Bureau of Land Management

Reno, Nevada

Overdrive®
Ecological Risk Assessment

Final Report

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Executive Summary

The Bureau of Land Management (BLM), United States Department of the Interior (USDI), is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental United States (U.S.) and Alaska. As part of this program, the BLM is proposing the use of ten herbicide active ingredients (a.i.) to control invasive plants and noxious weeds on approximately one million of the 6 million acres proposed for treatment. The BLM and its contractor, ENSR, are preparing a Vegetation Treatments Programmatic Environmental Impact Statement (EIS) to evaluate this and other proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental U.S. and Alaska. In support of the EIS, this Ecological Risk Assessment (ERA) evaluates the potential risks to the environment that would result from the use of the herbicide Overdrive®, including risks to rare, threatened, and endangered (RTE) plant and animal species.

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of invasive plants (including noxious weeds and other plants not native to the region) across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, invasive plants will jeopardize the health of public lands and the activities that occur on them. Herbicides are one method employed by the BLM to control these plants.

Herbicide Description

In 2003, Overdrive®, manufactured by BASF Corporation, was approved by the United States Environmental Protection Agency (USEPA) for use in noncropland sites, pastures, grass hay, and rangelands. This herbicide contains the a.i. diflufenzopyr and dicamba, the same ones found in the herbicide Distinct®, which is registered for use on field corn and non-cropland areas. However, the Overdrive® label does not specify use in areas growing corn, and the Distinct® label does not specify use in pastures. Overdrive® is reported to be effective for all the weeds that are listed on the Distinct® label in addition to others that are common in pastures and noncrop areas. Since Overdrive® is approved for use in noncropland sites, pastures, grass hay, and rangeland, BLM proposes to use Overdrive® rather than Distinct® to treat land.

Overdrive® is a selective, post-emergence, systematic herbicide used for the control of annual broad-leaf weeds, the suppression or control of many perennial broad-leaf weeds, and the suppression of annual grasses on noncropland sites. This herbicide inhibits the transport of hormones (auxin) that regulate plant growth and development.

Overdrive® is proposed for use by the BLM for vegetation control in their Energy and Mineral Sites, Rights-of-Way, and Recreation Areas programs. Ground applications are made using backpack sprayers and from all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The Recreation Areas programs also use horseback dispersion. The BLM would typically apply Overdrive® at 0.2625 pounds (lbs) a.i. per acre (a.i./ac), with a maximum rate of 0.4375 lbs a.i./ac.

Ecological Risk Assessment Guidelines

The main objectives of this ERA were to evaluate the potential ecological risks from Overdrive® to the health and welfare of plants and animals and their habitats and to provide risk managers with a range of generic risk estimates that vary as a function of site conditions. The categories and guidelines listed below were designed to help the BLM determine which of the proposed alternatives evaluated in the EIS should be used on BLM lands.

- Exposure pathway evaluation – The effects of Overdrive® on several ecological receptor groups (i.e., terrestrial animals, non-target terrestrial plants, fish and aquatic invertebrates, and non-target aquatic plants) via particular exposure pathways were evaluated. The resulting exposure scenarios included the following:
    - direct contact with the herbicide or a contaminated waterbody;

- indirect contact with contaminated foliage;
- ingestion of contaminated food items;
- off-site drift of spray to terrestrial areas and waterbodies;
- surface runoff from the application area to off-site soils or waterbodies;
- wind erosion resulting in deposition of contaminated dust; and
- accidental spills to waterbodies.

- Definition of data evaluated in the ERA – Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM. These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). Some of these calculations required computer models:
    - AgDRIFT® was used to estimate off-site herbicide transport due to spray drift.
    - Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) was used to estimate off-site transport of herbicide in surface runoff and root-zone groundwater.
    - CALPUFF was used to predict the transport and deposition of herbicides sorbed to wind-blown dust.
- Identification of risk characterization endpoints – Endpoints used in the ERA included acute mortality; adverse direct effects on growth, reproduction, or other ecologically important sublethal processes; and adverse indirect effects on the survival, growth, or reproduction of salmonid fish. Each of these endpoints was associated with measures of effect such as the no observed adverse effect level (NOAEL) and the median lethal effect dose and median lethal concentration (LD_{50} and LC_{50}).
- Development of a conceptual model – The purpose of the conceptual model is to display working hypotheses about how Overdrive® might pose hazards to ecosystems and ecological receptors. This is shown via a diagram of the possible exposure pathways and the receptors for each exposure pathway.

