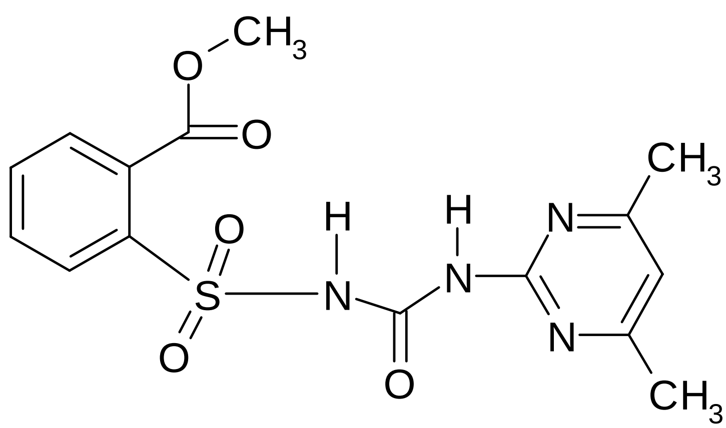
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Environmental Fate and Ecological Risk Assessment for the Reregistration of Sulfometuron-methyl: Vegetative Management and Other Non-crop Uses

For Use as Pre/Early post Emergence Herbicide for Selective Control of Certain Broadleaf Weeds & Grasses



SULFOMETURON METHYL

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1. EXECUTIVE SUMMARY

1.1. Nature of Chemical Stressor

Sulfometuron methyl, (2-[[[[(4,6-Dimethyl-2-pyrimidinyl) amino] carbonyl] amino] sulfonyl] benzoic acid, methyl ester), is a broad-spectrum pre- and post-emergence herbicide that is currently registered for weed control in forestry and non-food crop situations, including vegetative management in right of ways and railroads. It is used to control a variety of broad-leaf weeds and grasses. Similar to other sulfonylurea herbicides, the mode of action of sulfometuron methyl involves inhibiting the activity of the enzyme acetolactate synthase (ALS), which in turn inhibits the synthesis of selected amino acids that are required for cell proliferation in plants.

Sulfometuron methyl is formulated as a water dispersible granule (WDG) and applied using a variety of methods including helicopter, fixed-wing aircraft, ground spray (boom and backpack) and spot treatment. It is generally applied once per year for non-crop areas in years that vegetation management is needed. In some instances (weed escapes) a second application may be made, but all products limit the total quantity of sulfometuron methyl that may be applied (from any source) to 6 ounces of active ingredient per acre per year (0.375 lb ai/A). Therefore, application rates in general forestry, and for site preparation and/or release in conifer, hardwood and Christmas tree plantations, will vary significantly depending upon the specific purpose of the application and the desirable tree species. In forestry, uses can be similar to plantation sites, but may also include the maintenance of access routes and fire breaks. It is further noted that use rates can also vary with climate and soil type.

1.2. Conclusions- Exposure Characterization

1.2.1. Environmental Fate

a. Persistence

Sulfometuron methyl is expected to be relatively persistent in soil and water (half-life ranging from about 2 weeks to 6 months, depending on environmental conditions). The persistence of sulfometuron is likely to be lowest under low pH conditions in soil and water.

Abiotic and microbially-mediated hydrolysis / degradation are both major routes of transformation of sulfometuron methyl in water, soil, and water-sediment systems. The degradation in soil and water appears to be enhanced in the presence of an active microbial population (aerobic and anaerobic degradation both proceed more slowly under sterile conditions).

b. Transport and Bioaccumulation

Sulfometuron has a low potential to volatilize from soil or water or to bioaccumulate. Off-site transport of sulfometuron methyl occurs via spray drift, and the wind erosion of soil particulates containing sulfometuron methyl.

Sulfometuron methyl does not sorb strongly to soils and has the potential to leach to ground water and/or reach surface water during runoff events. Sulfometuron methyl is a weak acid (pKa of 5.2). The mobility of sulfometuron methyl is expected to increase with increasing pH based upon available data submitted to EPA for related sulfonylurea herbicides and published studies; however direct, definitive evidence of this for sulfometuron methyl has not been produced.

1.3. Conclusions- Effects Characterization

Available acute toxicity data for freshwater fish and invertebrates indicate that sulfometuron methyl is practically non-toxic on an acute exposure basis. All EC_{50}s/ LC_{50}s are >100 mg/L. For marine and estuarine fish and invertebrates, available acute toxicity data indicate that sulfometuron methyl is at most slightly toxic on an acute exposure basis (EC_{50}/ LC_{50}s range from >38 to >45 mg ai/L).

No acceptable studies were available for evaluating the effects of chronic exposure to sulfometuron methyl on freshwater, estuarine or marine fish. Chronic NOAEC for freshwater fish was therefore estimated to be >21 mg ai/L using an acute-chronic ratio derived from flazasulfuron, another sulfonylurea herbicide with the same mode of action. The aquatic invertebrate NOAEC is 97 mg ai/L (highest concentration tested) at which survival and reproduction were not significantly different from controls. Estimated chronic effects for estuarine/marine fish and invertebrates are uncertain because no chronic data on saltwater species were submitted by the registrant. However, comparison of freshwater and saltwater species acute toxicity values does not suggest considerable differences in sensitivity between freshwater and saltwater species.

Aquatic vascular plants are more sensitive than any of the aquatic nonvascular plants tested. The 14-day EC_{50} and NOAEC for the freshwater vascular plant (duckweed) for frond count (the most sensitive endpoint tested) was 0.48 and 0.21 μg/L, respectively. The green-algae was the most sensitive non-vascular plant tested with EC_{50} and NOAEC values of 4.6 and 0.63 μg/L, respectively, based on cell density.

Sulfometuron methyl is practically non-toxic to birds (LD_{50} >4,650 mg/kg-bw; LC_{50} >4,600 mg/kg-diet), mammals (LD_{50} >5000 mg/kg-bw), and bees (LD_{50} >100 ug/bee) on an acute toxicity basis. No sublethal effects were observed from the acute toxicity studies of birds and mammals. Data on reproductive effects of sulfometuron methyl to birds were not available. Acceptable data on mammalian reproductive effects were also not available. Data on the effects of gestational exposure to sulfometuron methyl were available from a rabbit developmental toxicity study which resulted in a NOAEL of 300 mg ai/kg-bw/d (highest dose tested).

Seedling emergence and vegetative vigor studies in terrestrial plants were submitted by the registrant. Based on the most sensitive species and endpoints reported, sulfometuron methyl is slightly more toxic to terrestrial plants in the vegetative vigor study compared to seedling emergence. The seedling emergence EC25 for the most sensitive dicot (sugar beet) and monocot (sorghum) are 3.2×10^{-5} and 1.9×10^{-4} lb ai/A, respectively. The vegetative vigor EC25 for the most sensitive dicot (soybean) and monocot (corn) are 1.8×10^{-5} and 3.7×10^{-5} lb ai/A, respectively. The guideline seedling emergence and vegetative vigor studies reported non-lethal effects of sulfometuron methyl exposure on plants such as chlorosis, growth retardation, necrosis, and unusual pigmentation.

1.4. Potential Risks to Non-target Animals and Plants

Potential risks to aquatic and terrestrial plants are indicated by this risk assessment, as LOCs are widely exceeded for terrestrial and aquatic plants at the maximum application rate. For terrestrial plants, RQs calculated at the edge of a treated field resulting from spray drift alone were as high as 22,000 for non-endangered plants and 400,000 for endangered plants. Terrestrial plant RQs dropped substantially 50 ft from the edge of a treated field but still exceeded Agency LOCs at 900 ft (700 to 12,000 for non-endangered and endangered plants, respectively. The impact of spray drift practices recommended by the label did not reduce RQ values below LOCs for terrestrial plants (RQs were reduced only by a factor of three compared to 'high end' exposure assumptions). Potential risks to terrestrial plants from irrigation with sulfometuron methyl contaminated surface water were also evident (RQ = 3.9 and 71 for non-endangered and endangered species, respectively).

The RQ values for aquatic plants exceeded LOCs and ranged from 49 to 148 for endangered nonvascular and vascular plants, respectively and from 6.7 to 65 for non-endangered nonvascular and vascular plants, respectively. Based on comparisons of adverse effect levels with longer-term average EECs predicted from the PRZM/EXAMS model (e.g., 90-d EEC of 16 µg/L), the ability of duckweed and other vascular aquatic plants to recover from predicted long-term exposure concentrations of sulfometuron methyl in adjacent, static aquatic systems appears unlikely under the exposure conditions modeled.

Although use of 'typical' application rates would result in RQs of up to one order of magnitude lower than the maximum application rate, RQs would still exceed Agency LOCs for terrestrial and aquatic plants. The conclusion of potential risks to aquatic and terrestrial plants from sulfometuron methyl application in non-crop uses is consistent with findings from other sulfonylurea herbicide risk assessments and ecological incident reports associated with sulfometuron methyl usage. Wind-driven erosion and drift of sulfometuron was implicated in one of the largest ecological incidents reported following its application (as Oust) to fire-damaged rangeland (crop damage estimated at $72 million). Although LOCs were not exceeded for terrestrial or aquatic animals, animals that depend on plants for survival or reproduction (presumably all taxa at the screening level) are also potentially at risk from indirect effects resulting from direct effects of sulfometuron to aquatic or terrestrial plants.

An analysis of the of the effects of various spray drift management practices (using the AgDRIFT model; see http://www.agdrift.com/AgDRIFt2/DownloadAgDrift2_0.htm) demonstrates that a substantial reduction in off-site exposure is possible with the implementation of application methods known to reduce drift. Droplet size is important in controlling spray drift. Using larger droplet sizes, such as coarse or extremely coarse spraying, reduces the downwind drift to adjacent areas compared to when medium or fine spraying is used. Thus, this assessment suggests that by placing drift management practices on labels such as specifying coarse or extremely coarse sprays (based on the ASAE standard), risks to non-target plants would not extend as far from the treated area. Reducing boom height during application and applying when wind speeds are between 3 and 10 mph are other examples of practices that control drift. Many of these practices are recommended, but not required by the product labels (see Section 3.2.3.1 and 4.2.3.1 for more details).

In addition, in regions where sulfometuron methyl has been used regularly, sulfometuron methyl concentrations in surface irrigation water may result in damage to agricultural crops that are sensitive to sulfometuron methyl.

1.5. Conclusions - Endangered Species

Direct effects LOCs were exceeded for endangered aquatic and terrestrial plants. In addition, there is potential for indirect effects to all animal taxa that depend on plants for survival, growth, or reproduction, which are presumably all animal taxa at the screening level. Therefore, listed species from all taxonomic groups are potentially at risk from sulfometuron methyl uses.

The results of this screening risk assessment indicate that direct effects to plant species could present an indirect risk at the higher levels of organization (i.e. population, trophic level, community, and ecosystem). The distance from the treated area that risks could extend is greater than 900 ft, which is the maximum distance that EFED's Tier 2 spray drift model (AgDRIFT; information on this model is available at http://www.agdrift.com/AgDRIFt2/DownloadAgDrift2_0.htm) can estimate. Due to the wide geographic distribution of potential application areas for non-crop uses of sulfometuron methyl, an action area for endangered species cannot be defined at this time for this assessment. A model is available for extending predictions of deposition from spray drift beyond 1000 feet (AgDISP with Gaussian extension; see Teske and Thistle, 2004; and Thistle et al., 2005). However, the trends observed in modeling of drift out to 900 feet downwind from treated areas imply that potential risks to the most sensitive species (non-target terrestrial plants) are likely to extend well beyond 1000 feet given the currently available information for our Tier II assessment. Field studies are not available to quantify actual risk to plant and animal communities in forest/edge and wetland/riparian habitats. However, in terrestrial and shallow-water aquatic communities, plants are the primary producers upon which the succeeding trophic levels depend. If the available plant material is impacted due to the effects of sulfometuron methyl, this may have negative effects not only on the herbivores, but also throughout the food chain. Also, depending on the severity of impacts to the plant communities [i.e., forests, wetlands, ecotones (edge and riparian habitats)], community assemblages and ecosystem stability may be altered (i.e. reduced bird populations in edge habitats; reduced riparian vegetation resulting in increased light penetration and temperature in aquatic habitats, loss of cover and food for fish). In addition, riparian vegetation, which is a significant component of the food supply for aquatic herbivores and detritivores provides habitat (i.e. leaf packs, materials for case-building for invertebrates) may also be affected.

The following table provides listed taxonomic groups that may be at risk from direct or indirect effects due to applications of sulfometuron methyl for vegetative management uses nationwide.

Table 1. Listed Taxonomic Groups Potentially at Risk from Direct or Indirect Effects of Sulfometuron Methyl Application for Vegetative Management Throughout the U.S.

Listed Taxon	Direct Effects	Basis for Direct Effects Concern	Indirect Effects	Basis for Indirect Effects Concern
Terrestrial and Semi-Aquatic Plants – monocots and dicots	Yes	The endangered and non-endangered species LOCs are exceeded for terrestrial plants.	Yes	Potential concerns from shifts in plant community structure and function due to from selective impacts on plant species.
Terrestrial Invertebrates	No	Sulfometuron methyl is practically nontoxic to honeybees, suggesting no direct effect concerns for terrestrial invertebrates.	Yes	Potential concerns for terrestrial invertebrates that use plants for habitat, feeding, or cover requirements.
Birds and Reptiles[1]	No	The LOC is not exceeded	Yes	Potential concerns for birds and reptiles that use plants for habitat, feeding, or cover requirements.
Terrestrial-phase Amphibians(1)	No	The LOC is not exceeded	Yes	Potential concerns for terrestrial-phase amphibians that use plants for habitat, feeding, or cover requirements.
Mammals	No	The LOC is not exceeded	Yes	Potential concerns for mammals that use plants for habitat, feeding, or cover requirements.
Aquatic Vascular Plants and Nonvascular Plants	Yes	The endangered and non-endangered species LOCs are exceeded for aquatic vascular and nonvascular plants.	Yes	Potential concerns from shifts in plant community structure and function due to from selective impacts on plant species.
Freshwater and Marine/Estuarine fish and Aquatic-phase Amphibians(2)	No	The LOC is not exceeded	Yes	Potential concerns for fish and aquatic-phase amphibians that use plants for habitat, feeding, or cover requirements.
Freshwater and Marine/Estuarine Crustaceans	No	The LOC is not exceeded	Yes	Potential concerns for crustaceans that use plants for habitat, feeding, or cover requirements.
Mollusks	No	The LOC is not exceeded	Yes	Potential concerns for mollusks that use plants for habitat, feeding, or cover requirements.

(1) Birds are used as surrogate species for terrestrial-phase amphibians and reptiles; therefore, potential direct and indirect effects to endangered avian, terrestrial-phase amphibians and reptilian species are considered equivalent.
(2) Fish are used as a surrogate for aquatic phase amphibians; therefore, potential direct and indirect effects to endangered fish and aquatic-phase amphibian species are considered equivalent.

1.6. Identification of Uncertainties and Their Impact on the Risk Assessment

1.6.1. Environmental Fate and Exposure

Limitations In Knowledge Of Actual Use Patterns

- Specific regions of use are not known. The use pattern of sulfometuron methyl does not lend itself to easy characterization geographically: There are a variety of vegetation management uses on sites that are less clearly defined than agricultural crops and have disjoint or unusual treatment area configurations (e.g., as with rights of way and railroad uses, or industrial site grounds)
- Practical limits on usage rates long-term at particular sites may different from legally allowable use levels (e.g., usage is highly unlikely to occur every year at a particular site even though this is allowable under the label language)

Variability In Sulfometuron Environmental Persistence

- Sulfometuron methyl persistence is significantly affected by soil or water chemistry and may not always be easy to predict from typically available soil / water property data alone. A clearer picture of the range of variability in sulfometuron methyl persistence in the environment would require environmental fate studies on a greater variety of soils / waters / sediments with a greater range of pH levels and other soil properties. This is particularly true for the aerobic soil and anaerobic aquatic metabolism studies

Insufficient Data And Methods Are Currently Available For Predicting Exposure To Sulfometuron Methyl Degradates.

- The total residues of sulfometuron methyl including environmentally significant degradates were not modeled with PRZM-EXAMS because of data and model limitations.
- Limitations in environmental fate data for the degradates constrains the modeling. The data on individual degradates, environmental persistence and mobility is insufficient to model each compound separately. Furthermore, total residue modeling with the currently available receiving water body assumes residues concentrate in that body (pond) since:
    - available data require assumptions of total stability of sulfometuron total residues (because insufficient decline data are available from the laboratory studies);
    - The existing surface water exposure scenario assumes these stable residues do not migrate from the pond and simply concentrate in the pond as applications of sulfometuron methyl are applied to the watershed.
- Data on sulfometuron effects on plants implies that low levels of sulfometuron methyl in soil and water may adversely affect the growth of sensitive terrestrial or aquatic species. For some sulfonylurea herbicides concentrations below 1ug/L in water or 1ug/kg in soil have been shown to affect the growth of sensitive plant species.

1.6.2. Ecological Effects

- **Indirect Effects to Animals.** In this screening-level risk assessment, aquatic and terrestrial plants were found to be at potential risk from the modeled sulfometuron methyl uses. Therefore, the potential exists for indirect effects on aquatic and terrestrial animals that depend on plants adversely affected by exposure to sulfometuron methyl. These indirect effects on aquatic and terrestrial animals could be expressed at the organism, population, community or ecosystem level of organization. No acceptable field studies were available to quantify the indirect effects of sulfometuron methyl to aquatic or terrestrial animals. Because risks associated with indirect effects on aquatic and terrestrial animals could not be assessed, ecological risks to animals could be underestimated to the extent that such indirect effects occur.

- **Ecological Risk of Sulfometuron Methyl Degradation Products.** In this screening level ecological risk assessment, ecological risks associated with the major degradates of sulfometuron methyl (e.g., pyrimidine amine, pyrimidine-ol, saccharin, sulfonamide) could not be reliably assessed. Reasons for this limitation are two-fold. First, the vastly different chemistries of the degradates (and likely correspondent differences in toxicological profiles) essentially precluded a meaningful application of the total residue approach in the exposure assessment. Second, acceptable ecotoxicity data were not available for the degradates. Because the chemical structure and environmental behavior of the major degradates differ substantially from the parent molecule (i.e., degradation involves cleavage of the sulfonylurea bridge, essentially splitting the molecule in half), it could not be assumed with reasonable confidence that the degradates are equivalent in toxicity to the parent compound.

- **Toxicity Data Quality and Data Gaps.** Acceptable or supplemental toxicity data were not available for assessing the chronic toxicity of sulfometuron methyl to freshwater fish or the reproductive toxicity to birds and mammals. A bounding analysis suggests that the risk assessment results are not likely to be sensitive to the lack of chronic toxicity data for fish, given the large difference between EECs and extrapolated toxicity limits. For mammals, the NOAEL of 300 mg ai/kg-bw/d was used from a developmental toxicity study to rabbits. While providing some information on the effect of sulfometuron methyl on mammalian development during gestational exposure, results from this study do not capture the potential effects of sulfometuron methyl on reproductive endpoints including courtship, mating, sex ratios and offspring survival, growth and development. Diet and dose-based RQs based on this NOAEL were 0.01 or lower, thus indicating that reproductive toxicity would have to occur at exposures that are approximately two orders of magnitude lower than developmental effects.

- **Vascular Plant Reproduction**. Terrestrial and aquatic plants appear most sensitive to sulfometuron methyl exposure. While toxicity data were available for endpoints related to systemic growth, seedling emergence and visual injury, these guideline studies are not designed to capture reproductive endpoints. There is some evidence to suggest plant reproduction may be affected by sulfonylurea herbicides at levels below effects on vegetative growth or visual injury (Fletcher et al., 1993). Uncertainty regarding the potential greater sensitivity of terrestrial plant reproduction has been discussed extensively in the environmental fate and effects assessment for chlorsulfuron (D330621). Therefore, to the extent that terrestrial and aquatic plant reproduction are more sensitive to sulfometuron methyl than growth endpoints, risks to aquatic and terrestrial plants may be underestimated in this risk assessment. Additional information on the reproductive toxicity of sulfometuron methyl to terrestrial plants would help address this uncertainty.

2. PROBLEM FORMULATION

The purpose of problem formulation is to provide the foundation for the ecological risk assessment being conducted for sulfometuron methyl. It sets the objectives for the risk assessment, evaluates the nature of the problem, and provides a plan for analyzing the data and characterizing the risk (US EPA, 1998).

2.1. Nature of the Regulatory Action

Under section 4 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA is reevaluating existing pesticides to ensure that they meet current scientific and regulatory standards. With this document, EPA has completed its baseline environmental fate and ecological effects risk assessment to support a Reregistration Eligibility Decision (RED) for the herbicide, sulfometuron methyl. Sulfometuron methyl was first registered for use in 1982 by E.I. du Pont de Nemours and Company (DuPont); all registered uses then and now have been for vegetation control in non-agricultural areas. Currently, both DuPont and Vegetation Management, LLC have registered end-use products containing sulfometuron methyl.

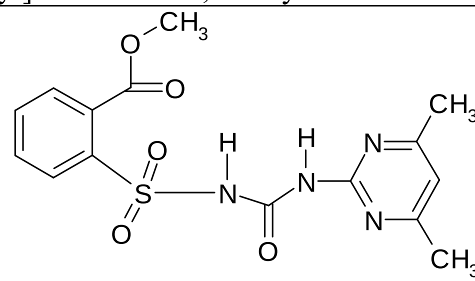
2.2. Stressor Source and Distribution

2.2.1. Nature of the Chemical Stressor

Sulfometuron methyl, a broad-spectrum pre- and post-emergence herbicide, is currently registered for weed control in forestry and non-food crop situations, including vegetative management in rights-of-ways and railroads. It is used to control a variety of broad-leaf weeds and grasses. Similar to other sulfonylurea herbicides, the mode of action of sulfometuron methyl involves inhibiting the activity of the enzyme acetolactate synthase (ALS), which in turn inhibits the synthesis of selected amino acids that are required for cell proliferation in plants. A brief summary of the product chemistry data on sulfometuron methyl is provided in Table 2.

Table 2. Nature and product chemistry of the chemical stressor - Sulfometuron methyl.

Common name	Sulfometuron methyl
IUPAC Chemical Name	2-(4,6-Dimethylpyrimidin-2-ylcarbamoylsulfamoyl) benzoic

	acid, methyl ester ***OR*** 2-[3-(4,6-dimethylpyrimidin-2-yl)ureidosulfonyl] benzoic acid, methyl ester
CAS Chemical Name	2-[[[[(4,6-Dimethyl-2-pyrimidinyl) amino] carbonyl] amino] sulfonyl] benzoic acid, methyl ester
Structure	
Pesticide type	Herbicide
Chemical class	Sulfonylurea herbicide
CAS number	74222-97-2
Empirical formula	$C_{15}H_{16}N_4SO_5$
Molecular Mass (g/mol)	364.38
Vapor pressure at 20° C	5.4 x10^{-16} Torr
Henry's Law Constant at 20° C (atm m3/mol)	1.1 x 10^{-18}, calculated from vapor pressure
Solubility in water (mg/L)at 20°C	pH 5 buffer...... 6.42 ppm pH 7 buffer ...... 244 ppm pH 8.6 buffer.. 12,500 ppm
Log K_{ow}	pH 5 = 1.03 pH 7 = -0.46 pH 9 = -1.87
pKa at 25°C	5.2

Sulfometuron methyl may be persistent and mobile and may have a significant impact on ground water and surface water resources. Degradation half-lives in soil and water range from about 2 weeks to 6 months due to aerobic metabolism, anaerobic aquatic, aerobic aquatic, and hydrolysis (except in acidic solution the half-life is only about 1 week). Parent persistence is similar under anaerobic and aerobic conditions. Complete degradation / mineralization is more rapid under aerobic conditions and is generally enhanced substantially when microbes are present. The primary route of degradation is by the following pathway involving cleavage of the sulfonylurea bridge:

(1) Hydrolytic cleavage generating a sulfonamide plus the aminopyrimidine (resulting in elimination of a carbon dioxide molecule)
(2) The sulfonamide (produced by hydrolysis of the sulfonylurea) is further cyclized with the carbomethoxy group in the ortho position, yielding a saccharin.

Degradation by this same pathway occurs at a slower rate under sterile conditions.

Sulfometuron methyl is considered "mobile" according to the classification system of the Food and Agricultural Organization, Agriculture and Consumer Protection Department's "Assessing Soil Contamination: A Reference Manual" (see: http://www.fao.org/DOCREP/003/X2570E/X2570E06.htm). Sulfometuron methyl mobility is "high" to "very high" based upon the classification system of McCall et al. (1981; see also http://www.epa.gov/oppefed1/ecorisk_ders/terrestrial_field_dissipation.htm for a description). Soil persistence is sufficient such that vulnerable aquifers may be expected to be impacted. Sulfometuron methyl concentrations in surface waters may be relatively high when significant runoff events occur after application and / or spray drift to water bodies in close proximity to the treatment area occurs.

2.2.2. Overview of Pesticide Usage

Sulfometuron methyl is formulated as a water dispersible granule (WDG) and applied using a variety of methods including helicopter, fixed-wing aircraft, ground spray (boom and backpack) and spot treatment. Sulfometuron methyl is registered for non-crop agricultural and vegetative management uses throughout the United States. The most significant uses include forestry and tree nurseries (weed control to promote seedling growth), vegetative management in utility right-of-ways, roadsides and railroads, industrial sites (e.g., to maintain bare ground in utility substations), under asphalt and concrete prior to paving and for broadleaf weed control in unimproved turf and on non-crop restoration sites. The highest use areas are believed to be in Pacific Coast states and the southeastern United States.

The application rates and frequency varies widely depending on use and the specific pest situation, but all uses are restricted to an annual maximum application of 6 oz ai./acre.

2.3. Receptors

2.3.1. Aquatic and Terrestrial Effects

The receptor is the biological entity that is exposed to the stressor (US EPA, 1998). Aquatic receptors potentially at risk include (but are not limited to): fish, amphibians, invertebrates (e.g., aquatic insects, mollusks, crustaceans, and worms), vascular plants and algae. Terrestrial receptors potentially at risk include (but are not limited to): birds, mammals, reptiles, amphibians, terrestrial invertebrates (e.g., insects, worms, arachnids), and plants.

Consistent with the process described in the Overview Document (US EPA, 2004), this risk assessment uses a surrogate species approach in its evaluation of sulfometuron methyl. Toxicological data generated from surrogate test species, that are intended to be representative of broad taxonomic groups, are used to extrapolate to potential effects on a variety of species (receptors) included under these taxonomic groupings.

Acute and chronic toxicity data from studies submitted by pesticide registrants along with the available open literature are used to evaluate potential direct effects of sulfometuron methyl to the aquatic and terrestrial receptors identified in this section. This includes toxicity data on the technical grade active ingredient, degradates, and when available, formulated products (e.g. "Six-Pack" studies). The open literature studies are identified through EPA's ECOTOX database (http://cfpub.epa.gov/ecotox/), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of sulfometuron methyl on biotic communities due to loss of species that are sensitive to the chemical and changes in structure and functional characteristics of the affected communities.

Table 3 provides a summary of the taxonomic groups and the surrogate species tested to help understand potential acute ecological effects of pesticides to these non-target taxonomic groups. In addition, the table provides a preliminary overview of the potential acute toxicity of sulfometuron methyl by providing the acute toxicity classifications. Based on a preliminary review of the ecological effect data, sulfometuron methyl is, for the most part, practically non-toxic to freshwater fish, freshwater invertebrates, birds, mammals, and honeybees under acute exposure conditions. Acute toxicity to estuarine/marine fish and invertebrates was not observed at the highest concentrations tested, which fell into the slightly toxic category. Under chronic exposure conditions, the sulfometuron methyl inhibited reproduction of both fathead minnow (*Pimephales promelas*) and water fleas (*Daphnia magna*). Acceptable chronic reproductive toxicity data were not available for birds or mammals**.** As expected, aquatic and terrestrial plants show the greatest sensitivity to the parent compound.

Major environmental degradates of sulfometuron methyl most commonly include: the sulfometuron sulfonamide, the sulfometuron pyrimidine amine, and saccharin; other degradates occur less commonly (see Table 10 and APPENDIX A: Structures and Chemical Names of Sulfometuron methyl Metabolites). Other than deesterification from sulfometuron methyl to the free acid, the degradates are formed from cleavage of the sulfonyl urea bridge between the phenyl and pyrimidine ring structures. The latter compounds are not expected to be substantially phytotoxic, however, information is requested from the registrant to confirm this.

Table 3. Taxonomic Groups, Test Species and Acute Toxicity Classification for Assessing Ecological Risks of Sulfometuron Methyl to Non-target Organisms.

Taxonomic Group	Example(s) of Surrogate Species	Acute Toxicity Classification
Birds[1]	Mallard duck (*Anas platyrhynchos*) Bobwhite quail (*Colinus virginianus*)	Practically non-toxic
Mammals	Laboratory rat (*Rattus norvegicus*)	Practically non-toxic
Insects	Honey bee (*Apis mellifera L.*)	Practically non-toxic
Freshwater fish[2]	Bluegill sunfish (*Lepomis macrochirus*) Rainbow trout (*Oncorhynchus mykiss*)	Practically non-toxic Practically non-toxic
Freshwater invertebrates	Water flea (*Daphnia magna*)	Practically non-toxic
Estuarine/marine fish	Sheepshead minnow *(Cyprinodon variegatus)*	≥ Slightly toxic[4]

Taxonomic Group	Example(s) of Surrogate Species	Acute Toxicity Classification
Estuarine/marine invertebrates	Mysid shrimp *(Mysidopsis bahia)* Eastern oyster (*Crassostrea virginica)*	$\geq$ Slightly toxic[4] $\geq$ Slightly toxic[4]
Terrestrial plants[3]	Monocots – corn (*Zea mays*) Dicots – soybean (*Glycine max*)	Not classified
Aquatic plants and algae	Duckweed (*Lemna gibba*) Green algae (*Selenastrum capricornutum*) Bluegreen algae (*Anabaena flos-aquae)* Diatom (*Navicula pelliculosa)*	Not classified

[1] In absence of data, birds are used as surrogates for terrestrial-phase amphibians and reptiles.
[2] In absence of data, freshwater fish may be surrogates for aquatic-phase amphibians.
[3] Data required for 4 species of monocots from 2 families (must include corn) and 6 species of dicots from 4 families (must include soybean).
[4] Toxicity endpoint was greater than the highest concentration tested, which fell in the slightly toxic category.

2.3.2. Ecosystems at Risk

The ecosystems at potential risk from sulfometuron methyl are extensive in scope due to the wide geographic distribution of potential sulfometuron methyl application sites. As a result, it is not possible to identify specific ecosystems at risk during the development of this baseline risk assessment. However, in general terms, terrestrial ecosystems potentially at risk could include the treatment areas directly and adjacent areas that may receive herbicide drift or runoff. This could include the treatment area itself as well as other cultivated fields, fencerows and hedgerows, meadows, fallow fields or grasslands, woodlands, riparian habitats and other uncultivated areas. Within these ecosystems, available toxicity data indicate terrestrial plants are highly sensitive to sulfometuron methyl and thus, they could be directly affected. Organisms dependent on sensitive terrestrial plants could be affected indirectly, which could result in subsequent effects at the community and ecosystem levels. Birds and mammals appear to be much less sensitive to the direct exposure of sulfometuron methyl compared to plants, although they could be affected indirectly to the extent they depend on affected plants for food and habitat.

Aquatic ecosystems potentially at risk include water bodies adjacent to, or down stream from, the treatment area and might include impounded bodies such as ponds, lakes, reservoirs and wetland areas, or flowing waterways such as streams and rivers. For uses in coastal areas, aquatic habitat also includes marine ecosystems, including estuaries and salt marshes. Similar to the terrestrial ecosystems, available toxicity data indicate aquatic plants are highly sensitive to sulfometuron methyl exposure and thus could be directly affected. Other organisms dependent on aquatic plants could be affected indirectly. Aquatic animals appear to be much less sensitive to direct exposure to sulfometuron methyl compared to plants, although they could be affected indirectly to the extent they depend on affected plants for food and habitat.

2.4. Assessment Endpoints

Assessment endpoints represent the actual environmental value that is to be protected, defined by an ecological entity (species, community, or other entity) and its attribute or characteristics (US EPA, 1998). For sulfometuron methyl, the ecological entities may include the following: birds, mammals, freshwater fish and invertebrates, estuarine/marine fish and invertebrates, terrestrial plants, insects, and aquatic plants and algae. The attributes for each of these entities may include growth, reproduction, and survival and are discussed further in the Analysis Plan (Section 2.6).

2.5. Conceptual Model

For a pesticide to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

A conceptual model is used in this risk assessment to provide a written and visual description of the predicted relationships between sulfometuron methyl, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypotheses and a conceptual diagram (US EPA, 1998).

2.5.1. Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (i.e., changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (EPA 1998a). For sulfometuron methyl, the following ecological risk hypothesis is being employed for this baseline risk assessment:

> *Given persistence and mobility of sulfometuron methyl and some of its degradates, there is a likelihood that terrestrial and/or aquatic organisms will be exposed when sulfometuron methyl is used in accordance with the label. Consequently, considering the mode of action, direct toxicity and potential indirect effects, labeled uses of sulfometuron methyl have the potential to cause adverse effects upon the survival, growth, and reproduction of non-target terrestrial and aquatic plants and animals.*

2.5.2. Conceptual Diagram

Based on the iterative process of examining the usage information, fate and effects data, the risk hypotheses described previously, conceptual diagrams are shown in Figure 1 and Figure 2 for aquatic and terrestrial ecosystems, respectively. These conceptual models illustrate: (1) the most likely stressors/exposure pathways, and (2) the organisms that are most relevant and applicable to this assessment.

The dominant sources/transport pathways of sulfometuron methyl to aquatic ecosystems include spray drift, runoff and erosion from treated areas to surface waters and aquatic sediments. Sulfometuron methyl also has the potential to leach to groundwater which can serve as inputs to surface water, although this is not explicitly modeled for ecological effects in this risk assessment due to modeling and data limitations. Once in surface water and sediments, sulfometuron methyl may be directly toxic to aquatic vascular plants (rooted macrophytes) and nonvascular plants (algae) via uptake through the roots or cell membrane. Sulfometuron methyl exposure in surface water and sediments may also cause direct toxicity to aquatic animals, although the generally low toxicity to aquatic animals renders this pathway less of a concern compared to aquatic plants. Indirect effects on aquatic animals via impacts on aquatic plants is also a concern, but is not explicitly modeled in this risk assessment due to model and data limitations.

The dominant sources/transport pathways of sulfometuron methyl to terrestrial ecosystems include direct spray on terrestrial food items, spray drift, runoff and erosion from herbicide treated areas, and leaching to groundwater. Wind-driven erosion of treated soils is also a potential source of concern, particularly to non-target plants but is not modeled in this risk assessment due to data and modeling limitations. Volatilization of sulfometuron methyl is also a potential source of exposure for terrestrial animals via inhalation, but is of less concern given its low volatility and low inhalation toxicity based on mammalian data (MRID 430892-03)**.** Once sorbed onto food items, terrestrial animals (birds, mammals) may be exposed to sulfometuron methyl via diet and dermal absorption, although its low toxicity to birds and mammals suggest that effects from this exposure pathway are much less likely than effects on terrestrial plants. Adverse effects on non-target terrestrial plants may occur through exposure to herbicide spray drift, contaminated runoff and groundwater, erosion of herbicide treated soil via direct contact and root uptake, and irrigation with contaminated ground water or surface water sources. Indirect impacts may occur on animals that depend on affected terrestrial plants for food or habitat.

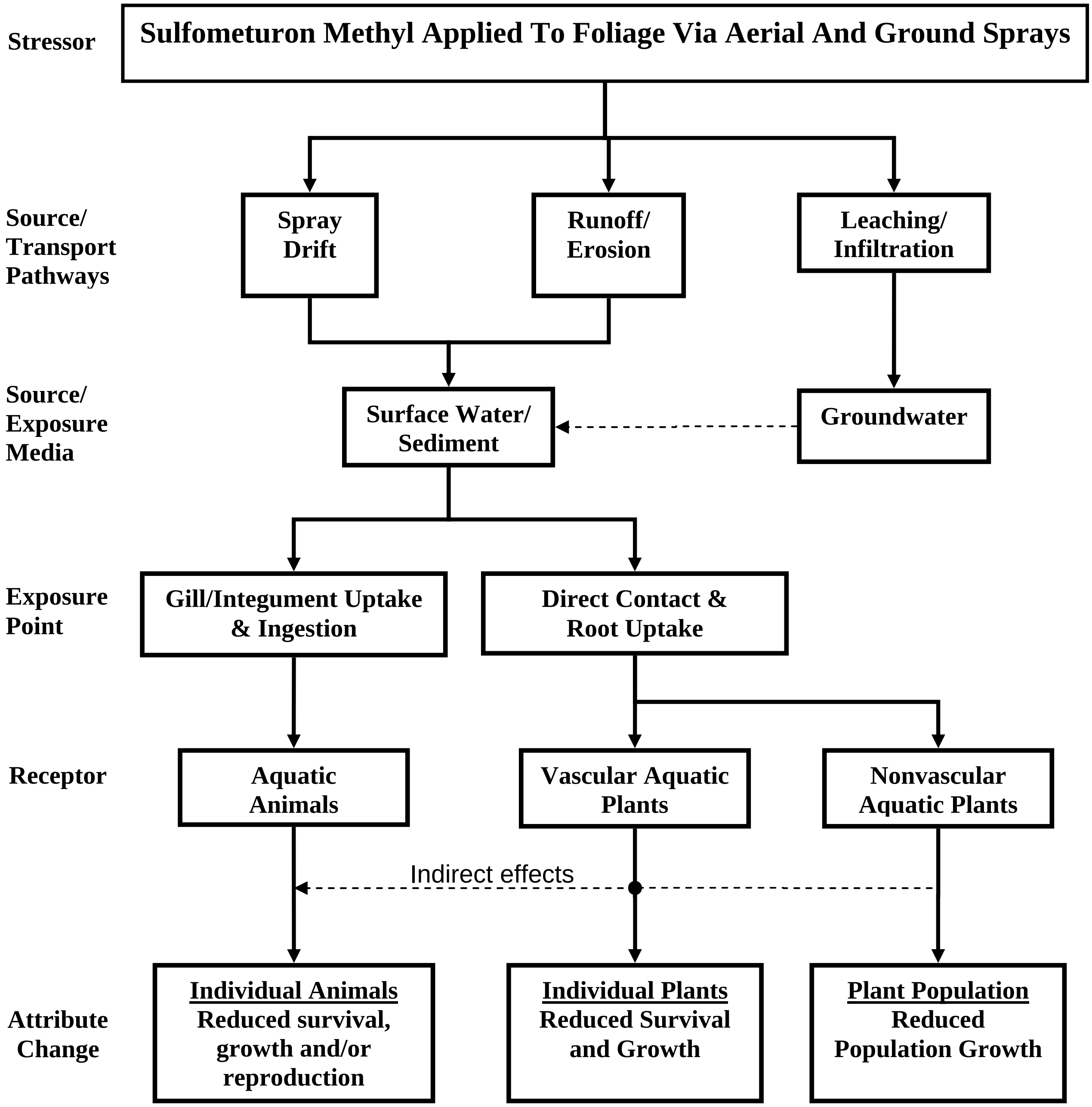


Figure 1. Conceptual model for sulfometuron methyl fate and effects in aquatic ecosystems.

[1] Bold lines and text boxes represent exposure pathways and effects that were assessed quantitatively in this risk assessment. Dashed lines indicate potential exposure pathways or effects that were not assessed quantitatively.

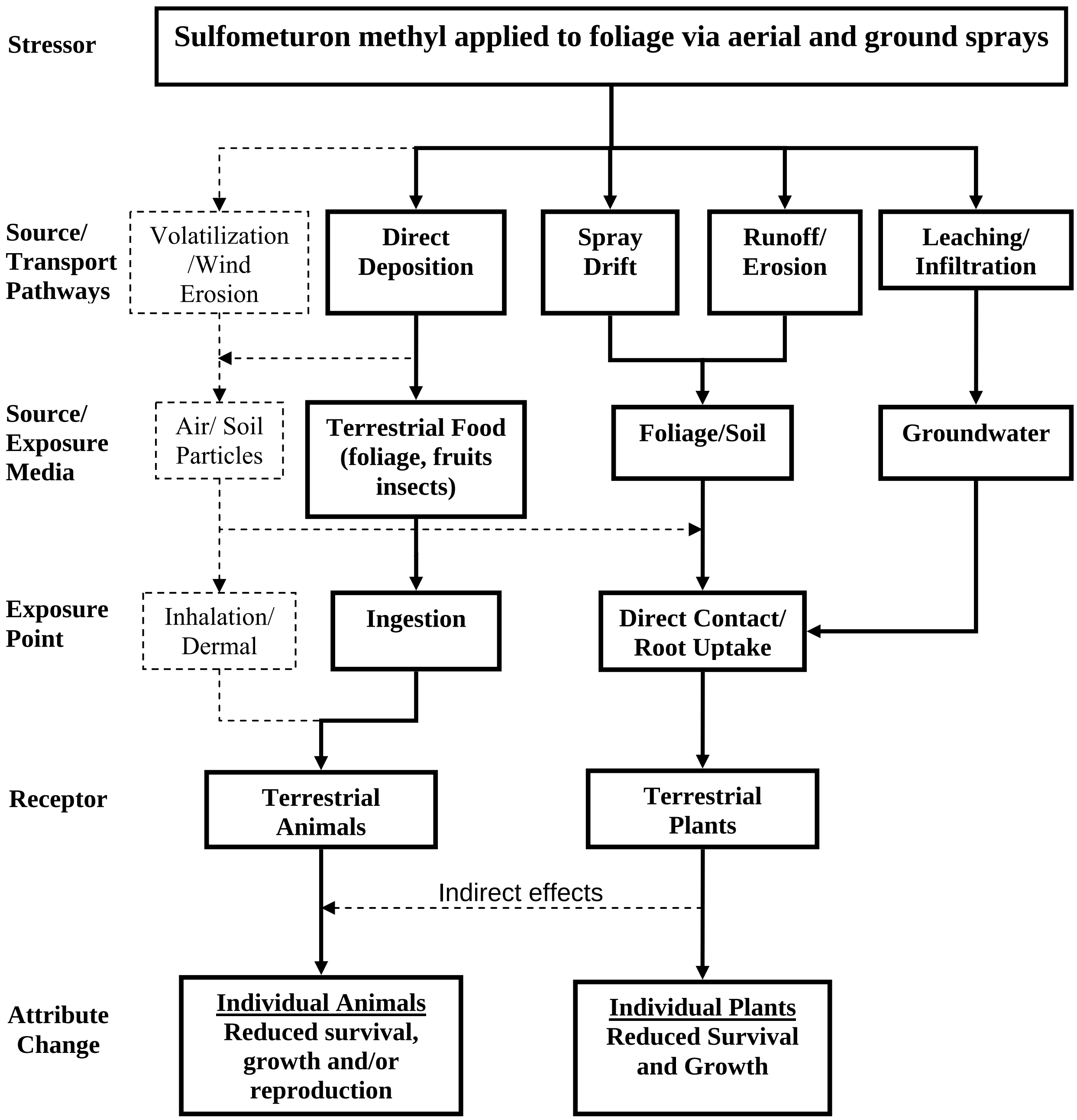


Figure 2. Conceptual model for sulfometuron methyl fate and effects in terrestrial ecosystems.

