was initially present in the 0- to 3-inch depth at 95.1% (0.102 ppm) of the applied radioactivity, was 59.5% (0.064 ppm) at 17 days and 32.4% (0.035 ppm) at 27 days, decreased to 13.2% (0.014 ppm) by 69 days, and was 5.1-5.5% (0.005-0.006 ppm) at 111-177 days. Unidentified radioactivity (designated as "Region 2"; fractions 15-22) was detected in the 0- to 3-inch depth at a maximum of 11.0-11.2% (0.012 ppm) from 17 to 43 days post-treatment, and was 6.0-6.4% (0.006 ppm) from 111 to 177 days; unidentified radioactivity consisted of multiple components, each of which was <0.01 ppm. Non-extractable [^{14}C]residues were 6.5% (0.007 ppm) of the applied radioactivity at 6 days post-treatment, were 17.8% (0.019 ppm) at 17 days, and increased to 25.2-29.0% (0.027-0.031 ppm) by 43-177 days. Total [^{14}C]residues were not detected above 0.01 μg/g (designated the limit of analysis) below the 3-inch depth. [^{14}C]Residues were not detected in the leachate samples and were only detected once in the run-off samples, at 0.02% (day 111) of the applied radioactivity.

Indiana Field Lysimeter/Dissipation Study in 1996 (MRID 44295047)
Uniformly phenyl ring-labeled [^{14}C]Flumioxazin, applied as a pre-emergent at a nominal application rate of 45 g a.i./A (0.361 mg/lysimeter) to lysimeter-enclosed soybean plots of loam soil in Charlestown, IN, dissipated with a half-life of 4.8 days (0-16 day data; $r^2 = 0.86$); the half-life was determined only from the parent compound detected in the 0- to 3-inch depth. Dissipation was observed to be biphasic with the more rapid phase occurring through 16 days. The observed first half-life occurred between 0 and 2 days post-treatment. Concentration data were reported as parent equivalents. The parent compound was initially present in the 0- to 3-inch depth at 88.5% (0.13 ppm) of the applied radioactivity, was 50.2% (0.060 ppm) at 2 days and 28.0-33.5% (0.032-0.045 ppm) from 5 to 9 days post-treatment, and was 0.9% (0.001 ppm) at 106 days. The minor degradates APF and 482-HA were detected at maximums of 8.2% (0.010 ppm, day 2) and 2.6% (0.004 ppm, day 0) of the applied radioactivity, respectively. The minor degradates 482-CA and IMOXA were present at ≤1.9% (≤0.002 ppm, days 2 to72) and ≤1.3% (≤0.001 ppm, days 2 to 106) of the applied radioactivity, respectively. Total [^{14}C]residues were not detected above 0.01 µg/g (designated as the level of analysis) below the 3-inch depth. Nonextractable [^{14}C]residues were initially 7.5% of the applied radioactivity, were 28.6% at 2 days post-treatment, increased to 51.7% by 5 days, and were a maximum of 93.1% at 316 days.

California Field Lysimeter/Dissipation Study in 1999 (MRID 45375502)
Soil dissipation/accumulation of N-(7-fluoro-3,4-dihydro-3-oxo-4-prop-2-ynyl-2H-1,4-benzoxazin-6-yl)cyclohex-1-ene-1,2-dicarboxamide (Flumioxazin) under U.S. field conditions was conducted in a bare plot located within a mature walnut orchard at one site in Fresno, CA (ecoregion not reported). Flumioxazin was broadcast twice (30-day interval) onto bare soil at a target application of 0.420 kg a.i./ha/application (total application rate of 0.84 kg a.i./ha) in a 7.6 x 97.5 m plot. Rainfall was supplemented with irrigation to reach 554% of the 30-year average rainfall. The control plot was located approximately 15.2 m away from the treated plot.

Soil samples were taken at 0 and 29 days following the first application and at 0, 1, 3, 7, 10, 14, 28, 42, 60, 90, 120, 181, 239, and 365 days following the second application to a depth of 0-90 cm. Soil samples were extracted with acetone:0.1N hydrochloric acid (5:1, v:v), partitioned into dichloromethane, cleaned up using florisil column chromatography, and analyzed for Flumioxazin by gas chromatography using a nitrogen-phosphorus detector. Soil samples were not analyzed for any degradates of Flumioxazin. The LOQ was 0.01 ppm and the LOD was 0.005 ppm. Samples were stored frozen for up to 375 days prior to analysis.

The measured zero-time concentration of Flumioxazin in the 0-7.5 cm soil depth following the first application was 0.426 mg a.i./kg, which is 95.7% of the applied rate (reviewer-calculated based on a theoretical concentration of 0.445 mg/kg in the 7.5-cm soil depth). Flumioxazin dissipated to 0.053 mg a.i./kg (0-7.5 cm soil depth) by 29 days after the first application (one day prior to the second application). Following the second application, Flumioxazin dissipated from a mean maximum concentration of 0.484 mg a.i./kg at 1 day after the second application to 0.298 mg a.i./kg by 10 days and 0.083 mg a.i./kg by 14 days, and was last detected at 0.015 mg a.i./kg at 239 days after the second application in the 0-7.5 cm soil depth. Flumioxazin was detected in the 7.5-15 cm soil layer at a mean maximum concentration of 0.049 mg a.i./kg immediately following the first application and was last detected above the LOQ at 0.037 mg/kg at 10 days after the second application. Flumioxazin was only detected above the LOQ once in the 15-30 cm soil layer, and was not detected above the LOD below that depth.

Under field conditions at the test site, Flumioxazin had a half-life value of 12.5 days. Flumioxazin was last detected in the soil above the LOD at the 239-day posttreatment sampling interval and does not have the potential to carryover. The major route of dissipation of Flumioxazin under terrestrial field conditions could not be determined because no transformation products were reported, the parent compound did not leach below 15 cm (with one exception), and volatilization and run-off were not studied.

Water Resource Assessment

Flumioxazin is unlikely to contaminate surface water and groundwater. However, its hydrolysis degradates (482-HA, APF, and THPA) appear to be more persistent and mobile than the parent compound and these degradates tend to reach surface water and groundwater at much higher concentrations. Fate studies show that Flumioxazin is relatively mobile (average Koc = 557, note: Koc values were estimated from a column leaching study), but non-persistent (hydrolysis half-life at pH 7 = 1 day; aqueous photolysis half-life at pH 5 = 1 day; soil aerobic metabolism half life = 14.7 days; aquatic anaerobic metabolism half-life = 0.2 days). Since hydrolysis appears to be one of the major routes of dissipation in the environment and the levels of degradates (482-HA, APF and THPA) were found to increase with time during the course of the hydrolysis study, EFED used the residue levels detected at the end of the hydrolysis study as the application rates for the degradates in modeling. It should be noted that default values were used if there were no available data for the input parameters in modeling. The following table lists the degradates identified and their relative concentrations at various pH from the hydrolysis study.

Percentages of the applied radioactivity identified at the end of 30-day hydrolysis study.

Compound	pH 5	pH 7	pH 9
	% of the applied*		
Flumioxazin	negligible	4.7	negligible
482-HA	negligible	9.3	97.3
APF	41.8	40.0	negligible
THPA	47.7	41.8	negligible

- % of the applied identified as 482-HA was based on the studies in which [PH-14C]Flumioxazin and [THP-14C]Flumioxazin were used.

  % of the applied identified as APF was based on the studies in which [PH-14C]Flumioxazin was used. Note: THPA would not be identified in these studies.

  % of the applied identified as THPA was based on the studies in which [THP-14C]Flumioxazin was used. Note: APF would not be identified in these studies.

Based on the relative concentrations presented in the table above and the application rate of the parent, the maximum residue levels that could be found on the soil surface were estimated in the table below:

Maximum amounts of Flumioxazin and its degradates expected to be on the soil surface after Flumioxazin was applied at the maximum rate of 0.383 lb ai/A/application (two applications per year with an application interval of 30-60 days).

Compound	pH 5	pH 7	pH 9
	lbs ai/A/application		
Flumioxazin	negligible	0.019	negligible
482-HA	negligible	0.038	0.391
APF	0.199	0.192	negligible
THPA	0.176	0.153	negligible

The FIRST and SCI-GROW models were used to estimate the concentrations of this chemical and its degradates in surface water and groundwater, respectively. These values represent upper-bound estimates of the concentrations that might be found in surface water and groundwater due to the use of Flumioxazin at the maximum application rate.

Surface Water and Groundwater Input Parameters

Surface water concentrations of Flumioxazin were estimated with FIRST. The estimates made with FIRST are intended here to represent drinking water sources with significant turnover such that there is no year-to-year accumulation. Ground water concentrations were predicted with SCI-GROW. Input parameters for FIRST and SCI-GROW at pH 7 were selected according to current EFED guidance. The application rates for Flumioxazin for pH 5 and 9 can be found below. It should be noted that the worst cases were assumed for those input parameters which no information were available (such as APF was assumed to be very stable under aerobic soil metabolism conditions with a half-life of 999 days). Since the intended use of FIRST in this particular simulation is only to represent a water body with significant water turnover, only the peak concentration has physical significance.

FIRST and SCI-GROW input parameters for Flumioxazin at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.019 lb ai/acre	0.019 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	1 day	1 day
Photolysis half life	1 day	n/a
Aerobic soil metabolism half life	23.4	14.7 days (mean value)
Aerobic aquatic half life	n/a	n/a
Solubility	1.8 ppm	n/a
Koc*	656	112

* Koc was estimated from a column leaching study instead of the adsorption study. Due to the rapid

hydrolysis rate of the parent compound, EFED acknowledged the difficulty in obtaining adsorption coefficients from the batch equilibrium study.

FIRST and SCI-GROW input parameters for 482-HA at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.038 lb ai/acre	0.038 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc**	13	13

* No water solubility is available so 10,000 ppm was assumed.

** Koc for THPA was used for 482-HA

FIRST and SCI-GROW input parameters for APF at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.192 lb ai/acre	0.192 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc	201	201

* No water solubility is available so 10,000 ppm was assumed.

FIRST and SCI-GROW input parameters for THPA at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.153 lb ai/acre	0.153 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a

Parameter	FIRST Values	SCI-GROW Values
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc	13	13

* No water solubility is available so 10,000 ppm was assumed.

Surface Water
Flumioxazin may contaminate surface water through spray drift during application or by runoff and erosion from treated areas after application. Although the fate laboratory studies for Flumioxazin suggest that the parent is relatively non-persistent, its degradation products may be available for transport for several weeks after application. The soil/water partitioning coefficient (average Koc = 557) suggest that this compound has the potential to contaminate surface water via dissolution in runoff water. In the absence of mobility data on the major degradates detected in the hydrolysis and the aqueous photolysis studies their potential to reach surface water is unknown.

Once Flumioxazin reaches the surface water, it is likely to be relatively non-persistent. The primary routes of dissipation appear to be hydrolysis and photolysis. In the aqueous phase photolysis is rapid with half-life of about 1 day. However, aqueous photolysis will only play a major role in clear shallow water bodies since sunlight is attenuated with depth and by particulates in the water column. Anaerobic aquatic metabolism (half-life = 0.2 day) will also be a significant degradation mechanism. The hydrolysis and photolysis degradation products could be stable and mobile in the environment.

Input parameters for Flumioxazin.

Application Rate (lbs ai/A)	0.383
Max. # of applications per year	2
Application Type	Aerial Spray
Depth of incorporation (inches)	0
Aerobic Soil Metabolic Half Life (Maximum value in days)	17.5
Photolysis Half-life (days)	1
Solubility (mg/L)	1.8
Organic Carbon Partitioning Coefficient (K_{oc})	112
pH 7 Hydrolysis Half-life (days)	1

Surface water estimated environmental peak concentrations for Flumioxazin and its major degradates in various pH.

Compound	pH 5	pH 7	pH 9
Flumioxazin	negligible	1.03 ppb	negligible

Compound	pH 5	pH 7	pH 9
482-HA	negligible	6.87 ppb	70.71 ppb
APF	27.43 ppb	26.46 ppb	negligible
THPA	31.83 ppb	27.67 ppb	negligible

Ground Water

Ground water concentrations were predicted with SCI-GROW. Input parameters and output and the resulting EEC are summarized in the table below. The SCI-GROW output file is located in **Appendix IV**. The predicted ground water concentration is 0.0084 μg/L. Based on the column leaching studies, Flumioxazin has Kd values ranging from 0.5 to 19.3 corresponding to Koc values of 112 to 1,190. Based on these values, this compound is expected to have moderate mobility, and has a low potential to leach to groundwater. The compound is relatively non-persistent in soil under aerobic conditions (half-life = 15 days) and in aquatic system under anaerobic conditions (half-life = 0.2 day). The mobility of the major degradates detected in the hydrolysis and aqueous photolysis studies is unknown. These degradates may persist in the environment and may leach to groundwater.