In the analysis phase of the ERA, estimated exposure concentrations (EECs) were identified for the various receptor groups in each of the applicable exposure scenarios via exposure modeling. Risk quotients (RQs) were then calculated by dividing the EECs by herbicide- and receptor-specific or exposure media-specific Toxicity Reference Values (TRVs) selected from the available literature. These RQs were compared to Levels of Concern (LOCs) established by the USEPA Office of Pesticide Programs (OPP) for specific risk presumption categories (i.e., acute high risk, acute high risk potentially mitigated through restricted use, acute high risk to endangered species, and chronic high risk).

Uncertainty

Uncertainty is introduced into the herbicide ERA through the selection of surrogates to represent a broad range of species on BLM lands, the use of Overdrive® with other potentially toxic ingredients (i.e., degradates, inert ingredients, and adjuvants), and the estimation of effects via exposure concentration models. The uncertainty inherent in screening-level ERAs is especially problematic for the evaluation of risks to RTE species, which are afforded higher levels of protection through government regulations and policies. To attempt to minimize the chances of underestimating risk to RTE and other species, the lowest toxicity levels found in the literature were selected as TRVs; uncertainty factors were incorporated into these TRVs; allometric scaling was used to develop dose values; model assumptions were designed to conservatively estimate herbicide exposure; and indirect as well as direct effects on species of concern were evaluated.

Herbicide Effects

Literature Review

According to the Ecological Incident Information System (EIIS) database run by the USEPA OPP, diflufenzopyr has been associated with 1 reported "ecological incident," involving damage to corn plants. The incident report indicated that because there were a variety of pesticides applied, it is possible that all played a role in the observed crop damage. The EIIS database contained 99 incident reports involving dicamba and 23 incident reports involving dicamba with 2,4-D. Of the 99 incident reports involving dicamba, 66 listed dicamba as the 'probable' cause and one listed dicamba as the 'highly probable' cause of the incident. Most of these incidents involved plant damage to crops (e.g., beans, corn, soybeans [*Glycine max*]) and grasses that occurred during the routine use or accidental misuse of a dicamba-based herbicide.

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for Overdrive® to negatively directly or indirectly affect non-target taxa. This review was also used to identify or derive TRVs for use in the ERA. No specific toxicity data were available for the product Overdrive®, so the a.i., dicamba and diflufenzopyr, and the herbicide Distinct® were also investigated. Toxicity data for all three compounds are discussed in Section 3.1 and presented in Appendix A.

According to the USEPA, diflufenzopyr alone poses little to no acute toxicity hazard to mammals via dermal and oral exposure, while Distinct® herbicide poses a slight toxicity hazard to mammals. Dicamba is considered to be slightly toxic to mammals via dermal and oral exposures. Adverse effects to small mammals have been documented from long-term dietary exposure to technical grade diflufenzopyr. Long term exposures to dicamba did not show significant mortality, reproductive, or teratogenic effects at the tested levels (up to 25 mg/kg/day). Diflufenzopyr and dicamba are considered practically non-toxic to birds. Diflufenzopyr causes slight toxicity to honeybees (*Apis* spp.), but dicamba is considered non-toxic to honeybees. For terrestrial plants, adverse effects to non-target species occurred at diflufenzopyr concentrations as low as 0.0008 lbs a.i./ac, at dicamba concentrations as low as 0.00027 lbs a.i./ac, and at Distinct® concentrations as low as 0.0043 lbs a.i./ac. Diflufenzopyr was moderately toxic to fish and aquatic invertebrates, while dicamba has only low toxicity to aquatic organisms. Diflufenzopyr was toxic to aquatic macrophytes, specifically duckweed (*Lemna gibba*), with Distinct® being more toxic than diflufenzopyr alone and dicamba being less toxic.