[1] Solid lines and text boxes represent exposure pathways and effects that were assessed quantitatively in this risk assessment. Dashed lines indicate potential exposure pathways or effects that were not assessed quantitatively.

2.6. Analysis Plan

This document characterizes the environmental fate and effects of sulfometuron methyl to assess whether existing label uses for reregistration of this compound result in potential risk to non-target organisms above the Agency's levels of concern (LOCs). Available environmental fate, ecotoxicity, and physicochemical property data were taken from studies submitted previously to EPA and where available, the open scientific literature. At or near the time of their submission to EPA, environmental fate and effect studies underwent formal data evaluation review (DER) to determine their acceptability relative to published EPA guidelines. For the ecotoxicity data, the studies and/or DERs were re-reviewed to ensure that studies met current acceptability guidelines. For the environmental fate studies, new data or information or new studies were submitted in response to Agency reviews of earlier data submissions; most of these new study addendums or replacements for older studies were submitted in the early 1990s but were not previously subject to formal review by the Agency. Any literature studies used in this risk assessment were evaluated according to EPA/OPP/EFED review guidelines in place at the time of submission and accepted if deemed scientifically valid; however, test conditions deviate in some ways from the current OECD Guidelines (See
http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_exp.htm#WSAN2 and
http://www.oecd.org/department/0,3355,en_2649_34377_1_1_1_1_1,00.html).

2.6.1. Conclusions from Previous Risk Assessments

No previous environmental fate and ecological risk assessment was available for sulfometuron methyl that was comparable to current OPP practices. However, comprehensive ecological risk assessments were available from two other Federal sources: US Forest Service (USDA, 2004) and the Bureau of Land Management (BLM, 2005). In many cases, the overall methodology and data used in these assessments was similar to that used by OPP, although some differences in the models, interpretation of data, and associated assumptions were evident.

Results from the US Forest Service Ecological Risk assessment (USDA, 2004) indicate that risk of direct toxicity to aquatic and terrestrial animals is unlikely, due to exposure via contaminated diet, dermal contact, and inhalation. Risks were evident to terrestrial and aquatic plants, with hazard quotients (equivalent to Agency RQ values) up to 4 for aquatic plants (peak concentrations) and up to 15,000 for terrestrial plants based on the NOAEC for vegetative vigor. The US Forest Service assessment considered only ground applications, which would likely result in lower RQs compared to aerial applications that are modeled in the OPP ecological risk assessment.

Results from the BLM ecological risk assessment (BLM, 2005) are similar to those of the US Forest Service. No risks from direct spray, drift, or surface runoff of sulfometuron methyl were identified for terrestrial animals, fish or aquatic invertebrates. Risks to terrestrial and aquatic plants from off site drift and surface runoff were evident, with RQs up to 2,500 associated with aerial application 100ft from the treated area and up to 40 for aquatic plants from surface runoff to a model pond. Results from modeling wind-driven erosion did not indicate risk to terrestrial plants, although results depended largely on the treatment area size and may underestimate risks from larger scale applications.

2.6.2. Preliminary Identification of Data Gaps and Analysis Plan

Data from registrant-submitted studies and the open literature were used to assess the potential effects of sulfometuron methyl and its major metabolites on non-target organisms. For aquatic and terrestrial plants, a re-review of the toxicity data indicated that the ecological effect studies meet basic guideline requirements and no data gaps were identified for terrestrial and freshwater aquatic plants. For aquatic animals, a re-review of the toxicity data indicates that no acceptable data were available for chronic toxicity to fish (freshwater, or marine/estuarine). For birds, no data were available to assess effects on avian growth or reproduction. Similarly for mammals, no acceptable data were available on reproductive effects of sulfometuron methyl. Thus, for ecological effects, the following data gaps are identified along with associated uncertainties:

- Avian Reproduction Study (71-4)
- Fish Early Life Stage Study for Freshwater or Estuarine/Marine Species (72-4)
- 2-generation reproduction study with rat (83-4)

There are no outstanding environmental fate data gaps.

In accordance with OPP practices for conducting baseline ecological risk assessments of pesticides (see the "Overview Document; US EPA, 2004), the primary method used to assess risk in this screening-level assessment is the risk quotient (RQ). The RQ is the result of comparing measures of exposure to measures of effect. A commonly used measure of exposure is the estimated exposure concentration (EEC) and commonly used measures of effect include toxicity values such as the LD_{50} or NOAEC. The resulting RQ is then compared to a specified LOC. If the RQ exceeds an LOC, then risks are identified.

2.6.3. Measures of Effect and Exposure

Considering the previous discussion of data gaps and risk assessment procedures, the following measures of effects and exposure presented in Table 4 are selected for this baseline risk assessment.

Table 4. Measures of Ecological Effects and Exposure for Sulfometuron Methyl

Assessment Endpoint		Surrogate Species and Measures of Ecological Effect[1]	Measures of Exposure
Birds[2]	Survival	Bobwhite acute oral LD_{50} Bobwhite and mallard subacute dietary LC_{50}	Maximum residues on food items (foliar)
	Reproduction and growth	Bobwhite and mallard chronic reproduction NOAEC and LOAEC **(no studies available)**	
Mammals	Survival	Laboratory rat acute oral LD_{50}	
	Reproduction and growth	Laboratory rat oral reproduction chronic NOAEC and LOAEC **(no acceptable studies available)**	
Freshwater fish[3]	Survival	Rainbow trout and bluegill sunfish acute LC_{50}	Peak EEC[4]
	Reproduction and growth	Fathead minnow chronic (early life-stage) NOAEC and LOAEC **(no acceptable studies available)**	60-day average EEC[4]
Freshwater invertebrates	Survival	Water flea acute EC_{50}	Peak EEC[4]
	Reproduction and growth	Water flea chronic (life cycle) LOAEC	21-day average EEC[4]
Estuarine/marine fish	Survival	Sheepshead minnow acute LC_{50}	Peak EEC[4]
	Reproduction and growth	Sheepshead minnow chronic (early life-stage) NOAEC and LOAEC **(No studies available)**	60-day average EEC[4]
Estuarine/marine invertebrates	Survival	Eastern oyster acute EC_{50} and mysid acute LC_{50}	Peak EEC[4]
	Reproduction and growth	Mysid chronic NOAEC and LOAEC **(no data available)**	21-day average EEC[4]
Terrestrial plants[5]	Survival and growth	Monocot and dicot seedling emergence and vegetative vigor $EC_{25,}$ EC_{05}, and NOAEC values	Estimates of runoff and spray drift to non-target areas
Insects	Survival (not quantitatively assessed)	Honeybee acute contact LD_{50}	Maximum application rate
Aquatic plants and algae	Survival and growth	Algal and vascular plant (i.e., duckweed) EC_{50} and NOAEC values for growth rate and biomass measurements	Peak EEC

[1] Species listed in this table represent most commonly encountered species from registrant-submitted studies, risk assessment guidance indicates most sensitive species tested within taxonomic group are to be used for baseline risk assessments.
[2] Birds may be used as surrogates for amphibians (terrestrial phase) and reptiles.
[3] Freshwater fish may be used as surrogates for amphibians (aquatic phase).
[4] One in 10-year return frequency.
[5] Data required for 4 species of monocots from 2 families (must include corn) and 6 species of dicots from 4 families (must include soybean). LD_{50} = Lethal dose to 50% of the test population; NOAEC = No observed adverse effect concentration; LOAEC = Lowest observed adverse effect concentration; LC_{50} = Lethal concentration to 50% of the test population; EC_{50}/EC_{25} = Effect concentration to 50%/25% of the test population.

3. ANALYSIS

3.1. USE CHARACTERIZATION

Information in this section is taken from the "Sulfometuron Methyl Use Closure Memo" from John Pates, Special Review and Reregistration Division (dated January 30, 2007). In addition, some data submitted to the Agency by DuPont Corp. is used by permission.

Sulfometuron methyl is a broad-spectrum sulfonylurea herbicide (numerous other herbicides in this class are also registered for various uses in the United States). There are no agricultural uses for sulfometuron methyl, but it is used on a wide variety of non-crop situations for vegetation management (railroad, highway, power line, and other rights-of-way; suppression of vegetation at utility substations, unimproved turf in industrial areas, in preparation of ground for asphalt or concrete paving, etc.) and in forestry plantings. It is applied either post-emergent or pre-emergent. It works by blocking the active growing regions of stem and root tips. Sulfometuron methyl is formulated as a water dispersible granule (WDG) and applied using a variety of methods including helicopter, fixed-wing aircraft, ground spray (boom and backpack) and spot treatment (Table 5 and Table 6).

Sulfometuron methyl is generally applied once per year for non-crop areas. In some instances (weed escapes) a second application may be made, ***but all products limit the total quantity of sulfometuron methyl that may be applied (from any source) to 6 ounces[1] of active ingredient per year.*** Therefore, application rates in general forestry, and for site preparation and/or release in conifer, hardwood and Christmas tree plantations, will vary significantly depending upon the specific purpose of the application and the desirable tree species. In forestry, uses can be similar to plantation sites, but may also include the maintenance of access routes and fire breaks. It is further noted that use rates can also vary with climate and soil type. Ranges of application rates by use are summarized in Table 9.

Considering all types of uses, regions of the U.S. where sulfometuron methyl appears to have the greatest use include the southeast and west coast states. Data from DuPont (used by permission) indicate that OR and TX are the highest use states overall (Table 7). However, Vegetation

[1] That is, 0.375 pounds of active ingredient per acre per year.

Management LLC also markets sulfometuron methyl products and the geographical distribution of the use of its products could be somewhat different. The total amount used annually is estimated to be close to 250,000 pounds active ingredient Table 8.

Table 5. Permitted application methods for sulfometuron methyl, DuPont Products

Forestry/ Plantations	Aerial (fixed wing, helicopter), ground (closed cab), and backpack (spot spray).
Vegetative Management	Aerial (helicopter) and ground (closed and open cab).
Railroad	Aerial (helicopter) and ground (closed and open cab).

Table 6. Permitted application methods for sulfometuron methyl, Vegetation Management LLC Products

SFM	Ground (broadcast, directed), air (helicopter- only), backpack sprayers (forestry applications include banded or spot hand applications).
SFM Extra	Ground (broadcast, directed), air (helicopter or fixed wing aircraft, backpack sprayers (forestry applications include banded or spot hand applications).

Table 7. States with high sulfometuron usage (based upon DuPont sales data, 2001-2004).

	Thousands of Pounds A.I. Applied Annually Statewide			
Use Site	**1 to 5**	**5 to 10**	**10 to 20**	**> 20**
Forestry	OR, TX, LA, GA, VA	AR, MS, AL	---	---
Vegetation Management	WA, OK, LA, MS, AL, GA, SC, VA, PA	CA, TX	OR	---
Railroad	WA, OR, CA, NM, ND, NE, KS, TX, IL, MS, OH, FL, MA	TN, WV	---	---
Total Uses (sales)	MT, CO, NM, ND, NE, KS, OK, MN, IL, OH, PA, VA, SC, FL, MA	OR, CA, AR, LA, TN, MS, AL, GA, WV	TX	OR

Table 8. Annual usage of sulfometuron methyl in the US by use site.

Use Site	*Low Estim.* Annual Usage, Lbs ai	*High Estim.*
(Commercial Christmas Trees - Nurseries)	50	830
Forestry	89,000	100,000
Non-crop Vegetative Management (VM - includes Roadway, Utility & Pipeline)	80,000	100,000
Railroad (RR)	50,000	71,000
Total	230,000	261,000

Estimates reflect ranges from combined registrant and OPP-BEAD generated estimates. Registrant estimates are combined for DuPont and Vegetation Management for any and all years of reported data. BEAD estimates reflect multiple data sources from 1999 to 2003 period.

Table 9. Sulfometuron application rate ranges by product label and use site.

Product Name	Type of Formulation	Additional Active Ingredient(s)	Use Site(s)	Single App. Low Rate (pounds a.i.)	Single App. High Rate (pounds a.i.)
DuPont™ Oust® Herbicide Or "Sulfometuron methyl 75"	Dispersible granules	None (may be tank mixed)	Forestry Non-Crop	0.047 0.047	0.375 0.375
DuPont™ Oust® XP Herbicide	Dispersible granules	None (may be tank mixed)	Forestry Non-Crop	0.023 0.047	0.375 0.375
DuPont™ Oust® Extra Herbicide	Dispersible granules	Metsulfuron Methyl	Conifer Plantations Non-Crop	0.023 0.016	0.281 0.188
DuPont™ Oustar® Herbicide	Dispersible granules	Hexazinone	Forestry	0.075	0.175
DuPont™ Westar® Herbicide	Dispersible granules	Hexazinone	Christmas Trees Forestry Non-Crop	0.025 0.100 0.131	0.100 0.131 0.194
DuPont™ Landmark® MP Herbicide	Dispersible granules	Chlorsulfuron	Non-Crop	0.023	0.281
DuPont™ Landmark® II MP Herbicide	Dispersible granules	Chlorsulfuron	Non-Crop	0.035	0.350
DuPont™ Landmark® XP Herbicide	Dispersible granules	Chlorsulfuron	Non-Crop	0.023	0.281
DuPont™ Landmark® II XP Herbicide	Dispersible granules	Chlorsulfuron	Non-Crop	0.035	0.350
DuPont™ Throttle™ MP Herbicide	Dispersible granules	Sulfentrazone Chlorsulfuron	Non-Crop **	0.141	0.141
DuPont™ Throttle™ XP Herbicide	Dispersible granules	Sulfentrazone Chlorsulfuron	Non-Crop	0.141	0.141

Product Name	Type of Formulation	Additional Active Ingredient(s)	Use Site(s)	Single App. Low Rate (pounds a.i.)	Single App. High Rate (pounds a.i.)
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Conifer Site Preparation (pre-plant)	0.063	0.250
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Conifer Release (post-transplant)	0.125	0.188
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Conifer Site Preparation or Post-transplant for specific weeds (e.g., Kudzu)	0.281	0.375
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Hardwoods (seedlings or transplants in dormancy)	0.023	0.234
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Non-Crop: "Non-Agricultural"*	0.035	0.375

Product Name	Type of Formulation	Additional Active Ingredient(s)	Use Site(s)	Single App. Low Rate (pounds a.i.)	Single App. High Rate (pounds a.i.)
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Non-Crop: Under asphalt and concrete pavements (before paving)	0.188	0.375
SFM 75, SFM Extra	Dispersible granules	Only in tank mixes	Non-crop: Turf (unimproved)	0.023	0.188
** Non-Crop lumps together uses such as rights-of-way, industrial site weed management, applications prior to concrete or asphalt paving, unimproved turf, etc. * "Non-agricultural" is a term on Vegetation Management LLC labels that includes most of the non-crop uses not otherwise specifically listed.					

3.2. EXPOSURE CHARACTERIZATION

3.2.1. Environmental Fate and Transport Characterization

The body of environmental fate data submitted demonstrates sulfometuron is mobile and persistent in the environment (Table 10). Sulfometuron methyl is more soluble in neutral and alkaline water than in acidic water. The major route of dissipation for sulfometuron methyl is believed to be aerobic and anaerobic degradation / metabolism in soil and water (pseudo first-order degradation half-lives[2] generally around 2 to 6 months), with hydrolysis potentially dominant under acidic conditions. First-order rate aerobic soil metabolism half lives range from 52 to 58 days in two laboratory studies (technically both with the same soil type, but measured in two independent studies several years apart). In comparison, lump dissipation half-lives in the field ranged from 44 to 128 days at four sites (when considering only the residues remaining in the upper 15 cm of topsoil and calculating a lumped pseudo first-order rate including all residue data during the entire ca. 350 to 500 days of each study)[3]. At all four field study sites, about 99 % of the applied sulfometuron methyl had dissipated from the upper six inches of the soil profile within 3 to 6 months after application, but dissipation of the small amount of sulfometuron methyl remaining in the topsoil a few months after application was much slower. Sulfometuron methyl is subject to hydrolysis at environmental pHs; with significantly more rapid hydrolysis occurring under acidic conditions (e.g., a hydrolysis half-life of 9 days at pH 5 and 139 days at pH 7). None of the laboratory and field studies in soil or sediment / water environments, albeit all at measured pHs somewhat greater than 5, show as rapid degradation as measured in the pH 5 hydrolysis study.

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Metabolism in the aquatic environment is variable, ranging from half-life of 17 to 104 days in anaerobic conditions and 9 to 187 days for aerobic conditions (the more rapid degradation with a 9-day total system half-life took place in a test system with sediment pH of 5.4 and water pH of 7.6). Although sulfometuron methyl persistence is expected to generally increase with higher soil pH (rotational crop restrictions for many other sulfonylureas, which are all weak acids, reflect this), a consistent trend was not found in the available studies.

Soil retention of sulfometuron methyl is low, with Freundlich adsorption K_F values ranging between 0.15 and 2.1 $(mg/kg)/(mg/L)^n$ in four test soils with soil organic carbon content ranging between 0.6 and 2.6 percent.

Sorption was not found to be strongly dependent on any of the major properties of the tested soils in the registrant-submitted studies. The pKa of sulfometuron methyl is 5.4, and theoretically, adsorption may increase in very acidic soils where the methyl ester form of

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[2] All first-order rates / degradation half-lives discussed in this document, were, unless otherwised specified, calculated from linear regression of log-transformed decay data.

[3] In most cases simple first-order degradation rates and half-lives (calculated from linear regression of log-transformed data) are used (often along with DT50 and DT90 values) to represent sulfometuron methyl persistence in the environmental fate studies. However, particularly in the field dissipation studies, over time pseudo first-order kinetics often became less of an adequate descriptor for residue decline; in such cases the DT50 and DT90 values provide perspective on how much the decline patterns deviated from that predicted by a first-order model.

sulfometuron would predominate. However, the pH range of the four test soils in the batch equilibrium adsorption / desorption study was only 6.7 to 7.7 . The published literature do seem to show more of a relationship of sulfometuron methyl and other sulfonylureas to mobility in soil; Weber et al. (2004) have reviewed the literature and concluded that there is consistent relationship between pH and mobility of sulfonylureas ("$NHSO_2$ acid herbicides" means sulfonylurea herbicides):

> OM and pH were also the primary soil properties in best-fit K_d equations obtained for five of the six $NHSO_2$ acid herbicides, with all three soil properties utilized in the K_d equation for sulfometuron-methyl. Cl was also one component of the K_d equation for sulfometuron-methyl, but Cl and pH were also related soil properties. As was the case for the COOH acid herbicides, sorption increased as OM increased or as pH decreased.

Other abbreviations used in the above excerpt from the Weber et al. article:
OM = Soil organic mater content
Cl = Chloride ion concentration
COOH acid herbicides = Herbicides with a carboxy acid functional group such as 2,4-D and Imazethapyr

Weber et al. developed the following specific equation for predicting sulfometuron adsorption from soil properties:

$K_d = 3.0 + 0.49(OM) – 0.03(Cl) – 0.47(pH) \pm 2.3$

In general, sulfonylureas were found to have the strongest correlation between soil pH and the measured pesticide K_d of any of ten families of pesticides tested; the correlation of soil percent OM and K_d was second to "OH acid" (uracil) herbicides such as bromacil. Similarly, soil pH and % OM together accounted for more of the variability in soil K_d for these two classes of herbicides (54% for sulfonylureas and 67% for uracils) than for any of the other pesticide families evaluated.

Based on the of McCall et al. (1981) mobility classification system sulfometuron methyl is mobile to highly mobile in each of the test soils.

In terrestrial field dissipation studies at four US sites, leaching of parent sulfometuron methyl occurred at measurable concentrations; (>10 ppb in depth increments from 15 to 90 cm) was noted at each test site. Consistent with the terrestrial field dissipation and the aged leaching results, minimal levels (but possibly still high enough to be phytotoxic) of sulfometuron methyl residues were estimated for ground water (0.33 ug/L for vulnerable aquifers) using the SCI-GROW model. Leaching of the degradates was not evaluated in the field dissipation studies.

Sulfometuron persistence in water indicates that if, either via spray drift or any runoff event, sulfometuron methyl reaches surface water, it may persist for a few weeks to several months and present some concern to surface water resources. The fairly low use rate (maximum annual rate of 0.375 lb ai/A) and the apparent typical use pattern of applying in only one or two years out of a several year period should limit the actual exposure of sulfometuron methyl parent residues in surface water (however, note that sulfometuron methyl could negatively affect certain sensitive plants at very low exposure levels because it is such a potent herbicide with respect to many plant species).

Aquatic modeling at the highest application rate applied every year results in a peak surface water estimated environmental concentration (EEC) of 31.5 µg/L; additional assumptions for this modeling are discussed in "Section 3.2.2.2, Aquatic Exposure Modeling". Note that sulfometuron methyl was not predicted to accumulate in the receiving pond so the effect of sulfometuron methyl on EECs determined only was significant for the chronic (not acute) exposure estimates.

Volatility studies were not reported. However, based its chemical properties, volatilization is not expected to be a route of dissipation of sulfometuron methyl in water or soils.

Sulfometuron methyl degrades to CO_2 under aerobic, non-sterile conditions (relatively little mineralization occurs under sterile conditions), but with significant accumulation of intermediate degradates, including a sulfonamide and saccharin from the phenyl ring part of the parent molecule and a pyrimidine amine from the pyrimidine ring portion (see "APPENDIX A: Structures and Chemical Names of Sulfometuron methyl Metabolites"). For the phenyl ring labeled studies, CO_2 was up to 28 to 44 % of applied at study termination whereas for the pyrimdine-ring labeled studies CO_2 was up to 53% of applied at study termination (see Table 10, aerobic soil metabolism studies, for further information). Additional details on the accumulation of sulfometuron methyl degradates in the various studies will be provided in a Drinking Water Assessment for Sulfometuron Methyl.

The only submitted studies directly evaluating the fate of sulfometuron methyl degradates were adsorption / desorption studies on the pyrimidine amine and saccharin. The soil retention characteristics of two of the sulfometuron methyl degradates were studied in batch equilibrium adsorption / desorption studies: saccharin K_fs were 0.03 to 0.27 and the pyrimidine amine K_fs were 0.17 to 3.70 in the four test soils (Table 10). This means saccharin would be slightly more mobile and the pyrimidine amine slightly less mobile than parent (K_fs of 0.15 to 2.12 in the same four soils)

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value[1]***	***MRID(s)***
Hydrolysis [161-1]	**$t_{½}$= 8.8 days** @ 25 °C, pH 5; **$t_{½}$=139 days** @ 25 °C, pH 7; **$t_{½}$= 224 days** @ 25 °C, pH 9. **Major degradates (from cleavage of the sulfonylurea bridge):** Sulfonamide – only in acidic water Saccharin – all pH levels Pyrimidine amine – all pH levels	42715201

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value*[1]**	***MRID(s)***
Direct photolysis in water [161-2]	**Combined labels results:** **$t_{½}$= 428 days** @ 24 °C, pH 5; **$t_{½}$= stable** @ 24 °C, pH 7; **$t_{½}$= stable** @ 24 °C, pH 9. (calculated by the difference in degradation rates between irradiated and dark controls and adjusting for typical light levels on sunny days) **Major degradates (irradiated water):** pH 5: sulfonamide, pyrimidine amine; pH 7: none; pH 9: none.	42182401 43174101
Photolysis on soil [161-3]	**$t_{½}$= 72.1 days** @ 25 °C, Study duration was 33 days, substantial degradation occurred in dark controls and the calculated photolysis half-life represents the difference in the dissipation rate in the irradiated and the dark control samples. **Major degradates (from cleavage of the sulfonylurea bridge):** Saccharin reached a maximum of 48.4% of the applied at 33 days (study termination.) Pyrimidine amine reached a maximum of 53.1% at 33 days (study termination.) There was no substantial difference in the degradation pathway of sulfometuron methyl between the irradiated- and the dark control soil. No other degradate accounted for >4% of the applied radioactivity regardless of whether the phenyl ring or the pyrimidine ring was ^{14}C-labeled.	41420601

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value[1]***	***MRID(s)***
Aerobic soil metabolism [162-1]	Study with [pyrimidine-2-^{14}C] Sulfometuron Methyl **Soil: Keyport Silt loam (pH 6.3, 1.6% O.C.) from Delaware** First Order **$t_{½}$**: 57.8 days (r^2 = 0.9239). Observed DT50: 23 days. Observed DT90: 110 days. Sterile soil First Order **$t_{½}$**: 364 days Major transformation products: Pyrimidine amine (maximum 41.0% of the applied) Pyrimidine-ol (maximum 10.5% of the applied). CO_2 (maximum 53.1% of applied). Minor transformation products: Free acid sulfometuron methyl. Pyrimidine urea.	42091401
Aerobic soil metabolism [162-1]	Study with U-^{14}C-phenyl-labeled Sulfometuron Methyl **Soil: Keyport Silt loam (pH 6.4, 1.6 % O.C.) from Delaware (0.12 mg a.i./kg).** First Order **$t_{½}$**: 52.5 days (r^2 = 0.9239). Observed DT50: 29 days. Observed DT90: 162 days. Major transformation products: Sulfonamide. Saccharin. Free acid sulfonamide plus urea (1.0 mg a.i./Kg only). CO_2. Minor transformation products: Free acid sulfonamide plus urea (0.12 mg a.i./Kg only)	43174102 and 245375

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	*Value[1]*	*MRID(s)*
Anaerobic aquatic metabolism [162-3]	Study performed with [pyrimidine-2-^{14}C] Sulfometuron Methyl **Matrix: Bradenton Pond water-sand sediment.** First Order $\mathbf{t_{½}}$: 37.4 days (r^2 = 0.6125). Observed total system DT50: 22 to 61 days (inconsistent decline data). Observed total system DT90: 102 days. **Matrix: Landenberg Pond water-sandy loam sediment.** First Order $\mathbf{t_{½}}$; total system: 17.1 days (r^2 = 0. 0.6394). Observed total system DT50: 6.1 days. Observed total system DT90: 21.7 days. Major transformation products (both systems): free acid sulfometuron methyl. pyrimidine amine. Minor identified transformation products: pyrimidine-ol. CO_2.	42091402 and 43188601

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	*Value*[1]	*MRID(s)*
Anaerobic aquatic metabolism [162-3]	Study with [phenyl-U-^{14}C] Sulfometuron Methyl **Matrix: Pond water-sandy loam sediment from Bradenton, Florida.** **(water pH 5.5 . Sediment: pH 5.1; O.C. = 5.9 %).** First Order **t**½; total system: 104 days (r^2 = 0.4883)*. Observed DT50 in total system: *ca.* 21 days. Sterile **t**½; total system: 44 days ** Based upon limited and inconsistent data.* **Matrix: Pond water-silt loam sediment from Landenberg, Pennsylvania.** **(water pH 5.8 . Sediment: pH 5.6; O.C. = 2.1 %).** First Order **t**½; total system: 87 days (r^2 = 0.3577). Observed DT50 in total system: *ca.* 28 days. Sterile **t**½; total system: 175 days **Matrix: Pond water-loam sediment from Saskatoon, Canada.** **(water pH 8.3 . Sediment: pH 7.8; O.C. = 0.9 %).** First Order **t**½; total system: 77 days (r^2 = 0.5853). Observed DT50 in total system: *ca.* 70 days. Sterile **t**½; total system: 399 days **Matrix: Pond water-silt loam sediment from Walnut Grove, Tennessee. (water pH 5.5 . Sediment: pH 5.1; O.C. = 0.5 %).** First Order **t**½; total system: 73 days (r^2 = 0.5691). Observed DT50 in total system: *ca.* 28 days. Sterile **t**½; total system: 95 days Major transformation products: saccharin. free acid sulfonamide. Minor identified transformation products: Methyl-2-aminocarbonyl(aminosulfonyl)benzoate.	4413010-20 (143540)

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value[1]***	***MRID(s)***
Aerobic aquatic metabolism [162-4]	Study performed with [pyrimidine-2-^{14}C] Sulfometuron Methyl **Matrix used: Pond water-silt loam sediment (Landenberg, acidic system).** First Order **$t_{½}$**; total system: 9.2 days (r^2 = 0.94). Observed DT50 in total system: 15 days. Observed DT90 in total system: 31 days (extrapolated). Major transformation products: Pyrimidine amine (pyrimidine label). Hydroxymethyl-pyrimidine sulfometuron methyl. Free acid sulfonamide (phenyl label). Sulfonamide (phenyl label). Minor identified transformation products: CO_2. **Matrix used: Pond water-sand sediment (Bradenton, alkaline system).** First Order **$t_{½}$**; total system: 187.3 days (r^2 = 0.5713). Observed DT50 in total system: >39 days. Major transformation products: Pyrimidine amine (pyrimidine label). Free acid sulfonamide (phenyl label). Minor identified transformation products: Hydroxymethyl-pyrimidine sulfometuron methyl. Sulfonamide (phenyl label). CO_2.	42091403 and 43174103

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	*Value*[1]	*MRID(s)*
Adsorption/ Desorption (K_d and $\mathbf{K_{oc}}$ in L Kg^{-1})	**Parent sulfometuron methyl:** Soil type: Chino Sandy loam; pH 7.1, organic carbon 1.0%. Adsorption K_d: 0.35. Adsorption K_{oc}: 35. Freundlich adsorption K_F: 0.153. Freundlich adsorption K_{Foc}: 14.7. 1/N 0.504 Soil type: Fargo silt loam ; pH 7.7, organic carbon 2.6%. Adsorption K_d: 2.07. Adsorption K_{oc}: 79.6. Freundlich adsorption K_F: 2.12. Freundlich adsorption K_{Foc}: 83.2. 1/N 1.23 Soil type: Miaka Sand ; pH 7.0, organic carbon 0.6%. Adsorption K_d: Not applicable. Adsorption K_{oc}: Not applicable. Freundlich adsorption K_F: 0.508. Freundlich adsorption K_{Foc}: 87.6. 1/N 1.61 Soil type: Tama Silt loam ; pH 6.7, organic carbon 1.5%. Adsorption K_d: 0.79. Adsorption K_{oc}: 52.7. Freundlich adsorption K_F: 0.974. Freundlich adsorption K_{Foc}: 67.2. 1/N 0.851	42789301

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value[1]***	***MRID(s)***
Adsorption/ Desorption Of Degradates	**<u>Pyrimidine amine</u>** Although the registrant conducted adsorption / desorption studies for the pyrimidine amine degradate, the results were insufficiently documented to verify their calculations of adsorption coefficients (and furthermore, they only reported Freundlich adsorption "K_F" and "K_{Foc}" values without 1/N values (or sufficient data for the reviewer to calculate them) and K_d values were also not reported. For rimsulfuron, a structurally similar pyrimidine amine degradate (but with 4-, 6-dimethoxy rather than 4-, 6-dimethyl substitution of the pyrmidine amine) was reported to have K_d values of 0.23 to 1.52 and K_{oc} values of 19 to 61 in four test soils. See DP Barcode D326660, EFED review of rimsulfuron methyl new uses dated 3/14/07 for more details. **<u>Saccharin</u>** Although the registrant conducted adsorption / desorption studies for saccharin, the results were insufficiently documented to verify their calculations of adsorption coefficients (and furthermore, they only reported Freundlich adsorption "K_F" and "K_{Foc}" values without 1/N values and K_d values were also not reported. Saccharin has been reported elsewhere to be quite mobile, e.g.: When tested as a degradate of metsulfuron methyl (http://ec.europa.eu/food/plant/protection/evaluation/existactive/list1-13_en.pdf)	42789301

Table 10. Key results of sulfometuron methyl environmental fates studies.

Parameter [Guideline #]	***Value[1]***	***MRID(s)***
Terrestrial Field/Lysimeter Dissipation [2]	Greenville, MS silty clay loam soil: pH 6.7, 0.6% O.C. Half-life: 49.2 days (based on 0- to 359-day data); 12.2 days (based on 0- to 91-day data). DT90: 32 days Major transformation products detected (>0.01 ppm): Sulfometuron free acid (SFA) Pyrimdine amine (PYA) Sulfonamide IN-D5803 (SFN) Saccharin IN-581 (SCC) Rochelle, IL silty clay loam soil: pH 6.8, 1.0% O.C. Half-life: 128 days (based on 0- to 723-day data, residues in 0-15 cm depth only); 14.4 days (based on 0- to 90-day data). DT90: 35 days Major transformation products detected (>0.01 ppm): PYA, SFN, and SCC Uvale, TX clay soil: pH 7.9, 1.3% O.C. Half-life: 53.3 days (based on 0- to 447-day data); 13.0 days (based on 0- to 90-day data). DT90: 25 days Major transformation products detected (>0.01 ppm): PYA, SFN, and SCC Maldera, CA sandy loam soil: pH 7.8, 0.7% O.C. Half-life: 44.1 days (based on 0- to 420-day data); 22.9 days (based on 0- to 180-day data). DT90: 55 days Major transformation products detected (>0.01 ppm): PYA, SFN, and SCC	Numbers 43212101 and 43637101

[1] Unless otherwise specified, half-lives were derived with a "Log-linear" degradation rate calculation; a process of calculating degradation rates and half-lives from linear regression of log-transformed concentration measurements over time. This provides a first-order type of measurement of pesticide decline.

[2] For these field dissipation studies, differences between half-lives measured over various time durations apparently reflect both slowing of degradation at lower temperatures and a large variability in measured concentrations; also, a 2-compartment degradation model for adsorbed and dissolved sulfometuron is quite possibility more appropriate (little dissipation of the remaining residues in the topsoil occurred during the second year of these studies, for example). A 2-compartment model was not used to represent dissipation rate here because the data are not sufficient robust (e.g., very high variability between replicate measurements), the effects of weather changes on degradation rate cannot easily be isolated, and the amount of residues lost through dissipation out of the topsoil also cannot be separated from the amount lost to degradation. At all four of these field study sites about 99% of the applied sulfometuron methyl dissipated from the topsoil within 3 to 6 months.

3.2.2. Measures of Aquatic Exposure

3.2.2.1. Aquatic Exposure Monitoring and Field Data

A few surface-water monitoring studies are available for sulfometuron methyl. In streams, Michael (2003) found that application of sulfometuron methyl at 0.42 kg/ha (spayed) and 0.37 kg/ha (pelleted formulation) to watersheds reflecting a forestry planting usage resulted in concentrations of sulfometuron methyl in runoff water collected at the edge of the field of up to 30 ug/L for the spayed formulation and 49 ug/L for the experimental pelleted formulation (24-h average). However, samples taken approximately 150 meters downstream never exceeded the minimum limit of quantification of 1 ug/L (a fairly high MDL given the potency of this herbicide) reported in this study (stream flow data were not supplied).

In the most widespread monitoring survey available, sulfometuron methyl was detected only rarely (2 of 132 samples from 52 sites – mostly Midwestern US streams and rivers, but including some reservoirs as well); see Battaglin et al. (2000). The maximum concentration of sulfometuron methyl detected was 0.018 ug/L; but it is not known how much sulfometuron methyl usage was associated with the watersheds included in this monitoring survey.

Blomquist et al. (2001) in a monitoring study of 12 reservoir systems across the United States found sulfometuron occurred above the minimum reporting limit of 0.05 ug/L in 12% of the samples collected with a maximum concentration of 0.16 ug/L and a 95th percentile concentration of 0.10 ug/L. This study focused on drinking water supplies and may not represent the most vulnerable water bodies for ecological exposure.

3.2.2.2. Aquatic Exposure Modeling

EFED's PRZM (Pesticide Root Zone Model) and EXAMS (EXposure Analysis Modeling System) models (Table 11) were used in this assessment to estimate the exposure of sulfometuron methyl residues to the aquatic environment as a result of the proposed uses in forestry and various non-crop land vegetation control uses. PRZM simulates pesticide transport as a result of runoff and erosion from an 10-hectare agricultural field and EXAMS considers environmental fate and transport of pesticides in surface water and predicts EECs in a standard pond (10,000-m^2 pond, 2-m deep), with the assumption that the small field is cropped at 100%. Calculations are carried out with the linkage program shell – PE5.pl - which incorporates the standard scenarios developed by EFED. (For additional information see http://www.epa.gov/oppefed1/models/water/index.htm). Potential exposure from ground-water (for, example, via contaminated irrigation water) was also estimated using the SCI-GROW model.

Table 11. Models Used to Estimate Exposure Concentrations for Aquatic Ecosystem.

Exposure Estimate Type	Models Used
Aquatic ecosystems Surface water (Tier II)	PE v5.0, PRZM v3.12.2, EXAMS v2.98.04.06 Details of executables: PRZM 3.12.2, named przm3122.exe (dated May 12, 2005) EXAMS 2.98.04.06, executable file named EXAMS.EXE (dated April 12, 2005) PE v5.0, Executable file PE5.pl (dated July 24, 2006)
Ground water (Tier I)	SCI-GROW v2.3 Executable file sg23.exe (dated May 16, 2006)

The estimated environmental concentrations (EECs) were predicted assuming 1 aerial or ground application at the maximum allowable single application rate of 0.375 lbs. a.i./A (which also represents the maximum annual application amount permitted on all labels). Applications were broadcast without incorporation, according the uses endorsed by the label. None of the available modeling scenarios as currently set up represents a clear match for the sulfometuron methyl use pattern as described in Section 3.1 . Nonetheless, a combination of scenarios which represent usage patterns and locations that can reasonably be expected to represent a range of conditions for the forestry planting and non-crop uses of sulfometuron methyl were able to be selected from the suite of available standard scenarios and, with slight adjustments, the available regional scenarios (see Table 12). The major adjustments to the standard scenario modeling were:

1. **Specific regional scenario adjustments**. The rights-of-way regional scenarios were selected for this national assessment because they are the only scenarios currently approved in EFED for specific modeling of this type of use. However, they were run with both their native meteorological files as the source of weather data and with alternate weather data files believed to represent more runoff-prone climates that may represent areas with significant use of sulfometuron methyl

2. **Modeling with multiple application dates**. The multiple PRZM – EXAMS runs with multiple application dates were used for final development of EECs for the highest exposure scenarios because the product labels frequently refer to uses that are recommended for spring, summer, fall, and even winter application (although only spring, summer, and fall dates were tested with our modeling, as they were judged to be significantly more common than winter applications).

The most important reason for modeling with multiple application dates is that there is significant variability in the results (calculated EECs) of the modeling that can arise strictly as a factor of the application date chosen. In fact, when, for example, the Texas Right-of-Way scenario (using Port Arthur, Texas meteorological data) was rerun with 28 different application dates, the acute (peak daily value) EECs (a distribution of 1 in 10-year return frequency values) ranged from 8.5 to 49.5 ug/L and the 90-day EECs ranged from 5.5 to 27.2 ug/L[4]. This is quite a significant difference when it is considered that this variability is solely for the 1 in 10 year return frequency exposure levels, not for all of the year-to-year differences in EECs from the modeling.

Sulfometuron methyl product labels allow for flexibility in when sulfometuron methyl is applied and there is not as much consistency in the optimal application season as there would be, for example, with most agricultural crops. In this case, the 90th percentile application date model results were chosen for risk calculations.

Both aerial and ground applications were simulated, but ground applications were only simulated for a few scenarios since the ground application assumption yielded lower EEC estimates for sulfometuron methyl than aerial applications at the same site.

The pesticide-specific input parameters for this modeling (summarized in Table 13) were selected from the environmental fate studies submitted by the registrant, and in accordance with the US EPA-OPP EFED water model parameter selection guidelines, *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides*, Version II, February 28, 2002.

We considered modeling total residues of sulfometuron methyl (including sulfometuron methyl, sulfometuron free acid, the sulfonamide, saccharin, and the pyrimidine amine) as well, since the Health Effects Division has made a preliminary call that they might contribute to toxicity in mammals (electronic mail message from Larry Chitlik, HED dated /7/2007). However, with the available data total residue model inputs would be different from assumptions for the parent compound (Table 13) in that stability to hydrolysis, aerobic aquatic metabolism, and anaerobic aquatic metabolism hand to be assumed (only aerobic soil metabolism had a measurable total residue half-life: 136 days). This would lead to an assumption of no degradation in the pond represented by EXAMS, which is set up for a pond with no turnover in ecological risk assessments (an additional conservative assumption). Further details on the limitations of the modeling and uncertainties regarding exposure to sulfometuron methyl degradates are provided in Section 3.2.4.3.

[4] A measure of how often (on average) an event will occur that is greater than some chosen value. In this case, the chosen frequency is 1 in 10 years; the chosen EEC is such that the sulfometuron methyl concentration would equal or exceed the EEC on average of one in ten years. The full distribution of the 1 in 10 year return frequency values is provided in APPENDIX C: Ecological Aquatic Exposure Modeling.

TABLE 12. AQUATIC EXPOSURE WITH PRZM – EXAMS: MODELING SCENARIOS AND REPRESENTATIVE USAGE PATTERN SUMMARY.

Scenario ID[1]	WBAN (met. file)[2]	appl. meth.	CAM[3]	applictn. dates (MM-DD)	Use(s) represented
PA Apples (std)	W14751	Aerial	2	03-15	Forestry, Conifer Plantations
FL Citrus (std)	W12844	Ground	1	03-01	Forestry, Conifer Plantations
FL Citrus (std)	W12844	Aerial	1	03-01	Forestry, Conifer Plantations
FL Turf (std)	W12834	Ground	1	03-01	Non-crop (e.g., unimproved turf & rights of way)
FL Turf (std)	W12834	Aerial	2	03-01	Unimproved turf, non-crop
PA Turf (std)	W14751	Aerial	2	03-01	Unimproved turf, non-crop
OR Xmas Trees (std)	W24232	Ground	1	03-01	Christmas Trees, Forestry, Conifer Plantations
OR Xmas Trees (std)	W24232	Aerial	2	03-01	Christmas Trees, Forestry, Conifer Plantations
CA right of way (RLF)	W23234	Aerial	2	03-01	Non-Crop (rights of way, unimproved turf, railroads, etc.)
CA right of way (RLF)	W94224	Aerial	2	03-01	Non-Crop (rights of way, unimproved turf, railroads, etc.)
CA right of way (RLF)	W94224	Aerial	2	Feb to Oct[4]	Non-Crop (rights of way, unimproved turf, railroads, etc.)
TX right of way (BSS)	W13958	Aerial	2	03-01	Non-Crop (rights of way, unimproved turf, railroads, etc.)
TX right of way (BSS)	W12917	Aerial	2	03-01	Non-Crop (rights of way, unimproved turf, railroads, etc.)
TX right of way (BSS)	W12917	Aerial	2	Feb to Oct[4]	Non-Crop (rights of way, unimproved turf, railroads, etc.)
TX right of way (BSS)	W12917	Ground	2	Feb to Oct[4]	Non-Crop (rights of way, unimproved turf, railroads, etc.)