SCI-GROW input parameters for Flumioxazin.

Application Rate	0.383 lbs ai/A
Max. # of applications per year	2
Mean Aerobic Soil Half Life	14.7 days
Organic Carbon Partitioning Coefficient (K_{oc})	112
Hydrolysis	1 day

Groundwater estimated environmental concentrations for Flumioxazin and its major degradates in various pH.

Compound	pH 5	pH 7	pH 9
Flumioxazin	negligible	negligible	negligible
482-HA	negligible	45.27 ppb	465.82 ppb
APF	2.76 ppb	2.66 ppb	negligible
THPA	209.68 ppb	182.28 ppb	negligible

Drinking Water Recommendations to HED

EFED recommends that the Health Effects Division (HED) use the concentrations presented below for drinking water EECs. The drinking water EECs were based on the FIRST (surface water) and SCI-GROW (groundwater) simulations described above.

Drinking Water Exposure
Tier I Estimated Environmental Concentrations (EECs) were calculated using FIRST for use in the human health risk assessment for Flumioxazin. These values represent high-end to bounding estimates of the concentrations that might be found in surface water due to the use of Flumioxazin.

FIRST is a new screening model designed to estimate the pesticide concentrations found in water for use in drinking water assessments. It provides high-end values on the concentrations that might be found in a small drinking water reservoir due to the use of pesticide. Like GENEEC, the model previously used for Tier I screening level, FIRST is a single-event model (one run-off event), but can account for spray drift from multiple applications. FIRST uses a Drinking Water Reservoir instead of a pond as the standard scenario. The FIRST scenario includes a 427 acres field immediately adjacent to a 13 acres reservoir, 9 feet deep, with continuous flow (two turnovers per year). The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 8% of the applied pesticide into the pond. This amount can be reduced due to degradation on 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. FIRST also makes adjustments for the percent crop area. While FIRST assumes 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 FIRST include the use of a small drinking water reservoir surrounded by a runoff-prone watershed, the use of the maximum use rate, no buffer zone, and a single large rainfall.

SCI-GROW provides a ground water screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. Since the SCI-GROW concentrations are likely to be approached in only a very small percentage of drinking water sources, i.e., highly vulnerable aquifers, it is not appropriate to use SCI-GROW concentrations for national or regional exposure estimates.

SCI-GROW estimates likely ground water concentrations if the pesticide is used at the maximum allowable rate in areas where ground water is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have ground water that is less vulnerable to contamination that the areas used to derive the SCI-GROW estimate.

Estimated EECs for Flumioxazin and its degradates in surface water and groundwater at pH 7.

Compound	Average 56-Day Conc. in Surface Water	Peak Conc. in Surface Water	Conc. in Groundwater
Flumioxazin	**negligible**	**1.03 ppb**	**negligible**
482-HA	**4.84 ppb**	**6.87 ppb**	**45.27 ppb**
APF	**12.85 ppb**	**26.46 ppb**	**2.66 ppb**
THPA	**19.50 ppb**	**27.67 ppb**	**182.28 ppb**

Uncertainties
The mobility of the major degradate (482-HA) detected in the hydrolysis, aqueous photolysis and anaerobic

aquatic metabolism studies have not been determined and thus the degree to which this compound will access ground water is unknown. The fate of the major degradates identified in the environmental fate laboratory studies has not been determined. Furthermore, these degradates were not analyzed in the field dissipation studies. In addition, the toxicity of the degradates are unknown.

ECOLOGICAL EFFECTS TOXICITY ASSESSMENT

Toxicity testing reported in this section does not represent all species of bird, mammal, or aquatic organism. Since not all wildlife species can ever be tested, representatives from large groups of species must be used. Only two **surrogate species** for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, acute studies are usually limited to the Norway rat or the house mouse. Estuarine/marine testing is usually limited to a crustacean, a mollusk, and a fish. Also, neither reptiles nor amphibians are tested. The assessment of risk or hazard makes the assumption that avian and reptilian toxicity are similar. The same assumption is used for fish and amphibians. Generally, the most toxic endpoints for the technical grade active ingredient (TGAI) are used in the assessment to represent each group of organism.

Based on ecological effects data, the toxicity endpoints used in the assessment of Flumioxazin can be characterized as follows:

- Avian acute oral - Practically non-toxic (LD50= > 2250 mg/Kg)
- Avian acute dietary - Practically non-toxic (LC50= > 5620 ppm)
- Avian chronic (reproduction)- (NOAEC= 250 ppm)
- Mammalian acute oral - Practically non-toxic (LD50= 5000 mg/Kg)
- Mammalian chronic (reproduction)-(NOAEL= 100 ppm)
- Honey bee acute - Practically non-toxic (LD50= > 105 ug/bee)
- Fish (freshwater) acute - moderately toxic (LC50= 2.3 ppm)
- Fish (freshwater) chronic - Reduced larval growth (NOAEC= 7.7 ppb)
- Fish (estuarine) acute - Moderately toxic (96 hr LC50= >4.7 ppm)
- Invertebrate (freshwater) acute - Moderately toxic (48 hr LC50= 5.5 ppm)
- Invertebrate (freshwater) chronic- Decreased reproduction (21-day NOAEC= 28.0 ppb)
- Invertebrate (estuarine) acute - (96 hr LC50/EC50= 0.23 ppm)
- Invertebrate (estuarine) chronic - Decreased reproduction and growth (NOAEC= 15 ppb)
- Plants - Phyto- and photo- toxic to plants (EC50 = 0.0005 ppm)

+ For a complete listing of toxicity studies for Flumioxazin, please see the appendix.

Toxicity to Terrestrial Organisms

Bird and mammal overview

Flumioxazin is practically non-toxic to birds and mammals on an acute basis. Chronic avian reproductive effects include significant reductions in the number of viable embryos and live 3-week embryos in birds and decreased number of liveborn pups and decreased pup weights in mammals.

Avian Species (Acute Oral, Subacute Dietary and Reproduction)
In acute oral toxicity studies conducted on bobwhite quail and mallard duck, the LD_{50} for the technical product is > 2250 mg/kg. The results suggest that Flumioxazin is practically non-toxic to birds on an acute oral basis.

Subacute dietary toxicity studies conducted on mallard duck and bobwhite quail suggest that Flumioxazin is also practically non-toxic, with LC_{50s} of > 5620 ppm for the technical grade active ingredient. An avian reproduction study on bobwhite quail indicated that there were no significant treatment related effects. The No Observable Adverse Effect Concentration (NOAEC) and the Low Observable Adverse Effect Concentration (LOAEC) was determined to be 500 and >500 ppm, respectively. Also, an avian reproduction study using mallard ducks indicated that significant reductions in the number of viable embryos and live 3-week embryos were evident at the highest concentration (500 ppm). The No Observable Adverse Effect Concentration (NOAEC) and the Low Observable Adverse Effect Concentration (LOAEC) was determined to be 250 and 500 ppm, respectively.

Mammalian Species (Acute Oral and Reproduction)
In toxicity studies conducted on laboratory rats for the Agency's Health Effects Division (HED), Flumioxazin was practically non-toxic to small mammals on an acute oral basis (LD_{50} of 5000 mg/kg). Results from a chronic reproduction study indicate reproductive toxicity at a LOAEL of 200 ppm (NOAEL of 100 ppm) with decreased number of live-born pups and decreased pup weights being the endpoints affected. Increases in the incidence of reproductive organ abnormalities (predominately atrophied or hypoplastic testes and/or epididymides) were also noted that may imply an endocrine modulated pathway. Absolute organ weight for the testes, epididymides and prostate were significantly reduced at 300 ppm for F1 males.

Insects
Flumioxazin is practically non-toxic to bees on an acute contact basis (LD_{50} > 105 µg/bee).

Toxicity to Non-target Aquatic Animals

Freshwater organism toxicity overview

Flumioxazin exhibits slight to moderate acute toxicity to freshwater fish (LC50 ranges of 2.3 to >21.0 ppm) and freshwater aquatic invertebrates (LC50 was 5.5 ppm). Chronic effects include reduction in larval growth in freshwater fish (NOAEC= 7.7 ug/L) and decreased reproduction, survival and growth in aquatic invertebrates (NOAEC= 28 ug/L).

Freshwater fish
In acute toxicity studies conducted on coldwater and warmwater species, the 96-hour LC_{50} values for the technical grade material ranged from 2.3 to > 21 ppm, suggesting that Flumioxazin will be moderately to slightly toxic to freshwater fish on an acute basis. An early life-stage toxicity test conducted on rainbow trout show that Flumioxazin significantly affected larval growth (length and weight) at concentrations equal to 16.0 or greater than 7.7 ppb.

Freshwater invertebrates
Acute toxicity studies conducted on freshwater aquatic invertebrates suggest that the active ingredient of Flumioxazin is moderately toxic on an acute basis. The 48-hour LC_{50} or EC_{50} value was 5.5 mg/L. The chronic data indicate that Flumioxazin (S-53482) significantly reduced reproduction at concentrations equal to 57 or greater than 28 ppb and survival and growth (length and weight) at concentrations equal to 107 or greater than 57 ppb.

Estuarine/Marine organism toxicity overview

Flumioxazin exhibits moderate acute toxicity to estuarine/marine fish and ranges from moderate to highly toxic to estuarine/marine aquatic invertebrates. Chronic effects to estuarine/marine aquatic invertebrates included reductions in reproduction, survival and growth. No data were submitted to assess chronic risk to estuarine/marine fish.

Estuarine/Marine fish
Testing on sheepshead minnow resulted in an 96-hour LC_{50} of >4.7 mg/L, which is considered to be moderately toxic on an acute basis. No data were submitted to assess chronic risk to estuarine/marine fish.

Estuarine/Marine invertebrates
Acute toxicity testing on estuarine/marine invertebrate species with the technical product resulted in a 96-hour LC_{50}/EC_{50} values ranging from 2.4 to 0.23 ppm which fall into the moderate to highly toxic acute classes for estuarine/marine invertebrates. The chronic data indicate that Flumioxazin (V-53482) significantly reduced reproduction and growth (length and weight) at concentrations equal to 27 or greater than 15 ppb and survival at concentrations equal to 55 or greater than 27 ppb.

Toxicity to Plants

Flumioxazin is a light-dependent peroxidizing herbicide (LDPH) which acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of photo-toxic porphyrins. This class of herbicides are known to have a photo-toxic mode of action in plants. Standard toxicity testing may not include light with the same wavelength or intensity as natural sunlight. LDPHs may be more toxic when exposed to natural sunlight, such as exposure conditions in the field. The following is a summary of the submitted plant toxicity data currently available:

MRID 442950-29. Tier II seedling emergence non-target phyto-toxicity study using Flumioxazin. This study was scientifically sound and fulfills the guidelines for a seedling emergence study with terrestrial plants. The most sensitive monocot and most sensitive parameter was ryegrass and dry weight, respectively. The EC50 and NOAEL for the study was 0.0037 lb ai/A and 0.003 lb ai/A, respectively. The most sensitive dicot and most sensitive parameter was lettuce and also dry weight, respectively. The EC25 and NOAEL for the study was 0.0008 lb ai/A and 0.0004 lb ai/A, respectively.

MRID 442950-30. Tier II vegetative vigor non-target phyto-toxicity study using Flumioxazin. This study was scientifically sound and fulfills the guidelines for a vegetative vigor study with terrestrial plants. The most sensitive monocot and most sensitive parameter was oat and dry weight, respectively. The EC50 and NOAEL for the study was 0.0071 lb ai/A and 0.006 lb ai/A, respectively. The most sensitive dicot and most sensitive parameter was cucumber and phyto-toxicity, respectively. The EC25 and NOAEL for the study was 0.00008 lb ai/A and 0.00005 lb ai/A, respectively.

MRID 442950-31. Toxicity to the freshwater green alga (*Selenastrum capricornutum*). This study was scientifically sound and fulfills the guidelines for an algal aquatic plant toxicity study. (EC50= 1.02 ppb ai; NOAEC= 0.79 ppb ai; 95% CI of 0.82-1.26 ppb ai).