Ecological Risk Assessment Results

Based on the ERA conducted for Overdrive®, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM lands. Table 8-1 and the following bullets summarize the risk assessment findings for Overdrive®:

- Direct Spray – Risk to terrestrial and aquatic non-target plants may occur when plants or waterbodies are accidentally sprayed. No risks were predicted for terrestrial wildlife, fish, or aquatic invertebrates.

- Off-Site Drift – Risk to typical non-target terrestrial plant species may occur within 25 feet (ft) of ground applications. Risk to RTE terrestrial plant species may occur at the typical application rate within 25 ft of ground application with a low boom, within 100 ft of ground application with a high boom, and at the maximum application rate within 100 ft of ground application with a low or high boom. No risks were predicted for aquatic plants, fish, aquatic invertebrates, or piscivorous birds.

- Surface Runoff – Risk to RTE terrestrial plant species may occur in the base watershed with clay soils and more than 50 inches of precipitation per year and in three variations of the base watershed (silt loam, silt, or clay loam soils with 50 inches of precipitation per year). Chronic risks to aquatic plant species in the pond may occur in selected watersheds (primarily with clay or loam soils and more than 25 inches of precipitation per year, with sandy soils and more than 10 inches of precipitation per year, and in three variations of the base watershed (silt loam, silt, or clay loam soils) with 50 inches of precipitation per year. No risks to typical terrestrial plant species were predicted. Essentially no acute risks were predicted for aquatic plants in the pond, and no risks were predicted for aquatic plants in the stream, fish or invertebrates in the pond or stream, or for piscivorous birds.

- Wind Erosion and Transport Off-Site – No risks were predicted for non-target terrestrial plants under any of the evaluated conditions.

- Accidental Spill to Pond – Risk to non-target aquatic plants may occur when herbicides are spilled directly into the pond. No risks were predicted for fish or aquatic invertebrates.

In addition, species that depend on non-target plant species for habitat, cover, and/or food may be indirectly impacted by a possible reduction in terrestrial or aquatic vegetation. For example, accidental direct spray, off-site drift, and surface runoff may negatively impact terrestrial plants in riparian zones, reducing the cover available to RTE salmonids within the stream.

Based on these results, it is unlikely RTE species would be harmed by appropriate use (see following section) of the herbicide Overdrive® on BLM lands. Although non-target terrestrial and aquatic plants have the potential to be adversely affected by application of Overdrive® for the control of invasive plants, adherence to certain application guidelines (e.g., defined application rates, equipment, herbicide mixture, and downwind distance to potentially sensitive habitat) would minimize the potential effects on non-target plants and associated indirect effects on species that depend on those plants for food, habitat, and cover.

Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from the application of Overdrive®:

- Select herbicide products carefully to minimize additional impacts from degradates adjuvants, and inert ingredients. Herbicide labels provide recommendations for adjuvants and tank mixtures that must be considered. This is especially important for application scenarios that already predict potential risk from the product itself (e.g., off-site drift from high boom applications with buffer zones of less than [<] 100 ft).

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the most significant potential impacts.

- Use the typical application rate, not the maximum application rate, to reduce risk to more acceptable levels for off-site drift and surface runoff exposures.

- Establish the following buffer zones during ground applications to reduce impacts to terrestrial plants due to off-site drift:

    - Application by low boom (spray boom height set at 20 inches above the ground) and typical application rate – 100 ft from RTE terrestrial plants

    - Application by low boom and maximum application rate – 100 ft from typical species and 900 ft from RTE terrestrial plants

    - Application by high boom (spray boom height set at 50 inches above the ground) and typical or maximum application rate – 100 ft from typical species and 900 ft from RTE terrestrial plants

- To reduce potential impacts to terrestrial plants due to surface runoff, limit the use of Overdrive® within watersheds composed of clay or clay loam soils with annual precipitation greater than (>) 50 inches.

- To reduce potential chronic impacts to aquatic plants in downgradient ponds, limit the use of Overdrive® within watersheds composed of clay or loam soils with annual precipitation > 25 inches, in watersheds composed of silt-loam, silt, or clay-loam soils with annual precipitation > 50 inches, and in watersheds composed of sand soils with annual precipitation > 10 inches.