[1] Native scenario designation state and use site. Native scenario target in parenthesis, where: std = std scenario used in nationwide assessments; RLF = scenario originally developed for regional assessments related to the California red-legged frog; and BSS = scenario originally developed for regional assessments related to the Barton Springs salamander.
[2] The Weather Bureau Automated Network (WBAN) meteorological station used for weather inputs in the runoff modeling.
[3] CAM = Chemical application method. CAM 1 is application direct to soil, although a 4 cm incorporation depth is automatically assumed, to account for surface roughness. CAM 2 is linear foliar decay based on crop canopy, default soil incorporation depth for non-foliar intercepted chemical is 4 cm.
[4] Only one application per year in each model run. PRZM-EXAMS was separately run for application dates between February 1 and October 29, increasing the application date by 10 Julian days with each successive model run (2/1, 2/11, 2/21, etc.).

Table 13. PRZM/EXAMS input parameters for modeling (Aquatic ecological EECs).

Input Parameter	*Value**	*Reference*

Table 13. PRZM/EXAMS input parameters for modeling (Aquatic ecological EECs).

Input Parameter	*Value**	*Reference*
Molecular Weight (gram mole $^{-1}$)	364.38	MRID: 416728-02
Vapor Pressure (torr)	$5.4x10^{-16}$	
Aerobic Soil Metabolism Half-life (days)	60.9	90% Upper Confidence Limit of the mean of measured values (MRIDs 42091401; 43174102 and 245375)
Water column Half-life (days) (Aerobic Aquatic Metabolism half-life)	292	90% Upper Confidence Limit of the mean of measured values (MRIDs 42091403 and 43174103)
Benthic sediment Half-life (days) (Anaerobic Aquatic Metabolism half-life)	76	90% Upper Confidence Limit of the mean of measured values (MRIDs 43174102, 245375, 42091402, and 43188601)
Application Rate (Kg a.i./ha)	0.41	Efficiency= 0.99 for ground spray, 0.95 for aerial.
Application Number (Method of application)	One	Product Label; typical use.
Application method; Depth of Incorporation (cm)	Aerial or ground; 0	CAM=1 or CAM=2 depending on the use.
Spray Drift (fraction)	0.01 (GS), 0.05 (aerial)	Default values per guidance document. (GS= ground spray)
Solubility (ppm)	244	Highest solubility was recorded for alkaline water (12,500 ppm at pH 8.6). However, experience from other studies indicates these experimental values are too high (Therefore, this value was not multiplied by 10 as normally recommended).
K_{oc} (L Kg^{-1})	47.5	Average of four values (MRID 42789301). K_{oc} model was determined to be appropriate.
Hydrolysis Half-life @ pH 7 (days)	139 days	MRID 42715201.
Direct Aqueous Photolysis Half-life(days)	Stable	Maximum dark control corrected value (MRIDs 42182401 and 43174101)

Fate data values are as per Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides; Version II February 28, 2002.

The highest exposures were determined to occur with aerial applications at rights of way sites; the southeast Texas (using Port Arthur, Texas weather) scenario and a scenario for Pacific Coastal areas utilizing Astoria, Oregon weather). The Florida citrus scenario also yielded relatively high EEC estimates, and it provides some representation of forestry planting and other uses in the southeastern US (Table 14). Chosen EEC values for the aquatic risk assessments are provided in Table 15. Note that whereas in the modeling sulfometuron methyl applications were simulated for every year of a 30-year simulation period for each scenario (standard EFED practices if the product labels do not expressly prohibit this), in most cases sulfometuron does not appear to be repeatedly used from year to year at a particular site. However, in this modeling, sulfometuron methyl was not predicted to accumulate in the receiving pond so the effect of sulfometuron methyl on EECs determined only was significant (e.g., if the 30 applications simulated were to be spread over 150 years, the acute EECs would remain about the same, but the chronic EECs estimated would be lower).

Table 14. Estimated environmental concentrations (µg/L) for aquatic exposure to parent sulfometuron methyl: scenario-specific results from PRZM-EXAMS modeling.

(all values are listed as ppb or ug/L)

Scenario Description	*Site*[1]	*Peak*	*96 hr*	*21 Day*	*60 Day*	*90 Day*	*Yearly*	*Lifetime*	*Applictn. Date, mm-yy*	*App-Type*[3]
PA Apple	Fr	2.28	2.23	2.05	1.61	1.39	0.45	0.31	3-15	aerial
FL Citrus	Fr	9.39	9.09	7.97	6.03	4.93	1.48	0.72	3-01	aerial
FL Citrus	Fr	7.32	7.08	6.19	4.71	3.81	1.14	0.43	3-01	ground
FL Turf	NC	1.47	1.43	1.27	1.01	0.86	0.29	0.20	3-01	aerial
FL Turf	NC	0.46	0.44	0.39	0.30	0.25	0.09	0.05	3-01	ground
PA Turf	NC	1.22	1.20	1.12	0.96	0.84	0.29	0.26	3-01	aerial
OR Xmas	Fr	1.57	1.53	1.42	1.21	1.06	0.40	0.29	3-01	aerial
OR(Astoria) Xmas	Fr	2.87	2.82	2.61	2.18	1.91	0.73	0.42	3-01	aerial
OR(Astoria) Xmas	Fr	1.78	1.74	1.58	1.29	1.13	0.43	0.35	9-01	aerial
CA RightsWay	NC	8.33	8.15	7.47	6.17	5.35	2.00	0.84	3-01	aerial
CA(As-OR) [4] RightsWay	NC	13.64	13.37	12.39	10.35	9.04	3.42	1.34	3-01	aerial
CA(As-OR) RightsWay 90th date[5]	NC	11.01	10.83	10.10	8.46	6.73	2.73	1.44	various [6]	aerial
TX RightsWay	NC	6.96	6.74	5.99	4.72	3.94	1.22	0.64	3-01	aerial
TX(PtAr) [7] RightsWay	NC	11.87	11.55	10.66	8.84	7.41	2.30	1.06	3-01	aerial
TX(PtAr) RightsWay 50th date	NC	21.75	20.93	18.33	13.51	10.99	3.39	1.97	Various	aerial
TX(PtAr) RightsWay 90th date	NC	31.45	30.34	26.24	20.45	16.49	5.26	3.14	Various	aerial
TX(PtAr) RightsWay 90th date	NC	26.08	25.20	21.64	15.51	12.48	3.92	2.05	Various	ground

[1] Fr = forestry plantings uses. NC = Non-crop uses on rights of way, industrial land with unimproved turf, on ground prior to paving, railroads, etc.
[2] CAF = crop area factor.
[3] App-Type = application type.
[4] As-OR = Astoria, Oregon meteorological weather substituted for the original San Francisco, CA weather data for this regional scenario.
[5] 90th Date or 50th Date = For the specified exposure distribution the 90th percentile of the 10th percentile exceedence probability (1 in 10 year return

frequency) values were sorted for each model run with different Julian day application dates (single application per year). Then each of the 1 in 10 year values were sorted and the concentration exceeded for 1 in 10 of the possible application dates was selected to be representative for the scenario.

[6] Pt-Ar = Port Arthur, Texas meteorological weather substituted for the original Austin, TX weather data for this regional scenario.

[7] Only one application per year in each model run. PRZM-EXAMS was separately run for application dates between February 1 and October 29, increasing the application date by 10 Julian days with each successive model run (2/1, 2/11, 2/21, etc.).

Table 15. Sulfometuron methyl surface water EECs used in aquatic risk assessment.

Surface Water EECs in ug/L[1]							
Application method	Peak	96-hr	21-day	60-day	90-day	Annual Average	Yearly Average
Aerial	31.45	30.34	26.24	20.45	16.49	5.26	3.14
Ground	26.08	25.20	21.64	15.51	12.48	3.92	2.05

[1] Results based on PRZM/EXAMS modeling described in Section 3.2.2.2 using the maximum annual application rate of 0.375 lb ai/A.

Since some exposure to sensitive terrestrial plants is possible from contaminated ground water as well as from ground-water entering surface waters during base flow periods, a Tier I estimate of ground-water exposure was conducted using SCI-GROW 2.3 (executable file dated 5/16/2006). The estimate of 0.33 ug/L concentrations in vulnerable ground water (defined as aquifers where the water table is about 10 to 30 feet in depth and the overlying soil layers are permeable) would indicate that contributions from ground water into surface waters would not reach levels estimated to enter surface waters from direct runoff and spray drift in the PRZM – EXAMS modeling . However, the levels of sulfometuron methyl in contaminated well water used for irrigation could be phytotoxicologically significant.

Table 16. Estimated concentrations of sulfometuron methyl in ground water (SCI-GROW inputs and results).

Input Parameter	*Value**	*Reference*
Aerobic Soil Metabolism Half-life (days)	55.2	Mean of measured values (MRIDs 42091401; 43174102 and 245375)
Application Rate (Kg a.i./ha)	0.41	Maximum permitted single (and annual) rate.
Application Number (Method of application)	One	Typical use.
K_{oc} (L Kg^{-1})	73.4	Median of four values (MRID 42789301).
SCI-GROW Modeling Results		
Acute Exposure EEC, ug/L	0.33	
Chronic Exposure EEC, ug/L	0.33	

3.2.3. Measures of Terrestrial Exposure

3.2.3.1. Terrestrial Exposure Modeling

Terrestrial Animals. Estimates of terrestrial wildlife exposure to pesticides are typically evaluated for the dietary pathway for birds and mammals (USEPA, 2004). Birds are used as surrogates for reptiles and terrestrial phase amphibians when specific data are unavailable for these taxonomic groups. Consistent with this practice and with the conceptual model for sulfometuron in Section 2.5**,** a screening-level risk assessment was conducted for spray applications of sulfometuron methyl for estimating wildlife exposure to sulfometuron methyl via dietary uptake. Specifically, pesticide residues on food items of wildlife (birds and mammals) were estimated based on the assumption that animals are exposed to a single pesticide residue (sulfometuron methyl) in a given exposure scenario. For this terrestrial exposure assessment, only spray application methods for sulfometuron methyl are considered, since labeling does not permit granular applications.

Estimating sulfometuron methyl concentrations on wildlife food items focuses on quantifying possible dietary ingestion of residues on vegetative matter and insects. No field residue data or field study information is available for sulfometuron methyl except for lump dissipation rates from the application of sulfometuron methyl to two forest sites (MRIDs 42091404 and 43174104), therefore, the residue estimates were based on a nomogram that relates food item residues to pesticide application rate. The residue EECs were generated from a spreadsheet-based model (T-REX Version 1.3.1) that calculates the decay of a chemical applied to foliar surfaces for single or multiple applications and is based on the methods of Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). Residue EECs were calculated for an application rate at 0.375 lbs a.i./A (i.e., the maximum annual application rate allowed according to the label) applied one time over a single year**.** As discussed in Section 3.1, the typical application frequency of sulfometuron methyl is not well documented and expected to be highly variable depending on site conditions and the type of vegetation to be controlled. However, because application of sulfometuron methyl is limited to an annual maximum rate of no more than 0.375 lb a.i./A for its registered uses, a one-time application at the maximum rate was chosen to represent a conservative estimate of the EEC for wildlife dietary exposure. Residue data supporting a specific value for foliar dissipation half-life were not available for sulfometuron (e.g., total magnitude of residue [171-4], reduction of residue [171.5], and foliar dissipation [132-1]). Although the default foliar dissipation default half-life of 35 days (Willis and McDowell, 1987) would apply to sulfometuron methyl, a foliar dissipation half-life was not used since only one application event was modeled.

The EECs on terrestrial food items may be compared directly with dietary toxicity data or converted to an oral dose and compared to dose-based toxicity data. This screening-level risk assessment for sulfometuron methyl uses estimated upper bound (i.e., 90^{th} percentile) residues as the initial measure of exposure. For comparisons with avian and mammalian dietary-based toxicity data, the maximum predicted upper bound residues of sulfometuron methyl are used directly without adjustment (Table 17). For a single application season, these EECs are considered to represent an estimate of the upper bound exposure following sulfometuron methyl application at the maximum label rate. For comparisons with dose-based toxicity data, EECs are adjusted to an average daily dose (mg/kg-bw/d) using standard allometric relationships. Additional information on the modeling of sulfometuron methyl exposure to terrestrial animals is provided in APPENDIX F: T-REX Output

Table 17. Unadjusted Dietary Terrestrial EECs for Birds and Mammals Following Sulfometuron Methyl Spray Application For Non-Crop Vegetative Management.

Uses	# of App. x App. Rate (application method)	Food Items	Upper Bound EECs (ppm)
Non-Crop Vegetative Management [1]	1 x 0.375 lb a.i./A (ground broadcast)	Short Grass Tall Grass Sm. Insects, Broadleaf Plants Lg. Insects, Fruits, Pods	90.0 41.3 50.6 5.6

[1] Includes uses on unimproved turf, forestry (Christmas trees & other conifer plantations), non-crop vegetative management including roadsides, railroads and industrial sites

Terrestrial Plants. For non-target plants, exposures to sulfometuron methyl are considered most likely to occur as a result of spray drift and/or runoff from aerial and ground applications. Spray drift and runoff are important factors in characterizing the risk of sulfometuron methyl to non-target plants, which is assumed to reach off-site areas. Two different models were used to evaluate impacts on terrestrial plants:

1. TerrPlant, which focuses more on selection of the environmental setting for exposure and the combined contributions from runoff and spray drift; and
2. AgDRIFT, which focused on evaluation of the effects of different application procedures on spray drift; only environmental concentrations from spray drift are measured. AgDRIFT is designed to provide quantification of spray drift amounts at distances of less than 1000 feet from the treatment area.

The TerrPlant model (Ver.1.2.2) predicts EECs for terrestrial plants located in dry and semi-aquatic areas adjacent to the treated areas. The EECs are based on the application rate, solubility of the pesticide in water and drift characteristics, which depend on application method. Different loading ratios are used for runoff to dry and semi-aquatic areas. For dry areas, pesticide runoff exposure is estimated as sheet runoff. In the model, sheet runoff is defined as the amount of pesticide in water that runs off of the soil surface of a treated field which is equal in size to the non-target area (1:1 ratio of areas). For semi-aquatic areas, runoff exposure is estimated as channelized runoff. In the model, channelized runoff is the amount of pesticide that runs off of a treated field 10 times the size of the area adjacent to the treated field (10:1 ratio of areas).

According to the TerrPlant model, the amount of sulfometuron methyl that runs off is a proportion of the application rate and is assumed to be 5% based on a solubility of >100 mg/L for sulfometuron methyl in water (pH 7 or above). Drift from aerial applications is assumed to be 5% of the application rate, whereas drift from ground spray applications is assumed to be 1% (this differs from AgDRIFT, for which spray drift is not predefined). Predicted terrestrial plant

EECs (expressed as a fraction of the application rate) following single, aerial and ground spray application at the maximum application rate of sulfometuron methyl are summarized in Table 18. Details on inputs and outputs from the TerrPlant model are provided in "APPENDIX D: Terrplant Spreadsheet".

Table 18. EECs for Terrestrial Plants Located Adjacent to Sulfometuron Methyl (aerial and ground spray application) Treated Sites.

Terrestrial Use	Application Method (Non-granular)	EEC (lbs ai/A)		
		Total Loading to Dry Areas Adjacent to Treated Areas[2]	Total Loading to Semi-Aquatic Areas Adjacent to Treated Areas[3]	Drift to Adjacent Areas[4]
Vegetative management[1] (1 x 0.375 lb ai/A)	Aerial	0.038	0.21	0.019
	Ground (unincorporated)	0.023	0.19	0.0038

[1] Includes uses on unimproved turf, forestry (Christmas trees & other conifer plantations), non-crop vegetative management including roadsides, railroads and industrial sites
[2] EEC = Sheet Runoff + Drift (5% for aerial or 1% for ground) assuming 1:1 runoff loading ratio
[3] EEC = Channelized Runoff + Drift (5% for aerial or 1% for ground) assuming 10:1 runoff loading ratio
[4] EEC for aerial (appl. rate x 5% drift) or ground application (appl. rate x 1% drift)

Because sulfometuron methyl is an herbicide, a more in-depth spray drift exposure assessment utilizing Tier I and II[5] AgDRIFT® (version 2.01) modeling is also provided to better characterize potential exposure of terrestrial plants. AgDRIFT® utilizes empirical data to estimate off-site deposition of aerial and ground applied pesticides, and acts as a tool for evaluating the potential of buffer zones to protect sensitive habitats from undesired exposures. TABLE 20 contains EECs at several distances from the edge of the field.

A total of four different application scenarios were modeled (Columns labeled [A] through [D]) to illustrate predicted spray deposition of sulfometuron at various distances from the edge of the field under:

1. what may be characterized as typical applications that mostly follow best management practices (that are recommended on the sulfometuron label) – columns A and C.
2. Reasonable worst case assumptions following use scenarios that are not necessarily typical or recommended, but are plausible and permitted on the label. See columns B and D.

For ground applications, there is only a "Tier 1" module in AgDRIFT, but there are some input options still available to vary. For this assessment, only the boom height was varied between the

[5] Note that the AgDRIFT Tier I and II terminology should not be confused with the Tier 1 and 2 used for most other EFED models. In AgDRIFT, Tier I refers to an operating mode with more limited options and Tier II refers to a mode where there is much more user access to selection of model inputs. Unlike with most EFED models, a Tier I AgDRIFT assessment should not be presumed to represent more conservative (higher exposure) scenarios than those represented in a Tier II AgDRIFT assessment.

ground spray scenario [A] (0.51 meter height) and the scenario [C] (1.27 m height). Other key assumptions in the ground application spray drift modeling include:

1. Drop Size Distribution: ASAE very fine to fine classification (ASAE is now ASABE: the American Society of Agricultural and Biological Engineers)
2. Number of swaths = 20
3. Swath Width = 45 feet
4. Application Efficiency (20 rows): 97.96 %
5. Use of the 90 %ile upper bound numbers from the empirical data set which is the basis of AgDRIFT spray drift estimates.

Aerial applications were simulated with the AgDRIFT tier 2 module, which allowed incorporation of some the best management practices to minimize spray drift recommended (but not mandated) on product labels. The more high-end exposure use condition assumptions for aerial applications in scenario [B] are given in Table 19. Factors varied for the more typical-use scenario [D] with some best-management practices include:

1. Wind speed of 10 mph
2. ASAE droplet size of fine to medium
3. Temperature = 86 deg F
4. Relative Humidity = 75 percent
5. Boom Height = 10 feet

The model results demonstrate a several fold to 30-fold difference in the percentage and amount of sulfometuron deposited off-site (the percentage difference between estimates with each scenario increases with increasing distance from the targeted field); see TABLE 20 and TABLE 21.

Table 19. Selected AgDRIFT inputs for high-end exposure from aerial applications of sulfometuron methyl using best management practices.

Input type	Input value	Justification
Aircraft	Air Tractor AT-401	Commonly used aircraft. Typical size and weight. Aircraft type does not greatly affect drift.
Boom length	76.3% of wingspan	Recommended to reduce drift and increase application efficiency. Greater boom lengths generate more drift. 3/4 wingspan should be specified on the label.
Release (boom) height	15 ft.	Estimated upper bound under normal conditions. Should be specified on labels with no-spray zones.
Flight lines	20	Approximate standard scenario field size.

Swath width	60 ft.	Typical. Does not greatly affect drift.
Swath displacement fraction (as a fraction of the swath width)	fine: 0.6833	Swath offset is good application practice. The value used results in 50% deposition at the edge of the field.
Drop size Distribution	Fine (ASAE definition)	Dependent upon product.
Spray material	50% water 50% nonvolatile	Dependent on tank mix. Calculate nonvolatile rate based on the portion of the tank mix which is not easily evaporated (e.g. the fraction that is not water or high vapor pressure solvent).
Wind speed (at 2 meters above the surface.	15 mph	Typical wind speed varies greatly with geographic region and other factors. Ten mph is an adequate, high drift, input for many areas. Model runs for the plains states may require higher wind speeds. Wind speed limitations should be specified on the label.
Humidity	50%	Conservative input adequate for much of the US. Extreme values may significantly affect drift levels under certain conditions.
Temperature	86 degrees F	Conservative input adequate for much of the US. Extreme values may significantly affect drift levels under certain conditions.

Table 20. Estimated percentage of sulfometuron methyl spray drift from ground or aerial applications at various distances from a treated field.

DISTANCE DOWN WIND (FEET)	[A] GROUND APPLICATION (LOW BOOM)	[B] GROUND APPLICATION (HIGH BOOM)	[C] AERIAL (FOLLOWING MANY LABEL RECOMMENDATIONS)	[D] AERIAL (HIGH-END EXPOSURE SCENARIO)
	Percent	*Percent*	*Percent*	*Percent*
0	102.0	106.0	50.00	77.35
50	1.77	5.00	17.12	38.32
100	0.95	2.48	9.79	25.11
200	0.51	1.20	4.69	14.07
500	0.21	0.39	1.92	5.40
750	0.13	0.22	1.39	3.82
900	0.11	0.17	1.24	3.32

Table 21. Estimated amount of sulfometuron methyl spray drift from ground or aerial applications at various distances from a field treated with the maximum labeled rate of 0.375 lb ai/A.

DISTANCE DOWN WIND (FEET)	[A] GROUND APPLICATION (LOW BOOM)	[B] GROUND APPLICATION (HIGH BOOM)	[C] AERIAL (FOLLOWING MANY LABEL RECOMMENDATIONS)	[D] AERIAL (HIGH-END EXPOSURE SCENARIO)
	Lbs ai/A	*Lbs ai/A*	*Lbs ai/A*	*Lbs ai/A*
0	0.3822	0.3956	0.1874	0.2900
50	0.0066	0.0187	0.0642	0.1437
100	0.0036	0.0093	0.0367	0.0941
200	0.0019	0.0045	0.0176	0.0527
500	0.0008	0.0015	0.0072	0.0203
750	0.0005	0.0008	0.0052	0.0143
900	0.0004	0.0006	0.0046	0.0125

The AgDRIFT results illustrate the importance of droplet size in controlling spray drift. Using larger droplet sizes, such as coarse or extremely coarse spraying, reduces the downwind drift to adjacent areas compared to when medium or fine spraying is used. Reducing boom height during application and applying when wind speeds are between 3 and 10 mph are also important in controlling drift.

3.2.3.2. Residue Studies

Environmental residue studies can also provide useful information regarding the potential exposure of terrestrial wildlife receptors. This data can be used to corroborate modeling results or to provide additional insights into chemical fate with respect to exposure. For sulfometuron methyl, no studies are available; all estimates of exposure are based on modeling efforts

3.2.4. Uncertainties and Limitations for this Exposure Assessment

3.2.4.1. Limitations In Knowledge Of Actual Use Patterns

Knowledge on the specific regions of use of sulfometuron methyl is limited. The use pattern of sulfometuron methyl does not lend itself to easy characterization geographically: There are a variety of vegetation management uses on sites that are less clearly defined than agricultural crops and have disjoint or unusual treatment area configurations (e.g., as with rights of way and railroad uses, or industrial site grounds).

Practical limits on usage rates long-term at particular sites may different from legally allowable use levels (e.g., usage is highly unlikely to occur every year at a particular site even though this is allowable under the label language).

3.2.4.2. Variability In Sulfometuron Environmental Persistence

Sulfometuron methyl persistence is significantly affected by soil or water chemistry and may not always easy to predict from typically available soil / water property data alone. A clearer picture of the range of variability in sulfometuron methyl persistence in the environment would require environmental fate studies on a greater variety of soils / waters / sediments with a greater range of pH levels and other soil properties. This is particularly true for the aerobic soil and anaerobic aquatic metabolism studies.

3.2.4.3. Exposure To Sulfometuron Methyl Degradates

Limitations in environmental fate data for the degradates made specific modeling for exposure to each of the degradates very problematic. The data on individual degradates, environmental persistence and mobility is insufficient to model each compound separately. This may not provide realistic estimates with the PRZM / EXAMS models which utilize a receiving pond with no turnover or outflow of residues. If any of the degradation products of sulfometuron methyl should be found to be of toxicological concern at potential environmental exposure levels, than additional data and exposure assessment specific to the degradates of concern would be needed.

3.3. ECOLOGICAL EFFECTS CHARACTERIZATION

In screening-level ecological risk assessments, the ecological effects characterization describes the types of effects a pesticide can potentially produce in an animal or plant. The toxicity data used in the effects characterization for sulfometuron methyl are derived primarily from registrant-submitted toxicity studies that are conducted (and reviewed) according to OPP test guidelines. These "guideline" studies are also supplemented by data reported in the USEPA ECOTOX database that have met Agency criteria for acceptability.

Toxicity testing reported in this section does not include all species potentially affected by sulfometuron methyl usage. Only a few surrogate species for fish, aquatic invertebrates and birds are used to represent all species in the United States. For mammals, effects are typically extrapolated from laboratory rat studies. Also, neither reptiles nor amphibians are tested, although data from reptiles and amphibians may be available from the literature as reported in ECOTOX. In absence of such data, the risk assessment assumes that avian and reptilian and terrestrial-phase amphibian sensitivities to the chemical are similar. A similar assumption is made for fish as surrogates for aquatic-phase amphibians. Terrestrial plant data are derived from the vegetative vigor and seedling emergence tests, typically conducted on 10 agricultural crop species, and do not account for potential chronic or reproductive effects. Lack of plant reproduction data is particularly relevant to sulfometuron methyl because some data suggest plant reproduction may be more sensitive to sulfonylurea herbicide exposure compared to growth and endpoints measured in the seedling emergence and vegetative vigor tests (Fletcher et al, 1993). For aquatic plants, five aquatic plant species (1 vascular, 4 nonvascular) are used to represent potential toxicity to all aquatic plant species.

Most of the studies with non-target organisms were conducted with sulfometuron methyl technical (i.e., > 90% purity). These studies provide the effects basis for risk estimation. Registrant-submitted studies of the acute, oral toxicity of end use product (Oust®) were available only for rats. Other toxicity studies of end- use product were obtained from ECOTOX for selected aquatic invertebrates and terrestrial plants. Details of each of the guideline and literature studies of sulfometuron methyl effects on non-target organisms are provided in "APPENDIX H: Ecological Effects Data Summaries."

Toxicological information on the primary degradates of sulfometuron methyl (e.g., pyrimidine amine, pyrimidine-ol, saccharin, sulfonamide) appears very limited. Specifically, no guideline toxicity studies with ecologically relevant endpoints (e.g., growth, reproduction, development, survival) were identified for the primary degradates of sulfometuron methyl. Based on literature searches conducted with ECOTOX, toxicological studies were identified only for one major degradate (saccharin). Of the nine saccharin studies identified in ECOTOX, all were considered inapplicable to the ecological risk assessment because they lack evaluation of saccharin effects using ecologically relevant endpoints (e.g., survival, growth, reproduction, development). This finding is not surprising given the role of saccharin as a sugar substitute and the corresponding toxicological focus on measures of effect that pertain to human health (e.g., biochemical, organ-level, mutagenicity and carcinogenicity assays). A summary of the ecological toxicity studies involving the saccharin metabolite of sulfometuron methyl is provided in "APPENDIX H: Ecological Effects Data Summaries." Appendix J contains the results of the ECOTOX literature search with respect to those studies found to be acceptable to ECOTOX but not OPP for the purposes of this risk assessment.

Table 22 contains a summary of the most sensitive ecological effects endpoints used in this risk assessment. As expected, the acute toxicity of sulfometuron methyl to animals is very low (slightly to practically non-toxic) while its toxicity to plants is very high. This finding is consistent with the mode of action of sulfometuron methyl (inhibition of ALS) and is similar to toxicity findings from other sulfonylurea herbicides.

Table 22. The Most Sensitive Endpoints Used In The Sulfometuron Methyl Screening-Level Risk Estimation.

Environment	Taxa	Type of Risk	Type of Endpoint	Endpoint	Units	MRID
Aquatic	Freshwater Fish	Acute	LC_{50}	> 148	mg ai/L	435018-02 [A]
		Chronic	NOAEC	Data gap		
	Freshwater Invertebrates	Acute	EC_{50}	> 150	mg ai/L	435018-03
		Chronic	NOAEC	97	mg ai/L	416728-06[A]
	Saltwater Fish	Acute	LC_{50}	> 45	mg ai/L	416728-03
	Saltwater Invertebrates	Acute	EC_{50}	> 38.2	mg ai/L	416728-04
	Plants	Non-Listed	EC_{50}	0.48	µg ai/L	435385-03
		Listed	NOAEC	0.21	µg ai/L	435385-03
Terrestrial	Avian	Acute	LD_{50}	> 4650	mg ai/kg-bw	245375
		Acute	LC_{50}	> 4600	mg ai/kg-diet	00071414
	Mammalian	Acute	LD_{50}	> 5000	mg ai/kg-bw	430892-01
		Chronic	NOAEC	> 300	mg ai/kg-bw/d	78798
	Plants	Non-Listed	EC_{25}	1.8×10^{-5}	lb ai/A	435385-01[A]
		Listed	EC_5 [B]	9.9 x 10-7	lb ai/A	435385-01(A)

[A] Toxicity value was revised after a re-review and analysis of the study results in 2007.

[B] EC5 was used for estimating effects to listed (endangered) terrestrial plants because the NOAEC equaled or exceeded the EC_{25}, as discussed in the terrestrial effect characterization section.

3.3.1. Aquatic Effects Characterization

3.3.1.1. Freshwater Fish, Acute

Acute toxicity studies with the technical grade active ingredient (TGAI) were required for two freshwater fish species for sulfometuron methyl. Preferred test species are bluegill sunfish (warm water fish) and rainbow trout (cold water fish). Based on results from preliminary range finding tests, definitive toxicity tests were not required for bluegill or rainbow trout (i.e., LC_{50} >200 mg ai/L). Therefore, toxicity 'limit' tests were conducted at a single test concentration of 150 mg ai/L (bluegill, MRID 435018-01; rainbow trout, 435018-02).

Results from these studies are summarized in Table 23 and indicate that sulfometuron methyl is practically non-toxic to freshwater fish on an acute toxicity basis. No mortality was reported in the test concentration of 150 mg ai/L (nominal) and measured concentrations were within 80-120% of nominal concentrations in both tests. To prevent formation of insoluble precipitate, the pH of test solutions were buffered w/ addition of sodium hydroxide, which resulted in pH values that exceeded guideline recommendations (up to pH 9.0). The authors report no formation of precipitate or solubility problems in test solutions and no mortality in pH buffered controls. The pH range deviation is therefore considered a necessary byproduct of increasing the solubility of the test chemical. All other test guideline deviations are considered minor. These studies are classified as acceptable and meet the guideline requirements for an acute toxicity study with warm water and cold water fish.

Table 23. Freshwater Fish Acute Toxicity of Sulfometuron Methyl.

Guideline	Species	% ai	96-hour LC_{50} (mg/L)	Toxicity Category	MRID No. Author/Year	Study Classification
72-1	Bluegill sunfish *(Lepomis macrochirus)*	99.6	> 150	Practically non-toxic	435018-01 Brown (1994a)	Acceptable
72-1	Rainbow trout *(Oncorhynchus mykiss)*	99.6	> 148	Practically non-toxic	435018-02 Brown (1994b)	Acceptable

3.3.1.2. Freshwater Invertebrates, Acute

The toxicity of sulfometuron methyl to freshwater invertebrates is indicated by a 48-hr acute toxicity test with the water flea, *Daphnia magna* (MRID 435018-03; Table 24. As observed with freshwater fish, no mortality was observed in a range finding test up to 200 mg ai/L or the follow-up toxicity limit test at 150 mg ai/L. Buffering of test solutions was required to prevent formation of precipitates which resulted in a greater pH range (8.4-9.0) than recommended (7.2-7.6). No mortality was observed in the 150 mg/L treatment or in the negative control. One daphnid died in the pH adjusted control (mortality 3%). The test concentration was measured and found to be 100% of nominal. The pH range deviation is therefore considered a necessary byproduct of increasing the solubility of the test chemical. This study was originally classified as 'supplemental' by EFED in 1995 because of concerns over chemical composition of the dilution water. A re-review of this study in conjunction with other data on the dilution water from a separate study with the same lab indicates that it is acceptable. A detailed study review and explanation of the study reclassification are provided in "APPENDIX H: Ecological Effects Data Summaries."

Table 24. Freshwater Invertebrate Acute Toxicity of Sulfometuron Methyl.

Guideline	Species	% ai	48-hour LC_{50} (mg/L)	Toxicity Category	MRID No. Author/Year	Study Classification
72-2	Water flea *(Daphnia magna)*	99.6	> 150	Practically Non-toxic	435018-03 Brown (1994c)	Acceptable(1)

(1) reclassified as acceptable for this risk assessment, see APPENDIX H: Ecological Effects Data Summaries for details.

3.3.1.3. Estuarine and marine Fish, Acute

The toxicity of sulfometuron methyl to estuarine and marine fish is indicated by a 96-hr acute toxicity test with the sheepshead minnow, *Cyprinodon variegatus* conducted at nominal concentrations ranging from 15 to 100 mg ai/L (MRID 416728-03, Table 25. The LC_{50} based on measured concentrations from this study was found to be greater than 45 mg ai/L. No mortality or observable signs of sublethal effects occurred in the study except for one dead fish (5%) at 8.2 mg/L (measured).

This study was re-reviewed for this risk assessment and found to contain several significant deficiencies which render its classification as supplemental. Specifically, measured concentrations ranged widely from test initiation to termination (4 to 7 times), which is believed due to the formation of an observable precipitate in test solutions. This occurred despite buffering of the dilution water to an initial pH of 8.5 (pH ranged thereafter from 7.4 to 8.5). Although these deficiencies could render the study classification as "unacceptable," it is considered to provide some useful information in this risk assessment (i.e., an indication of a lack of toxicity at or near solubility limits in test solutions). Furthermore, when viewed in the context of screening level EECs (i.e., a maximum peak concentration of 0.031 ppm in water, Table 15), the bioavailable (dissolved) portion sulfometuron methyl would have to be approximately 1500-fold lower than the highest measured test concentration (~45 ppm) in order for risks to be evident. Therefore, this study is classified as supplemental but is not recommended for repeat testing at this time because a repeat test would be highly unlikely to alter the risk assessment conclusions.

Table 25. Estuarine/Marine Fish Acute Toxicity of Sulfometuron Methyl.

Guideline	Species	% ai	96-hour LC_{50} (mg/L)	Toxicity Category	MRID No. Author/Year	Study Classification
72-3	Sheepshead minnow *(Cyprinodon variegatus)*	99.1	> 45	≥ Slightly toxic	416728-03 Ward and Boeri (1990a)	Supplemental(1)

(1) Reclassified as supplemental for the purposes of this risk assessment. See APPENDIX H: Ecological Effects Data Summaries for additional study details.

3.3.1.4. Estuarine and marine Invertebrates, Acute

The toxicity of sulfometuron methyl to estuarine and marine invertebrates is indicated by acute toxicity tests with mysid shrimp, *Mysidopsis bahia*, and embryo/larvae of the eastern oyster, *Crassostrea virginica*. For mysids, a 96-h assay was conducted at nominal concentrations ranging from 15 to 100 mg/L. The 96-h LC_{50} based on measured concentrations from this study was found to be greater than 44.8 mg ai/L. No mortality or observable signs of sublethal effects occurred in the study at any test concentration or the control. For oysters, a 48-h assay was conducted on embryos at the same nominal concentrations as used for mysids. The 48-h EC_{50} based on measured concentrations for this study was found to be greater than 38.2 mg ai/L. No mortality occurred and 99% of the surviving control oysters were normal.

A re-review of both the mysid and oyster studies indicates they have several significant deficiencies which render their classification as supplemental. Specifically, measured concentrations of sulfometuron methyl ranged widely from test initiation to termination (3X to 13X in the mysid tests; 3X in the oyster test) and were substantially below nominal concentrations. The low % nominal is believed due to the formation of an observable precipitate in test solutions. In the mysid test, low % nominal occurred despite buffering of the dilution water to an initial pH of 8.5 (pH ranged thereafter from 7.6 to 8.5). In the oyster test, pH ranged from 7.7 to 8.0. The pH range in both the mysid and oyster tests extended beyond the recommended range for test guidelines (7.7-8.0 for euryhaline shrimp; 8.0-8.3 for stenohaline oysters).

Although these deficiencies could render both study classifications as "unacceptable," they are considered to provide some useful information in this risk assessment (i.e., an indication of a lack of toxicity at or near solubility limits in test solutions). Furthermore, when viewed in the context of screening level EECs (i.e., a maximum peak concentration of 0.031 ppm in water, Table 15)**,** the bioavailable (dissolved) portion sulfometuron methyl would have to be approximately 1300-fold lower than the highest measured test concentration (~ 40 ppm) in order for risks to be evident. Therefore, this study is classified as supplemental but is not recommended for repeat testing at this time because a repeated test would not likely affect the risk assessment conclusions.

Table 26. Freshwater Invertebrate Acute Toxicity of Sulfometuron Methyl.

Guideline	Species	% ai	96-hour LC_{50} or 48-h EC_{50} (mg/L)	Toxicity Category	MRID No. Author/Year	Study Classification
72-3	Mysid shrimp[(1)] *(Mysidopsis bahia)*	99.1	> 44.8	≥ Slightly toxic	416728-04 Ward and Boeri (1990c)	Supplemental [(2)]
72-3	Eastern oyster[(1)] *(Crassostrea virginica)*	99.1	> 38.2	≥ Slightly toxic	416728-05 Ward and Boeri (1990b)	Supplemental[(2)]

(1) 96-h LC_{50} applies to mysids; 48-h EC_{50} applies to oyster.

(2) Reclassified as supplemental for the purposes of this risk assessment. See APPENDIX H: Ecological Effects Data Summaries for additional study details.

3.3.1.5. Freshwater Fish, Chronic

No acceptable or supplemental data on the chronic toxicity of sulfometuron methyl to freshwater fish were available. A chronic, early life-stage toxicity test was conducted in 1982 to determine the effect of sulfometuron methyl on fathead minnow embryo hatching, larval survival, and growth (MRID 423857-04; Accession No. 249796), however upon further review, this study was classified as unacceptable.

3.3.1.6. Freshwater Invertebrate, Chronic

The chronic toxicity of sulfometuron methyl to freshwater invertebrates is indicated by a 21-day life cycle test conducted on the water flea, *Daphnia magna* (MRID 416728-06; Table 27). Daphnids (<24-h old) were exposed to six concentrations of sulfometuron methyl ranging from 0.1 to 100 mg/L (nominal) in a static-renewal system. In order to promote solubility of the test substance, the pH of the stock solutions of the 25 mg/L and 100 mg/L treatments were adjusted with NaOH to pH 8.5. Both a negative and pH-adjusted controls were included. Mean measured concentrations were close to nominal concentrations (i.e., within 20%), thus indicating that variability in test concentrations was well within the acceptable limits of 1.5X. Survival and growth (length) were not affected at any test concentration. Reproduction, as measured by the number of neonates produced/daphnid, was not significantly different from negative controls in any treatment (ANOVA, 0.05). Although the Dunnett's multiple comparison test indicated a marginally significant difference in the 24 mg/L treatment (mean measured concentration), it is not considered statistically valid to apply means testing when ANOVA results indicate lack of significant differences among treatments. Furthermore, an inconsistent concentration-response relationship is indicated by the lack of a significant reduction in daphnid reproduction at 97 mg/L (the highest treatment tested). Therefore, the NOAEC for daphnid reproduction is re-interpreted as 97 mg/L (unbounded) and the LOAEC is > 97 mg/L. This study is classified as acceptable and meets the guideline requirements for a chronic study using a freshwater invertebrate.

Table 27. Freshwater Aquatic Invertebrate Chronic Toxicity for Sulfometuron Methyl.

Species/ Static Renewal	% ai	21-day NOAEC / LOAEC (mg/L)(1)	Endpoints Affected	MRID No. Author (Year)	Study Classification
Water flea *(Daphnia magna)*	99.1	97 / >97	Reproduction	416728-06 Baer (1990)	Acceptable

(1) NOAEC and LOAEC were re-analyzed as part of this risk assessment. See Appendix H for additional study details.

3.3.1.7. Aquatic Animal Sublethal Effects: Formulated Product and Degradate Toxicity

No signs of toxicity or sublethal effects were observed in the acute or chronic toxicity tests of sulfometuron methyl that were described previously in this Exposure Characterization (considering acceptable and supplemental studies). This is not surprising, given that sulfometuron methyl is practically nontoxic on an acute toxicity basis.

Two studies of the toxicity of sulfometuron methyl in formulated product (e.g., Oust®) to aquatic animals were identified and discussed further below. The first study, Naqvi and Hawkins (1989) exposed four genera of field-collected microcrustaceans (*Diaptomus sp. Eucyclops sp., Alonella sp., and Cypria sp.*) to sulfometuron methyl from the Oust® formulated product at nominal concentrations of ranging from 100 to 2500 mg/L for 48-h. Consistent, monotonic exposure-response relationships across the six treatments occurred for all four species and 48-h LC_{50}s (probit analysis) were reported as follows:

Species	Test Chemical	48-h LC_{50} (mg/L) (95% confidence limits)	Classification	Reference
Diaptomus sp.	Oust® (~93% ai)	1315 (1207-1524)	supplemental	Naqvi and Hawkins (1989)
Eucyclops sp.		1320 (1154-1536)		
Alonella sp.		802 (475-928)		
Cypria sp		2241 (1744-4517)		

This study is classified as supplemental primarily because test concentrations were not measured in the study and the field collected test organisms were provided a relatively short application period (96-h) vs. the 7-d minimum acclimation period recommend for freshwater invertebrate testing. Furthermore, organisms were not positively identified to the species level, thus indicating that more than one test species may have been tested in each study. Finally, the study authors do not indicate whether nominal concentrations were adjusted to reflect the percent active ingredient in the formulated product. Assessment of the relative acute toxicity of sulfometuron methyl as technical grade and in formulated to aquatic animals is somewhat uncertain because LC_{50} and EC_{50} values were not achieved for the technical grade herbicide (e.g., EC_{50} and LC_{50} varied from >38 to >150 mg ai/L). However, results from the Naqvi and Hawkins (1989) study indicate that sulfometuron methyl formulated in Oust® is practically nontoxic to aquatic microcrustaceans. Thus, the comparative toxicity of technical grade sulfometuron methyl and sulfometuron methyl formulated at least appear similar in terms of both ingredients being practically nontoxic to aquatic invertebrates.