MRID 442950-32. Toxicity to the freshwater diatom (*Navicula pelliculosa*). This study was scientifically sound and fulfills the guidelines for a freshwater diatom toxicity study. (EC50= 1.4 ppb ai; NOAEC= 0.041 ppb ai; 95% CI of 1.3-1.6 ppb ai).

MRID 442950-33. Toxicity to the marine diatom (*Skeletonema costatum*). This study was scientifically sound and fulfills guideline requirements for a marine diatom toxicity study. (EC50= 19.2 ppb ai; NOAEC= 1.9 ppb ai; 95% CI of 13.3-27.8 ppb ai).

MRID 442950-34. 5-day toxicity to the freshwater blue-green alga (*Anabaena flosaquae*). This study was scientifically sound and fulfills the guideline requirements for an algal aquatic plant toxicity study. (EC50= 0.83 ppb ai; NOAEC= 0.022 ppb ai; 95% CI of 0.47-1.46 ppb ai).

MRID 442950-35. Toxicity to the Duckweed (*Lemna gibba*). This study was scientifically sound and fulfills the guideline requirements for a tier II aquatic plant toxicity study. (EC50= 0.49 ppb ai; NOAEC= 0.22 ppb ai; 95% CI of 0.40-0.60 ppb ai).

ENVIRONMENTAL RISK ASSESSMENT

In order to evaluate the potential risk to aquatic and terrestrial organisms from the use of Flumioxazin, risk quotients (RQs) are calculated from the ratio of estimated environmental concentrations (EECs) to generally the most toxic ecotoxicity value (acute) or no-effect level (chronic) for that group of organisms. These RQs are then compared to levels of concern (LOCs) used by OPP to indicate potential risk to nontarget organisms and the need to consider regulatory action. EECs are based on the maximum application rates (worst case) for selected modeled crop uses for Flumioxazin.

Risk to Nontarget Terrestrial Organisms

The estimated environmental concentration (EEC) values used for foliar terrestrial exposure are derived from the Kenega nomograph, as modified by Fletcher et al. (1994), based on a large set of actual field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenega, 1972). The Fletcher et al. (1994) modifications to the Kenaga nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes. These modifications represent the 95th percentile of the expanded data set. Risk quotients are based on the most sensitive LC_{50} and NOAEC for birds and calculated dietary endpoint and reproductive NOAEC for mammals (based on lab rat or mouse studies). EFED uses the FATE model for multiple applications, incorporating the appropriate degredation half-life to generate EECs. For single application EECs, day zero maximum Fletcher residue values are used (lbs ai/A x 240, 110, 135, and 15 ppm).

Exposure and Risk to Endangered Species

The Endangered Species Protection Program is expected to become final in the future. Limitations in the use of Flumioxazin may be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

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

Since Flumioxazin was found to exhibit photo- and phyto- toxicity, and RQs exceeded LOCs, endangered terrestrial and aquatic plant species are potentially at risk, should exposure actually occur. Also, RQs of 1.33-2.60 exceeded the chronic LOC of 1.0 for freshwater fish and estuarine/marine invertebrates respectively, should the degradates APF and THPA enter aquatic habitats where these organisms live. These RQ values were based on the toxicity profiles of the parent due to an absence of data for the degradates, thus risk is uncertain.

Risk Characterization

Flumioxazin is a light-dependent peroxidizing herbicide (LDPH) which acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of phototoxic porphyrins. This class of herbicides are known to have a phototoxic mode of action in plants and possibly in fish. Standard toxicity testing may not include light with the same wavelength or intensity as natural sunlight. LDPHs may be more toxic when exposed to natural sunlight, such as exposure conditions in the field.

Toxicity and exposure of terrestrial and aquatic organisms

Most acute and chronic LOC's were not exceeded for either avian or mammalian species. The chronic LOC of 1.0 was slightly exceeded with an RQ of 1.42 for small mammals eating short grass in the multiple application of Flumioxazin under the grape, almond, Christmas and deciduous tree scenarios. However it is unlikely that small mammals eating only short grass would frequent areas growing grapes and almonds to feed due to intensive cultivation practices resulting in the almost total absence of most vegetation other than the crop itself. Thus, since the magnitude of the screening level RQ is low, characterization of the use site itself may limit exposure and the uncertainty surrounding extrapolation from one data point, likelihood of risk is low. This scenario would also likely apply to small endangered mammalian species only eating shortgrass. However, it is uncertain what concentrations may be at the edges of the fields where vegetation is abundant, especially as a result of drift from aerial applications.

The toxicity of the potentially toxic degradates (482-HA and APF) are unknown and is an uncertainty. RQs of 1.33-2.60 exceeded the chronic LOC of 1.0 for freshwater fish and estuarine/marine invertebrates respectively, should the degradates APF and THPA enter aquatic habitats were these organisms live. These RQ values were based on the toxicity profiles of the parent due to an absence of data for the degradates. In addition, the potential for the parent compound to migrate into ground water and to move with surface runoff water is very low. However, the degradates are much more persistent and mobile than the parent and will likely enter surface and groundwater based on their physical and chemical properties and the results of modeling.

Currently, EFED does not assess risk to non-target insects. Results of acceptable studies are used for recommending appropriate label precautions. As Flumioxazin is practically non-toxic to honeybees, low risk is assumed.

Risks to plants

Acute and chronic non-target plant species levels of concern are exceeded at maximum application rates. Since Flumioxazin was also found to exhibit photo- and phyto- toxicity, and RQs exceeded LOCs, terrestrial and aquatic plant species may be potentially at even greater risk.

Endocrine Disruption
Based on available data, Flumioxazin may be an endocrine disrupting compound in mammals. Based on the weight of the evidence, the following effects suggest possible endocrine system related action. Effects that may be associated with endocrine disruption were an increased incidence of reproductive organ abnormalities in rats (predominately atrophied or hypoplastic testes and/or epididymides). Results from a chronic reproduction study indicate reproductive toxicity at a LOAEL of 200 ppm (NOAEL of 100 ppm) with decreased number of live-born pups and decreased pup weights being the endpoints affected. Increases in the incidence of reproductive organ abnormalities (predominately atrophied or hypoplastic testes and/or epididymides) were also noted that may imply an endocrine modulated pathway. Absolute organ weight for the testes, epididymides and prostate were significantly reduced at 300 ppm for F1 males. Expected environmental concentrations (maximum estimated concentration = 92 ppm for 1 application and 142 ppm for 2 applications) are below the LOAEL but above the NOAEL, thus suggesting a possible risk. Nevertheless, it is unknown if other endocrine related effects at these low concentrations may or may not occur or if the degradates will produce endocrine disrupting effects. Thus the following language from EPA's Interim Policy for Potential Endocrine Disruptors is recommended:

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

Uncertainties
Available environmental fate studies suggest Flumioxazin is short-lived and its potential to contaminate the environment is relatively low. However, with the exception of the adsorption studies for APF and THPA, there are no other information available to describe the fate of its major degradates in the environment It should be noted that the registrant did not submit these adsorption studies for APF and THPA to EPA in the original package. These studies were submitted on 2/9/01, when EFED had expressed concerns on the mobility of the degradates which were found to be in the inclining mode during the course of the hydrolysis study. Based on their Koc, the potential for APF and THPA to leach to groundwater is higher than the parent compound. However, the mobility of its major degradation product (482-HA) detected in the hydrolysis and the unidentified residues detected in the aqueous photolysis and anaerobic aquatic metabolism studies is unknown. These residues may persist in the environment and may leach to groundwater. Furthermore, since all the submitted field dissipation studies did not analyze for any degradates, the fate of the major degradates detected

in the hydrolysis and the aqueous photolysis as well as those unidentified residues reported in the anaerobic aquatic metabolism study in the natural environments remains unknown.

As a result, EFED is requiring additional fate information to assess the impact of these residues on the environment. In addition, the toxicity of the degradates are unknown. EFED is not requiring toxicity studies at this time due to risk quotients indicating low concern.

Appendix I: Ecological Effects Characterization

Ecological toxicity studies required by the Agency for the registration/re-registration of a pesticide, and the rational behind these requirements, are listed in 40 CFR 158. The following studies submitted by the registrant were used to develop an ecological toxicity assessment for Flumioxazin.

Toxicity to Terrestrial Animals

Birds, Acute and Subacute

Avian Acute Oral Toxicity

Species	*% ai*	*LD50 (mg/kg)*	*Toxicity Category*	*MRID Author/Year*	*Study Classification*[1]
Bobwhite quail *(Colinus virginianus)*	94.8	>2250	Practically non-toxic	426849-45 Lloyd et al. (1990)	Core

* Core (study satisfies guideline).

Since the LD50 is >2250 mg/kg, Flumioxazin is considered to be practically no-toxic to avian species on an acute oral basis. The guideline (71-1) is fulfilled (MRID 426849-45).

Avian Subacute Dietary Toxicity

Species	*% ai*	*5-Day LC50 (ppm)*[1]	*Toxicity Category*	*MRID Author/Year*	*Study Classification*
Mallard duck *(Anas platyrhynchos)*	94.8	>5620	Practically non-toxic	426849-46 Culotta et al. (1991)	Core
Northern bobwhite quail *(Colinus virginianus)*	94.8	>5620	Practically non-toxic	426849-47 Culotta et al. (1991)	Core

[1] Test organisms observed an additional three days while on untreated feed.

Since both LC50's are >5620 ppm, Flumioxazin is considered to be practically non-toxic to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID 426849-46 and -47).

Birds, Chronic

Avian Reproduction

Species/ Study Duration	*% ai*	*NOAEC/LOAEC*[1] *(ppm)*	*LOAEC Endpoints*	*MRID No. Author/Year*	*Study Classification*
Northern bobwhite quail *(Colinus virginianus)*	94.8	500/>500	N/A	Beavers et al (1994) 442950-06	Supplemental
Mallard duck *(Anas platyrhynchos)*	94.8	250/500	Reductions in viable embryos and live 3wk embryos	Beavers et al (1994) 442950-05	Core

1 NOAEC = No Observed Effect Concentration; LOAEC = Lowest Observed Effect Concentration, ND = Not Determined

The guideline (71-4) is fulfilled (MRID 442950-05 and 442950-06).

Mammals, Acute and Chronic

In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported below.

Mammalian Toxicity: Acute and Chronic

Species	*% ai*	*Test Type*	*Toxicity Value*	*Year*	*MRID No.*
Laboratory rat *(Rattus norvegicus)*	Technical and Formulation 50 WDG	LD50	>5000 mg/Kg		426849-11 426849-12
Laboratory rat *(Rattus norvegicus)*	94.8	2 Generation reproduction	NOAEL= 100 ppm LOAEL= 200 ppm	1992	426849-34 426849-35 426849-36

In toxicity studies conducted on laboratory rats for the Agency's Health Effects Division (HED), Flumioxazin technical and the formulated product was practically non-toxic to small mammals on an acute oral basis (LD_{50} of >5000 mg/kg). Results from a chronic reproduction study indicate reproductive toxicity at a LOAEL of 200 ppm (NOAEL of 100 ppm) with decreased number of liveborn pups and decreased pup weights being the endpoints affected. Increases in the incidence of reproductive organ abnormalities (predominately atrophied or hypoplastic testes and/or epididymides) were also noted which may imply a possiblity of an endocrine modulated pathway. Absolute organ weight for the testes, epididymides and prostate were significantly reduced at 300 ppm for F1 males. The guidelines (81-1 and 83-3) are fulfilled (MRID 426849-11, -12, -34, -35 and -36).

Insects

Nontarget Insect Acute Contact Toxicity

Species	*% ai*	*48 hr LD50 (µg/bee)*	*Toxicity Category*	*MRID Author/Year*	*Study Classification*
Honey bee *(Apis mellifera)*	94.8	>105	practically non-toxic	426849-51 Hoxter et al (1990)	Core

The results indicate that Flumioxazin is practically non-toxic to bees on an acute contact basis. The guideline (141-1) is fulfilled (MRID 426849-51).