- Consider the proximity of potential application areas to salmonid habitat and the possible effects of herbicides on riparian vegetation. Buffer zones of 100 ft would protect riparian vegetation and any associated indirect effects on salmonids.

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute to the development of a Biological Assessment (BA), specifically addressing the potential impacts to proposed and listed RTE species on western BLM treatment lands. Furthermore, this ERA will inform BLM field offices on the proper application of Overdrive® to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ac	-	acres
a.i.	-	active ingredient
BA	-	Biological Assessment
BCF	-	Bioconcentration Factor
BLM	-	Bureau of Land Management
BW	-	Body Weight
°C	-	Degrees Celsius
CBI	-	Confidential Business Information
cm	-	centimeter
cms	-	cubic meters per second
CWE	-	Cumulative Watershed Effect
DPR	-	Department of Pesticide Registration
EC_{25}	-	Concentration causing 25% inhibition of a process (Effect Concentration)
EC_{50}	-	Concentration causing 50% inhibition of a process (Median Effective Concentration)
EEC	-	Estimated Exposure Concentration
EIS	-	Environmental Impact Statement
EIIS	-	Ecological Incident Information System
EFED	-	Environmental Fate and Effects Division
ERA	-	Ecological Risk Assessment
ESA	-	Endangered Species Act
FIFRA	-	Federal Insecticide, Fungicide, and Rodenticide Act
FOIA	-	Freedom of Information Act
ft	-	feet
g	-	grams
gal	-	gallon
GLEAMS	-	Groundwater Loading Effects of Agricultural Management Systems
HHRA	-	Human Health Risk Assessment
HSDB	-	Hazardous Substances Data Bank
in	-	inch
IPM	-	Integrated Pest Management
IRIS	-	Integrated Risk Information System
ISO	-	International Organization for Standardization
IUPAC	-	International Union of Pure and Applied Chemistry
Kd	-	Partition coefficient
kg	-	kilogram
K_{oc}	-	Organic carbon-water partition coefficient
K_{ow}	-	Octanol-water partition coefficient
L	-	Liters
lb(s)	-	pound(s)
LC_{50}	-	Concentration causing 50% mortality (Median Lethal Concentration)
LD_{50}	-	Dose causing 50% mortality (Median Lethal Dose)
LOAEL	-	Lowest Observed Adverse Effect Level
LOC(s)	-	Level(s) of Concern
Log	-	Common logarithm (base 10)
m	-	meter(s)
mg	-	milligrams

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Cont.)

mg/kg	-	milligrams per kilogram
mg/L	-	milligrams per liter
mmHg	-	millimeters of mercury
MSDS	-	Material Safety Data Sheet
MW	-	Molecular Weight
NASQAN	-	National Stream Quality Accounting Network
NMFS	-	National Marine Fisheries Service
NOAA	-	National Oceanic and Atmospheric Administration
NOAEL	-	No Observed Adverse Effect Level
OPP	-	Office of Pesticide Programs
OPPTS	-	Office of Pollution Prevention and Toxic Substances
ORNL	-	Oak Ridge National Laboratory
PIP	-	Pesticide Information Project
ppm	-	parts per million
RQ	-	Risk Quotient
RTE	-	Rare, Threatened, and Endangered
RTEC	-	Registry of Toxic Effects of Chemical Substances
SDTF	-	Spray Drift Task Force
TOXNET	-	National Library of Medicines Toxicology Data Network
TP	-	Transformation Product
TRV	-	Toxicity Reference Value
TSCA	-	Toxic Substances Control Act
US	-	United States
USDA	-	United States Department of Agriculture
USDI	-	United States Department of Interior
USEPA	-	United States Environmental Protection Agency
USFWS	-	United States Fish and Wildlife Service
USLE	-	Universal Soil Loss Equation
µg	-	micrograms
>	-	greater than
<	-	less than
=	-	equal to

1.0 INTRODUCTION

The Bureau of Land Management (BLM), United States Department of Interior (USDI), is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental United States (U.S.) and Alaska. The primary objectives of the proposed program include fuels management, weed control, and fish and wildlife habitat restoration. Vegetation would be managed using five primary vegetation treatment methods - mechanical, manual, biological, chemical, and use of prescribed fire.