The second study was submitted by the registrant (DuPont) per FIFRA Section 6(a)2 requirements on July 1, 1991. In this study, Romaire (1984) evaluated the acute toxicity of Oust® (% ai not reported) to juvenile red swamp crayfish, *Procambarus clarkii*. A static, acute toxicity study was conducted for 96 hours in 4 replicate aquaria (5 crayfish/aquarium) at 8 test concentrations ranging from 0 to 10,000 mg ai/L. Analytical measurements of sulfometuron methyl were not taken during the study. The authors report that the 96-h LC_{50} was > 5,000 mg ai/L for sulfometuron methyl and mortality did not exceed 50% in any test treatment. However, review of this study indicates that it is unacceptable because dissolved oxygen levels dropped precipitously throughout the study in test concentrations where mortality was observed, despite periodic aeration of test solutions. Dissolved oxygen levels repeatedly reached levels as low as 2.1 mg/L or approximately 25% saturation, which is well below ASTM recommendations of 60% saturation. Because the effect of dissolved oxygen on crayfish mortality could not be separated from the possible effects of sulfometuron methyl, this study is not considered scientifically sound for the purposes of describing the acute toxicity of sulfometuron methyl to juvenile crayfish.

Regarding the aquatic toxicity of sulfometuron methyl degradates to aquatic animals, a literature search conducted in May, 2007 of EPA's ECOTOX database revealed no acceptable or supplemental studies that described the toxicity of major sulfometuron metabolites: pyrimidine amine, pyrimidine-ol, saccharin, and sulfonamide. A list of studies considered acceptable to ECOTOX but not OPP is provided in "APPENDIX J: Ecological Effects Studies Rejected by OPP."

3.3.1.8. Field Studies

No field studies (e.g., mesocosm and microcosm studies) were found concerning the aquatic toxicity of sulfometuron methyl, either based on OPP guidelines or from the aforementioned search of the ECOTOX database.

3.3.1.9. Aquatic Plants

Aquatic plant toxicity studies using the TGAI are required to establish the toxicity of sulfometuron methyl to non-target aquatic plants (Table 28). Studies in five species are required for herbicides: freshwater green alga *(Selenastrum capricornutum)*, blue-green algae *(Anabaena flos-aquae)*, a freshwater diatom *(Navicula pelliculosa)*, a marine diatom *(Skeletonema costatum)*, and duckweed *(Lemna gibba).* Of the four non-vascular species tested, the green alga is the most sensitive non-vascular aquatic plant. This finding is consistent with the toxicity of flazasulfuron, another sulfonylurea herbicide with the same mode of action (DP Barcodes: D302482, D302484; EFED New Chemical review dated 4/11/2007).

The EC_{50} (reduction in cell density) for *S. capricornutum* is 4.6 µg ai/L and the NOAEC is 0.63 ug ai/L. At the LOAEL of 1.3 µg/L, growth was reduced approximately 20%, while the cell growth at the NOAEC showed a slight increase relative to controls. These toxicity values are based on reported nominal concentrations. Although the study authors indicate that samples were taken for analytical measurement and would be analyzed "if deemed necessary," results from chemical analysis were not provided in the study report. At these concentrations, solubility of the test compound is not expected to be problematic.

Preliminary tests with the two diatom species indicated that Tier II tests would not be necessary. Based on results from Tier 1 tests, growth (cell density) of neither diatom was affected significantly relative to controls at measured concentrations of 370 µg/L and 410 µg/L (i.e., the maximum values calculated for sulfometuron methyl applied directly to a 6 inch deep pond. Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions.

A tier 2 test was conducted on the freshwater blue-green algae, *Anabaena flos-aquae,* at measured test concentrations ranging from 14 to180 µg/L. Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions. An EC_{50} of 41.6 µg/L (cell density) is calculated for *Anabaena* and a NOAEC of <14 µg/L (lowest test concentration). This NOAEC corresponds to a 20% reduction in cell growth relative to controls. This study is considered scientifically sound but classified as supplemental because a NOAEL was not determined.

The 14-day EC_{50} and NOAEC for the freshwater vascular plant (duckweed) for frond count (the most sensitive endpoint tested) are 0.48 and 0.21 µg/L, respectively, based on exposure to measured concentrations ranging from 0.13 to 1.05 µg/L. Frond counts were reduced 4% at the NOAEC and 20% at the LOAEC. Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions.

Except for the test with blue-green algae, the toxicity studies of aquatic plants **(**Table 28**)** are classified as acceptable and meet the guideline requirements for toxicity tests with aquatic vascular and nonvascular plants. Toxicity values for the most sensitive species (green algae and duckweed) will be used to calculate risk quotients.

Table 28. Non-target Aquatic Plant Toxicity for Sulfometuron Methyl.

Species	% ai	EC_{50}/ NOAEC (µg/L)	Endpoints Affected	MRID No. Author (Year)	Study Classification
Vascular Species: Duckweed					
Duckweed (*Lemna gibba*)	95.7	0.48 / 0.21	Frond Count[i]	435385-03 Kannuck (1995)	Acceptable
Non-Vascular Species: Algae and Diatoms					
Green Algae [(1)] *(Selenastrum capricornutum)*	99.1	4.6 / 0.63	Cell Density	416801-02 Hobert (1990)	Acceptable
Blue-green Algae[(1)] (*A. flos-aquae*)	99.2	41.6 / <14	Cell Density	435385-02 Thompson (1994)	Supplemental
Fresh Water Diatom [(2)] (*Navicula pelliculosa*)	99.2	>370	Cell Density	435385-02 Thompson (1994)	Acceptable
Salt Water Diatom[(2)] (*Skeletonema costatum*)	99.2	>410	Cell Density	435385-02 Thompson (1994)	Acceptable

(1) Tier II definitive test
(2) Tier I screening test

3.3.2. Terrestrial Effects Characterization

3.3.2.1. Acute Effects on Birds

An acute oral toxicity study using the technical grade of the active ingredient is required to establish the acute toxicity of sulfometuron methyl to birds. The preferred guideline test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). An acute oral toxicity study with the mallard indicates sulfometuron methyl is practically non-toxic on an acute basis, with a reported oral LD_{50} >4,650 mg ai/kg-bw (Table 29). No mortality occurred in any treatment and birds appeared normal throughout the 14-d test period. Food consumption varied widely across treatments, but did not exhibit a dose-dependent trend. Weight gain/loss also did not exhibit a dose-dependent trend within or across sexes. Weight gain in females may have been confounded by induction of the egg laying cycle by the photoperiod used. Lack of acute oral toxicity to birds is consistent with testing results from other sulfonylurea herbicides (e.g., flazasulfuron, rimsulfuron). The guideline requirement (71-1) is fulfilled for an acute oral toxicity study with birds for sulfometuron methyl and the study (Accession No. 245375) is classified as acceptable.

Table 29. Avian Acute Oral Toxicity for Sulfometuron Methyl.

Species	% ai	LD_{50} (mg ai/kg-bw)	Toxicity Category	Accession No. Author (Year)	Study Classification
Mallard duck *(Anas platyrhynchos)*	≥93	>4,650	Practically non-toxic	245375 Dudeck and Bristol (1981)	Acceptable

Two dietary studies are required to establish the subacute dietary toxicity of sulfometuron methyl to birds. The preferred test species are mallard duck and bobwhite quail. The submitted data indicates that sulfometuron methyl is practically nontoxic to mallard and quail when administered via subacute, dietary exposure. The 8-day acute dietary LC_{50} values for bobwhite quail and mallard are > 5,620 mg ai/kg-diet and > 4,600 mg ai/kg-diet, respectively (Table 30. There was no mortality, signs of clinical toxicity, or abnormal behavior reported in the studies. The guideline (71-2) is fulfilled for a subacute dietary study with birds. The studies (Accession No. 246409 and MRID 71414) are classified as acceptable.

Table 30. Avian Subacute Dietary Studies for Sulfometuron Methyl.

Species	% ai	8-Day LC_{50} (mg ai/kg-diet)	Toxicity Category	MRID No. Author (Year)	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	95.2	>5,620	Practically non-toxic	246409 [1] Beavers and Fink (1981)	Acceptable
Mallard duck *(Anas platyrhynchos)*	92	>4,600	Practically non-toxic	71414 Hazelton Laboratories Inc (1980)	Acceptable

(1) Accession number.

3.3.2.2. Acute Effects on Mammals

Wild mammal testing is required by the Agency on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. For sulfometuron methyl, the acute toxicity of sulfometuron methyl (technical grade active ingredient) is indicated by an acute, oral toxicity study with the rat (MRID 43089201; Table 31. In this study, 5 male and 5 female rats were administered a single oral dose of 5000 mg ai/kg-bw technical grade sulfometuron methyl (approx. 100% a.i.) in corn oil via gavage. Rats were observed for mortality, signs of ill health, pharmacologic and toxicological effects for 14 days after dosing. No mortality occurred at 5,000 mg ai/kg-bw and no clinical signs of toxicity were observed that were related to sulfometuron methyl exposure. Male and females continued to gain weight throughout the study. An acute, oral LD_{50} value of >5000 mg ai/kg-bw was determined from this study, indicating that sulfometuron methyl is categorized as practically non-toxic (toxicity category IV) to small mammals on an acute oral basis. This finding is consistent with lack of acute oral toxicity observed with other sulfonylurea herbicides to rats (e.g., flazasulfuron). This study is considered acceptable and satisfies the guideline requirement (81-1) for an acute toxicity study with mammals.

Table 31. Mammalian Acute Toxicity for Sulfometuron Methyl.					
Species	**% ai**	**Toxicity**	**Affected Endpoints**	**MRID No. Author (Year)**	**Toxicity Category**
Rat (Sprague-Dawley)	~100	LD_{50} > 5,000 mg ai/kg bw (males/females)	Survival, weight gain, gross organ pathology	43089201 Dashiell and Sarver (1990)	IV

3.3.2.3. Acute Effects on Terrestrial-phase Amphibians, Reptiles and Beneficial Insects

A honeybee acute contact study is required for sulfometuron methyl because its post-emergence treatment use will likely result in honeybee exposure. The acute contact LD_{50}, using the honey bee, *Apis mellifera*, is a single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of bees. For sulfometuron methyl, bees were exposed at 5 treatments ranging from 13 to 100 µg ai/bee and included a solvent and negative control (MRID 416728-10; Table 32). Results indicate that sulfometuron methyl is practically non-toxic to bees on an acute contact basis. The contact 48-h LD_{50} for sulfometuron methyl is >100 µg ai/bee. Cumulative mortality and immobility ranged from 4-8% in the controls to 0-2% in the treatments. No overt signs of toxicity were observed in the study. The guideline (141-1) is fulfilled (MRID 416728-10).

Table 32. Non-Target Insects - Acute Contact Toxicity for Sulfometuron Methyl.					
Species	**% ai**	**LD_{50} (µg ai/bee)**	**Toxicity Category**	**MRID No. Author (Year)**	**Study Classification**
Honey Bee *(Apis mellifera)*	~100	>100 (contact)	Practically non-toxic	416728-10 Hoxter and Smith (1990)	Acceptable

No acceptable or supplemental terrestrial-phase amphibian or reptile toxicity studies were submitted or located in the open literature based on a search of the ECOTOX database.

3.3.2.4. Chronic Effects on Birds

Avian reproduction studies using the TGAI are required for pesticide registration if birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season. The preferred test species are mallard duck and bobwhite quail. No data (71-4 guideline or literature studies) were available on the reproductive toxicity of sulfometuron methyl to birds.

3.3.2.5. Mammals, Reproductive Effects

A combined 2-generation reproduction/oncogenicity study and 2-year chronic reproduction study with rats exposed to sulfometuron methyl was submitted to the agency (MRID 423857-05 and 423857-06). However, study authors had to abandon the study on about day 200 due to disease of the test organisms that was not related to exposure and the study was classified as unacceptable by HED. The developmental toxicity study with rat (MRID 00078796) was also classified as unacceptable by HED. Since no acceptable mammalian reproduction or developmental toxicity study was available with the rat for sulfometuron methyl, the developmental toxicity study with the rabbit (Accession No. 78798) was used in this risk assessment (Table 33).

In this study, rabbits were administered doses of 0, 30, 100, or 300 mg/kg/day from gestation days (GD) 6-18 and examined at GD 29. There were no mortalities and no treatment-related clinical signs or macroscopic findings. A slight decrease in maternal body weight occurred during the gestation period (GD 6-18) but this was judged biologically insignificant. There were no treatment related effects on fetal or maternal endpoints measured, including external, visceral or skeletal malformations, frequency of resorptions, live fetuses, or dead fetuses, or on the number of litters, sex ratio, or post-implantation loss. The developmental LOAEL was not observed. The developmental NOAEL is 300 mg/kg/day (highest dose tested). According to the data evaluation record provided by HED, this study is acceptable but does not fulfill the guideline requirement for a developmental toxicity study with rabbits because dose levels were not considered high enough to adequately assess developmental toxicity.

Table 33. Mammalian Developmental Toxicity of Sulfometuron Methyl .

Species	% ai	Test Type	Toxicity[1]	Affected Endpoints	Accession No. Author (year)
Rabbit (New Zealand White)	100	Developmental	NOAEL = 300 mg ai/kg/day (highest test dose) LOAEL > 300 mg ai/kg/day	None	78798 Serota (1981)

3.3.2.6. Terrestrial Animal Sublethal Effects, Formulated Product and Degradation Products

No sublethal effects were reported in either the avian dose or dietary acute toxicity studies for birds. However, data on the chronic toxicity of sulfometuron methyl to birds (and therefore, data on other potential sublethal effects) were not available. For mammals, no clinical signs of toxicity or abnormal behavior were noted in the acute toxicity study (MRID 43089201). No acceptable data on the chronic toxicity of sulfometuron methyl to mammals were available. Therefore, other potential sublethal effects resulting from chronic exposure could not be evaluated. Based on the developmental toxicity study of sulfometuron methyl to rabbits, no signs of sublethal toxicity were evident (Accession No. 78798).

Formulated pesticide products may contain a number of other 'inert' ingredients that alter their toxicity compared to the technical grade active ingredient (e.g., resulting in greater toxicity). For sulfometuron methyl, data on the oral toxicity of formulated products were available for one species of terrestrial animal (rat; Table 34). Results from this study indicate that the formulated product DPX-T5486-87 is practically nontoxic to laboratory rats, with a LD_{50} of >5,000 mg ai/kg-bw. No clinical signs of toxicity, weight loss or gross legions were observed in this study. This study satisfied guideline requirements for acute oral toxicity with rats and is considered acceptable.

Table 34. Mammalian Acute Toxicity to Sulfometuron Methyl in Formulated Product: DPX-T5486-87

Species	% ai	Toxicity	Affected Endpoints	MRID No.	Toxicity Category
Rat (Sprague-Dawley)	74%	LD_{50} > 5,000 mg ai/kg bw (males/females)	Survival, weight gain, gross organ pathology	44874103	IV

Except for saccharin, no toxicity information was available on the other major degradation products of sulfometuron methyl (e.g., pyrimidine amine, pyrimidine-ol, sulfonamide). Data on the toxicity of saccharin that met ECOTOX and OPP screening criteria were available for nine studies (Appendix J). However, further review of these data indicates they do not contain information on endpoints that are considered ecologically relevant (i.e., closely related to the assessment endpoints of survival, growth, reproduction and development). These studies mostly focused on saccharin as it relates to human health effects (e.g., carcinogenicity, mutagenicity, organ level endpoints, biochemical endpoints). The remaining ecologically-oriented saccharin studies evaluated the efficacy of saccharin as a deterrent to insect pest damage, fungal infection or its role as an attractant to aquatic life. A list of these studies with rationale for their rejection is provided at the end of "APPENDIX J: Ecological Effects Studies Rejected by OPP."

3.3.2.7. Field Studies

Data from field studies of the effects of sulfometuron methyl on terrestrial animals were not available to evaluate effects at organism, population or community levels of biological organization (e.g., population size/growth rate, age-class structure, or species richness).

3.3.2.8. Terrestrial Plants

Terrestrial plant Tier 2 seedling emergence and vegetative vigor studies are required for all low dose pesticides (those with the maximum use rate of 0.5 lbs ai/acre or less) and for any pesticide showing a negative response equal to or greater than 25% in Tier 1 studies. Tier 2 terrestrial plant toxicity studies were conducted to establish the toxicity of sulfometuron methyl to non-target terrestrial plants. The recommendations for seedling emergence and vegetative vigor studies are for testing of (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*), and the second of which is a root crop, and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*).

For sulfometuron methyl, six dicots (sugar beet, rape, tomato, pea, cucumber and soybean) and four monocots (onion, corn, wheat, sorghum) were tested using the Tier 2 protocols for effects on seedling emergence and vegetative vigor. Tier 1 tests were not conducted since preliminary testing indicated all plants would be promoted to Tier 2 testing. Test durations were 14 days and 21 days for the seedling emergence and vegetative vigor studies, respectively. Depending on the species and test, seven to eleven treatments were used with application rates ranged from 0.0000017 to 0.5625 lb ai/acre. For this risk assessment, a re-review and statistical analysis was conducted on the Tier 2 toxicity data from the more sensitive test species in both the seedling emergence and vegetative vigor tests. All statistical comparisons were made to negative controls (previous analyses in the DER made comparisons to solvent controls even though negative and solvent controls were not significantly different). For calculation of the EC_{25} and EC_{05}, nonlinear regression was conducted using the methods of Bruce and Versteeg (1992). In situations where the NOAEC was found to be greater than or equal to the EC_{25}, the EC_{05} was used for the comparison with threatened and endangered species.

Results for the most sensitive endpoints and species with monocots and dicots indicate that seedling emergence and vegetative vigor are impacted at exposures well below the maximum application rate of 0.375 lb ai/acre for sulfometuron methyl (Table 35). For seedling emergence, the EC_{25} of 1.9×10^{-4} lb ai/acre for the most sensitive monocot (sorghum) is about a factor of 5 greater than the EC_{25} of 3.2×10^{-5} lb ai/acre for the most sensitive dicot (sugar beet). The maximum application rate of 0.375 lb ai/acre exceeds these EC_{25} values for sorghum and sugar beet by approximately 2,000 and 10,000 times, respectively. For 9 of the 10 test species, a comparison of EC_{25} values indicates that species sensitivity is within a factor of 20 (based on summary data presented by McKelvey, 1995). This indicates that the most sensitive test species is <u>not</u> an outlier in terms of its relative sensitivity. The EC_{05} and NOAEC for the sorghum and sugar beet are 4.3×10^{-5} and 2.9×10^{-5}, respectively. A consistent, declining monotonic exposure-response curve was observed for sugar beet, while that for sorghum was monotonic following an increase in mean shoot height of 24% in the lowest test treatment and 2% in the next lowest treatment relative to the negative control. Because the statistical method of Bruce and Versteeg (1992) uses a pooled response from the non-monotonic portion of the dose-response curve for calculating EC_x values, the actual mean response associated with the EC_{05} for sorghum is slightly higher than the mean response observed for controls, rendering it a relatively conservative toxicological value.

Results from the vegetative vigor study indicate the most sensitive monocot (corn) and dicot (soybean) are impacted at somewhat lower levels compared to the seedling emergence study. The EC_{25} values for corn and soybean (shoot dry weight) are 3.7×10^{-5} and 1.8×10^{-5}, respectively. The maximum application rate for sulfometuron methyl is approximately 10,000 and 20,000 times these EC_{25} values. Because the NOEC exceeded the EC_{25} values for both species, the EC_{05} is used for risk assessment with threatened and endangered species. The EC_{05} values for corn and soybean are 8.4×10^{-6} and 9.9×10^{-7}, respectively. For all 10 test species, a comparison of EC_{25} values indicates that species sensitivity differences are within a factor of 20 (based on summary data presented by McKelvey, 1995). This indicates that the most sensitive test species is not an outlier in terms of its relative sensitivity. A consistent, declining monotonic exposure-response curve was observed for corn and soybean in the vegetative vigor test.

Table 35. Summary of Most Sensitive Tier II Terrestrial Non-target Plant Seedling Emergence and Vegetative Vigor Toxicity Data for Sulfometuron Methyl.

Most Sensitive Species	EC_{25} (lb ai/A)	NOAEC/[EC05]* (lb ai/A)	Endpoint Affected	MRID No. Author/year	Study Classification
Seedling Emergence					
Monocots					
Sorghum	1.9×10^{-4}	4.3×10^{-5} (*)	shoot height	435385-01 McKelvey (1995)	Acceptable
Dicots					
sugar beet	3.2×10^{-5}	2.9×10^{-5}	shoot dry wt		Acceptable
Vegetative Vigor					
Monocots				435385-01 McKelvey (1995)	
Corn	3.7×10^{-5}	9.9×10^{-7} (*)	shoot dry wt		Acceptable
Dicots					
Soybean	1.8×10^{-5}	8.4×10^{-6} (*)	shoot dry wt		Acceptable

* The NOAEC value is above or equal to the EC_{25} or below the lowest concentration, therefore, an EC_{05} is used instead.

4. RISK CHARACTERIZATION

Risk characterization provides the final step in the risk assessment process. In this step, exposure and effects characterization are integrated to provide an estimate of risk relative to established levels of concern (LOCs). The results are then interpreted for the risk manager through a risk description and synthesized into an overall conclusion.

4.1. Risk Estimation - Integration of Exposure and Effects Data

Risk characterization integrates EECs and toxicity estimates and evaluates the likelihood of adverse ecological effects to non-target species. For sulfometuron methyl, a deterministic approach is used to evaluate the likelihood of adverse ecological effects to non-target species. In this approach, risk quotients (RQs) are calculated by dividing estimated environmental exposures (EECs) by acute and chronic ecotoxicity values for non-target species.

Risk Quotient (RQ) = Exposure Estimate/Toxicity Estimate

RQs are then compared to levels of concern (LOCs). These LOCs are criteria used to indicate potential risk to non-target organisms and the need to consider regulatory action. LOC exceedence is interpreted to mean that the labeled use (or proposed use) of the pesticide has the potential to cause adverse effects on non-target organisms. LOCs currently address the following risk presumption categories:

(1) **acute** - potential for acute risk to non-target organisms which may warrant regulatory action in addition to restricted use classification,
(2) **acute restricted use** – potential for acute risk to non-target organisms, but may be mitigated through restricted use classification,
(3) **acute endangered species** – endangered species may be potentially affected by use,
(4) **chronic risk** – potential for chronic risk may warrant regulatory action, endangered species may potentially be affected through chronic exposure,
(5) **non-endangered plant risk** - potential for effects in non-target (non-endangered) plants, and
(6) **endangered plant risk** – potential for effects in endangered plants.

Currently, EFED does not calculate formal risk quotients to assess chronic risk to plants or acute or chronic risks to non-target insects. However, these endpoints are evaluated on a case-by-case basis as data allow.

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

Table 36. Risk Presumptions for Aquatic Animals.

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

(1) EEC units in (mg/L or µg/L) in water

Table 37. Risk Presumptions for Terrestrial Animals.

Risk Presumption	RQ	LOC
Acute Risk	EEC[1]/LC_{50} or LD_{50}/sqft[2] or LD_{50}/day[3]	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Acute Endangered Terrestrial Invertebrate	EEC[4]/LD_{50} [4]	0.05

(1) EEC units are in ppm diet

(2) mg/sqft

LD_{50} * wt. of bird

(3) mg of toxicant consumed/day

LD_{50} * wt. of bird

(4) EEC = ppm in small insects; LD_{50} = ug/g bw (ppm)

Table 38. Risk Presumptions for Plants.

Risk Presumption	RQ	LOC
Terrestrial Plants in Terrestrial and Semi-Aquatic Areas:		
Non-Endangered Species	EEC[1]/EC_{25}	1
Endangered Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants:		
Non-Endangered Species	EEC[2]/EC_{50}	1
Endangered Species	EEC/EC_{05} or NOAEC	1

(1) EEC units in lbs ai/acre
(2) EEC units in µg/L or mg/L in water

4.1.1. Non-target Aquatic Animals and Plants

A summary of the toxicity values used to derive risk quotients for aquatic animals and plants is provided in Table 39 below.

Table 39. Endpoints Used for Estimating Risks of Sulfometuron Methyl to Aquatic Animals and Plants.
(1)

Organism Group	Toxicity	Units	MRID #
Freshwater fish, LC_{50}	> 148	mg ai/L	435018-02
Freshwater invertebrate EC_{50}	> 150	mg ai/L	435018-03
Marine/estuarine fish LC_{50}	> 45	mg ai/L	416728-03
Marine/estuarine invertebrate (mollusk - oyster) EC_{50}	> 38	mg ai/L	416728-04
Chronic freshwater fish NOAEC	Data gap		
Chronic freshwater invertebrate NOAEC	97	mg ai/L	416728-06
Aquatic nonvascular plants EC_{50}/NOAEC	4.6 / 0.63	µg ai/L	416801-02
Aquatic vascular plants EC_{50}/NOAEC	0.48 / 0.21	µg ai/L	435385-03

(1) Details for each study are presented in earlier sections of this document and in APPENDIX H: Ecological Effects Data Summaries,

4.1.1.1. Fish and Aquatic Invertebrates

All available LC_{50} or EC_{50} values derived from acute toxicity tests on freshwater and marine/estuarine fish and invertebrates are greater than the highest test concentration measured in these studies (>38 to >150 mg ai/L; Table 39). Therefore, risks to these taxa are described qualitatively. Compared to these 'indefinite' toxicity values, the peak EEC derived from the PRZM/EXAMS scenario yielding the highest exposure (31 µg/L) is three orders of magnitude lower. For bounding purposes, if one assumes that these indefinite LC_{50} or EC_{50} values represent the lower bound of actual (definitive) LC_{50} or EC_{50} values from these tests, then the resulting acute RQs would be approximately *three orders of magnitude lower than the LOCs* for non-endangered aquatic animals. For endangered fish and aquatic invertebrates, the RQs would be *approximately two orders of magnitude lower than the LOC of 0.05*. Considering that no mortality was observed at the highest test concentrations from these acute toxicity tests, the actual RQ values clearly represent conservative estimates of acute risk to these species.

The lowest available chronic NOAEC in aquatic invertebrates is 97 mg/L (97,000 ug/L). Compared to the highest 21-d EEC of 26 µg/L derived from PRZM/EXAMS modeling, the chronic RQ for freshwater invertebrates would also be several orders of magnitude lower than the LOC of 1.0.

For chronic toxicity to freshwater fish, no acceptable data were available. In the absence of chronic toxicity data, it is common to apply an extrapolation factor (e.g., acute-chronic ratio or ACR) to estimate chronic toxicity from acute toxicity test results. However, a valid ACR could not be determined from the sulfometuron methyl toxicity database because a definitive LC_{50} or EC_{50} was not established for any aquatic animals. Considering data for another sulfonylurea herbicide with a similar toxicity profile and the same mode of action (flazasulfuron, PC code: 119011), an ACR of 7 can be calculated for rainbow trout:

Rainbow trout LC_{50} = 115.2 mg ai/L (MRID 46220967; Sousa 2003)
Rainbow trout NOAEC = 17 mg ai/L (MRID 46220970; Sousa, 2004)
ACR = 115.2 / 17 = 7 (rounded)

Thus, applying an ACR of 7 to the LC_{50} of > 148 for freshwater fish yields an estimated NOAEC of >21 mg/L for sulfometuron methyl. Compared to the maximum 60-d average EEC of 20 ug/L derived from the PRZM/EXAMS modeling, the chronic RQ would be *at least three orders of magnitude lower than the LOC of 1.0*.

Although chronic studies were not available for marine/estuarine fish and invertebrates, there is no evidence to indicate marine or estuarine animals are substantially more sensitive than freshwater animals such that the risk profile would differ markedly from freshwater animals. Furthermore, acute toxicity studies indicate that sulfometuron methyl is not acutely toxic at (or near) toxicity limits for both freshwater and saltwater fish and invertebrates. Considering that the freshwater chronic RQs for fish and invertebrates would be several orders of magnitude lower than the LOCs, it appears highly unlikely that marine and estuarine animals would be at risk from chronic exposures to sulfometuron methyl as determined by PRZM/EXAMS modeling.

Acute and chronic risk to aquatic animals is further discussed in the Risk Description (Section 4.2),

4.1.1.2. Aquatic Plants

Risk quotients were derived using the peak EEC of 31 ug/L (determined from the PRZM/EXAMS exposure scenario yielding the highest peak exposure concentrations) and EC_{50} and NOAEC values for vascular and non-vascular aquatic plants, respectively (Table 40). For sulfometuron methyl, RQs exceeded the endangered and non-endangered LOCs for both vascular and non-vascular aquatic plants receiving pesticide runoff/drift, indicating a potential risk to these species.

Table 40. Summary of Acute Aquatic Plant Risk Quotients for Rights of Way Uses.

Scenario	Endangered		Non-endangered	
	Vascular	Non-vascular	Vascular	Non-vascular
TX Rights of Way (max rate of 0.375 lbs ai/acre x 1 aerial application/ yr) [a,b]	**148** [c]	**49** [c]	**65** [d]	**6.7** [d]

[a] Based on a peak EEC of 31 ug/L derived from the TX rights of way exposure scenario which yielded the highest EECs. Details on scenarios and PRZM-EXAMS modeling are provided in Section 3.2.2.2 and APPENDIX C: Ecological Aquatic Exposure Modeling.
[b] For sulfometuron methyl, endangered plants toxicity threshold (NOAEC) was 0.21µg ai/L for vascular and 0.63µg ai/L for non-vascular plants; acute toxicity thresholds (EC_{50}) used for non-endangered plants were 0..48 and 4.6 µg ai/L for vascular and non-vascular plants, respectively.
[c] indicates an exceedence of Endangered Species Level of Concern (LOC); RQ > 1.0.

(d) indicates an exceedence of non-target (i.e., non-endangered) Species Level of Concern (LOC); RQ > 1.0.

4.1.2. Non-target Terrestrial Animals

A summary of the toxicity values used to derive risk quotients for terrestrial animals is provided in Table 41 below.

Table 41. Endpoints Used for Estimating Risks of Sulfometuron Methyl to Terrestrial Animals.

Organism Group [(a)]	Toxicity	MRID #
Bird LD_{50} (oral dose-based, mg ai/kg-bw)	>4,650	245375
Bird LC_{50} (dietary-based, mg ai/kg-diet)	>4,600	71414
Mammal LD_{50} (oral dose-based, mg ai/kg-bw)	>5,000	430892-01
Honeybee LD_{50}, µg ai/bee	>100	416728-10
Mammal chronic NOAEL (dose-based, mg ai/kg-bw/day)	300[(b)]	78798 [(c)]

(a) Details for each study are presented in earlier sections of this document and in APPENDIX H: Ecological Effects Data Summaries.
(c) Highest dose tested.
(c) Accession number.

4.1.2.1. Birds, Acute Risks

The acute LC_{50}/LD_{50}s for birds are greater than the highest concentration/dose tested in each study. Therefore, while precise estimates of RQs are not possible with indefinite (i.e., "greater than") LC_{50}/LD_{50} values, a bounding analysis can be conducted to provide a conservative, upper bound estimate of the RQs **(**Table 42 and Table 43**)**.

In this bounding analysis, calculated EECs for various food items from the TREX terrestrial exposure model are compared to dose-base LD_{50} values (treated as definitive values) that have been adjusted for different avian size classes. The highest dose-based EEC (102 mg ai/kg-bw/d) is approximately $1/25^{th}$ the lowest adjusted dose-based LD_{50} (> 2414 mg ai/kg-bw) thus yielding an upper bound RQ of < 0.04. This upper bound RQ is less than the LOCs for acute risk (0.5), acute restricted use (0.2) and acute endangered species (0.1) for terrestrial animals.

Results from diet-based RQ calculations with birds are similar to those described above for dose-based RQs (Table 43). Specifically, the highest diet-$_{based}$ EEC (90 mg ai/kg-diet for short grass) is approximately $1/50^{th}$ the avian subacute dietary LC_{50} of >4600 mg ai/kg-diet, thus yielding an upper bound RQ of <0.02. This upper bound RQ is less than the LOCs for acute risk (0.5), acute restricted use (0.2) and acute endangered species (0.1) for terrestrial animals. The potential for acute risk to birds is discussed further in the Risk Description (Section 4.2).

Table 42. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients (Bounding Analysis Only).

Size Class (grams)	Adjusted LD_{50} (mg ai/kg-bw)	Short Grass[1]	
		EEC	RQ[2]
20	> 2414	102.5	< 0.04
100	> 3074	58.5	< 0.02
1000	> 4342	26.2	< 0.01

(1) Calculations provided for short grass only because upper bound dose-based EECs were higher than any other food item modeled.
(2) RQs derived using unadjusted LD_{50} of >4650 mg ai/kg-bw for mallard and dose-based EECs (mg ai/kg-bw) calculated using TREX ver. 1.3.1 with a single application at the maximum allowable label rate (0.375 lb ai/acre/yr). See Section 3.2 and "APPENDIX H: Ecological Effects Data Summaries" for details on the model inputs, calculations and output.

Table 43. Upper Bound Kenaga, Subacute Dietary-Based Risk Quotients (Bounding Analysis Only).

Dietary-based LC_{50} (mg ai/kg-diet)	Short Grass[1]	
	EEC[2]	RQ
> 4600	90.0	< 0.02

(1) Calculations provided for short grass only because upper bound residues were higher than any other food item modeled.
(2) Diet-based EECs are expressed in units of mg ai/kg-diet and are calculated using TREX ver. 1.3.1 based on a single application at the maximum allowable label rate (0.375 lb ai/acre/yr). See Section 3.2 and "APPENDIX H: Ecological Effects Data Summaries" for details on the model inputs, calculations and output. Size class not used for dietary risk quotients.

4.1.2.2. Birds, Chronic Risks

As described in Section 3.3, no acceptable chronic toxicity data were available on the effects of sulfometuron methyl on birds. Therefore, chronic risks to avian fauna could not be characterized. Uncertainty associated with the lack of chronic toxicity data with avian fauna is further described in the Risk Description section.

4.1.2.3. Mammals, Acute Risks

The unadjusted, acute LD_{50} for mammals is greater than the highest dose tested in the study (> 5000 mg ai/kg for rat; MRID 430892-01). Therefore, while a precise estimate of the mammalian acute RQ is not possible with an indefinite (i.e., "greater than") LD_{50} value, a bounding analysis can be conducted to provide a conservative, upper bound estimate of the acute, mammalian RQ **(**Table 44**)**.

In this bounding analysis, calculated EECs for various food items from the TREX terrestrial exposure model are compared to dose-base LD_{50} values (treated as definitive values) that have been adjusted for different mammalian size classes. When the highest EECs (from the short grass food item) are compared to the size-class adjusted LD_{50} values, the largest upper bound RQ is < 0.02, which occurs for the 20g mammal size class. This upper bound RQ is less than the LOCs for acute risk (0.5), acute restricted use (0.2) and acute endangered species (0.1) for terrestrial animals. The RQ calculations are detailed in "APPENDIX F: T-REX Output" and acute mammalian risks are further described in the Risk Description (Section 4.2). "

Table 44. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients (Bounding Analysis Only).
(1)

Size Class (grams)	Adjusted LD_{50}	Short Grass[1]	
		EEC	RQ[2]
15	> 10989	85.8	< 0.01
35	> 8891	59.3	< 0.01
1000	> 3846	13.8	< 0.01

(1) Calculations provided for short grass only because upper bound dose-based EECs were higher than any other food item modeled.
(2) RQs derived using unadjusted LD_{50} of >5000 mg ai/kg-bw and dose-based EECs (mg ai/kg-bw) calculated using TREX ver. 1.3.1 with a single application at the maximum allowable label rate (0.375 lb ai/acre/yr). See Section 3.2 and "APPENDIX H: Ecological Effects Data Summaries" for details on the model inputs, calculations and output.

4.1.2.4. Mammals, Chronic Risks

To evaluate the chronic risk to mammals, dose-based and dietary-based RQs were calculated using the rabbit NOAEL of 300 mg ai/kg-bw/d from the developmental toxicity study (Accession No. 78798). The rabbit developmental toxicity study was selected for assessing chronic risks to mammals because an acceptable NOAEL was not available from the 2-generation chronic rat reproduction study (that study is considered invalid by HED) or other small mammals (mouse). Because TREX assumes the test NOAEL corresponds to a 350g mammal (rat), calculation of size-class adjusted NOAELs for the rabbit (which averaged 3.9 kg in the study) first involved adjusting the rabbit NOAEL to a 350g mammal adjusted NOAEL using the same equation as TREX. This 350g, size-adjusted NOAEL (549 mg ai/kg-bw/d) was then input to TREX for the remainder of the chronic mammalian EEC and RQ.

Neither the chronic, dose-based risk quotients (Table 45) nor the dietary-based risk quotients (Table 46) exceed the chronic LOC for all weight classes (15 g, 35 g, and 1000g) of mammals consuming short grass, tall grass, broadleaf forage/small insects and seeds. Details of the RQ calculations are provided in (See APPENDIX F: T-REX Output).

Table 45. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients.

Size Class (grams)	Adjusted NOAEL[1] (mg ai/kg-bw/d)	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ

15	1206.6	85.8	0.07	39.3	0.03	48.3	0.04	5.36	<0.01	1.19	<0.01
35	976.3	59.3	0.06	27.2	0.03	33.4	0.03	3.71	<0.01	0.82	<0.01
1000	422.3	13.8	0.03	6.3	0.01	7.7	0.02	0.86	<0.01	0.19	<0.01

(1) RQs derived for different size classes using unadjusted NOAEL of >300 mg ai/kg-bw/d and dose-based EECs (mg ai/kg-bw/d) calculated using TREX ver. 1.3.1 with a single application at the maximum allowable label rate (0.375 lb ai/acre/yr). See Section 3.2 and "APPENDIX H: Ecological Effects Data Summaries" for details on the model inputs, calculations and output.

Table 46. Upper Bound Kenaga, Chronic Mammalian Dietary-Based Risk Quotients

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10980	90.00	0.01	41.25	<0.01	50.63	<0.01	5.63	<0.01

Dietary-based RQs derived by converting the rabbit NOAEL (>300 mg ai/kg-bw/d) to a diet-based NOAEC and comparing with diet-based EECs (mg ai/kg-diet) calculated using TREX ver. 1.3.1 at the single maximum allowable label rate (0.375 lb ai/acre/yr). See Section 3.2 and "APPENDIX H: Ecological Effects Data Summaries" for details on the model inputs, calculations and output. Size class not used for dietary risk quotients

4.1.2.5. Non-Target Terrestrial-phase Amphibians, Reptiles and Terrestrial Invertebrates

In absence of taxa-specific data, EFED currently uses birds as surrogates for terrestrial non-target terrestrial phase amphibians and reptiles and fish for aquatic phase amphibians. LOCs were not exceeded for any of the surrogate species; therefore, potential risks to reptiles and amphibians are also presumably lower than the Agency's concern level.

EFED does not currently estimate risk quotients for terrestrial non-target invertebrates. However, a label statement is required to protect foraging honeybees when the LD_{50} is <11 µg/bee. Based on the acute contact toxicity study to honeybees, the LD_{50} for sulfometuron methyl is >100 µg/bee. This classifies sulfometuron methyl as practically non-toxic to honeybees on an acute contact exposure basis. For RQ derivation for endangered terrestrial invertebrates, the LD_{50} for honeybees (>100 ug a.i./bee) is converted to units of µg ai/g (of bee) by multiplying by 1 bee/0.128 g, thereby resulting in an LD_{50} of >780 µg ai/g. This LD_{50} value is then compared to the EEC of 50.6 ug/g for small insects/broadleaf plants (Table 17). The resulting RQ (EEC/LD_{50}) is <0.06, which is at or below the LOC for endangered terrestrial invertebrates (0.05). Therefore, the risk of direct adverse effects to terrestrial invertebrates is considered low; however, due to the potential risk identified to plants, the potential for indirect effects to terrestrial invertebrates from sulfometuron methyl use cannot be discounted.

Additional discussion of potential risks to these taxa is qualitatively discussed in the Risk Description portion of this document (Section 4.2).

4.1.3. Non-target Terrestrial Plants

A summary of the toxicity values used to derive risk quotients for terrestrial plants is provided in Table 47 below.

Table 47. Summary of Selected Endpoints from Terrestrial Plant Toxicity Studies of Sulfometuron Methyl

Organism Group	Toxicity (Lbs A.I./Acre)	MRID #
Terrestrial monocots emergence, EC_{25}, lbs ai/acre EC_{05} or NOAEC, lbs ai/acre	$EC_{25} = 1.9 \times 10^{-4}$ $EC_{05} = 4.3 \times 10^{-5}$	435385-01
Terrestrial dicots emergence, EC_{25}, lbs ai/acre EC_{05} or NOAEC, lbs ai/acre	$EC_{25} = 3.2 \times 10^{-5}$ NOAEC = 2.9×10^{-5}	435385-01
Terrestrial monocots vegetative vigor, EC_{25}, lbs ai/acre EC_{05} or NOAEC, lbs ai/acre	$EC_{25} = 3.7 \times 10^{-5}$ $EC_{05} = 8.4 \times 10^{-6}$	435385-01
Terrestrial dicots vegetative vigor, EC_{25}, lbs ai/acre EC_{05} or NOAEC, lbs ai/acre	$EC_{25} = 1.8 \times 10^{-5}$ $EC_{05} = 9.9 \times 10^{-7}$	435385-01

[a] Details for each study are presented in earlier sections of this document and in "APPENDIX H: Ecological Effects Data Summaries".

4.1.3.1. Non-Endangered and Endangered Plant Risks

Table 48 presents terrestrial plant RQs for sulfometuron methyl based on aerial and ground spray applications. These RQs were derived using TerrPlant (ver 1.2.2) using a single application rate at the annual maximum of 0.375 lb ai/A. TerrPlant is a Tier 1 model that estimates pesticide aerial drift and runoff to dry and semi-aquatic adjacent areas. Results indicate that the LOCs are widely exceeded for non-endangered and endangered monocots and dicots located in adjacent dry areas and in semi-aquatic areas as the result of receiving a combination of runoff and spray drift from ground and aerial applications. In addition, the LOCs were exceeded for terrestrial plants receiving spray drift alone from ground and aerial application. These risks will be discussed in detail in the AgDrift spray drift analysis in the Risk Description (Section 4.2). However, TerrPlant modeling results are based on the assumption of a single application, risk quotients for non-target terrestrial plants may be underestimated. Bold indicates an LOC exceedence in Table 48.

Table 48. RQ Values For Plants In Dry And Semi-Aquatic Areas Exposed To Sulfometuron Methyl Through Runoff And/Or Spray Drift.