Toxicity to Aquatic Organisms

Freshwater Fish, Acute

Freshwater Fish Acute Toxicity

Species	*% ai*	*96-hour LC50 (ppm)*	*Toxicity Category*	*MRID No.*	*Study Classification*
Rainbow trout *(Oncorhynchus mykiss)*	94.8 (S-53482)	2.3	Moderately toxic	426849-48	Core
Rainbow trout *(Oncorhynchus mykiss)*	94.3 (S-53482)	>2.4 (OECD 21-day test)	Moderately toxic	442950-07	Supplemental
Bluegill sunfish *(Lepomis macrochirus)*	94.8 (S-53482)	> 21.0	Slightly toxic	426849-49	Core

Because the LC50's for the technical grade material fall in the range of 2.3 and >21.0 ppm, Flumioxazin is considered to be moderately to slightly toxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 426849-48 and -49). MRID 442950-07 was a 21-day study conducted under OECD guidelines,

Freshwater Fish, Chronic

Freshwater Fish Early Life-Stage Toxicity Under Flow-through Conditions

Species	*% ai*	*NOAEC/LOAEC (ppb)*	*MATC[1] (ppb)*	*Endpoints Affected*	*MRID No.*	*Study Classification*
Rainbow trout *(Oncorhynchus mykiss)*	98.2 (S-53482)	7.7/16.0	11.0	Growth (length and wt.)	442950-12	Core

[1] MATC = Maximum Allowed Toxic Concentration, defined as the geometric mean of the NOAEC and LOAEC.

The guideline (72-4) is fulfilled (MRID# 442950-12). The data indicate that Flumioxazin significantly affected larval growth (length and weight) at concentrations equal to 16.0 or greater than 7.7 ppb.

Freshwater Invertebrates, Acute

Freshwater Invertebrate Acute Toxicity

Species	*% ai*	*48-hour LC50/ EC50 (ppm)*	*Toxicity Category*	*MRID/Author/Year*	*Study Classification*
Waterflea *(Daphnia pulex)*	94.7	5.5	Moderately toxic	426849-50 Reed and Swigert (1992)	Supplemental

Because the LC50/EC50 of the TGAI was 5.5 ppm, Flumioxazin is considered to be moderately toxic to aquatic invertebrates on an acute basis. Although the study was classified as being supplemental, the guideline (72-2) is fulfilled (MRID 426849-50). See D198054 for explanation.

Freshwater Invertebrate, Chronic

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species	% ai	21-day NOAEC/LOAEC (ppb)	MATC[1] (ppb)	Endpoints Affected	MRID No.	Study Classification
Waterflea *(Daphnia magna)*	94.8 (S-53482)	28.0/57.0	40.0	Reproduction, survival and growth	442950-11	Core

[1] Maximum Allowed Toxic Concentration, defined as the geometric mean of the NOAEC and LOAEC.

The data indicate that Flumioxazin (S-53482) significantly reduced reproduction at concentrations equal to 28 or greater than 57 ppb and survival and growth (length and weight) at concentrations equal to 57 or greater than 107 ppb. This study was scientifically sound and fulfilled guideline (72-4) requirements (MRID#442950-11).

Estuarine and Marine Fish, Acute

Estuarine/Marine Fish Acute Toxicity

Species	*% ai*	*96-hour LC50 (ppm)*	*Toxicity Category*	*MRID No.*	*Study Classification*
Sheepshead minnow *(Cyprinodon variegatus)*	93.8 (V-53482)	>4.7	Moderately toxic	442950-10	Core

Since the 96 hr LC50 is >4.7 ppm, Flumioxazin is considered to be moderately toxic to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID# 442950-10).

Estuarine and Marine Fish, Chronic

No data were submitted.

Estuarine and Marine Invertebrates, Acute

Estuarine/Marine Invertebrate Acute Toxicity

Species	*% ai.*	*96-hour LC50/EC50 (ppm)*	*Toxicity Category*	*MRID No.*	*Study Classification*
Eastern oyster (Shell deposition) *(Crassostrea virginica)*	93.8 (V-53482)	2.4	Moderately toxic	442950-08	Core

Estuarine/Marine Invertebrate Acute Toxicity

Species	*% ai.*	*96-hour LC50/EC50 (ppm)*	*Toxicity Category*	*MRID No.*	*Study Classification*
Mysid *(Mysidopsis bahia)*	94.3 (V-53482)	0.23	Highly toxic	442950-09	Core

Because the 96-hour LC50s range from 2.4 to 0.23 ppm, the TGAI of Flumioxazin is considered moderately tohighly toxic to estuarine/marine invertebrates on an acute basis. The guideline (72-3b and 72-3c) is fulfilled (MRID 442950-08 and 442950-09).

Estuarine and Marine Invertebrate, Chronic

Estuarine/marine Aquatic Invertebrate Life-Cycle Toxicity

Species	% ai	21-day NOAEC/LOEAC (ppb)	MATC[1] (ppb)	Endpoints Affected	MRID No.	Study Classification
Mysid *(Mysidopsis bahia)*	99.5 (V-53482)	15.0/27.0	20.0	Reproduction, survival and growth	442950-13	Core

[1] Maximum Allowed Toxic Concentration, defined as the geometric mean of the NOAEC and LOAEC.

The data indicate that Flumioxazin (V-53482) significantly reduced reproduction and growth (length and weight) at concentrations equal to 27.0 or greater than 15.0 ppb and survival at concentrations equal to 55.0 or greater than 27.0 ppb. This study was scientifically sound and fulfilled guideline (72-4) requirements (MRID#442950-13).

Toxicity to Plants

Flumioxazin is a light-dependent peroxidizing herbicide (LDPH) which acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of phototoxic porphyrins. This class of herbicides are known to have a phototoxic mode of action in plants. Standard toxicity testing may not include light with the same wavelength or intensity as natural sunlight. LDPHs may be more toxic when exposed to natural sunlight, such as exposure conditions in the field. The following is a summary of the submitted plant toxicity data currently available:

MRID 442950-29. Tier II seedling emergence non-target phytotoxicity study using Flumioxazin. This study was scientifically sound and fulfills the guidelines for a seedling emergence study with terrestrial plants. The most sensitive monocot and most sensitive parameter was ryegrass and dry weight, respectively. The EC25 and NOAEL for the study was 0.0037 lb ai/A and 0.003 lb ai/A, respectively. The most sensitive dicot and most sensitive parameter was lettuce and also dry weight, respectively. The EC25 and NOAEL for the study was 0.0008 lb ai/A and 0.0004 lb ai/A, respectively.

MRID 442950-30. Tier II vegetative vigor non-target phytotoxicity study using Flumioxazin. This study was scientifically sound and fulfills the guidelines for a vegetative vigor study with terrestrial plants. The most sensitive monocot and most sensitive parameter was oat and dry weight, respectively. The EC25 and NOAEL for the study was 0.0071 lb ai/A and 0.006 lb ai/A, respectively. The most sensitive dicot and most sensitive parameter was cucumber and phytotoxicity, respectively. The EC25 and NOAEL for the study was 0.00008 lb ai/A and 0.00005 lb ai/A, respectively.

MRID 442950-31. Toxicity to the freshwater green alga (*Selenastrum capricornutum*). This study was scientifically sound and fulfills the guidelines for an algal aquatic plant toxicity study. (EC50= 1.02 ppb ai; NOAEC= 0.79 ppb ai; 95% CI of 0.82-1.26 ppb ai).

MRID 442950-32. Toxicity to the freshwater diatom (*Navicula pelliculosa*). This study was scientifically sound and fulfills the guidelines for a freshwater diatom toxicity study. (EC50= 1.4 ppb ai; NOAEC= 0.041 ppb ai; 95% CI of 1.3-1.6 ppb ai).

MRID 442950-33. Toxicity to the marine diatom (*Skeletonema costatum*). This study was scientifically sound and fulfills guideline requirements for a marine diatom toxicity study. (EC50= 19.2 ppb ai; NOAEC= 1.9 ppb ai; 95% CI of 13.3-27.8 ppb ai).

MRID 442950-34. 5-day toxicity to the freshwater blue-green alga (*Anabaena flosaquae*). This study was scientifically sound and fulfills the guideline requirements for an algal aquatic plant toxicity study. (EC50= 0.83 ppb ai; NOAEC= 0.022 ppb ai; 95% CI of 0.47-1.46 ppb ai).

MRID 442950-35. Toxicity to the Duckweed (*Lemna gibba*). This study was scientifically sound and fulfills the guideline requirements for a tier II aquatic plant toxicity study. (EC50= 0.49 ppb ai; NOAEC= 0.22 ppb ai; 95% CI of 0.40-0.60 ppb ai).

Appendix II: Risk Assessment

A means of integrating the results of exposure and ecotoxicity data is called the quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic.

RQ = EXPOSURE/TOXICITY

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

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from the results of required studies. Examples of ecotoxicity values derived from the results of short-term laboratory studies that assess acute effects are: (1) LC50 (fish and birds) (2) LD50 (birds and mammals) (3) EC50 (aquatic plants and aquatic invertebrates) and (4) EC25 (terrestrial plants). An example of a toxicity test effect level derived from the results of long-term laboratory studies that assess chronic effects is: (1) NOAEC (birds, fish and aquatic invertebrates).

Risk presumptions, along with the corresponding RQs and LOCs are tabulated below:

Risk Presumptions for Terrestrial Animals

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

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

[2] $\frac{mg/ft^2}{LD50 * \text{wt. of bird}}$ [3] $\frac{\text{mg of toxicant consumed/day}}{LD50 * \text{wt. of bird}}$

Risk Presumptions for Aquatic Animals

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

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

Risk Presumptions for Plants

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

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

Terrestrial Exposure Assessment

The terrestrial exposure assessment is based on either the methods of Hoerger and Kenaga (1972)[1] as modified by Fletcher et al. (1994)[2] or on the calculation of an LD50 ft^2 for granular products (Felthousen, 1977). Uncertainties in the terrestrial EECs are primarily associated with a lack of data on interception and subsequent dissipation from foliar surfaces. EFED assumes that the foliar dissipation rate is equal to the aerobic soil metabolism rate. Open literature data suggest that foliar dissipation rates are generally less than 20 days[3].

Hoerger-Kenaga estimates are based on residue data correlated from more than 20 pesticides on more than 60 crops. Representative of many geographic regions (7 states) and a wide array of cultural practices, Hoerger-Kenaga estimates also considered differences in vegetative yield, surface/mass ratio and interception factors. In 1994, Fletcher, Nellessen and Pfleeger, reexamined the Hoerger-Kenaga estimates to determine whether the terrestrial EECs were accurate. They compiled a dataset 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 analyses, their conclusions were that Hoerger-Kenaga estimates needed only minor modifications to elevate the predictive values for forage and fruit categories from 58 to 135 and from 7 to 15. Otherwise, the Hoerger-Kenaga estimates were accurate in predicting the maximum residue values. In

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1 Hoerger, F., and E.E. Kenaga. 1972. Pesticide residues on plants: Correlation of representative data as a basis for estimation of their magnitude in the environment. In F. Coulston and F. Korte, eds., *Environmental Quality and Safety: Chemistry, Toxicology, and Technology,* Georg Thieme Publ, Stuttgart, West Germany, pp. 9-28.

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

3 Knisel, W.G., ed. 1980. CREAMS: A field-scale model for chemicals, runoff, and erosion from agricultural management systems. USDA Conserv. Res. Rep. No. 26).

addition, their findings indicate that residue levels of persistent pesticides (applied as granules or powders) were very low in comparison to day-0 values and that modification of these estimates to include decay or accumulation of pesticide over time following application is not justified. As a result, only 5 percent of actual residues will exceed the maximum values indicated. These values represent the arithmetic mean of values from samples collected the day of pesticide treatment. These values are the predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian, mammalian or reptilian food items immediately following a direct single application at a 1 lb ai/a application rate.

Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a single Application at 1 lb. ai/A (Hoerger and Kenaga, 1972, as modified by Fletcher et al, 1994)

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

In 1995, additional testing of the validity of the Hoerger-Kenaga simple linear model was also performed by Pfleeger, Fong, Hayes, Ratsch and Wickliff using field data. Regarding a simple linear relationship between application rate and residue level, Pflegger and his team concluded that assumption is questionable, rather the relationship between the application rate (x) and pesticide residue (y) is a polynomial function with a degree of 2, $y=Ax^2+Bx+C$, where A, B and C are coefficients of the various vegetation categories. Therefore, the Hoerger-Kenaga simple linear model should be modified as recommended by Fletcher, and these values would be predictive of 90 percent of the residues ranging from 0.05 to 2.5 lb ai/acre. However, at rates greater than 2.5 lb ai/acre, the modified Hoerger-Kenaga values could be underestimates, especially for tall grass. Pflegger's research team, performed regression analyses on the collected field data. As the regression lines were extrapolated out to represent increasing rates of application, tall grass, short grass, and forage plants exceeded Hoerger-Kenaga values at application rates greater than 2.5, 6.0, and 4.0 lb ai/acre, respectively.