The BLM and its contractor, ENSR, are preparing a *Vegetation Treatments Programmatic Environmental Impact Statement* (EIS) to evaluate proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental U.S. and Alaska (ENSR 2004a). As part of the EIS, several ERAs and a *Human Health Risk Assessment* (HHRA; ENSR 2004b) were conducted on several herbicides used, or proposed for use, by the BLM. These risk assessments evaluate potential risks the environment and human health that may result from exposure to the herbicides both during and after treatment of public lands. For the ERAs, the herbicide a.i. evaluated were tebuthiuron, diuron, bromacil, chlorsulfuron, sulfometuron-methyl, diflufenzopyr, Overdrive® (a mix of dicamba and diflufenzopyr), imazapic, diquat, and fluridone. The HHRA evaluated the risks to humans from only six a.i. (sulfometuron-methyl, imazapic, diflufenzopyr, dicamba, diquat, and fluridone) because the other a.i. were already quantitatively evaluated in previous EISs (e.g., BLM 1991). The purpose of this document is to summarize results of the ERA for the herbicide Overdrive®, composed of the a.i. diflufenzopyr (21.4%) and dicamba (55.0%). This ratio of a.i. is also found in the herbicide Distinct®, which is registered for use on field corn and non-cropland sites, while Overdrive® is registered for use on non-cropland, pasture, grass hay, and rangeland sites. BLM proposes to use Overdrive® rather than Distinct® to treat land.

Updated risk assessment methods were developed for the HHRA and the ERAs and are described in a separate document, *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (hereafter referred to as the "Methods Document;" ENSR 2004c). The methods document provides, in detail, specific information and assumptions used in three models utilized for this ERA (exposure point modeling using GLEAMS, AgDRIFT®, and CALPUFF).

1.1 Objectives of the Ecological Risk Assessment

The purpose of the ERA is to evaluate the ecological risks of selected herbicides on the health and welfare of plants and animals and their habitats, including threatened and endangered species. This analysis will be used by the BLM, in conjunction with analyses of other treatment effects on plants and animals, and effects of treatments on other resources, to determine which of the proposed treatment alternatives evaluated in the EIS should be used by the BLM. The BLM Field Offices will also utilize this ERA for guidance on the proper application of herbicides to ensure that impacts to plants and animals are minimized to the extent practical when treating vegetation. The US Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries), in their preparation of a BA, will also use the information provided by the ERA to assess the potential impact of vegetation treatment actions on fish and wildlife and their critical habitats.

This ERA, which provides specific information regarding the use of the terrestrial herbicide Overdrive®, contains the following sections:

Section 1: Introduction

Section 2: BLM Herbicide Program Description – this section contains information regarding herbicide formulation, mode of action, and specific BLM herbicide use, which includes application rates and methods of dispersal. This section also contains a summary of incident reports documented with the United States Environmental Protection Agency (USEPA).

Section 3: Herbicide Toxicology, Physical-Chemical Properties, and Environmental Fate – This section contains a summary of scientific literature pertaining to the toxicology and environmental fate of Overdrive® in terrestrial and aquatic environments, and discusses how its physical-chemical properties are used in the risk assessment.

Section 4: Ecological Risk Assessment – This section describes the exposure pathways and scenarios and the assessment endpoints, including potential measured effects. It provides quantitative estimates of risks for several risk pathways and receptors.

Section 5: Sensitivity Analysis – This section describes the sensitivity of each of three models used for the ERA to specific input parameters. The importance of these conditions to exposure concentration estimates is discussed.

Section 6: Rare, Threatened, and Endangered Species (RTE) – This section identifies RTE species potentially directly and/or indirectly affected by the herbicide program. It also describes how the ERA can be used to evaluate potential risks to RTE species.

Section 7: Uncertainty in the Ecological Risk Assessment – This section describes data gaps and assumptions made during the risk assessment process and how uncertainty should be considered in interpreting results.