Plant Type	Application Method	Terrestrial Adjacent Areas	Semi-Aquatic Adjacent Areas	Spray Drift
Non-endangered Plant RQs [a,b,d]				
Monocot	ground spray	**118**	**1007**	**101**
Dicot	ground spray	**703**	**5977**	**208**
Monocot	Aerial	**197**	**1086**	**507**
Dicot	Aerial	**1172**	**6445**	**1042**
Endangered Plant RQs [a,c,d]				

Monocot	ground spray	**523**	**4448**	**446**
Dicot	ground spray	**776**	**6595**	**3788**
Monocot	Aerial	**872**	**4797**	**2232**
Dicot	Aerial	**1293**	**7112**	**18939**

[a]Detailed calculations for RQs and TerrPlant (ver 1.2.2) input and output are provided in "APPENDIX D: Terrplant Spreadsheet."
[b] Non-endangered toxicity thresholds (EC_{25}) are 1.9 x 10^{-4} (seedling emergence, monocot), 3.2 x 10^{-5} (seedling emergence, dicot), 3.7 x 10^{-5} (vegetative vigor, monocot), 1.8 x 10^{-5} (vegetative vigor, dicot) lb ai/A.
[c] Endangered toxicity thresholds (NOAEC of EC_{05}) are 4.3 x 10^{-5} (seedling emergence, monocot), 2.9 x 10^{-5} (seedling emergence, dicot), 8.4 x 10^{-6} (vegetative vigor, monocot), 9.9 x 10^{-7} (vegetative vigor, dicot) lb ai/A.
[d] Bold RQ values exceed the Non-Endangered Species LOC and Endangered Species LOC (RQ >1.0).

4.1.4. Use of Contaminated Irrigation Waters

The potential risk to plants when exposed to irrigation water contaminated with sulfometuron methyl is presented in the form of RQs in Table 49. These RQs are derived using EECs of 0.33 µg/L (ground water) and 31 µg/L (surface water). The EEC for ground water was calculated using the Tier 1 SCIGROW model (Table 16) while that for surface water was calculated using PRZM/EXAMS for the scenario yielding the highest EECs (Table 15). For semi-aquatic and terrestrial areas adjacent to irrigation fields, EECs in lb ai/acre were calculated assuming 1% of the irrigation water drifts into adjacent wetlands. It was further assumed that no runoff of irrigation water occurs. Toxicity endpoints were taken from the vegetative vigor study because it was assumed that non-target plants are exposed to sulfometuron methyl directly through spray drift from irrigation water. Details of the calculation of the irrigation EECs are provided in APPENDIX G: Modeling of Terrestrial plant Exposure from Contaminated irrigation Water).

Based on this screening analysis, results suggest that sulfometuron methyl levels in irrigation water from ground water sources would not exceed non-target or endangered species LOCs (i.e, RQs < 1.0). However, RQs based on sulfometuron methyl in irrigation water derived from surface water sources exceed the LOCs for both non-target and endangered species (3.9 and 71, respectively), thus indicating a potential risk to plants adjacent to areas irrigated with surface water sources.

Table 49. Risk Quotients for Non-target and Endangered Plants, Resulting From Exposure to Sulfometuron Methyl in Irrigation Water

Location	Ground water and Surface Water EEC: [1, 2] (lbs ai/A)	Risk Quotients: Ground water (GW) and Surface Water (SW) Irrigation	
		Non-target plants[3] (EEC/EC25)	Endangered plants[3] (EEC/NOAEC)
Semi-aquatic and terrestrial areas adjacent to irrigated fields	Ground water: 7.5 x 10^{-7} Surface water: 6.1 x 10^{-5}	GW: 0.04 SW: **3.9**	GW: 0.76 SW: 71

[1] Estimated EEC assumes 1 inch of irrigation water is applied to the target field, 1% drift of irrigated water containing sulfometuron methyl, and no runoff of irrigated water. See Appendix G for details on irrigation exposure calculations.
[2] EECs based on sulfometuron methyl concentrations of 0.33 ug/L in ground water and 31 ug/L in surface water
[3] Based on non-target plant EC25 of 1.8 x 10^{-5} lb ai/A and endangered plant NOAEC of 9.9 x 10^{-7} (MRID 435385-01) for the most sensitive vegetative vigor endpoint. Bold RQ indicates exceedence of LOC of 1.0 (i.e., RQ > 1)

4.2. RISK DESCRIPTION

4.2.1. Risk to Aquatic Animals and Plants

In the conceptual model, spray drift and surface runoff/leaching to adjacent bodies of water were predicted as the most likely sources of exposure of sulfometuron methyl to non-target aquatic animals and plants. Risks to aquatic organisms (i.e. fish, invertebrates, and plants) were assessed based on modeled estimated environmental concentrations (EECs) and available toxicity data. Aquatic EECs for the ecological exposure to sulfometuron methyl were estimated using PRZM-EXAMS employing the standard ecological water body (Section 3.2.2.2; Table 13).

The risk hypothesis stated that the use of sulfometuron methyl has the potential to cause adverse effects to aquatic animals and plants. This assessment confirms this hypothesis. Risks of direct effects to aquatic vascular and nonvascular plants are above the Agency's LOCs. However, the assessment refutes the risk hypothesis regarding direct effects to aquatic animals, suggesting that direct effects to aquatic animals are unlikely. Although risk from direct toxicity to aquatic animals is not indicated in this screening level assessment, the dependence of aquatic animals on primary producers (plants) results in the potential for indirect effects to aquatic animals.

4.2.1.1. Fish and Aquatic Invertebrates

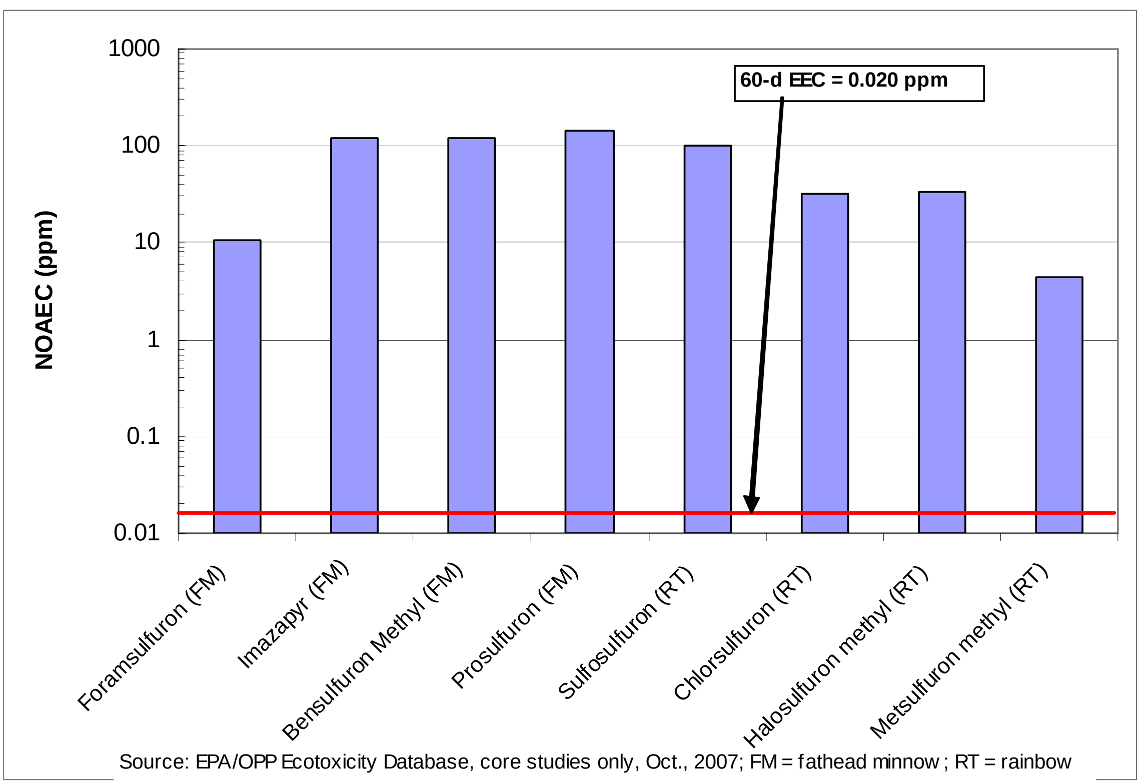
The submitted acute toxicity data for aquatic species indicate that sulfometuron methyl is practically non-toxic to fish and invertebrates with LC_{50} and EC_{50} values >38 to >150 mg ai/L, respectively. A comparison of the PRZM/EXAMS peak EEC of sulfometuron methyl in surface water of 31 ug/L to toxicity values for fish and invertebrates indicates that these indefinite (i.e., 'greater than) acute toxicity values are three orders of magnitude above the highest peak EEC. A bounding analysis indicates that even if these indefinite LC_{50} and EC_{50} values are interpreted as the lower bounds for acute toxicity (a conservative assumption since no mortality occurred in these test concentrations), the resulting acute RQs would still be at least two orders of magnitude below the LOCs for non-endangered and endangered aquatic animals. This risk finding is consistent with those from other ecological risk assessments with sulfonylurea herbicides (e.g., florasulam, flazasulfuron). While it was noted in the Analysis Section (3.3) that uncertainty exists in the actual exposure concentration derived from the estuarine/marine acute toxicity tests, this uncertainty is not judged to be large enough to impact the risk conclusions, given the large difference between EECs and toxicity levels.

Therefore, it is concluded that acute risk to aquatic animals from direct effects of sulfometuron methyl is expected to be minimal.

Similarly, chronic risk quotients are all less than the LOC of 1.0 for the modeled uses. For freshwater aquatic invertebrates and fish, the PRZM/EXAMS 21-day EEC (26 ug/L) and 60-d EEC (20 ug/L) are also three orders of magnitude below the chronic NOAEC of 97 mg/L and >21 mg/L, respectively. As noted in the Analysis Section (3.3), the chronic NOAEC for fish had to be estimated using an ACR of 7 derived from another chemical (flazasulfuron) with a similar toxicity profile and mode of action. Clearly, there is uncertainty associated with extrapolation of an ACR across chemicals, as ACRs can vary by chemical, species, test designs, and other factors. In a recent analysis, Raimondo et al. (2007) evaluated the variability in ACRs derived from multiple sources, including EFED's Pesticide Ecotoxicity database. Raimondo et al. (2007) report a 90th percentile ACR of 80 across all chemicals, which if applied to the freshwater fish LC_{50} of > 148 mg/L, would yield an estimated NOAEC of > 2 mg/L. This value is still 100-fold higher than the chronic 60-d EEC of 20 ug/L. This 90th percentile ACR reflects pesticides with modes of action that differ from sulfometuron methyl and therefore may not reflect the 90th percentile ACR within the sulfonylurea class of herbicides. However, for the purposes of evaluating uncertainty in acute-to-chronic toxicity extrapolations, it is considered a reasonable approximation of a "high end" ACR.

The potential for chronic risks to fish was further evaluated by comparing the 60-d (chronic) EEC for freshwater fish with available chronic toxicity values (NOAECs) for other sulfonylurea herbicides (Figure 3). Results indicate that chronic toxicity of other sulfonylurea herbicides occurs at concentrations two to three orders of magnitude greater than the chronic EEC of 0.020 mg/L. Therefore, based on the use of a conservative "high end" ACR and comparison with toxicity information for other sulfonylurea herbicides, the potential for chronic risk to aquatic animals from direct effects of sulfometuron methyl appears unlikely.

Figure 3. Chronic Toxicity of Sulfonylurea Herbicides to Freshwater Fish



Although no chronic studies in saltwater fish or invertebrates have been submitted to the Agency, the acute studies do not indicate that saltwater species are expected to be more sensitive than freshwater species. Given the low magnitude of the freshwater animal risk quotients, submission of chronic studies in saltwater species would not likely affect conclusions of this assessment.

An ECOTOX literature search found no acceptable or supplemental studies on the acute toxicity of technical grade sulfometuron methyl to fish or invertebrates. Results from a supplemental study of microcrustaceans using the formulated product, Oust, indicates that sulfometuron methyl is practically nontoxic to these aquatic invertebrate crustaceans. Therefore, toxicity findings of the formulated product (Oust®) are consistent with those using the technical grade active ingredient with *Daphnia magna* (MRID 435018-03).

4.2.1.2. Non-target Aquatic-phase Amphibians

EFED currently uses surrogate data (fish) to estimate potential risks to non-target aquatic phase amphibians. Risks to fish species were discussed above and do not indicate significant risk to these organisms.

One study of the effect of sulfometuron methyl on an aquatic-phase amphibian was found was found that met OPP/ECOTOX screening criteria (Table 50). In this study, Fort et al. (1999) conducted three separate tests of sulfometuron methyl exposure to the African clawed frog, *Xenopus laevis*: (1) a 4-day frog embryo teratogenesis assay (FETAX) to evaluate embryo mortality/ malformations; (2) a 14-d test to evaluate effects on tail resorption, and (3) a 30-d exposure to evaluate effects on limb development. Both analytically impure (85% ai) and purified (99.5% ai) sulfometuron methyl exposures were evaluated in the study, but due to the confounding influence of impurities on sulfometuron methyl toxicity, results from only the purified (99.5% ai) sulfometuron methyl are used here.

In the FETAX assay, 2 replicates of 20 mid-blastula frog embryos (stage 8) were exposed to 11 nominal test concentrations of sulfometuron methyl ranging from 0.001 to 24.9 mg ai/L for 96-h. Sulfometuron methyl stock solutions were prepared using a DMSO carrier and verified analytically (analytical results not reported). Both a negative and solvent control were included. Test procedures generally conformed to ASTM recommendations for the FETAX assay (ASTM, 1996). Results indicate no statistically significant effect of sulfometuron methyl on embryo survival or percent malformations up to (and including) the highest test concentration (24.9 mg ai/L). Solvent controls were not significantly different from negative controls.

Similar results were found in the 30-d study, whereby no statistically significant effect of sulfometuron methyl exposure was found on limb development (% malformations) up through 24.9 mg ai/L. Results from the 14-d tail resorption study indicate a significant reduction in tail resorption at 9.95 and 24.9 mg ai/L beginning at development stage 64 through 66 (test termination). No significant reduction occurred at or below 1 mg ai/L.

This study is classified as supplemental primarily because exposure concentrations were not measured during the test. Although the authors report that sulfometuron methyl was 'stable' over the 24 to 96-h renewal cycles used in the studies, no analytical chemistry results were provided. Furthermore, randomization of study organisms and replicates was not indicated (an ASTM requirement). Collection and testing of embryos by separate clutches (an ASTM recommendation) was not apparent in the study. Finally, the final concentrations of carrier solvent in the various treatments was not reported (solvent concentrations were only reported for the stock solutions).

Table 50. Toxicity of sulfometuron methyl to the African clawed frog from a study by Fort et al. (1999).

Species	Test Chemical	Exposure Duration	Endpoint (Effect)	Effect Level (mg ai/L)	Study Classification	Ref.
Xenopus laevis	sulfometuron methyl (99.5% ai)	96-h	LC_{50} (% mortality) NOAEC (% malformations)	> 24.9 24.9 [a]	Supplemental	Fort et al. (1999)
		14-d	NOAEC (tail resorption) LOAEC (tail resporption)	0.995 9.95		
		30-d	NOAEC (limb deformation)	24.9[a]		

[a] Highest tested dose, LOAEL not achieved in study.

Although results from the Fort et al (1999) study are not being used quantitatively in this risk assessment, they suggest that acute toxicity to *Xenopus* larvae occurs at levels > 1000 times the maximum EEC of 31 ug/L derived from the PRZM/EXAMS model. The lowest NOAEC from this study (1.0 mg/L) is approximately 45 times higher than the maximum 21-d EEC of 26 ug/L. Therefore, based on conclusions for fish discussed previously and supplemental information from Fort et al (1999), risk to aquatic phase amphibians is also expected to be lower than the Agency's concern level.

4.2.1.3. Aquatic Plants

Toxicity studies indicate that sulfometuron methyl is classified as highly toxic to aquatic plants, and the RQ values (65-148 for vascular plants; 6.7-49 for nonvascular plants) indicates the potential risk to aquatic vascular and nonvascular plants is above the Agency's concern level. The freshwater vascular plant (duckweed) is the most sensitive aquatic plant species (14-d EC_{50} and NOAEC are 0.48 and 0.21 µg/L, respectively) followed by the green algae (EC_{50} is 4.6 µg ai/L and the NOAEC is 0.63 ug ai/L). Sulfometuron methyl was much less toxic to diatoms (>370 and >410 mg/L), and potential risks to this taxonomic group do not exceed the Agency's concern level.

In the duckweed study described previously (MRID 435385-03), recovery from the 14-d sulfometuron methyl exposures was assessed at the end of the study by exposing organisms to untreated medium for an additional 14 days. Effects were expressed as percent inhibition of frond counts and biomass. The results are as follows:

14-d Exposure Conc.	14-d Recovery Frond Count Inhibition	14-d Recovery: Biomass Inhibition
1.045 ppb	41.1%	38.3%
0.590 ppb	11.8%	10.8%
0.323 ppb	0.6%	- 1.0%

Therefore, the study authors concluded that sulfometuron methyl was phytotoxic to duckweed at concentrations of ≥ 0.590 ppb and phytostatic at 0.323 ppb. These data suggest that the effects of sulfometuron methyl to aquatic vascular plants may be reversible following 14-d exposures at selected concentrations (0.323 ppb and below). To evaluate the potential for duckweed (and by extension, other vascular plants) to recover from sulfometuron methyl exposures predicted using PRZM/EXAMS modeling, the predicted long-term exposures to sulfometuron methyl (e.g., 90-d average concentration) was compared to available toxicity information. Results indicate that the 90-d average concentration (16 ug/L; Table 15) derived from the exposure scenario yielding the highest exposure concentrations still exceeds the 14-d EC_{50} (0.48 ug/L) by a factor of 33 and the 14-d phytotoxic concentration (0.59 ppb) by a factor of 27. Therefore, the ability of duckweed and other vascular aquatic plants to recover from predicted long-term exposure concentrations of sulfometuron methyl in adjacent, static aquatic systems appears unlikely. The sensitivity of RQ estimates for aquatic vascular and nonvascular plants to different assumptions regarding application rates and timing of application is discussed later in Section 4.3.

Byl et al. (1994) conducted a laboratory study on the effect of sulfometuron methyl on the aquatic vascular plant, *Hydrilla verticillata.* In this study, Byl et al. (1994) exposed plants to aqueous solutions ranging from 0.001 to 1.0 mg/L sulfometuron methyl (as Oust) in three replicate chambers per treatment for 5 days. The % ai was not reported nor is it clear whether nominal concentrations reflect adjustment for % ai. A significant decrease in combined shoot and root length was observed at or above 0.01 mg/L (approximating 30% of the controls). Although not conclusive, results from Byl et al. suggest that the combined root and shoot length response of *Hydrilla* is less sensitive to 5-d exposure to the formulated product (Oust) compared to the 14-d exposure to TGAI for duckweed (NOAEC = 0.21 ug ai/L), even if nominal concentrations are adjusted downward to reflect the typical 75% ai found in Oust. However, the relative toxicity of TGAI and formulated product can not be determined conclusively from comparison of these two studies because study protocols differed substantially (e.g., exposure duration, measurement endpoints).

4.2.1.4. Aquatic Toxicity of Sulfometuron Methyl Degradates

As discussed earlier in Section 3.3.1.7, no acceptable or supplemental studies were available on the toxicity of the major sulfometuron methyl degradates to aquatic organisms. To characterize the potential toxicity of the major degradates of sulfometuron methyl, predicted toxicity values were determined from EPA's ECOSAR model (v. 0.99h). Note that these QSAR results should not, by OPP policy, be used directly for risk management decisions. This model is based on quantitative structure activity relationships (QSAR) for chemical effects on fish, daphnids, and green algae. Table 51 displays the results of the ECOSAR model predictions for five major sulfometuron methyl degradates.

Table 51. ECOSAR-predicted toxicity values for major degradates of sulfometuron methyl.

Degradate Name	ECOSAR Class	Organism	Toxicity Endpoint	Toxicity Value (mg/L)
2-Hydroxy, 4,6-dimethyl pyrimidine	Phenols	Fish	96-h LC_{50} 90-d Chronic Value	49 0.31
		Daphnid	48-h LC_{50} 21-d Chronic Value	13 5.3
		Green Algae	96-h EC_{50}	257
2-(Aminosulfonyl) benzoic acid	Neutral organic acids	Fish	96-h LC_{50} 30-d Chronic Value	137,000* 12,600
		Daphnid	48-h LC_{50} 16-d EC_{50}	128,000* 2,620
		Green Algae	96-h EC_{50}	70,676
Saccharin	Thiazolinone (iso-)	Fish	96-h LC_{50} Chronic Value**	1.9 0.14
		Daphnid	48-h LC_{50} Chronic Value**	1.6 0.057
		Green Algae	96-h EC_{50}	0.41
2-(Aminosulfonyl) benzoic acid, methyl ester	Esters	Fish	96-h LC_{50} Chronic Value**	152 136
		Daphnid	48-h LC_{50}	2,350
		Green Algae	96-h EC_{50} Chronic Value**	11.6 8.7
2-Pyrimidinamine, 4,6-dimethyl	Aromatic amines	Fish	96-h LC_{50} Chronic Value**	214 0.93
		Daphnid	48-h LC_{50} Chronic Value**	1.6 0.042
		Green Algae	Chronic Value**	12.9

* predicted toxicity value may exceed compound's aqueous solubility
** duration associated with the reported chronic value was not reported by the ECOSAR program
The peak, 21-d, and 90-d EECs predicted for the parent chemical, sulfometuron methyl are: 0.031, 0.026, and 0.016 mg/L, respectively (Table 15)

Toxicity predictions from the ECOSAR model ranged widely across the five degradates, likely due in part to the differences in chemical structure and ECOSAR class used for the predictions (e.g., phenols, neutral organic acids, thialozinone, esters and aromatic amines).

Predicted toxicity and risk characterization for 2-(aminosulfonyl) benzoic acid
Of the five degradates evaluated, 2-(aminosulfonyl) benzoic acid was predicted to be the least toxic, with toxicity predictions for all aquatic species tested ranging from 2,600 to 137,000 mg/L. Predicted EECs were not modeled for the any of the degradates due to lack of appropriate data on the environmental fate of these compounds. However, if one assumes the EECs for the degradates are similar that of the parent compound (sulfometuron methyl), then the toxicity value for 2-(aminosulfonyl) benzoic acid appears at least 5 orders of magnitude greater than the EEC for sulfometuron methyl. While this assumption may have uncertainty due to the potential differential environmental fate characteristics of sulfometuron methyl and 2-(aminosulfonyl) benzoic acid, it appears highly unlikely that such differences would span the 5 order of

magnitude range between EECs and predicted toxicity values for 2-(aminosulfonyl) benzoic acid, thus suggesting that the potential ecological risk to fish, daphnids and green algae associated with 2-(aminosulfonyl) benzoic acid would be highly unlikely.

Predicted toxicity and risk characterization for the other degradates

Effects on Fish. With the remaining four degradates (2-hydroxy, 4,6-dimethyl pyrimidine, saccharin, 2-(aminosulfonyl) benzoic acid, methyl ester, and 2-pyrimidinamine, 4,6-dimethyl), the predicted acute and chronic toxicity values for fish ranged from 1.9-214 mg/L and 0.14-136 mg/L, respectively (Table 51). Except for saccharin, these predicted acute toxicity values for fish were comparable to those observed for sulfometuron methyl (>150 mg ai/L). The predicted acute toxicity of saccharin to fish was at least two orders of magnitude lower than that observed sulfometuron methyl. However, when compared to the peak predicted EEC for sulfometuron methyl (0.031 mg/L), the predicted acute toxicity of the degradates to fish is still at least two orders of magnitude greater (1.9-214 mg/L). The lowest predicted chronic toxicity value for fish (0.14 mg/L for saccharin) was about an order of magnitude greater than the predicted 90-d EEC for sulfometuron methyl (0.016 mg/L). Given the relatively long degradation half lives used to predict EECs for sulfometuron methyl (e.g., several months or longer, Table 13), it also appears unlikely that these degradates would reach concentrations that would exceed those of sulfometuron methyl by 1-2 orders of magnitude (although it is possible that exposure on a molar basis to the most persistent degradates could be somewhat higher than to parent).

Effects on daphnids. For daphnids, the acute and chronic toxicity values predicted from ECOSAR ranged from 1.6-2,350 mg/L and 0.042-5.3 mg/L, respectively, for the remaining four degradates: 2-hydroxy, 4,6-dimethyl pyrimidine, saccharin, 2-(aminosulfonyl) benzoic acid, methyl ester, and 2-pyrimidinamine, 4,6-dimethyl (Table 51). When compared to the peek EEC of 0.031 mg/L for sulfometuron methyl, the ECOSAR-predicted acute toxicity of the degradates was at least two orders of magnitude greater (1.6-2,350 mg/L). However, for two degradates (saccharin and 2-pyrimidinamine, 4,6-dimethyl), the ECOSAR-predicted chronic toxicity (0.052 and 0.042 mg/L, respectively) are relatively close to the 21-d EEC of sulfometuron methyl (0.026 mg/L). Thus, if the EECs for these degradates are comparable to the parent compound (sulfometuron methyl) and the toxicity predictions from ECOSAR are accurate, chronic toxicity of these two degradates to daphnia would be just a factor of two greater than the degradate EECs.

Effects on green algae. For green algae, the ECOSAR-predicted acute and chronic toxicity values for the degradates (0.41 - 257 mg/L; (Table 51) are much greater than those of sulfometuron methyl (0.0046 and 0.00063 for acute and chronic toxicity, respectively. This finding is expected given the mode of action of the degradates likely differ from sulfometuron methyl, which is specific to ALS inhibition in plants. The most sensitive of these toxicity values (0.41 mg/L for saccharin) is about an order of magnitude greater than the peak EEC of 0.031 mg/L for sulfometuron methyl. This implies the potential risks from sulfometuron methyl to aquatic plants (green algae) are much more of a concern compared to its degradates. However, the phytotoxicity of saccharin may not be discounted entirely, especially if there is an underestimation of saccharin toxicity by ECOSAR and/or a higher level of exposure to saccharin due to (possibly) greater environmental persistence.

Although the above comparisons are subject to considerable uncertainty in both the toxicity estimates (ECOSAR) and EECs (assumed to be similar to those for sulfometuron methyl), they do suggest that the toxicity of the degradates is likely not a dominant concern, with the possible exception of chronic toxicity to freshwater invertebrates (daphnia) and acute toxicity to algae.

4.2.2. Risk to Terrestrial Animals

In the conceptual model, direct deposition, spray drift, root uptake, sediment and water runoff water, wind erosion of soil particles, and volatilization/inhalation are identified as the most likely exposure routes for sulfometuron methyl exposure to non-target terrestrial organisms. Risks to terrestrial animals and plants (i.e. birds, terrestrial-phase amphibians, reptiles, mammals, and plants) were assessed based on modeled EECs and available toxicity data. As part of this screening terrestrial risk assessment, exposure concentrations of sulfometuron methyl to non-target terrestrial plants and animals were modeled according to maximum labeled application rates. For terrestrial birds, terrestrial-phase amphibians, reptiles and mammals, estimates of upper bound levels of sulfometuron methyl residues on various food items, which may be contacted or consumed by wildlife, were determined using the Fletcher nomogram followed by a first order decline model TREX 1.3.1. Likewise, the TerrPlant 1.2.2 model was used to estimate exposure to non-target plants and the AgDRIFT 2.0.1 model provided further refinement of spray drift dispersion and deposition to terrestrial plants located in proximity to treated fields. Note that AgDRIFT offers the ability to examine the variation in the amount of spray drift with application practices and conditions whereas TerrPlant does not (fixed values are used). Since spray drift is a dominant contributor to off-site exposure to terrestrial animals, the AgDRIFT predicted exposures, depending on the input assumptions, may be higher than those estimated with TerrPlant.

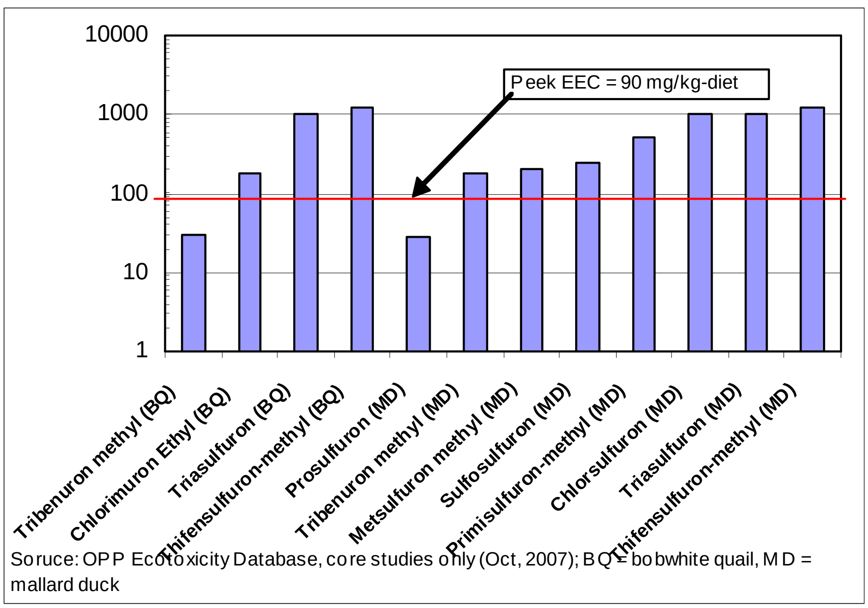
The risk hypothesis stated that the use of sulfometuron methyl has the potential to cause adverse effects to terrestrial animals and plants. This risk hypothesis is confirmed for terrestrial plants, and also for adverse effects to non-target terrestrial animals via indirect effects resulting from potential effects to plants. However, the assessment refutes the risk hypothesis regarding direct effects to animals and suggests that direct effects to terrestrial animals are unlikely.

4.2.2.1. Birds

Sulfometuron methyl is categorized as practically nontoxic to both waterfowl (mallard duck) on an acute oral basis (LD_{50} >4,650 mg/kg-bw) and practically nontoxic to both upland game birds and waterfowl by the subacute dietary route (LC_{50} >5,620 mg/kg-diet and > 4,600 mg/kg-diet, respectively). Since the LD_{50} and LC_{50} values are greater than the highest dose tested in the studies, with no effects occurring at any dose, a bounding analysis was conducted to evaluate potential effects associated with acute oral and subacute dietary exposure to sulfometuron methyl (Section 4.1; Table 42 and Table 43). This bounding analysis compared size class adjusted 'indefinite' LD_{50} values (i.e., 'greater than' values) based on a bird's weight to predicted doses on food residues (EEC equivalent dose) following a single ground application of sulfometuron methyl at 0.375 lb ai/A. Based on this analysis, predicted RQs were all < 0.04 or lower, despite the conservative assumption that the 'indefinite' LC_{50} and LD_{50} values (at which no mortality was observed in the test) represent definitive LC_{50} and LD_{50} values (where 50% mortality occurred). Therefore, risk to birds from acute oral and subacute dietary exposure to sulfometuron methyl is judged to be highly unlikely.

No data were available on the effects of sulfometuron methyl to avian fauna from chronic exposures. Therefore, risks to birds from chronic exposure to sulfometuron methyl could not be directly quantified in this risk assessment. A qualitative assessment is conducted here based on chronic avian toxicity data obtained for 12 studies from 9 other sulfonylurea herbicides with the same mode of action (inhibition of acetolactate synthase; Figure 4). These data were obtained from EFED's Ecotoxicity database using a cross reference with another EFED "Active Ingredient" database that links active ingredients with mode of action. Although these 12 sulfonylurea herbicides likely do not represent the entire universe of sulfonylureas with chronic avian toxicity data, they are considered to provide a representative sample from which to qualitatively evaluate the uncertainty associated with lack of chronic avian toxicity data for sulfometuron methyl.

Figure 4. Chronic Avian Toxicity of Sulfonylurea Herbicides



Results from Figure 4 indicate that out of the 12 chronic avian NOAECs examined for sulfonylurea herbicides, two occurred below the peek EEC of 90 mg ai/kg-diet calculated for short grass (Table 17). These two NOAECs were 30 mg ai/kg-diet for tribenuron methyl (MRID 43594201) and 28 mg ai/kg-diet for prosulfuron (MRID 42949701). The LOAELs from these two studies (180 and 100 ppm, respectively) are above the 90 mg ai/kg-diet peek EEC. Thus, out of the 9 sulfonylureas evaluated, the peak EEC would exceed the LOC for 2 herbicides (or 12% of the chemicals). This finding is consistent with the generally low toxicity sulfonylurea herbicides terrestrial animals. Thus, while considerable uncertainty exists in extrapolating chronic NOAELs across chemicals even within the same mode of action, these results suggest that chronic toxicity to avian fauna is not likely to be a dominant concern in this risk assessment, although it cannot be discounted entirely since LOCs would be exceeded for 2 of the 9 herbicides evaluated.

4.2.2.2. Mammals

As observed for avian fauna, sulfometuron methyl is classified as practically nontoxic on an acute basis to mammals. As described in Section 4.1, a bounding analysis compared predicted EECs to indefinite LD_{50} values (adjusted for different size classes) for the purposes of estimating the upper bound of acute toxicity risk. The highest EEC for mammals is 85.8 mg/kg-bw for short grass consumed by a 15 g mammal. The adjusted LD_{50} for 15 g mammals would be 10,989 mg/kg bw. There is an approximately 120-fold difference between these two values. Since the acute RQs for all weight classes of mammals consuming all feed types are < 0.01 and less than the Agency LOCs (Table 44), acute risks from direct effects of sulfometuron methyl on mammals is not expected from the modeled uses.

The chronic LOC for mammals was not exceeded for the modeled uses. Predicted residues of sulfometuron methyl on different food types was compared to size class adjusted NOAELs. The highest RQ (0.07) occurred for the 15g mammal (Table 45) which is below the Agency's LOC of 1.0 for chronic effects to terrestrial animals. Therefore, chronic risks from direct effects of sulfometuron methyl on mammals are not considered likely.

4.2.2.3. Non-target Terrestrial-phase Amphibians, Reptiles, and Beneficial Insects

EFED currently uses data on surrogate species (birds) to assess non-target terrestrial phase amphibians and reptiles and does not derive risk quotients for terrestrial non-target insects. Based on the evaluation of potential risks to birds as surrogates for reptiles, potential risks to reptiles and terrestrial phase amphibians is also considered lower than the Agency's concern level.

As previously discussed, EFED does not currently estimate risk quotients for terrestrial non-target invertebrates. However, submitted terrestrial insect toxicity data, based on tests with honeybees, suggest that sulfometuron methyl is practically non-toxic to bees (LD_{50} of >100 µg/bee). The mode of action of sulfometuron methyl suggests it is likely not to be highly toxic to terrestrial invertebrates. To the extent that honey bees are representative of the sensitivity of insects and other terrestrial invertebrates to sulfometuron methyl, potential risk to terrestrial insects and invertebrates in treatment area is expected to be minimal.

4.2.3. Risk to Terrestrial Plants

4.2.3.1. Tier 1 Modeling of Runoff and Spray Drift

Results presented in Section 4.1 using the TerrPlant model indicate the modeled uses of sulfometuron methyl result in exposures to non-endangered and endangered plants adjacent to treated areas that exceed the Agency's LOC of 1.0. Both monocots and dicots appear highly sensitive to sulfometuron methyl, with dicots appearing to be the more sensitive group of plants. At the maximum aerial application rate of 0.375 lb ai/A, the maximum predicted EEC resulting from combined drift and runoff to semi-aquatic areas (0.21 lb ai/A) exceeded terrestrial monocot and dicot EC25 values by approximately 1000 and 6500 times, respectively (Table 48). For endangered monocots and dicots where a more sensitive endpoint is used (NOAEC), the predicted EEC for combined drift and runoff were 4800 and 7100 for monocots and dicots, respectively. For the spray drift analysis, predicted EECs were compared to results from the vegetative vigor test, which resulted in RQs of 500 and 1000 for non-endangered monocots and dicots respectively (Table 48). RQ values for endangered monocots and dicots resulting from drift from aerial application were 2200 and 19000 for monocots and dicots, respectively.

These high RQ values are generally consistent with results from other sulfonylurea herbicide risk assessments both internal and external to the Agency. Furthermore, it is worth noting that the most sensitive monocot and dicot from the seedling emergence and vegetative vigor test is used to calculate risks to terrestrial plants. However, examination of the sensitivity of the other 9 test species indicates they too would be at risk from adverse effects of sulfometuron methyl at the modeled application rate. Specifically, the range in EC25s between the least and most sensitive plant from the seedling emergence study was about a factor of 75, while that for the vegetative vigor study was a factor of 5 (MRID 435385-01). The RQ values for the most sensitive monocot and dicot species are well above this margin. This indicates the predicted exceedence of the Agency's LOC would also occur for the 9 other terrestrial plants tested and are not simply a function of a single, highly sensitive species.

Given these high RQ values for terrestrial plants, a more refined spray drift analysis for exposures to non-target terrestrial plants in dry and semi-aquatic areas is provided in Section 4.2.4. The potential risk to endangered monocots and dicots will be discussed in greater detail in Section 4.2.8.2.

4.2.3.2. Field and Greenhouse Studies

Based on a search of EPA's ECOTOX database, field and greenhouse studies on the effects of sulfometuron methyl or its degradates were reviewed. Most of the field studies that passed the ECOTOX and OPP screening criteria were concerned with the efficacy of sulfometuron methyl control of target plants (weeds) and therefore are not considered useful indicators of the effects of sulfometuron methyl on non-target plant species (See APPENDIX H: Ecological Effects Data Summaries). Those studies that contained relevant information on the effects of sulfometuron methyl or its degradates on non-target plants are summarized below.

In a greenhouse study, Busse et al. (2005) studied the effect of sulfometuron methyl (applied as the formulated product Oust) on ectomycorrhizal formation and seedling growth of three conifer species: ponderosa pine (Pinus ponderosa), Douglas fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*). Conifer seedlings (5 replicates) were grown in four different soil types and applied with sulfometuron methyl at 0, 1X and 2X its application rate of 0.14 kg ai/ha (0.125 lb/A). Sulfometuron methyl was applied to soil at the onset of lateral root formation (approximately 45-55 d post planting) due to the high sensitivity of seedlings to sulfometuron methyl applied prior to this time period. Results indicate that ectomycorrhizal formation was not inhibited for any conifer regardless of soil type or application rate (1X or 2X). For ponderosa pine, seedling dry weight and root growth (number of root tips/plant) were significantly reduced relative to controls at 0.125 and 0.250 lb ai/A in two of the four soil types. For Douglas fir and white fir, no significant reduction in seedling dry weight occurred at any treatment level. However, root growth was reduced for Douglas fir at 0.125 lb ai/A for three of the four soil types and at 0.25 lb ai/A for the forth soil type. White fir appeared least sensitive to sulfometuron methyl, with significant reductions in root growth at 0.125 lb ai/A in one soil type and at 0.25 lb ai/A in a second soil type. The authors conclude that sulfometuron methyl does not inhibit mycorrhizal formation at the specified application rates but does inhibit plant growth of ponderosa pine and root growth of all three species, depending on soil type and application rate. The lowest NOAEC from this study is 1X the application rate or 0.125 lb ai/A, several orders of magnitude above NOECs observed in the seedling emergence and vegetative vigor guideline studies.

Boyle and Walters (2005) examined the effect of saccharin, a major degradation product of sulfometuron methyl, on resistance of broad bean (*Vicia faba*) to rust fungus. Although not conceived as a degradate study per se, these results nevertheless have some relevance to the ecotoxicology of one of the sulfometuron methyl degradation products. In this study, 200 ml of 0.3 mM saccharin was applied either as a soil drench or to foliage of broad bean which were exposed to rust fungus four times over a 14-d period. Results indicate that saccharin did not induce resistance to rust fungus nor did it significantly affect shoot weight or leaf area. However the authors report the number of leaflets formed was significantly reduced relative to controls.

Neary et al. (1984) evaluated the effects of sulfometuron methyl (as the formulated product Oust) on slash pine (*Pinus elliottii*) and loblolly pine (*Pinus taeda*) seedlings inhabiting coastal plain flatlands. In this study, 60 trees of each species were exposed to sulfometuron methyl via broadcast spray at 0.50 lb ai/A in a randomized factorial design involving different plot locations, irrigation and fertilization levels. Although this study was designed primarily to investigate the efficacy of different weed control methods, the authors reported three months after treatment, application of sulfometuron methyl did not reduce survival of slash or loblolly pine, suggesting an unbounded NOAEC of 0.50 lb ai/A (only dose tested).

4.2.3.3. Contaminated Irrigation Water

The potential risks to plants when exposed to irrigation water contaminated with sulfometuron methyl were estimated for both ground water and surface water irrigation sources (Section 4.1.4). The EEC for ground water (0.33 ug/L) was calculated using the Tier 1 SCIGROW model (Table 16) while that for surface water (31 ug/L) was calculated using PRZM/EXAMS from the scenario yielding the highest EECs (Table 15). Comparisons were made to the most sensitive endpoint from vegetative vigor study assuming that runoff of irrigation water does not occur. Results suggest that sulfometuron methyl levels in irrigation water from ground water sources would not exceed non-endangered or endangered species LOCs (i.e, RQs < 1.0). However, RQs based on sulfometuron methyl in irrigation water derived from surface water sources exceed the

LOCs for both non-endangered and endangered species (3.9 and 71, respectively), thus indicating a potential risk to plants adjacent to fields irrigated with surface water sources.

4.2.4. *Refined Spray Drift Analysis*

As described in Section 3.2.3.1 (Terrestrial Exposure Modeling), a more in-depth spray drift exposure assessment utilizing Tier I and II AgDRIFT® (version 2.01) was conducted to better characterize potential exposure of terrestrial plants. AgDRIFT® is a useful too for evaluating the potential of buffer zones to protect sensitive habitats from undesired exposures. Four different application scenarios were modeled reflecting typical and reasonable worst case assumptions regarding potential exposure conditions (labeled A through D in TABLE 20 and TABLE 21).