In addition, the modified Hoerger-Kenaga linear model does not contain information on expected residues after day 0; it assumes that residues will degrade, and the maximum residue levels will occur on the day of application. Overall, Pfleeger's data supported this assumption with a few exceptions, one exception being systemic pesticides. Systemic pesticides may accumulate in particular plant parts at higher concentrations, especially after irrigation or a rain event. Fletcher and his research team also investigated pesticide residue decay over time for a number of pesticides applied at rates between 0.5 and 1.5 lb ai/acre. Decay occurred exponentially after day 0, with the exception of systemic pesticides. With systemic pesticides, no exponential decay occurred over the first 30-to-40 days following application.

Environmental Residue Values

The value of 240 ppm residues on short range grass is a screen to cover all routes of exposure, not just ingestion of pesticide contaminated food items. Ingestion can also occur from drinking contaminated water, through preening of feathers, licking of fur containing pesticide residues or when animals dust themselves in fields treated with pesticides. Examples of other routes of exposure include dermal absorption and inhalation of pesticide particles suspended in the air. All these routes together contribute to the total exposure an animal faces when it is present in a treated field or adjacent habitat sprayed with a toxic chemical. As the exact contribution of each exposure component has not been determined, the use of the risk index calculated by 240 ppm/LC_{50} is not conservative, but may actually underestimate total risk.

The index does not account for the differences between dry/wet weight measurements, but it assumes safety factors, such as using the range of EECs from Fletcher (Hoerger and Kenaga as modified by Fletcher, 1994) which will help compensate for these differences. That is, laboratory birds are fed a mash that contains little water, about 10 percent by weight, while most of the residue data are reported as ppm wet weight. Estimates of avian dietary exposure may be understated when toxicity values based on dry laboratory diet values are compared to wet weight residue levels. This is because birds eating their natural diet in the field need to eat a higher portion of their body weight compared to birds eating laboratory food with a low moisture content to obtain the same amount of food energy. In doing so, birds in the field will consume greater quantities of pesticide than birds on laboratory diets. Therefore, the use of 240 ppm may underestimate the risk.

Toxicity Values

The LC_{50} toxicity value has a great deal of uncertainty. This index of toxicity denotes the concentration that killed 50 percent of the laboratory test population. Although the LC_{50} value has long been accepted in the field of toxicology as a reliable indicator of hazard, it may not be a good predictor of mortality to wildlife in the field. Although 50% mortality may be acceptable for comparisons of toxicity among several pesticides, this level of mortality may too high for a natural population to maintain itself. Therefore lower toxicity values calculated from the dose-response curve may be better predictors of risk. Two alternative approaches are: 1) to use the confidence interval around the LC_{50} value, particularly the lower value which provides a greater degree of safety in the risk calculation and 2) use of LC_{10} or LC_5 values as more realistic indices of hazard in the field. Using either of these alternatives will produce risk estimates greater than that used in this risk assessment.

Other Factors Affecting Risk

Only two bird species are tested--one waterfowl species and one upland gamebird species--under the Fish and Wildlife Data Requirements listed in CFR 158. There is a great deal of uncertainty associated with extrapolating from the acute oral and subacute dietary data from two species to the large numbers of bird species associated with agricultural areas. Field surveys indicate that a large variety of birds are associated with these areas, including a multitude of songbirds and many others. Waterfowl are also likely to be present in these regions. As the EFED ecological database indicates that songbirds tend to be more sensitive than the two required test species, using the maximum estimated environmental concentration to calculate risk helps to compensate for this uncertainty in the toxicity data.

Birds and mammals use agricultural fields and adjacent habitat for a number of purposes including feeding, resting and nesting. There is a misconception that wildlife in the adjacent edge habitat are not exposed to the pesticide at the levels present in the treated fields and consequently are not at risk. However, edge habitat around treated fields receives the same amount of pesticide residues; the reduction in residue levels from spray applications occurs a distance from the treated fields. Therefore wildlife occupying edge habitat and those in the treated field are equally at risk.

Furthermore, a review of over 40 terrestrial field studies conducted as part of registration requirements (Guideline 71-5) for a number of highly toxic pesticides showed that field mortality of wildlife nearly always occurred when the risk index indicated high risk calculated by the risk index of 240 ppm residues/dietary LC_{50} value for that pesticide. Therefore, use of this index is reasonable for predicting wildlife kills.

The lack or small number of reported incidents involving birds or mammals does not prove that animals are not dying from pesticide exposure. Finding dead animals in the field is difficult, even when experienced field biologists are searching treated fields. Reporting of incident data is still rather accidental, and only carefully designed field studies can confidently indicate the likelihood of field kill incidents occurring.

ECOLOGICAL INCIDENTS SUMMARY

No incidents were found in the database, which was not surprising due to low use rates, low terrestrial and mostly moderate aquatic toxicity and the current registration status of the compound.

The number of documented kills in the Ecological Incident Information System is believed to be but a very small fraction of total mortality caused by pesticides. Mortality incidents must be seen, reported, investigated, and have investigation reports submitted to EPA to have the potential for entry into the database. Incidents often are not seen, due to scavenger removal of carcasses, decay in the field, or simply because carcasses may be hard to see on many sites and/or few people are systematically looking. Poisoned birds may also move off-site to less conspicuous areas before dying. Incidents seen may not get reported to appropriate authorities capable of investigating the incident because the finder may not know of the importance of reporting incidents, may not know who to call, may not feel they have the time or desire to call, may hesitate to call because of their own involvement in the kill, or the call may be long-distance and discourage callers, for example. Incidents reported may not get investigated if resources are limited or may not get investigated thoroughly, with residue and ChE analyses, for example. Also, if kills are not reported and investigated promptly, there will be little chance of documenting the cause, since tissues and residues may deteriorate quickly. Reports of investigated incidents often do not get submitted to EPA, since reporting by states is voluntary and some investigators may believe that they don't have the resources to submit incident reports to EPA.

Incident reports submitted to EPA since approximately 1994 have been tracked by assignment of I-#s in an Incident Data System (IDS), microfiched, and then entered to a second database, the Ecological Incident Information System (EIIS). This second database has some 85 fields for potential data entry. An effort has also been made to enter information to EIIS on incident reports received prior to establishment of current databases. Although many of these have been added, the system is not yet a complete listing of all incident reports received by EPA. Incident reports are not received in a consistent format (e.g., states and various labs usually have their own formats), may involve multiple incidents involving multiple chemicals in one report, and may report on only part of a given incident investigation (e.g., residues). While some progress has been made in recent years, both in getting incident reports submitted and entered, there has never been the level of resources assigned to incidents that there has been to the tracking and review of laboratory toxicity studies, for example. This adds to the reasons cited above for why EPA believes the documented kills are but a fraction of total mortality caused by lindane and other highly toxic pesticides.

Incidents entered into EIIS are categorized into one of several certainty levels: highly probable, probable, possible, unlikely, or unrelated. In brief, "highly probable" incidents usually require carcass residues, substantial ChE inhibition in avian and/or mammalian species, and/or clear circumstances regarding the exposure. "Probable" incidents include those where residues were not available and/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. The "unlikely" category is used, for example, where a given chemical is practically nontoxic to the category of organism killed and/or the chemical was tested for but not detected in samples. "Unrelated" incidents are those that have been confirmed to be not pesticide-related.

Incidents entered into the EIIS are also categorized as to use/misuse. Unless specifically confirmed by a state or federal agency to be misuse, or there was very clear misuse such as intentional baiting to kill wildlife, incidents would not typically be considered misuse. 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 a variety of label-specific violations, for example.

Exposure and Risk to Non-target Terrestrial Organisms

Birds: Acute and Chronic, Single and Multiple Applications

Avian Acute and Chronic Risk Quotients for single and multiple Broadcast Spray Applications of Flumioxazin , based on a n Avian LC_{50} of 5620 ppm and NOAEC of 250 ppm .

Use/App. Method	Rate (lbs ai/A) x No. Apps.	Food Items	Max EEC (ppm) [1]	Acute RQ (Max EEC/LC_{50})	Chronic RQ (Max EEC/ NOAEC)
		Single Application			
Sugarcane	0.383 lb/A x 1	Short grass 240 ppm	92	0.02	0.37
		Tall grass 110 ppm	42	<0.01	0.17
		Broadleaf plants/Insects 135 ppm	52	<0.01	0.21
		Seeds 15 ppm	6	<0.01	0.02
		Multiple Applications[2]			
Almonds, grapes, trees	0.383 x 2 (30-da interval)	Short grass	142	0.02	0.57
		Tall grass	65	0.01	0.26
		Broadleaf plants/Insects	80	0.01	0.32
		Seeds	9	<0.01	0.04
		Levels of Concern (LOC)			
Endangered species may be affected (acute risk)				≥ 0.1	
Acute risk may be mitigated through restricted use, in addition to endangered species risk				≥ 0.2	
High acute risk, including endangered species				**≥ 0.5**	
Chronic risk, including endangered species					**≥ 1**

[1] EECs are based on Hoerger and Kenega (1972), modified by Fletcher et al (1994).
[2] For multiple applications, EFED uses EECs based on Hoerger and Kenega (1972) and Fletcher et al (1994), with first-order dissipation from foliage between applications (a 35 day default half life was used to calculate EECs)

An analysis of the results indicate that for single and multiple broadcast application of non-granular products, avian chronic, acute, restricted use, and endangered species levels of concern are not exceeded at registered maximum application rates.

Mammals: Acute and Chronic

To assess acute risk to mammals from the use of foliar spray products, an estimated dietary endpoint value calculated from the LD_{50} value is used. The EEC is then divided by this calculated dietary value to determine mammalian RQ's. Estimating the potential for adverse effects to wild mammals is based upon EFED's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher et al. (1994). The concentration of Flumioxazin in the diet that is expected to be acutely lethal to 50% of the test population (LC_{50}) is determined by dividing the LD_{50} value (usually a rat LD_{50}) by the percentage, expressed as a decimal, of body weight consumed. A risk quotient is then determined by dividing the EEC by the derived dietary value. Risk quotients are calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds).

The acute toxicity endpoint being used in the following table is not a typical LC_{50}, but a specified quantity of food which can be expected to be consumed in a day for which residues equal a single acute dose. McCann et al. (1981) compared rat LC_{50} values with published rat LD_{50} values. The data showed that the LD_{50} and LC_{50} values for rats can't be used interchangeably and that the LC_{50} values calculated from the LD_{50} values are generally not toxicologically equivalent to actual LC_{50} values from the study. Kenega (1977) made similar observations about avian toxicity tests. McCann (1981) also stated that the calculated values were different 35% of the time when compared to actual LC_{50} values when residue values were held constant. Calculated values, rather than actual LC_{50} values, could result in incorrect decisions in relation to acute hazard as much as 35% of the time. The hazard could be overestimated 29% of the time and underestimated 6% of the time. These are only predictive screening indices of potential hazard. In all cases where actual results from a dietary test (LC_{50}) are available or needed, these results should be factored into the assessment to provide a more realistic picture of dietary hazard potential. In instances where a clear conclusion can't be made from calculated values, the need for a wild mammal dietary test (40 CFR 158.490; guideline 71-3) should be considered.

Mammalian Acute (Single and multiple applications)

Mammalian (Herbivore/Insectivore and Granivore) Acute risk quotients (RQs) for single broadcast spray applications of Flumioxazin to foliage, based on a rat LD_{50} of 5000 mg/kg of body weight.

		--------------- EEC (ppm) [1] ---------------				Herbivore/Insectivore Acute RQ[2]			
Crop/Rate in lbs ai/A	Body Weight (g)	Short Grass	Forage/ Small Insects	Large Insects	Seeds	Short Grass	Forage/ Small Insects	Large Insects	Granivore Acute RQ [2] Seeds
Sugarcane 0.383	15	92	42	52	6	0.017	<0.01	<0.01	<0.01
	35	92	42	52	6	0.012	<0.01	<0.01	<0.01
	1000	92	42	52	6	0.003	<0.01	<0.01	<0.01

[1] EECs are based on Hoerger and Kenega (1972), modified by Fletcher et al (1994).

[2] $RQ = \frac{\text{EEC (mg/kg)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

where the % body weight consumed varies with body size and diet:

Herbivores/insectivores: 95% for 15 g wt; 66% for 35 g wt; 15% for 1000 g wt.

Granivores: 21% for 15 g wt; 15% for 35 g wt; 3% for 1000 g wt.