Section 8: Summary – This section provides a synopsis of the ecological receptor groups, application rates, and modes of exposure. This section also provides a summary of the factors that most influence exposure concentrations with general recommendations for risk reduction.

2.0 BLM HERBICIDE PROGRAM DESCRIPTION

2.1 Problem Description

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of weeds across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, noxious weeds will jeopardize the health of public lands and the myriad of activities that occur on them. The BLM's ability to respond effectively to the challenge of noxious weeds depends on the adequacy of the agency's resources.

Millions of acres of once healthy, productive rangelands, forestlands, and riparian areas have been overrun by noxious or invasive weeds. Noxious weeds are any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property (Sheley et al. 1999). Invasive plants include not only noxious weeds, but also other plants that are not native to the region. The BLM considers plants invasive if they have been introduced into an environment where they did not evolve. Invasive plants usually have no natural enemies to limit their reproduction and spread (Westbrooks 1998). They invade recreation areas, BLM-managed public lands, National Parks, State Parks, roadsides, streambanks, federal, state, and private lands. Invasive weeds can:

- destroy wildlife habitat, reduce opportunities for hunting, fishing, camping and other recreational activities;
- displace RTE species and other species critical to ecosystem functioning (e..g, riparian plants);
- reduce plant and animal diversity;
- invade following wildland and prescribed fire (potentially into previously unaffected areas), limiting regeneration and establishment of native species and rapidly increasing acreage of infested land;
- increase fuel loads and decrease the length of fire cycles and/or increase the intensity of fires;
- disrupt waterfowl and neo-tropical migratory bird flight patterns and nesting habitats; and
- cost millions of dollars in treatment and loss of productivity to private land owners.

The BLM uses an Integrated Pest Management (IPM) approach to control invasive plants. Management technologies include biological, mechanical, chemical, and cultural techniques. Many herbicides are currently used by the BLM under their chemical control program. This report considers the impact to ecological receptors (animals and plants) from the proposed use of the herbicide Overdrive® (a.i. diflufenzopyr and dicamba) for the control of weeds on BLM lands.

2.2 Herbicide Description

The herbicide-specific use-criteria discussed in this document were obtained from the product label as registered with the USEPA as it applies to BLM use. Overdrive® application rates and methods discussed in this section are based on proposed -BLM herbicide use and on requirements for herbicide use specified in relevant product labels approved by the USEPA. The BLM should be aware of all state specific and label requirements and restrictions. In addition, new USEPA approved herbicide labels may have been issued after publication of this report and BLM land managers should be aware of all newly approved federal, state, and local restrictions on herbicide use when planning vegetation management programs.

Overdrive® is a selective systematic herbicide for the control of broad-leaf weeds pre- or post-emergence. Diflufenzopyr inhibits the transport of auxin (a hormone that regulates plant growth and development), and dicamba functions as a synthetic auxin. When used together, these chemicals disrupt plant hormone balance and protein synthesis (Retzinger and Mallory-Smith 1997). Overdrive® is formulated as a wettable granular formulation, which can be applied using water as the carrier.

Overdrive® is used by the BLM for vegetation control in their Rangeland, Energy and Mineral Sites, Rights-of-Way and Recreation programs. It is rarely, if ever, used near estuarine or marine habitats. The majority of the land treated by BLM with herbicides is inland. Ground applications are executed though backpack, horseback, and all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The BLM typically applies Overdrive® at 0.2625 lbs a.i./ac, with a maximum single use rate of 0.4375 lbs a.i./ac. Details regarding expected Overdrive® usage by BLM are provided in Table 2-1 at the end of this section.

2.3 Herbicide Incident Reports

An "ecological incident" occurs when non-target flora or fauna is killed or damaged due to application of a pesticide. When ecological incidents are reported to a state agency or other proper authority, they are investigated and an ecological incident report is generated. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires product registrants to report adverse effects of their product to the USEPA.

The USEPA OPP manages a database, the EIIS, which contains much of the information in the ecological incident reports. As part of this risk assessment, the USEPA was requested to provide all available incident reports in the EIIS that listed diflufenzopyr or dicamba as a potential source of the observed ecological damage. The EIIS generally lists incidents by a.i. and not by product name. Therefore, specific data for Overdrive® was not identified.