Table 52. Risks to Terrestrial Plants from Spray Drift According to Distance Downwind, Application Method, and Drift Exposure Conditions

DISTANCE DOWN WIND (FEET)	PERCENT OF APPLICATION RATE	EEC (1)	NON-ENDANGERED PLANTS (2)	ENDANGERED PLANTS(3)
	Percent	*lb ai/A*	*RQ*	*RQ*
[A] Ground Application (Low Boom)				
0	102.0	0.3822	**21233**	**386061**
50	1.77	0.0066	**367**	**6667**
100	0.95	0.0036	**200**	**3636**
200	0.51	0.0019	**106**	**1919**
500	0.21	0.0008	**44**	**808**
750	0.13	0.0005	**28**	**505**
900	0.11	0.0004	**22**	**404**
[B] Ground Application (High Boom)				
0	106.0	0.3956	**21978**	**399596**
50	5.00	0.0187	**1039**	**18889**
100	2.48	0.0093	**517**	**9394**
200	1.20	0.0045	**250**	**4545**
500	0.39	0.0015	**83**	**1515**
750	0.22	0.0008	**44**	**808**
900	0.17	0.0006	**33**	**606**

[C] Aerial (Following Many Label Recommendations)				
0	50.00	0.1874	**10411**	**189293**
50	17.12	0.0642	**3567**	**64848**
100	9.79	0.0367	**2039**	**37071**
200	4.69	0.0176	**978**	**17778**
500	1.92	0.0072	**400**	**7273**
750	1.39	0.0052	**289**	**5253**
900	1.24	0.0046	**256**	**4646**
[D] Aerial (High-End Exposure Scenario)				
0	77.35	0.2900	**16111**	**292929**
50	38.32	0.1437	**7983**	**145152**
100	25.11	0.0941	**5228**	**95051**
200	14.07	0.0527	**2928**	**53232**
500	5.40	0.0203	**1128**	**20505**
750	3.82	0.0143	**794**	**14444**
900	3.32	0.0125	**694**	**12626**

(1) Details of the refined spray drift modeling are provided in Section 3.2.3.1.
(2) Non-endangered plant RQs based on vegetative vigor EC25 for soybean of 1.8 x 10^{-5} lb ai/A (MRID 435385-01)
(3) Endangered plant RQs based on vegetative vigor EC05 for soybean of 9.9 x 10^{-7} lb ai/A (MRID 435385-01).

Results from the refined spray drift modeling indicate that RQs exceed the Agency LOC of 1.0 for endangered and non-endangered terrestrial plants based on all four exposure scenarios at the maximum distance modeled (the model limit of 900 ft downwind of the treated field; see TABLE 20). The highest initial RQ values occurred with ground applications (high and low boom), although RQs dropped substantially as the distance downwind increased. At a downwind distance of 900 ft, RQs dropped by approximately a factor of 1000 and 600 of the edge of field RQs (0 ft) for low boom and high boom ground applications, respectively. The 50 ft buffer resulted in the largest proportional decline in EECs relative to edge of field estimates, declining to 1.7% and 5.0 % of the initial EECs for low and high boom ground applications, respectively.

Compared to ground applications, aerial applications resulted in lower initial EECs at the edge of the field (downwind distance = 0), however, the attenuation of EECs with distance downwind was not as great as that observed with ground applications. The EECs (and RQs) declined to

17% and 38% 50 ft from the edge of field for the typical and high end exposure scenarios, respectively. At 900 ft downwind, RQs for non-endangered plants are approximately 250 and 700 for the typical and high end aerial application exposure scenarios, respectively. For endangered plants, RQs calculated at 900 ft downwind are approximately 4,600 and 12,600 for the typical and high end aerial application exposure scenarios, respectively.

Pertinent to these modeling results are a number of recommendations (but not requirements) on the product labels for sulfometuron methyl. The labels suggest that "The most effective way to reduce drift potential is to apply large droplets (>I50 - 200 microns)"; but there is no specific mandate on the label. Other suggestions on the label include: that boom height less than 10 feet decreases the potential for spray drift from helicopter or aircraft applications, For ground applications; the applicator receives the following directions: "Setting the boom at the lowest height that provides uniform coverage and reduces the exposure of droplets to evaporation and wind." The label notes that drift is minimized when the wind speed is between 3 and 10 mph.

4.2.5. Review of Incident Data

An analysis of the ecological incidents associated with a pesticide application (or misapplication) is an important part of EPA's ecological risk assessment because such information can help establish additional lines of evidence to the risk assessment conclusions. A search of EPA's Ecological Incident Information System (EIIS) was conducted in September, 2007 which revealed 35 incidents reports for sulfometuron methyl with varying degrees of confidence in the causal association. Of these 35 incidents, one was classified as highly probable, 20 were classified as probable and 14 were classified as possible ("APPENDIX E: Adverse Ecological Incidents Associated with Sulfometuron Methyl Use"). Only the incidents classified as either highly probable or probable are discussed further here.

Highly Probable Incidents. The incident classified as highly probable is worthy of discussion here because it is one of the few incidents involving sulfonylurea herbicides where positive findings of pesticide residues were reported. In this case (Incident Report 1011666-001), Oust herbicide (containing sulfometuron methyl) was applied by the Bureau of Land Management (BLM) personnel to approximately 22,000 acres of Idaho forest and grassland in the autumn of 2000 for weed control. These areas were severely damaged or burned by wildfires that occurred the previous year. Following the aerial application of Oust at a rate of 0.0625 lb ai/A, drought and windy conditions (up to 20-40 mph) caused pesticide drift, presumably via erosion of dry treated soils. Thousands of acres were alleged to have been affected, including sugar beets, small grains, garlic, potato, corn, and alfalfa. Soil residues of sulfometuron methyl measured on BLM land ranged from 0.079 to 0.82 ppb. Documentation by the State of Idaho Dept. of Agriculture showed that in one case, there was evidence to show that sulfometuron methyl was present 13 miles from the application site. Crop damage was estimated to be in excess of $72 million.

Probable Incidents. Of the 20 probable incidents involving sulfometuron methyl, 5 involved accidental misuse and all but one of the remaining involved registered uses. Regarding the application method, the majority of probable incidents involved ground application, although about one third of the incident reports did not contain information on the application method.

Relative to the type of application site, 7 involved railroad or road rights of way and 6 involved agriculture sites. In terms of route of exposure, pesticide drift (either alone or in combination with runoff) was reported for 11 probable incidents, while runoff (either alone or in combination with drift) was reported for 9 probable incidents. A total of 19 probable incidents reported for sulfometuron methyl involved damage to terrestrial plants and only one reported damages to aquatic plants and animals.

Although these sulfometuron methyl ecological incident reports do not conclusively establish sulfometuron methyl as the cause of the reported damages, in the aggregate they suggest that non-target terrestrial plants in particular can be susceptible to both sulfometuron methyl drift and runoff, which was found to be the pathway and receptor of greatest concern in this risk assessment. The also are consistent with the risk assessment findings of no significant risk of direct toxicity to aquatic and terrestrial animals.

4.2.6. Overall Ecological Risk Conclusions

The results of this screening risk assessment indicate that potential risks from direct effects to aquatic and terrestrial animals from exposure to sulfometuron methyl modeled at the maximum annual application rate (0.375 lb ai/A) are below the Agency's LOCs. Therefore, risk from direct effects to aquatic and terrestrial animals is considered unlikely. Given the mode of action of sulfometuron methyl (ALS inhibitor), the potential for direct effects to aquatic and terrestrial plants is indicated by this screening level risk assessment. Based on a refined analysis of sulfometuron methyl spray drift, RQs for terrestrial plants exceed the Agency's LOC at 900 ft downwind from a treated field in all four application scenarios evaluated. While the potential for direct effects to aquatic and terrestrial animals is considered small, the potential exists for indirect effects on animals due to impairment of aquatic and terrestrial plants. Specifically, direct effects to plant species could present an indirect risk at the higher levels of organization (i.e. population, trophic level, community, and ecosystem). Field studies are not available to quantify actual risk to plant and animal communities in forest/edge and wetland/riparian habitats. However, in terrestrial and shallow-water aquatic communities, plants are the primary producers upon which the succeeding trophic levels depend. If the available plant material is impacted due to the effects of sulfometuron methyl, this may have negative effects not only on the herbivores, but throughout the food chain. Also, depending on the severity of impacts to the plant communities [i.e., forests, wetlands, ecotones (edge and riparian habitats)], community assemblages and ecosystem stability may be altered (i.e. reduced bird populations in edge habitats; reduced riparian vegetation resulting in increased light penetration and temperature in aquatic habitats, loss of cover and food for fish). In addition, riparian vegetation, which is a significant component of the food supply for aquatic herbivores and detritivores provides habitat (i.e. leaf packs, materials for case-building for invertebrates) may also be affected.

4.2.7. *Endocrine Effects*

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 a 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. When the appropriate screening and/or testing protocols being considered under the Agency's EDSP have been developed, sulfometuron methyl may be subjected to additional screening and/or testing to better characterize effects related to endocrine disruption.

4.2.8. *Federally Threatened and Endangered (Listed) Species*

Both acute endangered species and chronic risk LOCs are considered in this screening-level risk assessment of pesticide risks to listed species. Endangered species acute LOCs are a fraction of the non-endangered species LOCs or, in the case of endangered plants, RQs are derived using lower toxicity endpoints than non-endangered plants. Therefore, concerns regarding listed species within a taxonomic group are triggered in exposure situations where restricted use or acute risk LOCs are triggered for the same taxonomic group. The risk assessment also includes an evaluation of the potential probability of individual effects for exposures that may occur at the established endangered species LOC in both the risk characterization and the endangered species sections. This probability is calculated using the established dose/response relationship and assumes a probit (probability unit) dose/response relationship. This analysis is present below.

4.2.8.1. Action Area

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

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

The results of this screening risk assessment indicate that direct effects to plant species could present an indirect risk at the higher levels of organization (i.e. population, trophic level, community, and ecosystem). The distance from the treated area that risks could extend is greater than 900 feet based on AgDRIFT spray drift modeling. Therefore, an action area for endangered species cannot be defined at this time for this assessment. We note that, while the AgDISP model with Gaussian extension model is available for extending predictions of deposition from spray drift beyond 1000 feet the exceedances of levels of concern for non-target plants are likely to extend well beyond 1000 feet given the trends observed with AgDRIFT up to 900 feet. This is evident from the risk quotient calculations for terrestrial plants exposed to spray drift in TABLE 52 (the RQ range at 900 feet ranged from 22 to 12626 using different ground and aerial application condition and equipment assumptions).

4.2.8.2. Taxonomic Groups Potentially at Risk

This screening level risk assessment for endangered species indicates that sulfometuron methyl exceeds the Endangered Species LOCs for the specified use scenario for the following taxonomic groups:

- Terrestrial plants: monocots and dicots adjacent to treated areas, semi-aquatic areas, and drift for turf use at a single application rate of 0.375 lbs ai/A via ground or aerial spray.

- Freshwater, estuarine and marine aquatic vascular and nonvascular plants adjacent to treated areas receiving a combination of runoff and spray drift at a single application rate of 0.375 lbs ai/A.

No LOCs were exceeded for birds, mammals, reptiles, terrestrial-phase amphibians, fish, invertebrates, or aquatic-phase amphibians.

Discussion of Risk Quotients. For a screening level risk assessment, EFED determines what endangered species may be affected by performing a screening level assessment. If the RQs from this assessment do not exceed the listed species LOCs, endangered species may not be affected. However, the Agency's LOC for endangered aquatic plants and terrestrial plants is exceeded for the uses of sulfometuron methyl as outlined in previous sections. Should estimated exposure levels occur in proximity to listed resources, the available screening level information suggests a potential concern for direct effects on listed terrestrial and aquatic vascular plants and species that rely on these taxa for survival, growth, or reproduction.

Probit Dose Response Relationship. A probit dose response analysis is usually performed for aquatic and terrestrial animal toxicity studies for which slopes with 95% confidence intervals are available. The probit slope response relationship is evaluated to calculate the chance of an individual event corresponding to the listed species acute LOCs. It is important to note that the IEC model output can go as high as 1×10^{16} or as low as 1×10^{-16} in estimating the event probability. This cut-off is a limit in the Excel spreadsheet environment and is not to be interpreted as an agreed upon upper or lower bound threshold for concern for individual effects in any given listed species. To accomplish this interpretation, the Agency would use (1) the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measurement endpoints for each animal taxonomic group; (2) an assumption of a probit dose response relationship; (3) a mean estimate of slope consistent with current Agency statistical procedures; and (4) a lower limit to the estimate of individual effect chance based on what could be calculated by Excel spreadsheet "Normdist" function. . In cases where dose-response curves are unavailable, event probabilities are calculated for the listed species LOC based on a default slope assumption of 4.5 as per original Agency assumptions of typical slope cited in Urban and Cook (1986).

For sulfometuron methyl, LC_{50} or EC_{50} values were not achieved in any of the aquatic or terrestrial animal acute toxicity studies. Therefore, it is not possible to estimate the slope and confidence limits directly from these studies. In lieu of such information, EFED default values are used for the slope (4.5) and confidence intervals (2 to 9) and applied to the LOC values. Probability of an individual effect from sulfometuron methyl was estimated at the acute endangered species LOC for aquatic and terrestrial animals. This analysis is presented in the following table.

Taxa	Probit Slope	Endangered Species LOC	Estimated Probability of an Individual Effect at the Endangered Species LOC	Comment
Fish	4.5 (2 – 9)	0.05	1 in 4×10^{8} (1 in 2×10^{2} to 1 in 2×10^{31})	Data insufficient to allow for probit slope derivation; therefore, the default slope of 4.5 with lower and upper bounds of 2 – 9 was used.
Aquatic Invertebrates	4.5 (2 – 9)	0.05	1 in 4×10^{8} (1 in 2×10^{2} to 1 in 2×10^{31})	
Birds	4.5 (2 – 9)	0.1	1 in 2.9×10^{5} (1 in 44 to 1 in 9×10^{18})	
Mammals	4.5 (2 – 9)	0.1	1 in 2.9×10^{5} (1 in 44 to 1 in 9×10^{18})	

For aquatic organisms, the LOC for endangered species is 0.05. The RQ is the ratio of exposure to toxicity, so at the point where that ratio equals 0.05, there is a 1 in 418 million chance of an individual being affected. The uncertainty in this number lies primarily in whether the actual exposure of sensitive species is likely to equal that modeled. For birds, terrestrial-phase amphibians, reptiles and mammals, the endangered species LOC is 0.1. The chance of one individual being affected at an RQ equal to the LOC is 1 in 294,000

Because the screening level risk assessment indicates that sulfometuron methyl uses exceed the endangered species LOC for terrestrial and aquatic plants, a 'may affect' designation can not be precluded based on this assessment. Additionally, the acute level of concern for terrestrial and aquatic vascular plants is exceeded. The Agency considers this to be indicative of a potential for adverse effects to those listed species that rely either on a specific plant species (plant species obligate) or multiple plant species (plant dependant) for some important aspect of their life cycle. Further analysis regarding the overlap of individual species with each use site is required prior to determining the likelihood of potential impact to listed species. Such a refinement is outlined in the following sections.

Data Related to Under-represented Taxa. Data are not available to evaluate effects to under-represented taxa.

Implications of Sublethal Effects. Sublethal effects were not observed in acute aquatic and terrestrial animal studies. Chronic studies were available for freshwater invertebrates, but not fish, birds or mammals. The chronic RQ for freshwater invertebrates did not exceed the chronic LOC. Similarly for fish, a chronic RQ, calculated from an NOAEC estimated using acute-chronic ratio, did not exceed the chronic LOC. For birds, analysis of reproductive NOAECs from other sulfonylurea herbicides suggests that while potential chronic risks from sulfometuron methyl cannot be ruled out, they are considered unlikely. For mammals, results from a developmental toxicity test indicate the RQ does not exceed the chronic LOC, however, no data were available on the chronic, reproductive effects of sulfometuron methyl to mammals.

Indirect Effects Analysis. The non-endangered and endangered species LOCs for non-target plants were exceeded for both terrestrial (monocots and dicots) and aquatic plants (vascular, nonvascular) located adjacent to treated areas, in semi-aquatic areas, and by spray drift for the scenarios analyzed. The guideline plant studies indicate direct adverse effects to seedling emergence, vegetative vigor, and aquatic vascular and non-vascular plants, as well as non-lethal effects such as chlorosis, growth retardation, necrosis, and unusual pigmentation.

Damage to non-target plants may be sufficient to prevent the plant from competing successfully with other plants for resources and water. Sulfometuron methyl may increase a plant's susceptibility to disease and can disrupt nutrient cycling in soil by inhibiting the ability of enzymes to break down cellulose and thereby, decompose plant material. Endangered species may be especially impacted by exposure to sulfometuron methyl because of the impact of the loss of a few individuals to the population. There is a potential concern for listed species with either broad or narrow dependencies on impacted plant species/populations/communities for habitat, feeding or cover requirements. In terrestrial and shallow-water aquatic communities, plants are the primary producers upon which the succeeding trophic levels depend. If the available plant material is impacted due to the effects of sulfometuron methyl, this may have negative effects not only on the herbivores, but also throughout the food chain. In addition, depending on the severity of impacts to the plant community [i.e., forest, wetlands, ecotones (edge and riparian habitats)], assemblages and ecosystem may be altered (i.e., reduced bird populations in edge habitats, reduced riparian vegetation resulting in increased light penetration and temperature in aquatic habitats, loss of cover and food for fish).

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

The screening-level risk assessment has identified potential concerns for indirect effects on listed species for those animals dependant upon aquatic plants, and terrestrial and semi-aquatic plants. In light of the potential for indirect effects, the next step for EPA and the Service(s) is to identify which listed species and critical habitat are potentially implicated. Analytically, the identification of such species and critical habitat can occur in either of two ways. First, the agencies could determine whether the action area overlaps critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-endangered species would affect the listed species indirectly or directly affect a constituent element of the critical habitat. Alternatively, the agencies could determine which listed species depend on biological resources, or have constituent elements that fall into, the taxa that may be directly or indirectly impacted by the pesticide. Then EPA would determine whether use of the pesticide overlaps the critical habitat or the occupied range of those listed species. At present, the information reviewed by EPA does not permit use of either analytical approach to make a definitive identification of species that are potentially impacted indirectly or critical habitats that is potentially impacted directly by the use of the pesticide. EPA and the Service(s) are working together to conduct the necessary analysis.

This screening-level risk assessment for critical habitat provides a listing of potential biological features that, if they are constituent elements of one or more critical habitats, would be of potential concern. These correspond to the taxa identified above as being of potential concern for indirect effects and include the following: aquatic plants, and terrestrial and semi-aquatic plants. This list should serve as an initial step in problem formulation for further assessment of critical habitat impacts outlined above, should additional work be necessary.

Direct Effect Co-occurrence Analysis. Because the Endangered Species LOC for terrestrial and aquatic plants is exceeded for the proposed use of sulfometuron methyl, LOCATES would usually be run for all listed terrestrial and aquatic plants (monocots, dicots, ferns, lichen and conf/cycds) to determine the potential for co-occurrence of listed plant species location with areas of expected pesticide use. However, no preliminary analysis was performed for non-crop uses of sulfometuron methyl because the LOCATES tool does not include county-level location information for the proposed non-crop uses of sulfometuron methyl. Consequently, based on the information available at this step in the assessment process, it is presumed that all listed plant species are potentially directly affected from the broad range of sulfometuron methyl proposed uses which include vegetative management in railroad, utility, and roadside rights-of-ways, forestry, tree plantations, industrial sites, and road construction. These uses do not have a geographically distinct attribute which can be used to define the co-occurrence of listed species in the LOCATES database. Additional analysis of listed plant locations, refinement of the action area associated with sulfometuron methyl, and the biology of the potentially affected species would be needed before an effects determination can be made for any of the co-located species identified by this assessment.

Indirect Effect Co-occurrence Analysis. The screening-level RQ for terrestrial monocots and dicots and aquatic nonvascular and vascular plants exceeds the LOC for endangered species. In accordance with established procedures such findings suggest a potential concern for indirect effects to listed animal species with both narrow (i.e., species that are obligates or have very specific habitat or feeding requirements) and general dependencies (i.e., cover type requirements) on plants as a resource or important habitat component. LOCATES would usually be used to preliminarily identify listed animal species that are located within the counties in USA where sulfometuron methyl could be used. This analysis would consider all animal taxonomic groups (i.e., birds, mammals, terrestrial and aquatic-phase amphibians, reptiles, insects, fish, bivalves, crustaceans, arachnids, and gastropods). However, no preliminary analysis was available for non-crop use of sulfometuron methyl because the LOCATES tool does not include county-level location information for the non-crop uses of sulfometuron methyl. Consequently, based on the information available at this step in the assessment process, it is presumed that all listed plant species are potentially directly affected from the broad range of sulfometuron methyl proposed uses which include vegetative management in railroad, utility, and roadside rights of ways, forestry, tree plantations, industrial sites, and road construction. These uses do not have a geographically distinct attribute which can be used to define the co-occurrence of listed species in the LOCATES database. Additional analysis of listed plant locations, refinement of the action area associated with sulfometuron methyl, and the biology of the potentially affected species would be needed before an effects determination can be made for any of the co-located species identified by this assessment.

The following table provides listed taxonomic groups that may be at risk from direct or indirect effects due to applications of sulfometuron methyl for vegetative management uses nationwide.

Table 53. Listed Taxonomic Groups Potentially at Risk from Direct or Indirect Effects of Sulfometuron Methyl Application for Vegetative Management Throughout the U.S.

Listed Taxon	Direct Effects	Basis for Direct Effects Concern	Indirect Effects	Basis for Indirect Effects Concern
Terrestrial and Semi-Aquatic Plants – monocots and dicots	Yes	The endangered species LOC is exceeded for terrestrial plants.	Yes	Potential concerns from shifts in plant community structure and function due to from selective impacts on plant species.
Terrestrial Invertebrates	No	Sulfometuron methyl is practically nontoxic to honeybees, suggesting no	Yes	Potential concerns for terrestrial invertebrates that use plants for habitat, feeding, or cover

		direct effect concerns for terrestrial invertebrates.		requirements.
Birds and Reptiles(1)	No	The LOC is not exceeded	Yes	Potential concerns for birds and reptiles use plants for habitat, feeding, or cover requirements.
Terrestrial-phase Amphibians(1)	No	The LOC is not exceeded	Yes	Potential concerns for terrestrial-phase amphibians that use plants for habitat, feeding, or cover requirements.
Mammals	No	The LOC is not exceeded	Yes	Potential concerns for mammals that use plants for habitat, feeding, or cover requirements.
Aquatic Vascular Plants and Nonvascular Plants	Yes	The endangered species LOC is exceeded for aquatic vascular and nonvascular plants.	No	Potential concerns from shifts in plant community structure and function due to from selective impacts on plant species.
Freshwater and Marine/Estuarine fish and Aquatic-phase Amphibians(2)	No	The LOC is not exceeded	Yes	Potential concerns for fish and aquatic-phase amphibians that use plants for habitat, feeding, or cover requirements.
Freshwater and Marine/Estuarine Crustaceans	No	The LOC is not exceeded	Yes	Potential concerns for crustaceans that use plants for habitat, feeding, or cover requirements.
Mollusks	No	The LOC is not exceeded	Yes	Potential concerns for mollusks that use plants for habitat, feeding, or cover requirements.

(1) Birds are used as surrogate species for terrestrial-phase amphibians and reptiles; therefore, potential direct and indirect effects to endangered avian, terrestrial-phase amphibians and reptilian species are considered equivalent.
(2) Fish are used as a surrogate for aquatic phase amphibians; therefore, potential direct and indirect effects to endangered fish and aquatic-phase amphibian species are considered equivalent.

4.3. Description of Assumptions, Limitations, Uncertainties, and Data Gaps

4.3.1. Assumptions and Limitations Related to Effects on all Species

- **Indirect Effects.** Perhaps one of the largest uncertainties associated with the effects assessment for sulfometuron methyl is the inability to adequately quantify potential indirect effects resulting from adverse effects on aquatic and terrestrial plants. Specifically, direct effects to plant species could present an indirect risk at the higher levels of organization (i.e. population, trophic level, community, and ecosystem). Field studies are not available to quantify actual risk to plant and animal communities in forest/edge and wetland/riparian habitats. However, in terrestrial and shallow-water aquatic communities, plants are the primary producers upon which the succeeding trophic levels depend. If the available plant material is impacted due to the effects of sulfometuron methyl, this may have negative effects not only on the herbivores, but throughout the food chain. Also, depending on the severity of impacts to the plant communities [i.e., forests, wetlands, ecotones (edge and riparian habitats)], community assemblages and ecosystem stability may be altered (i.e. reduced bird populations in edge habitats; reduced riparian vegetation resulting in increased light penetration and temperature in aquatic habitats, loss of cover and food for fish). In addition, riparian vegetation, which is a significant component of the food supply for aquatic herbivores and detritivores provides habitat (i.e. leaf packs, materials for case-building for invertebrates) may also be affected.

- **Toxicity of Degradation Products.** In this screening level ecological risk assessment, the lack of data on major degradates is considered one of the primary limitations and uncertainty regarding the overall risk associated with one of the registered use of sulfometuron methyl. Since the chemical structure and environmental behavior of the major degradates differ substantially from the parent molecule (i.e., degradation involves cleavage of the sulfonylurea bridge, essentially splitting the molecule in half), it could not be assumed with reasonable confidence that the degradates were equivalent in toxicity to the parent compound. Limited toxicity data was available for one major degradation product: saccharin. However, this information was oriented towards human health concerns and lacked endpoints of ecological relevance that would be considered useful in this ecological risk assessment. This finding is somewhat expected since saccharin is used as a sugar substitute in the U.S. food supply.

- **Variability in Species Sensitivity.** Although the screening risk assessment relies on a selected toxicity endpoint from the most sensitive species tested, it does not necessarily mean that the selected toxicity endpoints reflect sensitivity of the most sensitive species existing in a given environment. The relative position of the most sensitive species tested in the distribution of all possible species is a function of the overall variability among species to a particular chemical. In the case of listed species, there is uncertainty regarding the relationship of the listed species' sensitivity and the most sensitive species tested. For terrestrial and aquatic animals, uncertainty associated with the limited quantification of interspecies variability in sensitivity to sulfometuron methyl would probably not impact the risk assessment results substantially, given that sulfometuron methyl is practically nontoxic to animals. For aquatic and terrestrial plants, variability in sensitivity across species could substantially alter the risk assessment results (e.g., higher RQs if more sensitive species were tested). However, toxicity data were available for 5 species of aquatic plants and 10 species of terrestrial plants distributed broadly across taxonomic groups, which suggests that at least a reasonable range of plant sensitivity to sulfometuron methyl was captured in this risk assessment.

- **Effects of Pesticide Mixtures:** This assessment considered only exposure to the active ingredient sulfometuron methyl. However, simultaneous exposures to multiple chemical and physical stressors are likely to occur in the environment. No acceptable data were located that evaluated potential additive, synergistic, or antagonistic interactions between sulfometuron methyl and other chemical stressors. If such interactions occur, then risks could be under or over-estimated.

4.3.2. Assumptions and Limitations Related to Effects on Aquatic Species

- **Study Quality and Data Gaps.** Several studies did not meet guideline requirements and therefore were classified as either supplemental or unacceptable. Specifically, all acute toxicity data for marine and estuarine organisms were classified as supplemental due to uncertainty associated with the bioavailability of sulfometuron methyl in these tests. However, conclusions of this risk assessment would not likely change with submission of additional acute toxicity data for marine and estuarine organisms because EECs were several orders of magnitude below reported toxicity limits. The freshwater chronic test with fathead minnow was found to be unacceptable, again because of uncertainty and variability associated with measurement of soluble (bioavailable) sulfometuron methyl. To address this data gap, acute-chronic ratios were applied to estimate chronic toxicity to freshwater fish. Results indicate that even with conservative assumptions regarding the selection of the ACR, risks from direct effects of chronic sulfometuron methyl exposure to freshwater fish are not likely.

4.3.3. Assumptions and Limitations Related to Effects on Terrestrial Species

- **Study Quality and Data Gaps.** Lack of toxicity data was noted for the effect of sulfometuron methyl on avian and mammalian reproduction. For mammals, the NOAEL of 300 mg ai/kg-bw/d was used from a developmental toxicity study to rabbits. While providing some information on the effect of sulfometuron methyl on mammalian development during gestational exposure, results from this study do not capture the potential effects of sulfometuron methyl on reproductive endpoints including courtship, mating, sex ratios and offspring survival, growth and development.

- **Vascular Plant Reproduction**. Terrestrial and aquatic plants appear most sensitive to sulfometuron methyl exposure. While toxicity data were available for endpoints related to systemic growth, seedling emergence and visual injury, these guideline studies are not designed to capture reproductive endpoints. There is some evidence to suggest plant reproduction may be affected by sulfonylurea herbicides at levels below effects on vegetative growth or visual injury (Fletcher et al., 1993). Uncertainty regarding the potential greater sensitivity of terrestrial plant reproduction has been discussed extensively in the environmental fate and effects assessment for chlorsulfuron (D330621). Therefore, to the extent that plant reproduction is more sensitive to sulfometuron methyl exposure compared to growth or visual injury-related endpoints, risks to aquatic and terrestrial plants may be underestimated. Additional information on the reproductive toxicity of sulfometuron methyl to terrestrial plants would help address this uncertainty.

- **Use of Maximum Pesticide Application Rate.** In this screening level analysis, risks of sulfometuron methyl to non-target plants and animals was evaluated using the maximum label application rate (0.375 lb ai/A). This was performed in concordance with the goals of a screening assessment: to rule out receptors and exposure pathways and identify those pathways where potential risks are evident. Other label application rates are available for sulfometuron methyl as identified in see Section 3.1 (Use Characterization). The lower range of application rates are mostly within a factor of 10 of the maximum application rates. Given that RQs for terrestrial and aquatic plants predicted using the maximum application rate are well above a factor of 10, use of the lower application rates would not likely change the risk assessment conclusions.

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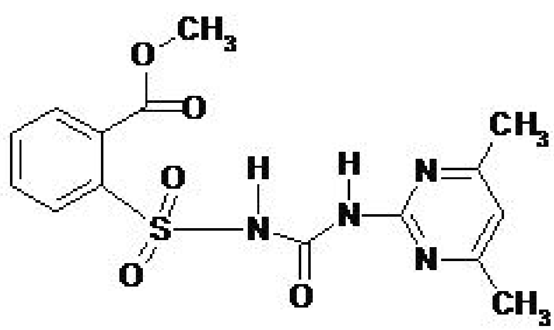
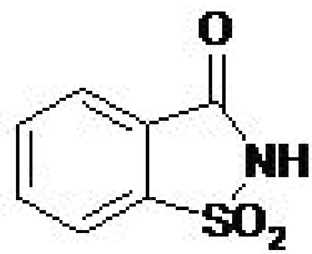
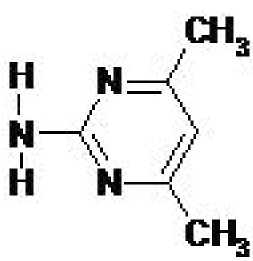
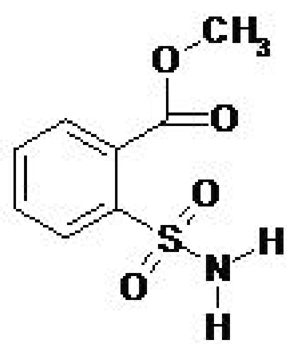
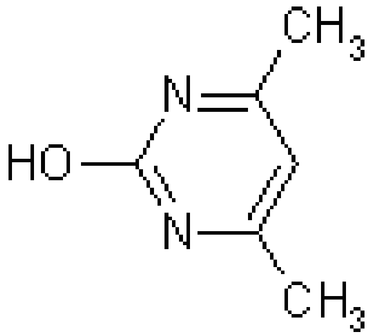
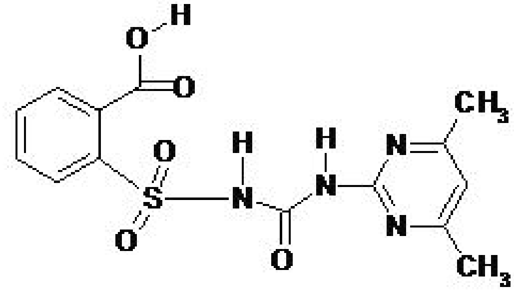
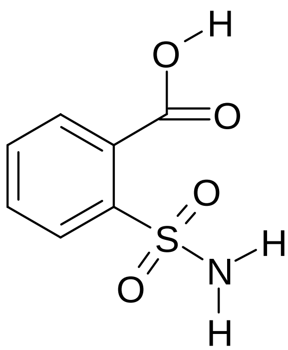
6. APPENDICES

APPENDIX A: STRUCTURES AND CHEMICAL NAMES OF SULFOMETURON METHYL METABOLITES

Chemical Structures Trivial or common names Company id or similar alternate names Full chemical names	
 Sulfometuron methyl DPX-T5648; DPX-5648; IN-T5648; IN T5648-18 Methyl 2-(4,6-dimethylpyrimidin-2-ylcarbamoylsulfamoyl)benzoate	 Saccharin IN-581 1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide
 Sulfometuron pyrimidine amine IN-X0993; IN-X993; PA 4,6-Dimethyl-2-pyrimidinamine 4,6-dimethyl-2-pyrimidinamine	 Sulfometuron sulfonamide IN-D5803; SA; methyl phenylsulfonamide Methyl 2-(aminosulfonyl)benzoate. 2-(Aminosulfonyl)-benzoic acid, methyl ester

 Pyrimidine-ol IN-11859 4,6-Dimethyl-2-pyrimidinol	 Sulfometuron free acid FA-SM; IN-T6385 2-[[[[(4,6-Dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-benzoic acid
 0Free acid Sulfonamide FA-Sulfonamide; Free acid; IN-D5119 2-(Aminosulfonyl)benzoic acid	

APPENDIX B: ENVIRONMENTAL FATE DATA REQUIREMENTS

Environmental Fate Data Requirements for Sulfometuron Methyl

Guideline	Data Requirement	Test Material	MRID	Study Classification	Data Requirement Met?	More Data Needed?
[161-1]	Hydrolysis	sulfometuron methyl	42715201	Acceptable	Yes	No
[161-2]	Direct photolysis in water	sulfometuron methyl	42182401 43174101	Acceptable	Yes	No
[161-3]	Photolysis on soil	sulfometuron methyl	41420601	Acceptable	Yes	No
[161-4]	Photodegradation in Air	NA	NA	not required	NA	NA
[162-1]	Aerobic soil metabolism	sulfometuron methyl	42091401	Acceptable	Yes	No
[162-1]	Aerobic soil metabolism	sulfometuron methyl	43174102 and 245375	Acceptable	Yes	No
[162-2]	Anaerobic Soil Metabolism	NA	NA	ref 162-3	Yes	No
[162-3]	Anaerobic aquatic metabolism	sulfometuron methyl	42091402 and 43188601	Acceptable	Yes	No
[162-3]	Anaerobic aquatic metabolism	sulfometuron methyl	4413010-20 (143540)	Acceptable	Yes	No
[162-4]	Aerobic aquatic metabolism	sulfometuron methyl	42091403 and 43174103	Acceptable	Yes	No
[163-1]	Adsorption/ Desorption	sulfometuron methyl	42789301	Acceptable	Yes	No
[163-1]	Adsorption/ Desorption	Pyrimidine amine	42789301	Acceptable	Yes	No
[163-1]	Adsorption/ Desorption	saccharin	42789301	Acceptable	Yes	No
[163-2]	Laboratory Volatility	NA	NA	not required	NA	NA

Environmental Fate Data Requirements for Sulfometuron Methyl						
Guideline	**Data Requirement**	**Test Material**	**MRID**	**Study Classification**	**Data Requirement Met?**	**More Data Needed?**
[163-3]	Field Volatility	NA	NA	not required	NA	NA
[164-1]	Terrestrial Field Dissipation	Sulfometuron methyl	43212101 and 43637101	Acceptable	Yes	No
[164-2]	Aquatic Field Dissipation	No study	NA	NA	NA	NA
[164-3]	Forestry Dissipation	Sulfometuron methyl	42091404 and 43174104	Acceptable	Yes	No
[165-4]	Accumulation in Fish	Waived	NA	NA	NA	NA
[165-5]	Accumulation in aquatic non-target organism (crayfish)	Waived	NA	NA	NA	NA
[166-1]	Ground Water- small scale prospective	No Study (not required)	NA	NA	NA	NA

APPENDIX C: ECOLOGICAL AQUATIC EXPOSURE MODELING

Multiple PRZM-EXAMS runs at single sites using different application date assumptions: Summary tables and sample input files

PRZM / EXAMS multiple application date assumption modeling: Sorted (by 21-day exposure estimates) List of 1 in 10 year return frequency for Various Exposure Durations - Aerial application using the Texas / Barton Springs Salamander scenario and Port Arthur Texas meteorological data.

DATE	Peak	96 hr	21 Day	60 Day	90 Day	Yearly	30-Year
09-10	49.472	47.733	43.139	33.437	27.192	7.450	4.065
12-05	36.060	34.879	30.054	20.981	16.522	4.884	2.415
30-08	32.625	31.363	27.061	21.239	17.805	5.586	2.992
20-08	30.949	29.903	25.886	19.000	15.626	4.967	2.808
10-08	30.601	29.743	25.451	18.437	15.009	5.118	2.625
29-09	29.668	28.637	25.585	20.158	16.479	5.638	3.434
19-10	27.970	27.134	24.748	20.222	14.168	5.007	3.257
21-06	27.622	26.773	22.849	16.110	12.749	3.867	1.986
19-09	27.223	26.413	23.585	18.717	15.510	4.768	3.042
31-07	26.516	25.765	22.706	16.344	13.286	4.136	2.180
29-10	25.269	24.619	22.258	17.629	13.919	4.750	3.091
01-07	22.932	22.383	19.082	13.514	10.730	3.479	2.005
09-09	22.903	22.276	19.198	14.672	12.353	4.305	2.653
02-05	21.703	20.976	18.837	13.835	11.003	3.254	1.923
11-06	21.795	20.881	17.461	12.414	9.917	3.114	2.057
11-07	21.572	20.696	17.817	12.818	10.264	3.220	1.900
01-06	21.430	20.570	17.539	12.484	9.849	2.948	1.944
12-04	20.368	19.822	17.811	13.507	10.822	3.210	1.767
22-05	20.277	19.455	16.521	12.017	9.476	2.927	1.730
21-07	20.064	19.205	16.126	11.487	9.199	2.939	1.960
23-03	18.931	18.470	17.070	13.343	10.972	3.333	1.469
22-04	18.700	18.253	15.762	11.875	9.712	2.980	1.705
21-02	17.801	17.397	16.164	13.272	11.138	3.448	1.372
02-04	17.776	17.228	15.491	11.441	9.083	2.691	1.492
13-03	13.882	13.555	12.579	9.934	8.174	2.522	1.361
01-02	10.387	10.157	9.247	7.440	6.303	2.010	1.164
11-02	9.156	8.956	8.476	6.885	5.827	1.856	1.028
03-03	8.483	8.348	7.965	6.554	5.458	1.673	1.031

Sample input file, Texas Rights of Way Scenario, multi-run

Output File: Sfmt_TXrway3_03-13_19-10

Metfile:	w12917.dvf			
PRZM scenario:	RightOfWayBSS.txt			
EXAMS environment file:	pond298.exv			
Chemical Name:	Sulfometuron Methyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	364.38	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	5.40E-16	torr	
Solubility	sol	2.44E+02	mg/L	
Kd	Kd		mg/L	
Koc	Koc	47.5	mg/L	
Photolysis half-life	kdp	0	days	Half-life
Aerobic Aquatic Metabolism	kbacw	292	days	Half-life
Anaerobic Aquatic Metabolism	kbacs	76	days	Half-life
Aerobic Soil Metabolism	asm	61	days	Half-life
Hydrolysis:	pH 5	8.8	days	Half-life
Hydrolysis:	pH 7	139	days	Half-life
Hydrolysis:	pH 9	224	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	4	cm	
Application Rate:	TAPP	0.42	kg/ha	
Application Efficiency:	APPEFF	0.95	fraction	
Spray Drift	DRFT	0.05	fraction of application rate applied to pond	
Application Date	Date	19-10	dd/mm or dd/mmm or dd-mm or dd-mmm	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR	EPA Pond		
Flag for runoff calc.	RUNOFF	none	none, monthly or total	

PRZM / EXAMS multiple application date assumption modeling: Sorted (by 21-day exposure estimates) List of 1 in 10 year return frequency for Various Exposure Durations - *Ground* application using the Texas / Barton Springs Salamander scenario and Port Arthur Texas meteorological data.

DATE	Peak	96 hr	21 Day	60 Day	90 Day	Yearly	30-Year
09-10	39.996	38.810	34.507	27.791	21.603	6.172	2.769
30-08	27.463	26.544	22.992	16.878	13.881	3.981	1.858
10-08	26.457	25.737	21.998	15.903	12.933	4.017	1.582
20-08	25.924	24.975	21.491	15.348	12.142	3.568	1.734

12-05	24.414	23.588	20.408	14.954	12.292	3.887	1.786
29-09	22.197	21.464	18.230	12.916	10.207	3.063	1.297
21-02	19.582	19.078	17.362	14.267	9.967	3.834	2.171
19-09	20.200	19.568	17.226	13.829	11.935	3.896	2.025
23-03	18.665	18.003	16.757	12.319	9.776	2.873	1.427
21-06	19.217	18.836	16.746	13.167	9.414	3.404	2.094
29-10	19.558	18.836	16.599	12.734	10.828	3.451	1.788
12-04	20.279	19.472	16.553	11.997	9.737	2.922	1.350
02-05	18.100	17.658	16.324	12.773	10.517	3.192	1.213
31-07	17.670	17.268	16.064	13.203	11.090	3.430	1.271
19-10	17.914	17.355	15.893	12.284	9.832	2.912	1.344
09-09	18.029	17.253	14.468	10.227	8.170	2.563	1.316
11-07	17.639	16.926	14.442	10.422	8.227	2.487	1.340
11-06	17.352	16.770	14.329	10.381	8.286	2.588	1.210
21-07	16.643	16.227	14.228	10.881	9.213	2.866	1.560
22-04	15.884	15.392	13.645	9.657	7.589	2.260	1.105
13-03	16.502	15.962	13.631	9.510	7.553	2.318	1.371
22-05	14.795	14.375	13.013	9.882	7.969	2.400	1.258
01-07	15.183	14.562	12.420	9.190	7.325	2.219	1.299
01-06	12.986	12.623	12.026	9.563	7.867	2.421	1.183
02-04	13.375	12.975	11.704	8.802	7.076	2.106	1.148
01-02	9.992	9.763	8.891	7.158	6.070	1.927	1.043
11-02	8.705	8.496	8.064	6.565	5.558	1.766	0.907
03-03	8.054	7.928	7.533	6.214	5.176	1.580	0.902

PRZM / EXAMS multiple application date assumption modeling: Sorted (by 21-day exposure estimates) List of 1 in 10 year return frequency for Various Exposure Durations - *Aerial* application using the California Red-Legged Frog scenario and Astoria, Oregon meteorological data.