The residues expected on mammalian food items after a single application of non-granular Flumioxazin products are based on the highest residue concentrations immediately after application (Fletcher, 1994). The results suggest that mammalian acute, restricted use and endangered species levels of concern are not exceeded for any use pattern at the highest single application rate.

Mammalian (Herbivore/Insectivore and Granivore) Acute risk quotients (RQs) for multiple broadcast spray applications of Flumioxazin to foliage, based on a rat LD_{50} of 5000 mg/kg of body weight and a 35 day halflife.

		EEC (ppm)[1] Maximum				Herbivore/Insectivore Acute RQ[2]			
Site/ Rate in lbs ai/A	Body Weight (g)	Short Grass	Forage/ Small Insects	Large Insects	Seeds	Short Grass	Forage/ Small Insects	Large Insects	Granivore Acute RQ[2] Seeds
Almonds, grapes and trees 0.383 x 2	15	142	65	80	9	<0.1	<0.1	<0.1	<0.1
	35	142	65	80	9	<0.1	<0.1	<0.1	<0.1
	1000	142	65	80	9	<0.1	<0.1	<0.1	<0.1

[1] EECs are based on Hoerger and Kenega (1972), modified by Fletcher et al (1994).

[2] $RQ = \dfrac{\text{EEC (mg/kg)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}}$

where the % body weight consumed varies with body size and diet:.

Herbivores/insectivores: 95% for 15 g wt; 66% for 35 g wt; 15% for 1000 g wt. Granivores: 21% for 15 g wt; 15% for 35 g wt; 3% for 1000 g wt.

The residues expected on mammalian food items after a multiple application of non-granular paraflufen-ethyl products are based on the highest residue concentrations immediately after application (Fletcher, 1994). The results suggest that no mammalian acute, restricted use and endangered species levels of concern are exceeded.

Mammalian Chronic (Single and multiple applications)

The following tables summarize the mammalian chronic risk quotients for single and multiple broadcast applications of non-granular products based on rat reproductive toxicity data.

Mammalian (Rat) chronic risk quotients for single broadcast spray applications of Flumioxazin, based on a rat NOAEC of 100 ppm in the diet.

Use/App. Method	Rate (lbs ai/A)	Food Items	Max EEC (ppm)[1]	Chronic RQ (EEC/NOAEC) Max/Ave
		Single Application		
Sugarcane/spray	0.383	Short grass	92	0.92
		Tall grass	42	0.42
		Broadleaf plants/Insects	52	0.52
		Seeds	6	0.06
		Levels of Concern		
Chronic risk				**≥ 1.0**

[1] EECs are based on Hoerger and Kenega (1972), modified by Fletcher et al (1994).

The residues expected on mammalian food items after a single application of non-granular Flumioxazin products are based on the highest residue concentrations immediately after application (Fletcher, 1994). The results suggest that mammalian chronic levels of concern are not exceeded at the single highest application rate.

Mammalian (Rat) chronic risk quotients for multiple broadcast spray applications of Flumioxazin, based on a rat NOAEC of 100 ppm in the diet using a 35 day halflife.

Use/App. Method	Rate (lbs ai/A) x No. Apps.	Food Items	Max/Ave EEC (ppm) [1]	Chronic RQ (EEC/NOAEC) Max/Ave
		Multiple Application[2]		
Almonds, grapes and trees	0.383 x 2	Short grass	142	**1.42**
		Tall grass	65	<1.0
		Broadleaf plants/Insects	80	<1.0
		Seeds	9	<1.0
		Levels of Concern		
Chronic risk				**≥ 1.0**

[1] EECs are based on Hoerger and Kenega (1972), modified by Fletcher et al (1994).
[2] For multiple applications, EFED uses EECs based on Hoerger and Kenega (1972) and Fletcher et al (1994), with first-order dissipation from foliage between applications. If foliar dissipation data are not available, a 35 day default value is used.

The residues expected on mammalian food items after multiple applications of non-granular Flumioxazin products are based on the highest residue concentrations after the last application (Fletcher, 1994). No chronic LOC's are exceeded, other than for mammals eating short grass.

Insects
Currently, EFED does not assess risk to non-target insects. Results of acceptable studies are used for recommending appropriate label precautions. As Flumioxazin is practically non-toxic to honeybees, low risk is assumed.

Plants

Aquatic Plant Risk:
GENEEC Maximum Peak EEC/Toxicity endpoint (EC50) = RQ
Parent= 0.0007 ppm/0.0005 ppm = 1.4 (RQ<LOC of 1.0)
Degradate = 0.02 ppm/0.0005 ppm = *40.0 (RQ<LOC of 1.0)
assuming that the toxicity of the degradate is equal to that of the parent

Terrestrial Plant risk: An analysis of the results indicates that for single broadcast applications of Flumioxazin, non-endangered non-target terrestrial and semi-aquatic plant species levels of concern are exceeded at maximum application rates (RQs ranged from 0.09 to 239.4); endangered species RQs ranged from 0.11 to 383 for single applications (with the brunt of the risk to dicots). For granular applications, acute non-endangered RQs ranged from 0.92 to 42.5 and 1.13 to 85 for endangered plants, again with more risk to dicots. The current single maximum application rate (0.383 lbs ai/A) is 54.7 to 7,660 times higher than the least (0.007 lbs ai/A) and most (0.00005 lbs ai/A) toxic NOAEL in submitted terrestrial plant studies, respectively. Since Flumioxazin may exhibit photo- and phyto- toxicity, and RQs exceeded LOCs, endangered and non-target terrestrial plant species are potentially at risk.

Flumioxazin belongs to the phenyl pyrazole class of chemicals called protox inhibitors. The chemical works by inhibiting an enzyme in a plant's chloroplasts causing subsequent cell membrane destruction. It is a light-dependent peroxidizing herbicide (LDPH) which acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of photo-toxic porphyrins. This class of herbicides are known to have a photo-toxic mode of action in plants and possibly in fish. LDPHs may be more toxic when exposed to natural sunlight, such as exposure conditions in the field.

Risk Quotients for Nontarget Plants

Dry and Semi-aquatic Areas
Terrestrial plants inhabiting dry and semi-aquatic areas may be exposed to pesticides from runoff, spray drift or volatilization. Semi-aquatic areas are those low-lying wet areas that may be dry at certain times of the year. EFED's runoff scenario is: (1) based on a pesticide's water solubility and the amount of pesticide present on the soil surface and its top one inch, (2) characterized as "sheet runoff" (one treated acre to an adjacent acre) for dry areas, (3) characterized as "channelized runoff" (10 treated acres to a distant low-lying acre) for semi-aquatic areas, and (4) based on % runoff values of 0.01, 0.02, and 0.05 for water solubility of <10 ppm, 10-100 ppm, and >100 ppm, respectively.

Spray drift exposure from ground application is assumed to be 1% of the application rate. Spray drift from aerial, airblast, forced-air, and chemigation applications is assumed to be 5% of the application rate.

EECs are calculated for the following application methods: (1) unincorporated ground applications, (2) incorporated ground application, and (3) aerial, airblast, forced-air, and chemigation applications. Formulas for calculating EECs for dry areas adjacent to treatment sites and EECs for semi-aquatic areas are in Appendix VII as well as for calculating the non-endangered and endangered plant species acute RQs. Estimated environmental concentrations for dry and semi-aquatic areas and RQs are tabulated below. The EC25 value of the most sensitive species in the seedling emergence study is compared to runoff and drift exposure to determine the risk quotient (EEC/toxicity value). The EC25 value of the most sensitive species in the vegetative vigor study is compared to the drift exposure to determine the acute risk quotient. EECs and acute high risk quotients for terrestrial and semi-aquatic plants based on a single application are also tabulated below. The results indicate that for a single application, acute risk levels of concern are exceeded for terrestrial and semi-aquatic plants for the proposed registration application rates of Flumioxazin. Currently, EFED does not perform assessments for chronic risk to terrestrial and semi-aquatic plants.

The NOAEC or EC05 (if NOAEC is unavailable) value of the most sensitive species in the seedling emergence study is compared to runoff and drift exposure to determine the endangered species risk quotient. The NOAEC or EC05 value of the most sensitive species in the vegetative vigor study is compared to the drift exposure to determine the endangered species risk quotient.

EECs and acute (endangered species) risk quotients for terrestrial plants based on a single application are tabulated below. The results indicate that, for a single application, endangered and non-endangered species levels of concern are exceeded for terrestrial and semi-aquatic plants at the proposed application rates of Flumioxazin.

Terrestrial Plant Acute Risk Quotients For Flumioxazin (Endangered and Non- Endangered)

Crop Details/Rate	EECs (lbs a.i./acre)			[1]EC_{25} or NOEC		RQ		
	Total Loading to Adjacent Dry Areas	Total Loading to Semi-Aquatic Areas	Total Drift	Seedling Emergence (Monocots and Dicots)	Vegetative Vigor (Monocots and Dicots)	Emergence RQs-Adjacent Dry Areas (Monocots and Dicots)	Emergence RQs, Semi-Aquatic Areas (Monocots and Dicots)	Drift RQ (Monocots and Dicots)
Non-Endangered								
Christmas Trees, Almonds & Grapes 0.383 lbs ai/A	0.0077-0.0214	0.0421	0.0038-0.0192	0.0037 0.0008	0.0071 0.00008	2.07-5.80 9.58-26.81	11.39 52.66	0.54-2.70 47.88-239.38
Cotton 0.064 lbs ai/A	0.0013-0.0036	0.007	0.0006-0.0032	0.0037 0.0008	0.0071 0.00008	0.35-.097 1.60-4.48	1.90 8.80	0.09-0.45 8.00-40.00
Ornamentals Granular 0.34 lbs ai/A	0.0034	0.034-0.0034	N/A	0.0037 0.0008	0.0071 0.00008	0.92 4.25	0.92-9.19 4.25-42.50	N/A
Endangered								
Christmas Trees, Almonds & Grapes 0.383 lbs ai/A	0.0077-0.0214	0.0421	0.0038-0.0192	0.003 0.0004	0.006 0.00005	2.55-7.15 19.15-53.62	14.04 105.33	0.64-3.19 76.60-383.00
Cotton 0.064 lbs ai/A	0.0013-0.0036	0.007	0.0038-0.0192	0.003 0.004	0.006 0.00005	0.43-1.19 3.20-8.96	2.35 17.60	0.11-053 12.80-64.00
Ornamentals Granular 0.34 lbs ai/A	0.0034	0.034	N/A	0.003 0.0004	0.006 0.00005	1.13 8.50	11.33 85.00	N/A

Acute Non-endangered Plant RQ = EEC/EC_{25}; Acute Endangered Plant RQ = EEC/EC_{05} or NOEC;
[1] EC_{25} for Non-endangered and NOEC for Endangered
Levels of Concern: RQ$\geq$1.0 = Acute Risk

Exposure and Risk to Non-target Freshwater Aquatic Animals

EFED uses environmental fate and transport computer models to calculate refined EECs. In this case the GENEEC model was used. The degradates (482-HA, APF and THPA are of potential toxicological concern) were modeled as well as parent Flumioxazin. EECs are tabulated below.

Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Compound	Initial (PEAK) EEC (ppm)	21-day average EEC (ppm)	56-day average EEC (ppm)
Parent Flumioxazin	0.0007	0.0001	0.00004
482-HA	0.005	0.005	0.005
APF	0.02	0.02	0.02
THPA	0.02	0.02	0.02

Freshwater Fish

Acute and chronic risk quotients are tabulated below.

Risk Quotients for Freshwater Fish Based On a LC50 of 2.3 ppm and a NOAEC of 0.0077 ppm.

Compound	LC50 (ppm)	NOAEC (ppm)	EEC Initial/Peak (ppm)	EEC 60-Day Ave. (ppm)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Parent Flumioxazin	2.3	0.0077	0.0007	0.00004	0.00	0.00
482-HA	2.3	0.0077	0.005	0.005	0.00	0.65
APF	2.3	0.0077	0.02	0.02	0.00	**2.60**
THPA	2.3	0.0077	0.02	0.02	0.00	**2.60**

An analysis of the results indicate that no acute LOC's were exceeded for freshwater fish. However, there are possible chronic risks to fish from APF and THPA, should these degradates enter freshwater aquatic habitat.

Freshwater Invertebrates

The acute and chronic risk quotients are tabulated below.

Risk Quotients for Freshwater Invertebrates Based On a EC50/LC50 of 5.5 ppm and a NOAEC of 0.028 ppm.