The USEPA EIIS contained one incident report involving diflufenzopyr. Damage to corn plants was reported after these plants were treated with a multiple pesticide mixture. The incident report indicated that with such a variety of products applied (atrazine, chlorpyrifos, dicamba, 2,4-D, and diflufenzopyr) it is possible that all played a role in the observed crop damage.

The USEPA EIIS contained 99 incident reports involving dicamba and 23 incident reports involving dicamba with 2,4-D (Table 2-2). Of the 99 incident reports involving dicamba, 66 listed dicamba as the 'probable' cause and one listed dicamba as the 'highly probable' cause of the incident. Most of these incidents involved plant damage to crops (e.g., beans, corn, soybeans) and grasses that occurred during the routine use or accidental misuse of a dicamba-based herbicide. None of these incidents occurred on BLM-managed land

TABLE 2-1
BLM Overdrive® Use Statistics

Program	Scenario	Vehicle	Method	Used?	Diflufenzopyr Component		Dicamba Component		Diflufenzopyr + Dicamba Components	
					Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)	Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)	Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)
Rangeland	Aerial	Plane	Fixed Wing	No						
		Helicopter	Rotary	No						
	Ground	Human	Backpack	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
			Horseback	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
		ATV	Spot	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
			Boom/Broadcast	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
		Truck	Spot	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
			Boom/Broadcast	Yes	0.075	0.1	0.1875	0.25	0.2625	0.35
Public-Domain Forest Land	Aerial	Plane	Fixed Wing	No						
		Helicopter	Rotary	No						
	Ground	Human	Backpack	No						
			Horseback	No						
		ATV	Spot	No						
			Boom/Broadcast	No						
		Truck	Spot	No						
			Boom/Broadcast	No						
Oil & Gas Sites	Aerial	Plane	Fixed Wing	No						
		Helicopter	Rotary	No						
	Ground	Human	Backpack	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Horseback	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		ATV	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		Truck	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
Rights-of-Way	Aerial	Plane	Fixed Wing	No						
		Helicopter	Rotary	No						
	Ground	Human	Backpack	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Horseback	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		ATV	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		Truck	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
Recreation	Aerial	Plane	Fixed Wing	No						
		Helicopter	Rotary	No						
	Ground	Human	Backpack	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Horseback	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		ATV	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
		Truck	Spot	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
			Boom/Broadcast	Yes	0.075	0.125	0.1875	0.3125	0.2625	0.4375
Aquatic				No						