DATE	Peak	96 hr	21 Day	60 Day	90 Day	Yearly	30-Year
13-03	11.346	11.125	10.256	8.581	7.493	2.779	1.194
29-10	11.134	10.934	10.233	8.604	6.248	2.715	1.610
19-10	11.046	10.854	10.202	8.547	6.635	2.788	1.629
11-02	10.995	10.813	10.059	8.418	7.375	2.811	1.648
01-02	10.284	10.105	9.405	7.891	6.932	2.696	1.317
23-03	9.964	9.816	9.119	7.570	6.591	2.455	1.145
21-02	9.996	9.786	9.049	7.574	6.639	2.528	1.351
22-04	9.587	9.432	8.660	7.130	6.146	2.227	0.826
03-03	8.919	8.739	8.146	6.838	5.990	2.250	1.360
12-04	8.775	8.674	8.055	6.686	5.789	2.111	0.859
09-10	8.495	8.366	7.783	6.526	5.464	1.963	1.081
19-09	8.390	8.237	7.550	6.240	5.484	1.987	0.998
12-05	7.639	7.473	6.855	5.553	4.763	1.709	0.563
09-09	7.313	7.145	6.531	5.356	4.704	1.549	0.913
02-04	6.253	6.167	5.795	4.808	4.167	1.544	0.867

02-05	6.182	6.045	5.514	4.535	3.905	1.417	0.765
01-06	5.513	5.389	5.037	4.131	3.543	1.272	0.749
29-09	5.466	5.382	4.939	4.118	3.627	1.094	0.754
20-08	5.518	5.387	4.841	3.886	3.353	1.394	0.683
30-08	4.742	4.628	4.216	3.437	2.999	1.026	0.695
22-05	4.562	4.466	4.086	3.335	2.859	1.049	0.509
21-06	4.304	4.211	3.833	3.084	2.643	0.980	0.554
01-07	3.938	3.853	3.516	2.863	2.437	0.866	0.466
10-08	3.738	3.644	3.277	2.627	2.265	0.911	0.542
21-07	3.677	3.584	3.273	2.643	2.281	0.855	0.490
11-07	3.705	3.607	3.250	2.577	2.200	0.802	0.505
11-06	3.351	3.273	2.999	2.427	2.072	0.750	0.461
31-07	3.347	3.266	2.936	2.353	2.028	0.856	0.538

Sample Input Files:

Output File: Sfmt_CArway4_02-04				
Metfile:	w94224.dvf			
PRZM scenario:	CArightofwayRLF.txt			
EXAMS environment file:	pond298.exv			
Chemical Name:	Sulfometuron Methyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	364.38	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	5.40E-16	torr	
Solubility	sol	2.44E+02	mg/L	
Kd	Kd		mg/L	
Koc	Koc	47.5	mg/L	
Photolysis half-life	kdp	0	days	Half-life
Aerobic Aquatic Metabolism	kbacw	292	days	Half-life
Anaerobic Aquatic Metabolism	kbacs	76	days	Half-life
Aerobic Soil Metabolism	asm	61	days	Half-life
Hydrolysis:	pH 5	8.8	days	Half-life
Hydrolysis:	pH 7	139	days	Half-life
Hydrolysis:	pH 9	224	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	4	cm	
Application Rate:	TAPP	0.42	kg/ha	
Application Efficiency:	APPEFF	0.95	fraction	
Spray Drift	DRFT	0.05	fraction of application rate applied to pond	
Application Date	Date	April 2	dd/mm or dd/mmm or dd-mm or dd-mmm	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			

	FEXTRC	0.5	
Flag for Index Res. Run	IR	EPA Pond	
Flag for runoff calc.	RUNOFF	none	none, monthly or total

Single PRZM-EXAMS runs for different sites: Sample EEC Summary tables and sample input files

Florida Citrus scenario

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.0323	1.642	1.592	1.403	1.072	1.000	0.340
0.0645	1.490	1.446	1.300	1.026	0.942	0.318
0.0968	1.487	1.446	1.279	1.020	0.864	0.292
0.1290	1.338	1.297	1.143	0.933	0.848	0.260
0.1613	1.199	1.172	1.056	0.918	0.782	0.248
0.1935	1.057	1.038	0.939	0.787	0.676	0.216
0.2258	1.057	1.028	0.928	0.767	0.666	0.210
0.2581	1.056	1.027	0.924	0.756	0.636	0.203
0.2903	1.056	1.026	0.921	0.731	0.606	0.198
0.3226	1.054	1.026	0.921	0.724	0.601	0.188
0.3548	1.053	1.025	0.921	0.721	0.600	0.187
0.3871	1.053	1.025	0.916	0.720	0.600	0.186
0.4194	1.053	1.025	0.915	0.720	0.595	0.185
0.4516	1.053	1.025	0.914	0.717	0.594	0.184
0.4839	1.053	1.024	0.914	0.714	0.593	0.184
0.5161	1.053	1.024	0.911	0.713	0.591	0.183
0.5484	1.053	1.024	0.910	0.709	0.587	0.182
0.5806	1.053	1.024	0.909	0.704	0.583	0.182
0.6129	1.053	1.024	0.908	0.703	0.579	0.181
0.6452	1.053	1.023	0.907	0.700	0.578	0.179
0.6774	1.053	1.023	0.907	0.700	0.578	0.177
0.7097	1.053	1.023	0.906	0.697	0.576	0.177
0.7419	1.052	1.023	0.905	0.695	0.573	0.177
0.7742	1.052	1.022	0.904	0.694	0.570	0.176
0.8065	1.052	1.022	0.904	0.694	0.570	0.175
0.8387	1.052	1.021	0.902	0.693	0.570	0.175
0.8710	1.052	1.021	0.902	0.691	0.570	0.174
0.9032	1.052	1.021	0.901	0.688	0.567	0.174
0.9355	1.052	1.020	0.900	0.688	0.566	0.173
0.9677	1.050	1.019	0.899	0.687	0.565	0.172
0.1000	1.472	1.431	1.265	1.011	0.863	0.28865
					Average of yearly averages:	0.20175

Output File: Sfmt_FLcitrus1	
Metfile:	w12844.dvf
PRZM scenario:	FLcitrusSTD.txt

EXAMS environment file:	pond298.exv			
Chemical Name:	Sulfometuron Methyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	364.38	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	5.40E-16	torr	
Solubility	sol	244	mg/L	
Kd	Kd		mg/L	
Koc	Koc	47.5	mg/L	
Photolysis half-life	kdp	0	days	Half-life
Aerobic Aquatic Metabolism	kbacw	292	days	Half-life
Anaerobic Aquatic Metabolism	kbacs	76	days	Half-life
Aerobic Soil Metabolism	asm	61	days	Half-life
Hydrolysis:	pH 5	8.8	days	Half-life
Hydrolysis:	pH 7	139	days	Half-life
Hydrolysis:	pH 9	224	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	4	cm	
Application Rate:	TAPP	0.42	kg/ha	
Application Efficiency:	APPEFF	0.95	fraction	
Spray Drift	DRFT	0.05	fraction of application rate applied to pond	
Application Date	Date	3-Jan	dd/mm or dd/mmm or dd-mm or dd-mmm	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR	EPA Pond		
Flag for runoff calc.	RUNOFF	none	none, monthly or total	

Florida Turf Scenario

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032	0.707	0.686	0.604	0.457	0.372	0.128
0.065	0.639	0.622	0.558	0.429	0.354	0.109
0.097	0.464	0.451	0.398	0.303	0.259	0.090
0.129	0.379	0.367	0.323	0.255	0.221	0.076
0.161	0.360	0.353	0.318	0.244	0.218	0.071
0.194	0.226	0.220	0.200	0.168	0.150	0.048
0.226	0.213	0.207	0.186	0.162	0.141	0.045

0.258	0.212	0.206	0.185	0.153	0.130	0.042
0.290	0.212	0.206	0.184	0.147	0.125	0.041
0.323	0.212	0.206	0.184	0.146	0.121	0.039
0.355	0.211	0.206	0.184	0.145	0.120	0.037
0.387	0.211	0.206	0.184	0.144	0.120	0.037
0.419	0.211	0.205	0.183	0.144	0.119	0.037
0.452	0.211	0.205	0.183	0.144	0.119	0.037
0.484	0.211	0.205	0.183	0.143	0.119	0.037
0.516	0.211	0.205	0.183	0.143	0.119	0.037
0.548	0.211	0.205	0.182	0.142	0.117	0.037
0.581	0.211	0.205	0.182	0.141	0.117	0.036
0.613	0.211	0.205	0.182	0.141	0.117	0.036
0.645	0.211	0.205	0.182	0.141	0.116	0.036
0.677	0.211	0.205	0.182	0.141	0.116	0.036
0.710	0.211	0.205	0.181	0.140	0.115	0.036
0.742	0.211	0.205	0.181	0.139	0.115	0.035
0.774	0.211	0.204	0.181	0.139	0.114	0.035
0.806	0.211	0.204	0.181	0.139	0.114	0.035
0.839	0.211	0.204	0.181	0.139	0.114	0.035
0.871	0.210	0.204	0.180	0.138	0.114	0.035
0.903	0.210	0.204	0.180	0.138	0.113	0.035
0.935	0.210	0.204	0.180	0.138	0.113	0.035
0.968	0.210	0.204	0.180	0.138	0.113	0.034
0.100	0.456	0.442	0.391	0.298	0.255	0.089
					Average of yearly averages:	0.046883

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: Sfmt_FLturf2				
Metfile:	w12834.dvf			
PRZM scenario:	FLturfSTD.txt			
EXAMS environment file:	pond298.exv			
Chemical Name:	Sulfometuron Methyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	364.38	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	5.40E-16	Torr	
Solubility	sol	244	mg/L	
Kd	Kd		mg/L	
Koc	Koc	47.5	mg/L	
Photolysis half-life	kdp	0	Days	Half-life
Aerobic Aquatic Metabolism	kbacw	292	Days	Half-life
Anaerobic Aquatic Metabolism	kbacs	109	Days	Half-life

Aerobic Soil Metabolism	asm	61	Days	Half-life
Hydrolysis:	pH 5	8.8	Days	Half-life
Hydrolysis:	pH 7	139	Days	Half-life
Hydrolysis:	pH 9	224	Days	Half-life
Method:	CAM	1	integer	See PRZM manual
Incorporation Depth:	DEPI	0	Cm	
Application Rate:	TAPP	0.42	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	3-Jan	dd/mm or dd/mmm or dd-mm or dd-mmm	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR	EPA Pond		
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)	

Inputs generated by pe5.pl - November 2006

Data used for this run:
Output File: Sfmt_FLturf1

Metfile:	w12834.dvf			
PRZM scenario:	FLturfSTD.txt			
EXAMS environment file:	pond298.exv			
Chemical Name:	Sulfometuron Methyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	364.38	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	5.40E-16	Torr	
Solubility	sol	2.44E+02	mg/L	
Kd	Kd		mg/L	
Koc	Koc	47.5	mg/L	
Photolysis half-life	kdp	0	Days	Half-life
Aerobic Aquatic Metabolism	kbacw	292	Days	Half-life
Anaerobic Aquatic Metabolism	kbacs	76	Days	Half-life
Aerobic Soil Metabolism	asm	61	Days	Half-life
Hydrolysis:	pH 5	8.8	Days	Half-life
Hydrolysis:	pH 7	139	Days	Half-life
Hydrolysis:	pH 9	224	Days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	4	cm	
Application Rate:	TAPP	0.42	kg/ha	
Application Efficiency:	APPEFF	0.95	fraction	

Spray Drift	DRFT	0.05	fraction of application rate applied to pond
Application Date	Date	3-Jan	dd/mm or dd/mmm or dd-mm or dd-mmm
Record 17:	FILTRA		
	IPSCND	1	
	UPTKF		
Record 18:	PLVKRT		
	PLDKRT		
	FEXTRC	0.5	
Flag for Index Res. Run	IR	EPA Pond	
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)

APPENDIX D: TERRPLANT SPREADSHEET

(TerrPlant Version 1.2.2)

Table D-1. Chemical Identity.	
Chemical Name	**Sulfometuron Methyl**
PC code	**122001**
Use	**non-crop vegetative management, forestry, rights of way**
Application Method	**ground**
Application Form	**water dispersible granule**
Solubility in Water (ppm)	**244 (pH 7)**

Table D-2. Input parameters used to derive EECs.

Input Parameter	Symbol	Value	Units
Application Rate	A	**0.375**	**lb a.i./A**
Incorporation	I	**1**	none
Runoff Fraction	R	**0.05**	none
Drift Fraction	D	**0.01**	none

Table D-3. EECs for Sulfometuron Methyl. Units in lb a.i./A.

Description	Equation	EEC
Runoff to dry areas	(A/I)*R	0.01875
Runoff to semi-aquatic areas	(A/I)*R*10	0.1875
Spray drift	**A*D**	**0.00375**
Total for dry areas	**((A/I)*R)+(A*D)**	**0.0225**
Total for semi-aquatic areas	**((A/I)*R*10)+(A*D)**	**0.19125**

Table D-4. Plant survival and growth data used for RQ derivation. Units are in lb a.i./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC_{25}	NOAEC	EC_{25}	NOAEC

Monocot	**1.90E-04**	**4.30E-05**	**3.70E-05**	**8.40E-06**
Dicot	**3.20E-05**	**2.90E-05**	**1.80E-05**	**9.90E-07**

Table D-5. RQ values for plants in dry and semi-aquatic areas exposed to Sulfometuron Methyl through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	118.42	1006.58	101.35
Monocot	listed	523.26	4447.67	446.43
Dicot	non-listed	703.13	5976.56	208.33
Dicot	listed	775.86	6594.83	3787.88

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

APPENDIX E: ADVERSE ECOLOGICAL INCIDENTS ASSOCIATED WITH SULFOMETURON METHYL USE

Incident ID	Use Site	Start Date	Legality	Certainty	State	County	Year	Total Magnitude	Appl. Rate	Appl. Method	Affected Species	Product
I011666-001	Municpal operation	01-Nov-00	Registered use	Highly Probable	ID		2000	Thousands Of Acres	1 Oz/Acre	Aerial	1	OUST
I013086-001	Right-of-way, rail	15-Jun-02	Registered use	Probable	WA	Kittitas	2002	Unknown	3 Oz Per 15 Gallons	Spray	1	Oust
I009556-043	Agricultural area	15-May-92	Registered use	Probable	CO	Costilla	1992	$4,400,000 Damages	N/R	Spray	1	OUST
I005972-001	PLANT SITE	01-Sep-97	Registered use	Probable	TX		1997		N/A	N/R	1	OUST
I006010-003	Utility plant	19-Aug-97	Misuse (accidental)	Probable	MS		1997	Unknown		RUN-OFF	1	
I000903-005	Forest	01-Sep-91	Misuse (accidental)	Probable	TX	Anderson	1991	N/R	500 Oz/ 3000 Acres	Spray	1	OUST
I000903-002	Agricultural area	01-Jan-94	Registered use	Probable	TX	Cherokee	1994	N/R	N/R	Spray	1	OUST
I006010-001	Right-of-way, road	20-Aug-97	Misuse (accidental)	Probable	LA		1997	Unknown	N/R	N/R	1	
I000903-003	Agricultural Area	01-Jan-94	Registered use	Probable	TX		1994	N/R	N/R	Spray	2,3,4	OUST
I000903-001	Agricultural area	01-Sep-91	Registered use	Probable	TX	Anderson	1991	N/R	2 Oz/25-30 Gal Water	Spray	1	OUST
I006010-002	Agricultural area	20-Aug-97	Misuse (accidental)	Probable	TX		1997	Unknown	N/R	N/R	1	
I007269-001	Agricultural area	21-May-98	Registered use	Probable	CA	Fresno	1998	All	N/R	N/R	1	OUST
I007269-002	YARD	29-May-98	Registered use	Probable	TN	Davidson	1998	All	N/R	N/R	1	OUST
I015217-001	Forest	21-May-04	Registered use	Probable	OH	Gallia	2004	8000 Sq Ft	3 Oz/Acre	Spray	1	Oust herbicide
I015832-001	Right-of-way, road	14-Dec-04	Registered use	Probable	LA	Lafayette	2004		N/R	Spray	1	Oust
I017481-001	Turf,	24-May-06	Undetermined	Probable	WI	Waukesha	2006	Unknown	Unknown	N/R	1	DuPont

Incident ID	Use Site	Start Date	Legality	Certainty	State	County	Year	Total Magnitude	Appl. Rate	Appl. Method	Affected Species	Product
	residential											Oust
I015576-001	Right-of-way, road	01-Apr-04	Registered use	Probable	OR	Multnomah	2004	$40,000	N/R	N/R	1	Landmark MP
I016302-001	Right-of-way, road	23-May-05	Registered use	Probable	WA	Grant	2005	Less Than An Acre	N/R	Spray	1	Oust
I016429-001	Industrial site	13-Jun-05	Registered use	Probable	WA	Grant	2005	$90,000 Damage	5 Oz/Acre	Spray	1	Oust
I015440-001	Right-of-way, utility	01-Jun-03	Misuse (accidental)	Probable	MN	Benton	2003	2 Acres	5 Oz/Acre	Spray	1	Oust
I013194-001	Right-of-way, rail	02-Jul-02	Registered use	Probable	ND	Walsh	2002	10 Acres	3 Oz/15 Gals Water	Spray	1	OUST
I014409-011	Right-of-way, road	03-Jun-92	Registered use	Possible	WA	Walla Walla	1992	Not Given			1	
B000601-010	Right-of-way	25-May-84	Registered use	Possible	CA	Fresno	1984	N/R		Spray	1	Oust
I015796-001	Right-of-way, utility	08-Nov-04	Registered use	Possible	KY	Jessamine	2004	1-4 Acres	3 Oz/Acre	Nr	1	Oust XP Herbicide
B000601-011	N/R	16-May-88	Registered use	Possible	CA	Kern	1988	N/R			1	Oust
I000071-001	Peach	01-Jan-92	Registered use	Possible	SC	Saluda	1992	Numerous Trees	N/R	N/R	1	OUST
B000601-009	N/R	23-May-85	Undetermined	Possible	LA	Acadia	1985	Less Than 50 Acres		Spray	1	Oust
I015265-001	Seedling	01-Mar-04	Registered use	Possible	TX	Cass	2004	Unknown	Unknown	Unknown	1	Oustar
I016680-001	Right-of-way	06-Apr-05	Undetermined	Possible	OR	Douglas	2005	13 Acres		Spray	1	
I009556-005	Agricultural area		Misuse (accidental)	Possible	NC		0	Unknown	N/R	N/R	1	OUST
B000601-001	N/R	04-May-88	Undetermined	Possible	CA	Kern	1988		NR	NR	1	Oust
I016312-001	Forest	01-Apr-05	Undetermined	Possible	OR	Benton	2005	300 Acres	2 Lb/Acre	Spray	1	Westar
B000601-008	Right-of-way, road	23-May-85	Registered use	Possible	LA	Acadia	1985	Nr		Spray	1	Oust
B000601-007	Right-of-way, road	23-May-85	Registered use	Possible	NE	Scotts Bluff	1985	Nr	2 Oz/Acre		1	Oust

Source: USEPA, OPP Ecological Incident Information System, October, 2007.
Affected Species: 1 = terrestrial plants, 2 = aquatic plants, 3 = terrestrial animals, 4= aquatic animals

APPENDIX F: T-REX OUTPUT

Table F-1. T-REX Model Inputs Used for Sulfometuron Methyl

TREX MODEL INPUTS

Chemical Name:	**Sulfometuron methyl**
Use:	**non-crop; forest, rights-of-way**
Product name and form:	**Oust (et al): water dispersible graunule**
% A.I. (leading zero must be entered for formulations <1% a.i.):	**100.00%**
Application Rate (lbs/A):	**0.375**
Half-life (days):	**35**
Application Interval (days):	
Number of Applications:	**1**

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

Endpoints

Avian			**Indicate test species below**
	LD50 (mg/kg-bw)	4650.00	2 (mallard)
	LC50 (mg/kg-diet)	**4600.00**	2 (mallard)
	NOAEL (mg/kg-bw)		2
	NOAEC (mg/kg-diet)		1
	Enter the Mineau et al. Scaling Factor		**1.15**
Mammals			
	LD50 (mg/kg-bw)	**5000.00**	Rat
	LC50 (mg/kg-diet)		
Reported Chronic Endpoint (mg/kg-bw/d)		**549.00**	Scaled to 350 g from Rabbit Developmental Tox Study
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)		**no**	
Enter dietary concentration (mg/kg-diet)			
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		**10980**	**mg/kg-diet based on standard FDA lab rat conversion**

Table F-2. T-REX Output: Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients									
Size Class (grams)	Adjusted LD50	EECs and RQs							
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	2414.40	102.50	0.04	46.98	0.02	57.66	0.02	6.41	0.00
100	3073.65	58.45	0.02	26.79	0.01	32.88	0.01	3.65	0.00
1000	4341.65	26.17	0.01	11.99	0.00	14.72	0.00	1.64	0.00

Table F-3. T-REX Output: Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients								
LC50	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
4600	90.00	0.02	41.25	0.01	50.63	0.01	5.63	0.00
Size class not used for dietary risk quotients								

Table F-4. T-REX Output: Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	10989.15	85.81	0.01	39.33	0.00	48.27	0.00	5.36	0.00	1.19	0.00
35	8891.40	59.30	0.01	27.18	0.00	33.36	0.00	3.71	0.00	0.82	0.00
1000	3845.80	13.75	0.00	6.30	0.00	7.73	0.00	0.86	0.00	0.19	0.00

Table F-5. T-REX Output: Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients								
NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10980	90.00	0.01	41.25	0.00	50.63	0.00	5.63	0.00
Size class not used for dietary risk quotients								

Table F-6: T-REX Output: Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	1206.61	85.81	0.07	39.33	0.03	48.27	0.04	5.36	0.00	1.19	0.00
35	976.28	59.30	0.06	27.18	0.03	33.36	0.03	3.71	0.00	0.82	0.00
1000	422.27	13.75	0.03	6.30	0.01	7.73	0.02	0.86	0.00	0.19	0.00

APPENDIX G: MODELING OF TERRESTRIAL PLANT EXPOSURE FROM CONTAMINATED IRRIGATION WATER

The following calculations were used for determining risk quotients for plants when groundwater or surface water contaminated by sulfometuron methyl is applied to areas as irrigation water and subsequently drift to adjacent areas.

SURFACE WATER IRRIGATION:

Assume a 1-acre field is irrigated with one inch of water containing 31 µg/L (or ppb) sulfometuron methyl (peak EEC for surface water, Table 15).

One acre has 6,272,640 square inches of surface area. A 1-acre field irrigated with 1 acre-inch of water (6,272,640 cubic inches of water) would have been treated with 3,630 cubic ft of water (6,272,640 cubic inches x 1 cubic ft/1728 cubic inches). Converting to gallons, the field has received 27,156 gallons of water (3,630 cubic ft x 7.481 gallons/cubic ft). On a pounds per acre basis, 1 inch of water applied to a 1-acre field weighs 226,625 lbs (27,156 gallons x 8.3453 lbs/gallon of water).

So, if surface water containing 31 ppb sulfometuron methyl is used to provide of 1 acre-inch of irrigation water, sulfometuron methyl is applied at a rate of:

$$226{,}625 \text{ lb of water/A} \times \frac{31 \text{ ppb (ai sulfometuron methyl)}}{1{,}000{,}000{,}000} = 0.00703 \text{ lbs ai/A sulfometuron methyl}$$

Therefore, the **risk quotient for sensitive plants adjacent to a field** that is irrigated with surface water containing 31 ppb (or µg/L) sulfometuron methyl is calculated as follows:

EEC (spray drift) = application rate of contaminated irrigation water (0.00703 lb ai/A) * 1% drift = 7.03×10^{-5} lb ai/A.

Non-endangered Plant RQ:

From 1 acre-inch of surface water: EEC/EC_{25} for vegetative vigor = $\frac{7.03 \times 10^{-5} \text{ lbs ai/A}}{1.8 \times 10^{-5} \text{ lbs ai/A}}$ = **3.9**

Endangered Plant RQ:

From 1 acre-inch of surface water: EEC/EC_{05} for vegetative vigor =

$$\frac{7.03 \times 10^{-5} \text{ lbs ai/A}}{9.9 \times 10^{-7} \text{ lbs ai/A}} = \mathbf{71}$$

GROUND WATER IRRIGATION

To calculate risk quotients for plants when ground water contaminated by sulfometuron methyl is applied as irrigation water and subsequently drifts to adjacent areas, the following method was used.

Assume a 1-acre field is irrigated with one inch of water containing 0.33 ppb (or µg/L) sulfometuron methyl (peak EEC for ground water, Table 15).

As calculated above, 1 acre-inch of irrigation water weighs 226,625 lbs. So, sulfometuron methyl is applied at a rate of:

$$226{,}625 \text{ lb of water/acre} \times \frac{0.33 \text{ (ai sulfometuron methyl)}}{1{,}000{,}000{,}000} = 7.48 \times 10^{-5} \text{ lbs ai/A.}$$

Therefore, the **risk quotient for sensitive plants adjacent to the irrigated area** with ground water containing 0.33 ppb (or µg/L) sulfometuron methyl is calculated as follows:

EEC (spray drift) = application rate of contaminated irrigation water (7.48×10^{-5} lb ai/A) * 1% drift = 7.03×10^{-7} lb ai/A.

Non-endangered Plant RQ:
From 1 acre-inch of ground water: EEC/EC_{25} for veg.vigor = $\frac{7.48 \times 10^{-5} \text{ lb ai/A}}{1.8 \times 10^{-5} \text{ lbs ai/A}} = 0.04$

Endangered Plant RQ:
From 1 acre-inch of ground water: EEC/EC_{25} for veg.vigor = $\frac{7.48 \times 10^{-5} \text{ lb ai/A}}{9.9 \times 10^{-7} \text{ lbs ai/A}} = 0.76$

APPENDIX H: ECOLOGICAL EFFECTS DATA SUMMARIES

I. OPP Guideline Toxicity Studies

Freshwater Fish, Acute

Bluegill Sunfish, *(Lepomis macrochirus)*. For bluegill, results from the range finding test indicated no mortality when exposed to sulfometuron methyl up to 200 mg ai/L (i.e., LC50 >200 mg/L). Accordingly, a definitive toxicity test was not required and a single treatment test was conducted at the toxicity limit of 150 mg ai/L using technical grade sulfometuron methyl (99.6% ai). Results from the limit test (MRID 435018-01) indicate no mortality to bluegill at an exposure concentration of 150 mg ai/L. To prevent the formation of chemical precipitate experienced during previous toxicity testing, test solutions were buffered with 5N sodium hydroxide. This resulted in a greater pH range (7.2 – 9.0) than recommended (7.2-7.6) in study guidelines. The study authors reported observing no precipitate or other signs of insolubility during the study. The test concentration were measured and found to be within 80% to 120% of nominal. The pH range deviation is therefore considered a necessary byproduct of increasing the solubility of the test chemical. No mortality was observed in the controls. All other test guideline deviations are considered minor. This study is classified as acceptable and meets the guideline requirements for acute toxicity to a fresh water fish.

Rainbow Trout, *(Oncorhynchus mykiss)*. Similarly for rainbow trout, no mortality was observed in a range finding test up to 200 mg ai/L or the follow-up toxicity limit test at 150 mg ai/L sulfometuron methyl (99.6% ai). Buffering of test solutions was required to prevent formation of precipitates which resulted in a greater pH range (7.9-8.7) than recommended (7.2-7.6). The test concentration were measured and found to be within 80% to 120% of nominal. The pH range deviation is therefore considered a necessary byproduct of increasing the solubility of the test chemical. No mortality was observed at 148 mg ai/L (measured concentration) or in the controls. All other test guideline deviations are considered minor. This study is classified as acceptable and meets the guideline requirements for acute toxicity to a fresh water fish.

Freshwater Invertebrates, Acute

Water flea (*Daphnia magna*). The toxicity of sulfometuron methyl to freshwater invertebrates is indicated by a 48-hr acute toxicity test with the water flea, *Daphnia magna* (MRID 435018-03). As observed with freshwater fish, no mortality was observed in a range finding test up to 200 mg ai/L or the follow-up toxicity limit test at 150 mg ai/L sulfometuron methyl (99.6% ai). Buffering of test solutions was required to prevent formation of precipitates which resulted in a greater pH range (8.4-9.0) than recommended (7.2-7.6). No mortality was observed in the 150 mg/L treatment or in the negative control. One daphnid died in the pH adjusted control (mortality 3%). The test concentration was measured and found to be 100% of nominal. The pH range deviation is therefore considered a necessary byproduct of increasing the solubility of the test chemical.

This test was originally classified as supplemental in 1995 by EFED because of concerns over chemical composition of the dilution water (filtered fish tank water housing fathead minnows) and the potential for microbial degradation. For the purposes of this risk assessment, this study was re-reviewed and upgraded to acceptable. According to the study authors, ammonia levels in the dilution water were not significantly raised and a summary of its chemical composition was provided in an earlier chronic life cycle test with the same organism (MRID 416728-06) and found to be acceptable. Furthermore, given the very low hydrophobicity of this chemical, alteration of its bioavailability due to sorption to organic carbon would not likely be significant, even if levels far exceeded those reported in the dilution water from the earlier daphnid study. Lastly, the chemical concentration was verified analytically which confirmed that significant chemical degradation was not occurring. This study is classified as acceptable and meets the guideline requirements for an acute toxicity study with a freshwater invertebrate.

Estuarine and marine Fish, Acute

Sheepshead minnow (*Cyprinodon variegatus*). The toxicity of sulfometuron methyl to estuarine and marine fish is indicated by a 96-hr acute toxicity test with the sheepshead minnow, *Cyprinodon variegatus* conducted at nominal concentrations of sulfometuron methyl (99.1% ai) ranging from 15 to 100 mg ai/L (MRID 416728-03). The LC_{50} based on measured concentrations from this study was found to be greater than 45 mg ai/L. No mortality or observable signs of sublethal effects occurred in the study except for one dead fish (5%) at 8.2 mg/L (measured). This study was re-reviewed for this risk assessment and found to contain several significant deficiencies which render its classification as supplemental. Specifically, measured concentrations ranged widely from test initiation to termination (4 to 7 times), which is believed due to the formation of an observable precipitate in test solutions. This occurred despite buffering of the dilution water to an initial pH of 8.5 (pH ranged thereafter from 7.4 to 8.5).

Although originally classified as supplemental by EFED in 1993, the study was subsequently upgraded to core/acceptable by EFED in 1994 upon the registrant's explanation that solubility limits in unbuffered water prevented adequate recovery of sulfometuron methyl from test solutions and that test concentrations were verified analytically. However, while this information may explain the low % of nominal concentrations observed in the study, there was high variability in measured test concentrations with treatments and substantial uncertainty in the actual exposure of organisms to dissolved sulfometuron methyl (no centrifugation of test samples prior to analysis). Although these deficiencies could render the study classification as "unacceptable," it is considered to provide some useful information in this risk assessment (i.e., an indication of a lack of toxicity at or near solubility limits in test solutions). Furthermore, when viewed in the context of screening level EECs (i.e., a maximum peak concentration of 0.031 ppm in water), the bioavailable (dissolved) portion sulfometuron methyl would have to be approximately <u>1500-fold lower</u> than the highest measured test concentration (~45 ppm) in order for risks to be evident. Therefore, this study is classified as supplemental but is not recommended for repeat testing at this time because a repeat test would be highly unlikely to alter the risk assessment conclusions.

Estuarine and Marine Invertebrates, Acute

Mysid shrimp, *Mysidopsis bahia.* For mysids, a 96-h assay was conducted at nominal concentrations of sulfometuron methyl (99.1%) ranging from 15 to 100 mg ai/L (MRID 416728-04). The 96-h LC_{50} based on measured concentrations from this study was found to be greater than 44.8 mg ai./L. No mortality or observable signs of sublethal effects occurred in the study at any test concentration or the control. A re-review of the mysid test indicates it has several significant deficiencies which render its classification as supplemental. Specifically, measured concentrations of sulfometuron methyl ranged widely from test initiation to termination (3X to 13X in the mysid tests) and were substantially below nominal concentrations. The low % nominal is believed due to the formation of an observable precipitate in test solutions. The low % nominal occurred despite buffering of the dilution water to an initial pH of 8.5 (pH ranged thereafter from 7.6 to 8.5). The pH range in the mysid test extended beyond the recommended range in the test guidelines (7.7-8.0 for euryhaline shrimp).

Although the mysid study was originally classified as supplemental by EFED in 1993, the study was subsequently upgraded to core/acceptable in 1994 by EFED upon the registrant's explanation that solubility limits in unbuffered water prevented adequate recovery of sulfometuron methyl from test solutions and that test concentrations were verified analytically. However, while this information may explain the low % of nominal concentrations observed in the study, there was high variability in measured test concentrations with treatments and substantial uncertainty in the actual exposure of organisms to dissolved sulfometuron methyl (no centrifugation of test samples prior to analysis per OPP test guidelines). Although these deficiencies could render the study classification as "unacceptable," it is considered to provide some useful information in this risk assessment (i.e., an indication of a lack of toxicity at or near solubility limits in test solutions). Furthermore, when viewed in the context of screening level EECs (i.e., a maximum peak concentration of 0.031 ppm in water)**,** the bioavailable (dissolved) portion sulfometuron methyl would have to be approximately <u>1300-fold lower</u> than the highest measured test concentration (~ 45 ppm) in order for risks to be evident. Therefore, this study is classified as supplemental but is not recommended for repeat testing at this time because a repeated test would not likely affect the risk assessment conclusions.

Eastern oyster, *Crassostrea virginica.* For oysters, a 48-h assay was conducted on embryos at the same nominal concentrations as used for mysids (MRID 416728-05). The 48-h EC_{50} based on measured concentrations for this study was found to be greater than 38.2 mg ai/L. No mortality occurred and 99% of the surviving control oysters were normal.

A re-review of the oyster study indicates it has several significant deficiencies which render its classification as supplemental. Specifically, measured concentrations of sulfometuron methyl ranged widely from test initiation to termination (up to 3X) and were substantially below nominal concentrations. The low % nominal is believed due to the formation of an observable precipitate in test solutions. In the oyster test, pH ranged from 7.7 to 8.0. The pH range in the oyster test extended beyond the recommended range in the test guidelines (8.0-8.3 for stenohaline oysters).

Although this study was originally classified as supplemental by EFED in 1993, it was subsequently upgraded to core/acceptable in 1994 by EFED upon the registrant's explanation that solubility limits in unbuffered water prevented adequate recovery of sulfometuron methyl from test solutions and that test concentrations were verified analytically. However, while this information may explain the low % of nominal concentrations observed in the study, there was high variability in measured test concentrations with treatments and substantial uncertainty in the actual exposure of organisms to dissolved sulfometuron methyl (no centrifugation of test samples prior to analysis per OPP test guidelines). Although these deficiencies could render the study classifications as "unacceptable," it is considered to provide some useful information in this risk assessment (i.e., an indication of a lack of toxicity at or near solubility limits in test solutions). Furthermore, when viewed in the context of screening level EECs (i.e., a maximum peak concentration of 0.031 ppm in water)**,** the bioavailable (dissolved) portion sulfometuron methyl would have to be approximately 1000-fold lower than the highest measured test concentration (~ 40 ppm) in order for risks to be evident. Therefore, this study is classified as supplemental but is not recommended for repeat testing at this time because a repeated test would not likely affect the risk assessment conclusions.

Freshwater Fish, Chronic

A chronic, early life-stage toxicity test was conducted in 1982 to determine the effect of sulfometuron methyl on fathead minnow embryo hatching, larval survival, and growth (MRID 423857-04; Accession No. 249796). Fertilized embryos and hatched larvae were exposed to 5 nominal concentrations ranging from 0.15 to 2.5 mg ai/L under flow-through conditions. Dimethylformamide (DMF) was used as a carrier (0.1 ml/L) and a solvent and negative control were used. Two replicates were used per test treatment, with each replicate containing 50 embryos and subsequent to hatching, 20 larvae. A statistically-significant reduction in hatching was attributed to the highest test concentration (2.5 mg/L nominal, 1.16 mg/L measured) using chi-square analysis (but not significant using ANOVA). Mean percent hatch was 38% in the highest test concentration compared to 75% in the solvent and negative controls. Larval survival was not significantly affected in any test concentration (ranging from 85-100%) compared to 92% in the negative control and 95% in the solvent control. Larval growth (length, weight) were also not significantly affected in any test concentration relative to either control. During the last week of the test, a diluter malfunction resulted in a precipitous drop in exposure concentrations in all treatments (at or below detection of 0.01 mg/L in several treatments). Thus, the NOAEC and LOAEC from this study (0.71 and 1.16 mg/L, respectively for % hatching) were determined by considering only the embryo exposure portion of the study prior up through hatching (i.e., prior to the diluter malfunction).

A re-review of this study conducted for this risk assessment the study is unacceptable primarily because of high uncertainty in quantifying exposure experienced by fathead minnows during the test. Specifically, temporal variability in test concentrations exceeded OPP test guidelines of < 1.5X in all test concentrations. Even when measured concentrations from the last week are not considered, the ratio of the highest to the lowest test concentration ranged from 1.6 to 2.7. As reported in the study, the stability of the test substance in the DMF carrier is in question and is thought to be responsible for the low measured concentrations (48% of nominal on average). Follow-up testing indicated that at the pH of the study (7.2-7.5), the solubility of the sulfometuron methyl with the DMF carrier would be approximately 3 mg/L. At higher pH, the solubility of sulfometuron methyl increases substantially (>100 mg/L). At the time this study was conducted (1982), however, pH adjusted test solutions was not conducted reportedly due to lack of knowledge of the NaOH pH adjustment method. However, results from the *Daphnia* life cycle study discussed below indicate that with appropriate buffering, stable and consistent concentrations are achievable with sulfometuron methyl. Because the NOAEC for fathead minnow from this study (0.71 mg/L) is within an order of magnitude of EECs (0.031 mg/L), there is a reasonable probability that a valid NOAEC for chronic effects could fall in the range of the EECs. Finally, the precipitous drop in exposure concentrations brings into question the study findings of a lack of a significant affect on fathead minnow larval growth, since exposure was terminated up to a week prematurely. This study is considered unacceptable and does not fulfill the guideline requirements for chronic toxicity to freshwater fish.

Freshwater Invertebrate, Chronic

Chronic toxicity sulfometuron methyl to freshwater invertebrates is indicated by a 21-day life cycle test conducted on the water flea, *Daphnia magna* (MRID 416728-06). Daphnids (<24-h old) were exposed to six concentrations of sulfometuron methyl ranging from 0.1 to 100 mg/L (nominal) in a static-renewal system. Reproduction, growth and survival were measured in 7 replicates per treatment (1 organism/rep.), while 3 additional replicates were designated solely for survival measurement (5 organisms/rep.). In order to promote solubility of the test substance, the pH of the stock solutions of the 25 mg/L and 100 mg/L treatments were adjusted with NaOH to pH 8.5. Both a negative and pH-adjusted controls were included.

Results indicate that mean measured concentrations were close to nominal concentrations (i.e., within 20% of the 0.1, 0.39, 1.6, 6.3, 25 and 100 mg/L nominal concentrations). Variability in test concentrations was well within the acceptable limits of 1.5X. Daphnid survival, growth and reproduction were not significantly different between negative and pH adjusted controls. Survival and growth (length) were not affected at any test concentration. Reproduction, as measured by the number of neonates produced/daphnid, was <u>not</u> significantly different from negative controls in any treatment (ANOVA, 0.05). Although the Dunnett's multiple comparison test indicated a marginally significant difference in the 24 mg/L treatment (mean measured concentration), it is not considered statistically valid to apply means testing when ANOVA results indicate lack of significant differences among treatments. Furthermore, an inconsistent concentration-response relationship is indicated by the lack of a significant reduction in daphnid reproduction at 97 mg/L (the highest treatment tested). Therefore, the NOAEC for daphnid reproduction is re-interpreted as 97 mg/L (unbounded) and the LOAEC is > 97 mg/L. This study is classified as acceptable and meets the guideline requirements for a chronic study using a freshwater invertebrate.

Aquatic Plants

Green Algae, *Selenastrum capricornutum*. A tier 2 growth and reproduction study was conducted on the effects of sulfometuron methyl (99.1% ai) on the green algae, *S. capricornutum* (MRID 416801-02). Six test concentrations were evaluated ranging from 0.63 to 20 ug ai/L (nominal). The 120 hr EC_{50} (reduction in cell density) for *S. capricornutum* was 4.6 µg ai/L and the NOAEC was 0.63 ug ai/L. At the LOAEC of 1.3 µg/L, growth was reduced approximately

20%, while the cell growth at the NOAEC showed a slight increase relative to controls. A monotonic concentration-response relationship with cell density was observed. These toxicity values are based on reported nominal concentrations. Although the study authors indicate that samples were taken for analytical measurement and would be analyzed "if deemed necessary," results from chemical analysis were not provided in the study report. At these concentrations, solubility of the test compound is not expected to be problematic. Therefore, this test is classified as acceptable and meets the guidelines requirement a test with a freshwater green algal species.

Freshwater and Marine Diatoms (*Navicula pelliculosa and Skeletonema costatum*). Preliminary tests with the freshwater diatom (*N. pelliculosa*) and saltwater diatom (*S. costatum*) indicated a lack of toxicity such that Tier II tests were not necessary. Both species were exposed to a nominal 'limit' test concentration of 414 ug ai/L (99.2% ai) for 120 hours including negative controls (4 reps each). This 'limit concentration' corresponded to the maximum concentration calculated for sulfometuron methyl applied to a 6 in. deep, 1 acre pond. For *N. pelliculosa*, no significant reduction in cell density was observed following exposure to 370 ug ai/L (measured, MRID 435385-02). The pH ranged from 7.4 to 7.5. Similarly for *S. costatum,* no significant reduction in cell density was observed following exposure to 410 ug ai/L (measured, MRID 435385-02). The test pH ranged from 7.9-8.7 at test termination. Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions. No significant guideline deviations were noted in these studies. These tests are considered acceptable and meet the guideline requirements for a freshwater and marine diatom.

Bluegreen Algae, *Anabena flos-aquae.* A tier 2 test was conducted on the freshwater blue-green algae, *Anabaena flos-aquae,* at 5 test concentrations of sulfometuron methyl (99.2% ai) ranging from 14 to180 µg/L (measured values, MRID 435385-02). Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions. The 120-hr EC_{50} (cell density) for *Anabaena* was calculated as 41.6 µg/L. A NOAEC for cell density was calculated as <14 µg/L (lowest concentration tested). This NOAEC corresponds to a 20% in cell growth relative to controls. This test is considered scientifically sound but is classified as supplemental because a NOAEC was not reached in the study. No other major guideline deviations were apparent in this test.