Compound	LC50 (ppm)	NOAEC (ppm)	EEC Initial/Peak (ppm)	EEC 21-Day Average (ppm)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Parent Flumioxazin	5.5	0.028	0.0007	0.0001	0.00	0.00
482-HA	5.5	0.028	0.005	0.005	0.00	0.20
APF	5.5	0.028	0.02	0.02	0.00	0.71
THPA	5.5	0.028	0.02	0.02	0.00	0.71

An analysis of the results indicate that no acute or chronic LOC's were exceeded for freshwater invertebrates.

Estuarine and Marine Fish

The acute and chronic risk quotients are tabulated below.

Risk Quotients for Estuarine/Marine Fish Based on a LC50 of 4.7 ppm.

Compound	LC50 (ppm)	NOAEC (ppm)	EEC Initial/ Peak (ppm)	EEC 56-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Parent Flumioxazin	4.7	No data	0.0007	N/A	0.00	N/A
482-HA	4.7	No data	0.005	N/A	0.00	N/A
APF	4.7	No data	0.02	N/A	0.00	N/A
THPA	4.7	No data	0.02	N/A	0.00	N/A

An analysis of the results indicate that no acute LOC's were exceeded for estuarine/marine fish. Chronic risk could not be evaluated due to a lack of toxicity data.

Estuarine and Marine Invertebrates

Risk Quotients for Estuarine/Marine Aquatic Invertebrates Based on a LC50/EC50 of 0.23 ppm and a NOAEC of 0.015 ppm.

Site/ Application Method	LC50 (ppm)	NOAEC/ (ppm)	EEC Initial/ Peak (ppm)	EEC 21-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Parent Flumioxazin	0.23	0.015	0.002	0.0001	0.00	0.00
482-HA	0.23	0.015	0.005	0.005	0.02	0.33
APF	0.23	0.015	0.02	0.02	0.08	**1.33**
THPA	0.23	0.015	0.02	0.02	0.08	**1.33**

An analysis of the results indicate that no acute LOC's were exceeded for estuarine/marine invertebrates. However, there are possible chronic risks to invertebrates from APF and THPA, should these degradates enter estuarine and marine habitat.

Appendix III:

Ecological Effects Data Requirements for:

Flumioxazin

Guideline #	Data Requirement	Is Data Requirement Satisfied?	MRID #'s	Study Classification
71-1	Avian Oral LD_{50}	Y	426849-45	Core
71-2	2 Avian Dietary LC_{50}'s	Y Y	426849-46 426849-47	Core Core
71-4	Avian Reproduction	Y	442950-05 442950-06	Core Supplemental
72-1	2 Freshwater Fish LC_{50}	Y Y	426849-48 426849-49 442950-07	Core Core Supplemental
72-2	Freshwater Invertebrate Acute LC_{50}	Y	426849-50	Supplemental
72-3(a)	Estuarine/Marine Fish LC_{50}	Y	442950-10	Core
72-3(b)	Estuarine/Marine Mollusk EC_{50}	Y	442950-08	Core
72-3(c)	Estuarine/Marine Shrimp EC_{50}	Y	442950-09	Core
72-4(a)	Freshwater Fish Early Life-Stage	Y	442950-12	Core
72-4(b)	Estuarine Fish Early Life-Stage	NR		
72-4(c)	Estuarine Invertebrate Life-Cycle	Y	442950-13	Core
72-4(d)	Freshwater Invertebrate Life-Cycle	Y	442950-11	Core
72-5	Freshwater Fish Full Life-Cycle	NR		
81-1	Acute Mammalian LD_{50}	Y	426849-11 426849-12	Core
83-5	2-generation mammalian reproduction	Y	426849-34 426849-35 426849-36	Core
Tier II 123-1(a)	Seed Germ./Seedling Emergence	Y	442950-29	Core
Tier II 123-1(b)	Vegetative Vigor	Y	442950-30	Core
Tier II 123-2	Aquatic Plant Growth	Y Y Y Y Y	442950-31 442950-32 442950-33 442950-34 442950-35	Core Core Core Core Core
144-1	Honey Bee Acute Contact LD_{50}	Y	426849-51	Core

NR=Not required
Y=Yes
N=No

Environmental Fate Data Requirements for:

Flumioxazin

Guideline #	Data Requirement	Is Data Requirement Satisfied?	MRID #'s	Study Classification
161-1	Hydrolysis	Yes	42697501	Core
		Yes	42684905	Core
161-2	Photodegradation in Water	No	44295036	Supplemental
		No	44295037	Supplemental
		under review	45914601	-
161-3	Photodegradation on Soil	Yes	44295038	Core
		Yes	44295039	Core
162-1	Aerobic Soil Metabolism	Yes	42684906	Core
		Yes	42884009	Core
		Yes	44295040	Core
162-2	Anaerobic Soil Metabolism	No (pending on the anaerobic aquatic metabolism study)	44295041	Supplemental
162-3	Anaerobic Aquatic Metabolism	under review	45914602	-
163-1	Leaching-Adsorption/Desorption	Yes	42684907	Core
		Yes	42684908	Core
		Yes	42684909	Core
		Yes	42884010	Core
		Yes	45309202	Core
		Yes	45309201	Core
164-1	Terrestrial Field Dissipation	Yes	44295045	Supplemental
		Yes	44295044	Supplemental
		Yes	44295047	Supplemental
		Yes	44295046	Supplemental
		Yes	44295043	Supplemental
		Yes	45375502	Supplemental
165-4	Accumulation in Fish/ Bioconcentration	Waived	Waived	Waived

Appendix IV: GENEEC, FIRST and SCI-GROW results for Flumioxazin

GENEEC (2003 runs)

Background Information on GENEEC:
GENEEC is a screening model designed to estimate the pesticide concentrations found in water for use in ecological risk assessments. As such, it provides high-end values on the concentrations that might be found in ecologically sensitive environments due to the use of a pesticide. GENEEC is a single-event model (one runoff event), but can account for spray drift from multiple applications. GENEEC is hardwired to represent a 10-ha field immediately adjacent to a 1-ha pond, 2 meters deep with no outlet. The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 10% of the applied pesticide into the pond. This amount can be reduced due to degradation on field and the effects of binding to soil. Spray drift is equal to 1% of the applied concentration from the ground spray application and 5% for aerial application.

Surface water EECs at PH 5 (based on GENEEC2/2003)

RUN No. 1 FOR APF ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.199(.398)	2 30	201.0	10000.0	AERL_A (24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	2	N/A .00-	.00	.00	.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
21.09	21.06	20.93	20.63	20.41

Surface water EECs at PH 7 (based on GENEEC2/2003)

RUN No. 2 FOR Flumioxazin ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.019(.027)	2 30	656.0	1.8	AERL_A(24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
23.40	2	1.00 1.00-	124.00	.00	.99

GENERIC EECs (IN NANOGRAMS/LITER (PPTr)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
732.20	463.26	112.61	39.43	26.28

****

RUN No. 3 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.038(.076)	2 30	13.0	10000.0	AERL_A(24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	2 N/A	.00-	.00	.00	.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
5.00	5.00	4.99	4.99	4.99

****

RUN No. 4 FOR APF ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.192(.384)	2 30	201.0	10000.0	AERL_A(24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	2 N/A	.00-	.00	.00	.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
20.34	20.32	20.19	19.91	19.70

****

RUN No. 5 FOR THPA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.153(.306)	2 30	13.0	10000.0	AERL_A(24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF		HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	2	N/A	.00-	.00	.00	.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
20.12	20.12	20.11	20.09	20.07

****

<u>Surface water EECs at PH 9 (based on GENEEC2/2003)</u>

RUN No. 3 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
.391(.782)	2 30	13.0	10000.0	AERL_A(24.1)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF		HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	2	N/A	.00-	.00	.00	.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB)) Version 2.0 Aug 1, 2001

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
51.41	51.41	51.39	51.33	51.29

FIRST (2003 runs)

Background Information on FIRST:
FIRST is a new screening model designed to estimate the pesticide concentrations found in water for use in drinking water assessments. It provides high-end values on the concentrations that might be found in a small drinking water reservoir due to the use of pesticide. Like GENEEC, the model previously used for Tier I screening level, FIRST is a single-event model (one run-off event), but can account for spray drift from multiple applications. FIRST uses a Drinking Water Reservoir instead of a pond as the standard scenario. The FIRST scenario includes a 427 acres field immediately adjacent to a 13 acres reservoir, 9 feet deep, with continuous flow (two turnovers per year). The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 8% of the applied pesticide into the pond. This amount can be reduced due to degradation on 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.

FIRST also makes adjustments for the percent crop area. While FIRST assumes 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 FIRST include the use of a small drinking water reservoir surrounded by a runoff-prone watershed, the use of the maximum use rate, no buffer zone, and a single large rainfall.

FIRST Results at various pHs:

PH 5

```
 RUN No. 11 FOR APF          ON   Christmas tree   * INPUT VALUES *
 -------------------------------------------------------------------------
  RATE (#/AC)  No.APPS &    SOIL  SOLUBIL  APPL TYPE    %CROPPED  INCORP
   ONE(MULT)  INTERVAL     Koc   (PPM )   (%DRIFT)      AREA      (IN)
 -------------------------------------------------------------------------
 .199(  .398)    2      30     201.0  10000.0   AERIAL(16.0)  87.0        .0

 FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
 ------------------------------------------------------------------------------
 METABOLIC  DAYS UNTIL    HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
 (FIELD)     RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
 ------------------------------------------------------------------------------
  .00          2     N/A       .00-           .00           .00          .00

 UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))   Ver 1.0 AUG 1, 2001
 -------------------------------------------------------
   PEAK DAY  (ACUTE)    ANNUAL AVERAGE (CHRONIC)
   CONCENTRATION       CONCENTRATION
 -------------------------------------------------------
      27.426                      13.322
************************************************************************************
```

pH 5

```
 RUN No.  2 FOR THPA          ON   Christmas tree   * INPUT VALUES *
 -------------------------------------------------------------------------
  RATE (#/AC)  No.APPS &    SOIL  SOLUBIL  APPL TYPE    %CROPPED  INCORP
```

ONE(MULT) INTERVAL Koc (PPM) (%DRIFT) AREA (IN)

.176(.352) 2 30 13.0 10000.0 AERIAL(16.0) 87.0 .0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
31.830	22.436

****

pH 7

RUN No. 3 FOR Flumioxazin ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.019(.027)	2 30	656.0	1.8	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
23.40	2	1.00	1.00- 124.00	.00	.99

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
1.034	.004

****

pH 7

RUN No. 4 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.038(.076)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC DAYS UNTIL HYDROLYSIS PHOTOLYSIS METABOLIC COMBINED

(FIELD)	RAIN/RUNOFF	(RESERVOIR)	(RES.-EFF)	(RESER.)	(RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
6.872	4.844

****

pH 7

RUN No. 4 FOR APF ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.192(.384)	2 30	201.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
26.461	12.854

****

pH 7

RUN No. 6 FOR THPA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.153(.306)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00 -	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION

27.670	19.504

****

pH 9

RUN No. 7 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.391(.782)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
70.713	49.843

SCI-GROW (2003 runs)

Background Information on SCI-GROW:
SCI-GROW provides a ground water screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. Since the SCI-GROW concentrations are likely to be approached in only a very small percentage of drinking water sources, i.e., highly vulnerable aquifers, it is not appropriate to use SCI-GROW concentrations for national or regional exposure estimates.

SCI-GROW estimates likely ground water concentrations if the pesticide is used at the maximum allowable rate in areas where ground water is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have ground water that is less vulnerable to contamination that the areas used to derive the SCI-GROW estimate.

SCI-GROW Results at pH 5

VERSION 2.2: NOVEMBER 1, 2001

```
 RUN No. 11 FOR APF            ** INPUT VALUES **
 --------------------------------------------------------------------
  APP RATE   APPS/  TOTAL/   SOIL  AEROBIC SOIL METAB
  (LBS/AC)   YEAR   SEASON   KOC   HALFLIFE (DAYS)
 --------------------------------------------------------------------
   .199        2      .398    201.0     999.00

 GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)
 ----------------------------------------
             2.756142
 ----------------------------------------

 RUN No. 12 FOR THPA           ** INPUT VALUES **
 --------------------------------------------------------------------
  APP RATE   APPS/  TOTAL/   SOIL  AEROBIC SOIL METAB
  (LBS/AC)   YEAR   SEASON   KOC   HALFLIFE (DAYS)
 --------------------------------------------------------------------
   .176        2      .352    13.0       999.00

 GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)
 ----------------------------------------
            209.676900
 ----------------------------------------
```

SCIGROW Results at pH 7 :

```
 RUN No. 1 FOR Flumioxazin     ** INPUT VALUES **
 --------------------------------------------------------------------
  APP RATE   APPS/  TOTAL/   SOIL  AEROBIC SOIL METAB
  (LBS/AC)   YEAR   SEASON   KOC   HALFLIFE (DAYS)
 --------------------------------------------------------------------
   .019        2      .038    112.0      14.70
```

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

.00317

RUN No. 2 FOR 482-HA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.038	2	.076	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

45.271150

RUN No. 3 FOR APF ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.192	2	.384	201.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

2.659193

RUN No. 4 FOR THPA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.153	2	.306	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

182.275900

SCI-GROW Results at pH 9

RUN No. 21 FOR 482-HA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.391	2	.782	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

465.816300

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

PC Code:129034

MEMORANDUM:

SUBJECT: Tier I Estimated Environmental Concentrations for Flumioxazin and Its Degradates from the Use on cotton, almonds, grapes, sugarcane, Christmas trees, deciduous trees and container and field grown ornamentals

TO: Joanne Miller, PM 23
J. Stone, PM Team Reviewer
Registration Division

Doug Dotson
Health Effects Division

FROM: Larry Liu, Ph.D., Environmental Scientist
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

THROUGH: Mah Shamim, Ph.D., Branch Chief
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

This document summarizes the Tier I Estimated Environmental Concentrations (EECs) for Flumioxazin under the use for cotton, almonds, grapes, sugarcane, Christmas trees, deciduous trees and container and field grown ornamentals. The FIRST and SCI-GROW models were used to estimate the concentrations of this chemical and its degradates in surface water and groundwater, respectively. These values represent upper-bound estimates of the concentrations that might be found in surface water and groundwater due to the use of Flumioxazin on cotton, almonds, grapes, Christmas trees, deciduous trees and container and field grown ornamentals. It should be noted that: (1) Flumioxazin water numbers were generated from the models in which the Koc values used were obtained from a column leaching study instead of the typical absorption study; (2) 482-HA water numbers were generated from the models in which the Koc values for THPA were used; (3) APF and THPA water numbers were generated from the adsorption/desorption studies; and (4) the initial residue levels for the parent and its degradates used in the models were based on the 30-day results of the hydrolysis study . Due to the rapid hydrolysis rate of the parent compound, EFED acknowledged the difficulty in obtaining adsorption coefficients from the batch equilibrium study. Due to the rapid dissipating of Flumioxazin in the environment, EFED is not concerned about the parent compound. Results at pH 7 are presented below:

	Peak Conc. in Surface Water	Conc. in Groundwater
Flumioxazin	1.03 ppb	negligible
482-HA	6.87 ppb	45.27 ppb
APF	26.46 ppb	2.66 ppb
THPA	27.67 ppb	182.28 ppb

Should the results of this assessment need further refinement, please contact us as soon as possible so that we may schedule a Tier II assessment.

Water Resource Assessment
Flumioxazin is unlikely to contaminate surface water and groundwater. However, its hydrolysis degradates (482-HA, APF, and THPA) are more persistent and mobile and they tend to reach surface water and groundwater at much higher concentrations. Fate studies show that Flumioxazin is relative mobile (average Koc = 557, note: Koc values were estimated from a column leaching study), but non-persistent (hydrolysis half-life at pH 7 = 1 day; aqueous photolysis half-life at pH 5 = 1 day; soil aerobic metabolism half life = 14.7 days; aquatic anaerobic metabolism half-life = 0.2 days). Since hydrolysis appears to be the major route of dissipation in the environment, EFED used the residue levels detected at the end of hydrolysis as the input parameters for modeling. Table 1 listed the degradates identified and their relative concentrations from the hydrolysis study. Based on the relative concentrations presented in Table 1 and the application rate of the parent, the worst residue levels that could be found on the soil surface were estimated (see Table 2).

Table 1. Percentages of the applied radioactivity identified at the end of 30-day hydrolysis study

Compound	pH 5	pH 7	pH 9
	% of the applied		
Flumioxazin	negligible	4.7	negligible
482-HA	negligible	9.3	97.3
APF	83.6	80.0	negligible
THPA	95.4	83.6	negligible

Table 2. Maximum amounts of Flumioxazin and its degradates expected to be on the soil surface after Flumioxazin was applied at the maximum rate of 0.383 lb ai/A/application (two applications per year with an application interval of 30-60 days).

Compound	pH 5	pH 7	pH 9
	lbs ai/A/application		
Flumioxazin	negligible	0.019	negligible
482-HA	negligible	0.038	0.391

APF	0.199	0.192	negligible
THPA	0.176	0.153	negligible

The FIRST and SCI-GROW models were used to estimate the concentrations of this chemical and its degradates in surface water and groundwater, respectively. These values represent upper-bound estimates of the concentrations that might be found in surface water and groundwater due to the use of Flumioxazin at the maximum application rate. Tables 3 and 4 listed the residue concentrations in the surface water and groundwater, respectively.

Table 3. Surface water estimated environmental peak concentrations for Flumioxazin and its major degradates in various pH.

	pH 5	pH 7	pH 9
Flumioxazin	negligible	1.03 ppb	negligible
482-HA	negligible	6.87 ppb	70.71 ppb
APF	27.43 ppb	26.46 ppb	negligible
THPA	31.83 ppb	27.67 ppb	negligible

Table 4. Groundwater estimated environmental concentrations for Flumioxazin and its major degradates in various pH.

	pH 5	pH 7	pH 9
Flumioxazin	negligible	negligible	negligible
482-HA	negligible	45.27 ppb	465.82 ppb
APF	2.76 ppb	2.66 ppb	negligible
THPA	209.68 ppb	182.28 ppb	negligible

Surface Water and Groundwater Input Parameters

Surface water concentrations of Flumioxazin were estimated with FIRST. The estimates made with FIRST are intended here to represent drinking water sources with significant turnover such that there is no year-to-year accumulation. Ground water concentrations were predicted with SCI-GROW. Input parameters for FIRST and SCI-GROW at pH 7 (Tables 5-8) were selected according to current EFED guidance. The application rates for Flumioxazin for pH 5 and 9 can be found in Table 2. It should be noted that the worst cases were assumed for those input parameters which no information were available (such as APF was assumed to be very stable under aerobic soil metabolism conditions with a half-life of 999 days). Since the intended use of FIRST in this particular simulation is only to represent a water body with significant water turnover, only the peak concentration has physical significance. The averaged concentrations reported in Appendix 1 do not account for the turnover and thus are less physically meaningful. The SCI-GROW output file is located in Appendix 2.

Table 5. FIRST and SCI-GROW input parameters for Flumioxazin at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.019 lb ai/acre	0.019 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	1 day	1 day
Photolysis half life	1 day	n/a
Aerobic soil metabolism half life	23.4	14.7 days (mean value)
Aerobic aquatic half life	n/a	n/a
Solubility	1.8 ppm	n/a
Koc*	656	112

* Koc was estimated from a column leaching study instead of the adsorption study. Due to the rapid hydrolysis rate of the parent compound, EFED acknowledged the difficulty in obtaining adsorption coefficients from the batch equilibrium study.

Table 6. FIRST and SCI-GROW input parameters for 482-HA at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.038 lb ai/acre	0.038 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc**	13	13

* No water solubility is available so 10,000 ppm was assumed.
** Koc for THPA was used for 482-HA

Table 7. FIRST and SCI-GROW input parameters for APF at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.192 lb ai/acre	0.192 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc	201	201

* No water solubility is available so 10,000 ppm was assumed.

Table 8. FIRST and SCI-GROW input parameters for THPA at pH 7.

Parameter	FIRST Values	SCI-GROW Values
Application number per year	2	2
Application rate	0.153 lb ai/acre	0.153 lb ai/acre
Application type	aerial	
pH 7 Hydrolysis half life	stable	stable
Photolysis half life	stable	n/a
Aerobic soil metabolism half life	stable	stable
Aerobic aquatic half life	stable	n/a
Solubility*	10,000 ppm	n/a
Koc	13	13

* No water solubility is available so 10,000 ppm was assumed.

Drinking Water Recommendations

EFED has recommended that the Health Effects Division use the concentrations presented in Table 9 for drinking water EECs.

Table 9. Estimated EECs for Flumioxazin and its degradates in surface water and groundwater at pH 7.

Compound	Average 56-Day Conc. in Surface Water	Peak Conc. in Surface Water	Conc. in Groundwater
Flumioxazin	negligible	1.03 ppb	negligible
482-HA	4.84 ppb	6.87 ppb	45.27 ppb
APF	12.85 ppb	26.46 ppb	2.66 ppb
THPA	19.50 ppb	27.67 ppb	182.28 ppb

Appendix 1: FIRST for Environmental Fate Assessment

Background Information on FIRST:
FIRST is a new screening model designed to estimate the pesticide concentrations found in water for use in drinking water assessments. It provides high-end values on the concentrations that might be found in a small drinking water reservoir due to the use of pesticide. Like GENEEC, the model previously used for Tier I screening level, FIRST is a single-event model (one run-off event), but can account for spray drift from multiple applications. FIRST uses a Drinking Water Reservoir instead of a pond as the standard scenario. The FIRST scenario includes a 427 acres field immediately adjacent to a 13 acres reservoir, 9 feet deep, with continuous flow (two turnovers per year). The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 8% of the applied pesticide into the pond. This amount can be reduced due to degradation on 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.

FIRST also makes adjustments for the percent crop area. While FIRST assumes 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 FIRST include the use of a small drinking water reservoir surrounded by a runoff-prone watershed, the use of the maximum use rate, no buffer zone, and a single large rainfall.

FIRST Results at various pHs:

PH 5

RUN No. 11 FOR APF ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL		SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.199(.398)	2	30	201.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF		HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2	N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
27.426	13.322

****

pH 5

RUN No. 2 FOR THPA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.176(.352)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
31.830	22.436

****

pH 7

RUN No. 3 FOR Flumioxazin ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.019(.027)	2 30	656.0	1.8	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
23.40	2	1.00	1.00- 124.00	.00	.99

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
1.034	.004

****

pH 7

RUN No. 4 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.038(.076)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2	N/A .00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
6.872	4.844

****

pH 7

RUN No. 4 FOR APF ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.192(.384)	2 30	201.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2	N/A .00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
26.461	12.854

****

pH 7

RUN No. 6 FOR THPA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.153(.306)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2	N/A .00 -	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION

27.670	19.504

****

pH 9

RUN No. 7 FOR 482-HA ON Christmas tree * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Koc	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.391(.782)	2 30	13.0	10000.0	AERIAL(16.0)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	2 N/A	.00-	.00	.00	.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 AUG 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
70.713	49.843

Appendix 2: SCI-ROW for Environmental Fate Assessment

Background Information on SCI-GROW:
SCI-GROW provides a ground water screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. Since the SCI-GROW concentrations are likely to be approached in only a very small percentage of drinking water sources, i.e., highly vulnerable aquifers, it is not appropriate to use SCI-GROW concentrations for national or regional exposure estimates.

SCI-GROW estimates likely ground water concentrations if the pesticide is used at the maximum allowable rate in areas where ground water is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have ground water that is less vulnerable to contamination that the areas used to derive the SCI-GROW estimate.

SCI-GROW Results at pH 5

VERSION 2.2: NOVEMBER 1, 2001

RUN No. 11 FOR APF ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.199	2	.398	201.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

2.756142

RUN No. 12 FOR THPA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.176	2	.352	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

209.676900

SCIGROW Results at pH 7 :

RUN No. 1 FOR Flumioxazin ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.019	2	.038	112.0	14.70

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

.00317

RUN No. 2 FOR 482-HA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.038	2	.076	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

45.271150

RUN No. 3 FOR APF ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.192	2	.384	201.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

2.659193

RUN No. 4 FOR THPA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)
.153	2	.306	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

182.275900

SCI-GROW Results at pH 9

RUN No. 21 FOR 482-HA ** INPUT VALUES **

APP RATE (LBS/AC)	APPS/ YEAR	TOTAL/ SEASON	SOIL KOC	AEROBIC SOIL METAB HALFLIFE (DAYS)

.391	2	.782	13.0	999.00

GROUND-WATER SCREENING CONCENTRATION (IN UG/L - PPB)

465.816300