Duckweed, *Lemna gibba*. The freshwater vascular plant (duckweed) was studied in a 14-day exposure to sulfometuron methyl (95.7% ai, MRID 435835-03) at 5 test doses ranging from 0.13 to 1.045 ug ai/L plus a negative control. A total of 3-5 plants were tested per replicate with 3-5 fronds per plant. The pH of test solutions ranged from 7.5 to 9.4 because test solutions were buffered to maintain adequate solubility. The 14-day exposure of EC_{50} and NOAEC for frond count (the most sensitive endpoint tested) were 0.48 and 0.21 µg/L, respectively. Frond counts were reduced 4% at the NOAEC and 20% at the LOAEC (0.32 ug/L). Measurements at test initiation and termination indicate stability of sulfometuron methyl in the test solutions. Following the 14-d exposure period, recovery of duckweed was assessed at the end of the study by exposing organisms to untreated medium for an additional 14 days. Effects were expressed as percent inhibition of frond counts and biomass. The results are as follows:

14-d Exposure Conc.	14-d Recovery Frond Count Inhibition	14-d Recovery: Biomass Inhibition
1.045 ppb	41.1%	38.3%
0.590 ppb	11.8%	10.8%
0.323 ppb	0.6%	- 1.0%

The study authors concluded that sulfometuron methyl was phytotoxic to duckweed at concentrations of $\geq$ 0.590 ppb and phytostatic at 0.323 ppb. These data suggest that the effects of sulfometuron methyl to aquatic vascular plants may be reversible following 14-d exposures at selected concentrations (0.323 ppb and below) provided a sufficient recovery period is available. This study is considered acceptable and satisfies the guideline requirement for a toxicity test using an aquatic vascular plant.

Avian, Oral Acute

Mallard duck, *Anas platyrhynchos.* An acute oral toxicity study with the mallard indicates sulfometuron methyl ($\geq$ 93% ai) is practically non-toxic on an acute basis (MRID 245375). An oral LD_{50} of >4,650 mg ai/kg-bw was reported in this study (recalculated by reviewer for % ai). No mortality occurred in any treatment and birds appeared normal throughout the 14-d test period. Food consumption varied widely across treatments, but did not exhibit a dose-dependent trend. Weight gain/loss also did not exhibit a dose-dependent trend within or across sexes. Weight gain in females may have been confounded by induction of the egg laying cycle by the photoperiod used. The guideline requirement (71-1) is fulfilled for an acute oral toxicity study with birds for sulfometuron methyl and the study is classified as acceptable.

Avian, Dietary Acute

Mallard duck, *Anas platyrhynchos* and bobwhite quail, *Colinus virginianus.* Two, 8-d dietary acute toxicity studies were submitted on the effects of sulfometuron methyl on bobwhite quail and mallard duck (Accession No. 246409 and MRID 71414, respectively). Both tests consisted of a 5-d exposure period followed by 3 days of observation. Mortality, food consumption and body weight were measured during the test. Mallards were 16 days old while quail were < 14 days old at test initiation, with each test using 10 birds per treatment level. The submitted data indicates that sulfometuron methyl (92 to 95.2% ai) is practically nontoxic to mallard and quail when administered via subacute, dietary exposure. The 8-day acute dietary LC_{50} values for bobwhite quail and mallard are > 5,620 mg ai/kg-diet and > 4,600 mg ai/kg-diet, respectively (adjusted by reviewer for & ai). There were no signs of mortality, clinical toxicity, or abnormal behavior reported in the studies. The guideline (71-2) is fulfilled for a subacute dietary study with birds and these studies are classified as acceptable.

Mammal, Acute

Rat, Sprague Dawley. The acute toxicity of sulfometuron methyl (technical grade active ingredient) is indicated by an acute, oral toxicity study with the rat (MRID 43089201). In this study, 5 male and 5 female rats were administered a single oral dose of 5000 mg ai/kg-bw technical grade sulfometuron methyl (approx. 100% a.i.) in corn oil via gavage. Rats were observed for mortality, signs of ill health, pharmacologic and toxicological effects for 14 days after dosing. No mortality occurred at 5,000 mg ai/kg-bw and no clinical signs of toxicity were observed that were related to sulfometuron methyl exposure. Male and females continued to gain weight throughout the study. An acute, oral LD50 value of >5000 mg ai/kg-bw was determined from this study, indicating that sulfometuron methyl is categorized as practically non-toxic (toxicity category IV) to small mammals on an acute oral basis. This study is considered acceptable and satisfies the guideline requirement (81-1) for an acute toxicity study with mammals.

Formulated Product, Rat (Sprague Dawley). Formulated pesticide products may contain a number of other 'inert' ingredients that alter their toxicity compared to the technical grade active ingredient (e.g., resulting in greater toxicity). For sulfometuron methyl, data on the oral toxicity of formulated products were available for one species of terrestrial animal (rat). Results from this study indicate that the formulated product DPX-T5486-87 (74% ai) is practically nontoxic to laboratory rats, with an LD50 of >5,000 mg ai/kg-bw. No clinical signs of toxicity, weight loss or gross legions were observed in this study. This study satisfied guideline requirements for acute oral toxicity with rats and is considered acceptable.

Mammals, Chronic/Developmental

A combined 2-generation reproduction/oncogenicity study and 2-year chronic reproduction study with rats exposed to sulfometuron methyl was submitted to the agency (MRID 423857-05 and 423857-06). However, study authors had to abandoned the study on about day 200 due to disease of the test organisms that was not related to exposure. Portions of this study were submitted to the Agency (e.g., 90-day and chronic reproduction) but were found unacceptable upon their review by HED. Similarly, a mammalian developmental toxicity study (MRID 78796) with the rat was also found to be invalid by HED.

A developmental toxicity study with the rabbit (Accession No. 78798) was submitted to the Agency. In this study, rabbits were administered doses of 0, 30, 100, or 300 mg/kg/day from gestation days (GD) 6-18 and examined at GD 29. There were no mortalities and no treatment-related clinical signs or macroscopic findings. A slight decrease in maternal body weight occurred during the gestation period (GD 6-18) but this was judged biologically insignificant. There were no treatment related effects on fetal or maternal endpoints measured, including external, visceral or skeletal malformations, frequency of resorptions, live fetuses, or dead fetuses, or on the number of litters, sex ratio, or post-implantation loss. The developmental LOAEL was not observed. The developmental NOAEL is 300 mg/kg/day (highest dose tested). According to the data evaluation record provided by HED, this study is acceptable but does not fulfill the guideline requirement for a developmental toxicity study with rabbits because dose levels were not considered high enough to adequately assess developmental toxicity.

Terrestrial Invertebrate

Honeybee, *Apis mellifera.* A honeybee acute contact study is required for sulfometuron methyl because its post-emergence treatment use will likely result in honeybee exposure. The acute contact LD_{50}, using the honey bee is a single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of bees. For sulfometuron methyl, bees were exposed at 5 treatments ranging from 13 to 100 µg ai/bee and included a solvent and negative control (MRID 416728-10). Results indicate that sulfometuron methyl is practically non-toxic to bees on an acute contact basis. The contact 48-h LD_{50} for sulfometuron methyl is >100 µg ai/bee. Cumulative mortality and immobility ranged from 4-8% in the controls to 0-2% in the treatments. No overt signs of toxicity were observed in the study. The guideline (141-1) is fulfilled.

Terrestrial Plants

For sulfometuron methyl, six dicots (sugar beet, rape, tomato, pea, cucumber and soybean) and four monocots (onion, corn, wheat, sorghum) were tested using the Tier 2 protocols for effects on seedling emergence and vegetative vigor. Tier 1 tests were not conducted since preliminary testing indicated all plants would be promoted to Tier 2 testing. Test durations were 14 days and 21 days for the seedling emergence and vegetative vigor studies, respectively. Depending on the species and test, seven to eleven treatments were used with application rates ranged from 0.0000017 to 0.5625 lb ai/acre. For this risk assessment, a re-review and statistical analysis was conducted on the Tier 2 toxicity data from the more sensitive test species in both the seedling emergence and vegetative vigor tests. All statistical comparisons were made to negative controls (previous analyses in the DER made comparisons to solvent controls even though negative and solvent controls were not significantly different). For calculation of the EC_{25} and EC_{05}, nonlinear regression was conducted using the methods of Bruce and Versteeg (1992). In situations where the NOAEC was found to be greater than or equal to the EC_{25}, the EC_{05} was used for the comparison with threatened and endangered species.

Results for the most sensitive endpoints and species with monocots and dicots indicate that seedling emergence and vegetative vigor are impacted at exposures well below the maximum application rate of 0.375 lb ai/acre for sulfometuron methyl. For seedling emergence, the EC_{25} of 1.9×10^{-4} lb ai/acre for the most sensitive monocot (sorghum) is about a factor of 5 greater than the EC_{25} of 3.2×10^{-5} lb ai/acre for the most sensitive dicot (sugar beet). For 9 of the 10 test species, a comparison of EC_{25} values indicates that interspecies sensitivity differences are within a factor of 20 (based on summary data presented by McKelvey, 1995). This indicates that the most sensitive test species are <u>not</u> 'outliers' in terms of their relative sensitivity. The EC_{05} and NOAEC for the sorghum and sugar beet are 4.3×10^{-5} and 2.9×10^{-5}, respectively. A consistent, declining monotonic exposure-response curve was observed for sugar beet, while that for sorghum was monotonic following an increase in mean shoot height of 24% in the lowest test treatment and 2% in the next lowest treatment relative to the negative control. Because the statistical method of Bruce and Versteeg (1992) uses a pooled response from the non-monotonic portion of the dose-response curve for calculating EC_x values, the actual mean response associated with the EC_{05} for sorghum is slightly higher than the mean response observed for controls, rendering it a relatively conservative toxicological value.

Results from the vegetative vigor study indicate the most sensitive monocot (corn) and dicot (soybean) are impacted at somewhat lower levels compared to the seedling emergence study. The EC_{25} values for corn and soybean (shoot dry weight) are 3.7 x 10^{-5} and 1.8 x 10^{-5}, respectively. Because the NOAEC exceeded the EC_{25} values for both species, the EC_{05} is used for risk assessment with threatened and endangered species. The EC_{05} values for corn and soybean are 8.4 x 10^{-6} and 9.9 x 10^{-7}, respectively. For all 10 test species, a comparison of EC_{25} values indicates that interspecies sensitivity differences are within a factor of 20 (based on summary data presented by McKelvey, 1995). This indicates that the most sensitive test species are <u>not</u> 'outliers' in terms of their relative sensitivity. A consistent, declining monotonic exposure-response curve was observed for corn and soybean in the vegetative vigor test.

II. Acceptable or Supplemental Studies from ECOTOX

Aquatic Organisms

Naqvi and Hawkins (1989). In this study, Naqvi and Hawkins (1989) exposed four genera of field-collected microcrustaceans (*Diaptomus sp. Eucyclops sp., Alonella sp., and Cypria sp.*) to sulfometuron methyl from the Oust® formulated product at nominal concentrations of ranging from 100 to 2500 mg/L for 48-h. Consistent, monotonic exposure-response relationships across the six treatments occurred for all four species and 48-h LC50s (probit analysis) were reported as follows:

Species	Test Chemical	48-h LC50 (mg/L) (95% confidence limits)	Classification	Reference
Diaptomus sp.	Oust® (~93% ai)	1315 (1207-1524)	supplemental	Naqvi and Hawkins (1989)
Eucyclops sp.		1320 (1154-1536)		
Alonella sp.		802 (475-928)		
Cypria sp		2241 (1744-4517)		

This study is classified as supplemental primarily because test concentrations were not measured in the study and the field collected test organisms were provided a relatively short application period (96-h) vs. the 7-d minimum acclimation period recommend for freshwater invertebrate testing. Furthermore, organisms were not positively identified to the species level, thus indicating that more than one test species may have been tested in each study. Finally, the study authors do not indicate whether nominal concentrations were adjusted to reflect the percent active ingredient in the formulated product.

Romaire (1984). A study was submitted by the registrant (DuPont) per FIFRA Section 6(a)2 requirements on July 1, 1991. In this study, Romaire (1984) evaluated the acute toxicity of Oust® (% ai not reported) to juvenile red swamp crayfish, *Procambarus clarkii*. A static, acute toxicity study was conducted for 96 hours in 4 replicate aquaria (5 crayfish/aquarium) at 8 test concentrations ranging from 0 to 10,000 mg ai/L. Analytical measurements sulfometuron methyl were not taken during the study. The authors report that the 96-h LC50 was > 5,000 mg ai/L for sulfometuron methyl and mortality did not exceed 50% in any test treatment. However, review of this study indicates that it is unacceptable because dissolved oxygen levels dropped precipitously throughout the study in test concentrations where mortality was observed, despite periodic aeration of test solutions. Dissolved oxygen levels repeatedly reached levels as low as 2.1 mg/L or approximately 25% saturation, which is well below ASTM recommendations of 60% saturation. Because the effect of dissolved oxygen on crayfish mortality could not be separated from the possible effects of sulfometuron methyl, this study is not considered scientifically sound for the purposes of describing the acute toxicity of sulfometuron methyl to juvenile crayfish.

Byl et al. (1994). The effects of sulfometuron methyl on the aquatic vascular plant, *Hydrilla verticillata,* were evaluated in a laboratory study conducted by Byl et al (1994). In this study, Byl et al.) exposed plants to four aqueous solutions ranging from 0.001 to 1.0 mg/L sulfometuron methyl (as the formulated product, Oust®, % ai not reported) . Three replicates were used per treatment and exposures continued for 5 days. The number of plants tested per replicate was not reported. A significant decrease in shoot length was observed at or above 0.01 mg/L, with combined shoot and root length approximating 30% of the controls. Reduction in mean growth followed a concentration dependent monotonic relationship. A significant increase in peroxidase activity (a potential biochemical indicator of chemical exposure) was also measured at 0.01 mg/L relative to controls. This study is classified as supplemental because sulfometuron methyl was not measured in the study and it is unclear whether results reported reflect % ai or total formulated product.

Fort et al (1999). In this study, Fort et al. (1999) conducted three separate tests of sulfometuron methyl exposure to the African clawed frog, *Xenopus laevis*: (1) a 4-day frog embryo teratogenesis assay (FETAX) to evaluate embryo mortality/ malformations; (2) a 14-d test to evaluate effects on tail resporption, and (3) a 30-d exposure to evaluate effects on limb development. Both analytically impure (85% ai) and purified (99.5% ai) sulfometuron methyl exposures were evaluated in the study, but due to the confounding influence of impurities on sulfometuron methyl toxicity, results from only the purified (99.5% ai) sulfometuron methyl are used here.

In the FETAX assay, 2 replicates of 20 mid-blastula frog embryos (stage 8) were exposed to 11 nominal test concentrations of sulfometuron methyl ranging from 0.001 to 24.9 mg ai/L for 96-h. Sulfometuron methyl stock solutions were prepared using a DMSO carrier and verified analytically (analytical results not reported). Both a negative and solvent control were included. Test procedures generally conformed to ASTM recommendations for the FETAX assay (ASTM, 1996). Results indicate no statistically significant effect of sulfometuron methyl on embryo survival or percent malformations up to (and including) the highest test concentration (24.9 mg/L). Solvent controls were not significantly different from negative controls.

Similar results were found in the 30-d study, whereby no statistically significant effect of sulfometuron methyl exposure was found on limb development (% malformations) up through 24.9 mg/L. Results from the 14-d tail resporption study indicate a significant reduction in tail resporption at 9.95 and 24.9 mg ai/L beginning at development stage 64 through 66 (test termination). No significant reduction occur at or below 1 mg ai/L.

This study is classified as supplemental primarily because exposure concentrations were not measured during the test. Although the authors report that sulfometuron methyl was 'stable' over the 24 to 96-h renewal cycles used in the studies, no analytical chemistry results were provided. Furthermore, randomization of study organisms and replicates was not indicated (an ASTM requirement). Collection and testing of embryos by separate clutches (an ASTM recommendation) was not apparent in the study. Finally, the final concentrations of carrier solvent in the various treatments was not reported (solvent concentrations were only reported for the stock solutions).

Toxicity of sulfometuron methyl to the African clawed frog from a study by Fort et al. (1999).

Species	Test Chemical	Exposure Duration	Endpoint (Effect)	Effect Level (mg ai/L)	Study Classification	Ref.
Xenopus laevis	sulfometuron methyl (99.5% ai)	96-h	LC50 (% mortality) NOAEC (% malformations)	> 24.9 24.9 [(a)]	Supplemental	Fort et al. (1999)
		14-d	NOAEC (tail resorption) LOAEC (tail resporption)	0.995 9.95		
		30-d	NOAEC (limb deformation)	24.9[(a)]		

[(a)] Highest tested dose, LOAEL not achieved in study.

Terrestrial Organisms

Busse et al. (2005). In a greenhouse study, Busse et al. (2005) studied the effect of sulfometuron methyl (applied as the formulated product Oust) on ectomycorrhizal formation and seedling growth of three conifer species: ponderosa pine (Pinus ponderosa), Douglas fir (Pseudosuga menziesii), and white fir (Abies concolor). Conifer seedlings (5 replicates) were grown in four different soil types and applied with sulfometuron methyl at 0, 1X and 2X its application rate of 0.14 kg ai/ha (0.125 lb/A). Sulfometuron methyl was applied to soil at the onset of lateral root formation (approximately 45-55 d post planting) due to the high sensitivity of seedlings to sulfometuron methyl applied prior to this time period. Results indicate that ectomycorrhizal formation was not inhibited for any conifer regardless of soil type or application rate (1X or 2X). For ponderosa pine, seedling dry weight and root growth (number of root tips/plant) were significantly reduced relative to controls at 0.125 and 0.250 lb ai/A in two of the four soil types. For Douglas fir and white fir, no significant reduction in seedling dry weight occurred at any treatment level. However, root growth was reduced for Douglas fir at 0.125 lb ai/A for three of the four soil types and at 0.25 lb ai/A for the forth soil type. White fir appeared least sensitive to sulfometuron methyl, with significant reductions in root growth at 0.125 lb ai/A in one soil type and at 0.25 lb ai/A in a second soil type. The authors conclude that sulfometuron methyl does not inhibit mycorrhizal formation at the specified application rates but does inhibit plant growth of ponderosa pine and root growth of all three species, depending on soil type and application rate. The lowest NOAEC from this study is 1X the application rate or 0.125 lb ai/A, several orders of magnitude above NOECs observed in the seedling emergence and vegetative vigor guideline studies.

Boyle and Walters (2005) examined the effect of saccharin, a major degradation product of sulfometuron methyl, on resistance of broad bean (*Vicia faba*) to rust fungus. Although not conceived as a degradate study per se, these results nevertheless have some relevance to the ecotoxicology of one of the sulfometuron methyl degradation products. In this study, 200 ml of 0.3 mM saccharin was applied either as a soil drench or to foliage of broad bean which were exposed to rust fungus four times over a 14-d period. Results indicate that saccharin did not induce resistance to rust fungus nor did it significantly affect shoot weight or leaf area. However the authors report the number of leaflets formed was significantly reduced relative to controls.

Neary et al. (1984) evaluated the effects of sulfometuron methyl (as the formulated product Oust) on slash pine (*Pinus elliottii*) and loblolly pine (*Pinus taeda*) seedlings inhabiting coastal plain flatlands. In this study, 60 trees of each species were exposed to sulfometuron methyl via broadcast spray at 0.50 lb ai/A in a randomized factorial design involving different plot locations, irrigation and fertilization levels. Although this study was designed primarily to investigate the efficacy of different weed control methods, the authors did report that three months after treatment, application of sulfometuron methyl did not reduce survival of slash or loblolly pine, suggesting an unbounded NOAEC of 0.50 lb ai/A (only dose tested).

APPENDIX I; ECOLOGICAL EFFECTS DATA REQUIREMENTS

Ecological Effects Data Requirements for Sulfometuron Methyl

Guideline	Data Requirement	Test Material	MRID	Study Classification	Data Requirement Met?	More Data Needed?
71-1	Avian Oral LD_{50}	sulfometuron methyl	245375	Acceptable	Yes	No
71-2	Avian Dietary LC_{50}	sulfometuron methyl	71414 246409 (2)	Acceptable Acceptable	Yes	No
71-4	Avian Reproduction	sulfometuron methyl		Data Gap	No	Reserved(3)
72-1	Freshwater Fish LC_{50}	sulfometuron methyl	435018-01 435018-02	Acceptable	Yes	No
72-2	Freshwater Invertebrate Acute LC_{50}	sulfometuron methyl	435018-03	Acceptable (1)	Yes	No
72-3(a)	Estuarine/Marine Fish LC_{50}	sulfometuron methyl	416728-03	Supplemental (1)	No	Reserved(3)
72-3(b)	Estuarine/Marine Mollusk EC_{50}	sulfometuron methyl	416728-05	Supplemental (1)	No	Reserved(3)
72-3(c)	Estuarine/Marine Shrimp EC_{50}	sulfometuron methyl	416728-04	Supplemental (1)	No	Reserved(3)
72-4(a)	Freshwater Fish Early Life-Stage	sulfometuron methyl	423857-04; 249796 (2)	Invalid (1)	No	Reserved(3)
72-4(b)	Aquatic Invertebrate Life-Cycle (freshwater)	sulfometuron methyl	416728-06	Acceptable	Yes	No
123-1(a)	Seedling Emergence (Tier II)	sulfometuron methyl	435385-01	Acceptable	Yes	No
123-1(b)	Vegetative Vigor (Tier II)	sulfometuron methyl	435385-01	Acceptable	Yes	No
123-2	Blue-green Algae	sulfometuron	435385-02	Acceptable	Yes	No

Ecological Effects Data Requirements for Sulfometuron Methyl

Guideline	Data Requirement	Test Material	MRID	Study Classification	Data Requirement Met?	More Data Needed?
Aquatic Plant Growth	(Tier II)	methyl				
	Duckweed, Lemna gibba (Tier II)	sulfometuron methyl	435385-03	Acceptable	Yes	No
	Freshwater Diatom, Navicula (Tier 1)	sulfometuron methyl	435385-02	Acceptable	Yes	No
	Marine Diatom (Tier 1)	sulfometuron methyl	435385-02	Acceptable	Yes	No
	Green algae (Tier II)	sulfometuron methyl	416801-02	Acceptable	Yes	No
141-1	Honey Bee Acute Contact LD_{50}	sulfometuron methyl	416728-10	Acceptable	Yes	No

(1) Study was re-classified as part of this risk assessment.
(2) Accession number.
(3) Data requirement not met for this guideline study. However, risk assessment results are not likely to change based on submission of new acceptable data. Therefore, the data requirement for this study is reserved but may be required in the future should additional information warrant additional testing.

APPENDIX J: ECOLOGICAL EFFECTS STUDIES REJECTED BY OPP

SULFOMETURON METHYL + DEGRADATES
Papers that Were Accepted for ECOTOX But Ultimately Rejected By OPP (May 2007)

Initial Screen Acceptable for ECOTOX and OPP

Ahrens, J. F. (1985). Evaluation of Sulfometuron Methyl for Weed Control in Christmas Tree Plantings. *Proc.Northeast.Weed Sci.Soc.* 39: 249-253. (Rejection Rationale: Target/efficacy study, Mixtures; EcoReference No.: 31608)

Anderson, R. L., Lefever, F. R., and Maurer, J. K. (1988). The Effect of Various Saccharin Forms on Gastro-Intestinal Tract, Urine and Bladder of Male Rats. *Food Chem.Toxicol.* 26: 665-669. (Rejection Rationale: Endpoint Relevancy; EcoReference No.: 82947)

Byl, T. D. and Klaine, S. J. (1991). Peroxidase Activity as an Indicator of Sublethal Stress in the Aquatic Plant Hydrilla verticillata (Royle). *In: J.W.Gorsuch, W.R.Lower, W.Wang, and M.A.Lewis (Eds.), Plants for Toxicity Assessment, 2nd Volume, ASTM STP 1115, Philadelphia, PA* 101-106. (Rejection Rationale: Superceded by Byl et al, 1994; EcoReference No.: 17181)

Cumberland, P. F. T., Richold, M., Parsons, J. F., and Pratten, M. K. (1994). Further Evaluation of a Teratogenicity Screen Using an Intravitelline Injection Technique. *Toxicol. In Vitro* 8: 153-166. (Rejection Rationale: Endpoint Relevancy, Exposure Route; EcoReference No.: 91195)

Dodel, J. B., Everaere, L., Gauthier, B., and Issaly, G. (1983). Use of Dpx 5648 Or Methyl 2-(((((4,6-Dimethyl-2-Pyrimidinyl)Amino)-Carbonyl)Amino)=Sulfonyl)Benzoate Or Dpx 5648, A New Herbicide for Weeding Uncultivated Plac. *Columa* 3: 257-265. (Rejection Rationale: Target/Efficacy study; EcoReference No.: 31204)

Epelbaum, S., Landstein, D., Arad, S., Barak, Z., Chipman, D. M., Larossa, R. A., and Vandyk, T. K. (1992). Is the Inhibitory Effect of the Herbicide Sulfometuron Methyl due to 2 Ketobutyrate Accumulation? *In: B.K.Singh, H.E.Flores, and J.C.Shannon (Eds.), 7th Annu. Penn. State Symp. in Plant Physiol., May 28-30, Univ.Park, PA, Am.Soc.of Plant Physiol., Rockville, MD* 352-353. (Rejection Rationale: Target/Efficacy study, Toxicity mechanisms);

Fleischer, S. J., Gaylor, M. J., Dickens, R., and Turner, D. L. (1989). Roadside Management of Annual Fleabane (Erigeron annuus) and Wild Carrot (Daucus carota). *Weed Technol.* 3: 72-75. (Rejection Rationale: Target/Efficacy study; EcoReference No.: 90965) EcoReference No.: 49268)

Harada, K., Miyasaki, T., and Tamura, Y. (1994). Chemoattractant Effects of Sugars and Their Related Compounds on Black Abalone Haliotis discus. *Comp.Biochem.Physiol.A* 109: 111-115. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90554)

Hirose, M., Shirai, T., Tsuda, H., Fukushima, S., Ogiso, T., and Ito, N. (1981). Effect of Phenobarbital, Polychlorinated Biphenyl and Sodium Saccharin on Hepatic and Renal Carcinogenesis in Unilaterally Nephrectomized Rats Given N-Ethyl-N-Hydroxyethylnitrosasmine Orally. *Carcinogenesis* 2: 1299-1302. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 82213)

Kim, H.-C., Cha, S.-W., Ha, C.-S., Roh, J.-K., Lee, Y.-S., Furukawa, F., Nishikawa, A., and Takahashi, M. (1996). Reappraisal of Eight Representative Carcinogenic and Non-Carcinogenic Compounds in a New Medium-Term Rat Liver Bioassay Using. *Cancer Lett.* 104: 85-90. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90556)

King, J. W. and Rogers III, J. N. (1986). Bermudagrass Growth Suppression with Sulfometuron Methyl and Metsulfuron Methyl. *Ark Farm Re* 35(2): 1-4. (Rejection Rationale: Target/Efficacy study, Mixture; EcoReference No.: 31373)

Kitchin, K. T. and Ebron, M. T. (1983). Studies of Saccharin and Cyclohexylamine in a Coupled Microsomal activating/Embryo Culture System. *Food Chem.Toxicol.* 21: 537-541. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90513)

Kramers, P. G. N. (1977). Mutagenicity of Saccharin in Drosophila: The Possible Role of Contaminants. *Mutat.Res.* 56: 163-167. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90961)

Liscia, A., Masala, C., Crnjar, R., Sollai, G., and Solari, P. (2004). Saccharin Stimulates the "Deterrent" Cell in the Blowfly: Behavioral and Electrophysiological Evidence. *Physiol.Behav.* 80: 637-646. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90053)

Nascimento, M. G., De Oliveira, M. L. C. S., Lima, A. S., and De Camargo, J. L. V. (2006). Effects of Diuron [3-(3,4-Dichlorophenyl)-1,1-Dimethylurea] on the Urinary Bladder of Male Wistar Rats . *Toxicology* 224: 66-73. (Rejection Rationale: Endpoint relevancy; EcoReference No.: 90555)

Pszczolkowski, M. A. and Brown, J. J. (2003). Effect of Sugars and Non-Nutritive Sugar Substitutes on Consumption of Apple Leaves by Codling Moth Neonates. *Phytoparasitica* 31: 283-291. (Rejection Rationale: Target/Efficacy; EcoReference No.: 91055)

Sivan, A. and Arad, S. (1998). Intraspecific Transfer of Herbicide Resistance in the Red Microalga Porphyridium sp. (Rhodophyceae) via Protoplast Fusion. *J.Phycol.* 34: 706-711. (Rejection Rationale: Target/Efficacy; EcoReference No.: 61449)

Initial Screen Acceptable for ECOTOX but not OPP

1. Amin, S., Moore, R. W., Peterson, R. E., and Schantz, S. L. (2000). Gestational and Lactational Exposure to TCDD or Coplanar PCBs Alters Adult Expression of Saccharin Preference Behavior in Female Rats. *Neurotoxicol.Teratol.* 22: 675-682.

   EcoReference No.: 75076
   Chemical of Concern: TCDD,PCB,SAC; Habitat: T; Effect Codes: REP,GRO,BEH; Rejection Code: NO ENDPOINT(SAC)//PCBRES CODED,RQA,DATA,ENTERED,DONE.

2. Asamoto, M., Mann, A. M., and Cohen, S. M. (1994). P53 Mutation is Infrequent and Might not give a Growth Advantage in Rat Bladder Carcinogenesis In Vivo. *Carcinogenesis* 15: 455-458.

   EcoReference No.: 90517
   Chemical of Concern: SAC; Habitat: T; Effect Codes: CEL; Rejection Code: NO MIXTURE(SAC),NO COC(SMM).

3. Bannasch, P., Griesemer, R. A., Anders, F., Becker, R., Cabral, J. R., Della Porta, G., Feron, V. J., Henschler, D., Ito, N., Kroes, R., Magee, P. N., McKnight, B., Montesano, R., Napalkov, N. P., Nesnow, S., Roberfroid, M., Slaga, T., Turusov, V. S., Wilbourn, J., and Williams, G. M. (1986). Assays for Initiating and Promoting Activities. *In: R.Montesano, et al.(Eds.), IARC (Int.Agency for Res.on Cancer) Sci.Publ.No.83, Long-Term and Short-Term Assays for Carcinogens: A Critical Appraisal, Oxford Univ.Press, New York, NY* 103-126.

   EcoReference No.: 90967
   Chemical of Concern: PbAC,EXQ,SAC,CTC; Habitat: T; Effect Codes: MOR,PHY; Rejection Code: NO CONTROL,ENDPOINT(SAC).

4. Bantle, J. A., Burton, D. T., Dawson, D. A., Dumont, J. N., Finch, R. A., Fort, D. J., Linder, G., and Rayburn, J. R. (1994). Fetax Interlaboratory Validation Study: Phase II Testing. *Environ.Toxicol.Chem.* 13: 1629-1637.

   EcoReference No.: 13502
   Chemical of Concern: SMM; Habitat: A; Rejection Code: NO CONTROL(SMM).

5. Boswell, K. J., Reid, M. L., Fitch, J. V., Bennett, S. M., Narciso, S. P., Hubbell, C. L., and Reid, L. D. (2005). Estradiol Valerate and Intake of Sweetened Water. *Pharmacol.Biochem.Behav.* 80: 1-7.

   EcoReference No.: 90545
   Chemical of Concern: SAC; Habitat: T; Effect Codes: GRO,BEH; Rejection Code:

NO CONTROL,ENDPOINT(SAC).

6. Byl, T. D. and Klaine, S. J. (1991). Peroxidase Activity as an Indicator of Sublethal Stress in the Aquatic Plant Hydrilla verticillata (Royle). *In: J.W.Gorsuch, W.R.Lower, W.Wang, and M.A.Lewis (Eds.), Plants for Toxicity Assessment, 2nd Volume, ASTM STP 1115, Philadelphia, PA* 101-106.

EcoReference No.: 17181
Chemical of Concern: SMM,CuS; Habitat: A; Effect Codes: BCM,GRO; Rejection Code: LITE EVAL CODED(CuS),NO ENDPOINT(SMM).

7. Byl, T. D., Sutton, H. D., and Klaine, S. J. (1994). Evaluation of Peroxidase as a Biochemical Indicator of Toxic Chemical Exposure in the Aquatic Plant Hydrilla verticillata, Royle. *Environ.Toxicol.Chem.* 13: 509-515.

EcoReference No.: 4016
Chemical of Concern: SMM,CuS,Se,Cd; Habitat: A; Effect Codes: BCM,GRO; Rejection Code: LITE EVAL CODED(CuS),NO ENDPOINT(SMM).

8. Cumberland, P. F. T., Richold, M., Parsons, J., and Pratten, M. K. (1994). Intravitelline Injection of Rodent Conceptuses: An Improved In Vitro Developmental Toxicity Screen. *Toxicol.In Vitro* 8: 731-733.

EcoReference No.: 91267
Chemical of Concern: ETU,SAC; Habitat: T; Effect Codes: GRO,BCM,CEL; Rejection Code: NO CONTROL,NO ENDPOINT(ETU,SAC).

9. Duan, J. J. and Prokopy, R. J. (1993). Toward Developing Pesticide-Treated Spheres for Controlling Apple Maggot Flies, Rhagoletis pomonella (Walsh) (Dipt., Tephritidae): I. Carbohydrates and Amino Acids as Feeding Stimulants. *J.Appl.Entomol.* 115: 176-184.

EcoReference No.: 91063
Chemical of Concern: SAC; Habitat: T; Effect Codes: BEH; Rejection Code: NO CONTROL,ENDPOINT(SAC).

10. Fedtke, C., Schmalfuss, J., and Couderchet, M. (1999). Chloroacetanilides, Oxyacetamides, Tetrazolinones: Mode of Action. 1. Cross Resistance and Oleic Acid Incorporation in Algal Model Systems. *Pestic.Sci.* 55: 580-582 .

EcoReference No.: 90964
Chemical of Concern: SMM,PCP,PAQT,DU,ACR,BTC,ATZ,BSF,CPP,MBZ; Habitat: A; Effect Codes: POP; Rejection Code: NO CONTROL,ENDPOINT(SMM,PCP,ATZ).

11. Ferguson, S. A., Delclos, K. B., Newbold, R. R., and Flynn, K. M. (2003). Dietary Ethinyl Estradiol Exposure During Development Causes Increased Voluntary Sodium

Intake and Mild Maternal and Offspring Toxicity in Rats. *Neurotoxicol.Teratol.* 25: 491-501.

EcoReference No.: 90547
Chemical of Concern: EED,SAC; Habitat: T; Effect Codes: GRO,BEH; Rejection Code: NO ENDPOINT(SAC).

12. Ferguson, S. A., Flynn, K. M., Delclos, K. B., and Newbold, R. R. (2000). Maternal and Offspring Toxicity but few Sexually Dimorphic Behavioral Alterations Result from Nonylphenol Exposure. *Neurotoxicol.Teratol.* 22: 583-591.

EcoReference No.: 68835
Chemical of Concern: SAC,NYP; Habitat: T; Effect Codes: BEH,GRO,MOR,REP; Rejection Code: NO ENDPOINT(SAC).

13. Flynn, K. M., Ferguson, S. A., Delclos, K. B., and Newbold, R. R. (2000). Effects of Genistein Exposure on Sexually Dimorphic Behaviors in Rats. *Toxicol.Sci.* 55: 311-319.

EcoReference No.: 90544
Chemical of Concern: SAC; Habitat: T; Effect Codes: GRO,BEH; Rejection Code: NO ENDPOINT(SAC).

14. Gonzalez, F. E., Atkins, R. L., and Brown, G. C. (1984). Sulfometuron Methyl, Rate and Timing Studies on Bermudagrass and Bahiagrass Roadside Turf. *Proc.South Weed Sci.Soc.* 37: 272-274.

EcoReference No.: 31768
Chemical of Concern: SMM; Habitat: T; Effect Codes: GRO; Rejection Code: NO ENDPOINT,NO CONTROL(TARGET-SMM).

15. Hannan, P. J. (1995). A Novel Detection Scheme for Herbicidal Residues. *Environ.Toxicol.Chem.* 14: 775-780.

EcoReference No.: 69628
Chemical of Concern: ATZ,PPZ,THF,CRME,TNM,AMTR,CZE,SMM; Habitat: AT; Effect Codes: PHY; Rejection Code: NO ENDPOINT(ALL CHEMS) .

16. Hartnett, M. E., Newcomb, J. R., and Hodson, R. C. (1987). Mutations in Chlamydomonas reinhardtii Conferring Resistance to the Herbicide Sulfometuron Methyl. *Plant Physiol.(Bethesda)* 85: 898-901.

EcoReference No.: 90536
Chemical of Concern: SMM; Habitat: A; Effect Codes: POP,PHY; Rejection Code: NO ENDPOINT(SMM).

17. Harvey, J. H. Jr., Dulka, J. J., and Anderson, J. J. (1985). Properties of Sulfometuron Methyl Affecting Its Environmental Fate: Aqueous Hydrolysis and Photolysis, Mobility and Adsorption on Soils, and Bioaccumulation Potential. *J.Agric.Food Chem.* 33: 590-596.

EcoReference No.: 90543
Chemical of Concern: SMM; Habitat: A; Effect Codes: ACC; Rejection Code: NO ENDPOINT(SMM).

18. Hicks, R. M., Wakefield, J. S. J., and Chowaniec, J. (1975). Evaluation of a New Model to Detect Bladder Carcinogens or Co-Carcinogens; Results Obtained with Saccharin, Cyclamate and Cyclophosphamide. *Chem.-Biol.Interact.* 11: 225-233.

EcoReference No.: 91040
Chemical of Concern: SAC; Habitat: T; Effect Codes: PHY; Rejection Code: NO ENDPOINT(SAC).

19. Ikeda, M., Mitsui, T., Setani, K., Tamura, M., Kakeyama, M., Sone, H., Tohyama, C., and Tomita, T. (2005). In Utero and Lactational Exposure to 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in Rats Disrupts Brain Sexual Differentiation. *Toxicol.Appl.Pharmacol.* 205: 98-105.

EcoReference No.: 80278
Chemical of Concern: TCDD,DXN,SAC; Habitat: T; Effect Codes: BEH,REP,GRO,BCM,PHY; Rejection Code: NO ENDPOINT(SAC)//PCBRES CODED,RQA,DATA ENTERED,DONE.

20. Ioannides, C., Lum, P. Y., and Parke, D. V. (1984). Cytochrome P-488 and the Activation of Toxic Chemicals and Carcinogens. *Xenobiotica* 14: 119-137 .

EcoReference No.: 90546
Chemical of Concern: ETHN,SAC,DDT,AND; Habitat: T; Effect Codes: CEL,BCM; Rejection Code: NO ENDPOINT(SAC).

21. Jaffe, R. L. (1995). Rapid Assay of Cytotoxicity Using Tetramitus flagellates. *Toxicol.Ind.Health* 11: 543-558.

EcoReference No.: 5895
Chemical of Concern: Cd,SMM; Habitat: A; Rejection Code: NO ENDPOINT(SMM).

22. Koeppe, M. K. and Mucha, C. F. (1991). Metabolism of Sulfometuron Methyl in Lactating Goats. *J.Agric.Food Chem.* 39: 2304-2309.

EcoReference No.: 90542
Chemical of Concern: SMM; Habitat: T; Effect Codes: ACC; Rejection Code: NO CONTROL,ENDPOINT(SMM).

23. Kovar, J. L., Zhang, J., Funke, R. P., and Weeks, D. P. (2002). Molecular Analysis of the Acetolactate Synthase Gene of Chlamydomonas reinhardtii and Development of a Genetically Engineered Gene as a Dominant Selectable Marker for Genetic Transformation. *Plant J.* 29: 109-117.

EcoReference No.: 90963
Chemical of Concern: SMM; Habitat: A; Effect Codes: CEL; Rejection Code: NO CONTROL(SMM).

24. Kuhns, L. J. and Kaps, M. A. (1986). Sulfometuron Methyl and Imazapyr Applied as a Directed Spray on White Pine. *Proc.Northeast.Weed Sci.Soc.* 40: 263-264 .

EcoReference No.: 31014
Chemical of Concern: IZP,SMM,SMU; Habitat: T; Effect Codes: POP,PHY; Rejection Code: NO ENDPOINT(ALL CHEMS,TARGET-IZP,SMM,SMU).

25. Landstein, D., Arad, S., Barak, Z., and Chipman, D. M. (1993). Relationships Among the Herbicide and Functional Sites of Acetohydroxy Acid Synthase from Chlorella emersonii. *Planta* 191: 1-6.

EcoReference No.: 91069
Chemical of Concern: SMM; Habitat: A; Effect Codes: BCM; Rejection Code: NO ENDPOINT(SMM).

26. Landstein, D., Epelbaum, S., Arad, S., Barak, Z., and Chipman, D. M. (1995). Metabolic Response of Chlorella emersonii to the Herbicide Sulfometuron Methyl. *Planta* 197: 219-224.

EcoReference No.: 90966
Chemical of Concern: SMM; Habitat: A; Effect Codes: BCM,PHY; Rejection Code: NO ENDPOINT(TARGET-SMM).

27. Langeland, K. A. (1986). Management Program for Alligatorweed in North Carolina. *Rep.No.224, Water Resour.Res.Inst.of the Univ.of N.Carolina* 36 p.

EcoReference No.: 90590
Chemical of Concern: MTPN,SMM,TPR,HXZ,BMC,AMTL,DU,IZP,DMB,FDE,GYP,24DXY; Habitat: AT; Effect Codes: POP; Rejection Code: NO CONTROL(SMM,HXZ,IZP,GYP),NO ENDPOINT(SMM,HXZ,BMC).

28. Lapidot, M., Raveh, D., Sivan, A., Arad, S., and Shapira, M. (2002). Stable Chloroplast Transformation of the Unicellular Red Alga Porphyridium Species. *Plant Physiol.* 129: 7-12.

EcoReference No.: 90535
Chemical of Concern: SMM; Habitat: A; Effect Codes: POP,PHY; Rejection Code: NO ENDPOINT(SMM).

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EcoReference No.: 60978
Chemical of Concern: 24DXY,GYP,HXZ,IZP,MSFM,SMM,TPR; Habitat: A; Effect Codes: GRO,MOR; Rejection Code: NO CONTROL(ALL CHEMS),TARGET SMM.

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EcoReference No.: 74836
Chemical of Concern:
CBF,PYT,MTM,ACP,CPY,DEM,MLN,CBL,FNV,PAQT,GYP,SMM ; Habitat: T;
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Chemical of Concern: SMM; Habitat: A; Effect Codes: POP,PHY; Rejection Code: NO ENDPOINT(SMM)