TABLE 2-2
Dicamba Ecological Incidents

Year	Application Area	Incident Type	Dicamba Certainty	Common Name	Exposure/ Dispersal Method	Organism	Distance From Application	Magnitude of Damage
1992	Around Paddock	Misuse (Accidental)	Unlikely	1	Drift	Forage/Hay	Vicinity	NA
1998	Agricultural Area	Registered Use	Possible	1	Drift	Vegetables	Vicinity	NA
1999	Agricultural Area	Misuse (Accidental)	Probable	2	Drift	Grape	20 Yards	1 Acre
1999	Agricultural Area	Misuse (Accidental)	Probable	2	Drift	Grape	20 Yards	1 Acre
1999	Agricultural Area	Misuse (Accidental)	Probable	2	Drift	Almond	30 Yards	2 Acres
1997	Bean	Misuse (Accidental)	Probable	1	Treated Directly	Beans	0	Not Given
2003	Conservation Reserve	Undetermined	Possible	4	Drift, Spray	Cotton	Vicinity	75% of 120 Acres
NA	Corn	Registered Use	Possible	6	Treated Directly	Corn	0	150 Acres
1991	Corn	Misuse	Possible	2	Drift, Spray	Ornamental	0	NA
1993	Corn	Registered Use	Possible	4	Treated Directly	Corn	0	399 Acres
1999	Corn	Registered Use	Possible	1	Drift	Soybean	20 Yards	All 40 Acres
1999	Corn	Registered Use	Possible	1	Drift	Soybean	10 Yards	All 15 Acres
1999	Corn	Misuse (Accidental)	Probable	2	Drift	Bean	20 Yards	NA
1999	Corn	Misuse (Accidental)	Probable	2	Drift	Bean	25 Yards	80 Acres
1999	Corn	Misuse (Accidental)	Possible	2	Drift	Soybean	30 Yards	50% of 80 Acres
1999	Corn	Misuse (Accidental)	Possible	1	Drift	Soybean	50 Yards	50% of 135 Acres
1999	Corn	Misuse (Accidental)	Unlikely	1	NA	Soybean	10 Yards	10 Acres
1999	Corn	Registered Use	Unlikely	2	Treated Directly	Corn	0	All 750 Acres
1999	Corn	Registered Use	Possible	1	Drift	Soybean	20 Yards	NA
2000	Corn	Undetermined	Possible	4	Treated Directly	Corn	0	All 56 Acres
2000	NA	Undetermined	Possible	2	Treated Directly	Corn	0	99 of 159 Acres
2001	Corn	Registered Use	Possible	5	Treated Directly	Corn	0	246 Acres
2001	Corn, Field	Undetermined	Possible	2	Treated Directly	Corn	0	140 Acres
2001	Corn, Field	Undetermined	Probable	2	Treated Directly	Corn, Field	0	174 Acres
2003	Corn, Field	Registered Use	Probable	5	Treated Directly	Corn, Field	0	130 of 228 Acres
1992	Corn/Soybean	Undetermined	Unlikely	4	Carryover	Corn	On Site	350 Acres
2001	Fence Row	Registered Use	Possible	4	Drift	White Pine	Vicinity	6 Acres
1999	Hay	Registered Use	Probable	6	Treated Directly	Hay	0	133 Acres
1994	Home/Lawn	Registered Use	Probable	4	NA	Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Lawn Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Lawn Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Lawn Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Lawn Grass	Vicinity	NA
1994	Home/Lawn	Registered Use	Probable	4	NA	Lawn Grass	Vicinity	NA
1998	Home/Lawn	Undetermined	Possible	4	Treated Directly	Grass	0	NA
1998	Home/Lawn	Undetermined	Possible	4	Treated Directly	Grass	0	Lawn
1999	Home/Lawn	Registered Use	Probable	1	NA	Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	1	Treated Directly	Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	4	Treated Directly	St. Augustine Grass	0	75% of Lawn
1999	Home/Lawn	Registered Use	Possible	4	Treated Directly	Grass	0	Unknown
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	300 Sq Ft
1999	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	1	Treated Directly	Grass	0	NA
1999	Home/Lawn	Misuse (Accidental)	Probable	1	Treated Directly	Blue Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	NA

TABLE 2-2 (Cont.)
Dicamba Ecological Incidents

Year	Application Area	Incident Type	Dicamba Certainty	Common Name	Exposure/ Dispersal Method	Organism	Distance From Application	Magnitude of Damage
1999	Home/Lawn	Misuse (Accidental)	Highly Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Misuse (Accidental)	Highly Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Misuse (Accidental)	Probable	4	Treated Directly	Grass	0	All Spots Treated
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	Unknown
1999	Home/Lawn	Undetermined	Probable	4	Treated Directly	St. Augustin Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	Unknown
1999	Home/Lawn	Misuse (Accidental)	Probable	4	Drift	Azales	2 To 3 Feet	Unknown
1999	Home/Lawn	Misuse (Accidental)	Probable	4	Treated Directly	Grass	0	NA
1999	Home/Lawn	Registered Use	Probable	1	Treated Directly	Grass	0	75% of Lawn
1999	Home/Lawn	Misuse (Accidental)	Probable	4	Drift	Roses	2 Feet	Unknown
1999	Home/Lawn	Undetermined	Probable	1	Treated Directly	Grass	0	80% of Lawn
1999	Home/Lawn	Undetermined	Probable	1	Treated Directly	Grass	0	50% of Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	60% of Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	50 to 60% of Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	80% of Lawn
2000	Home/Lawn	Registered Use	Possible	4	Treated Directly	Grass	0	Unknown
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	Where Applied
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	95% of Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	Unknown
2000	Home/Lawn	Undetermined	Possible	4	Treated Directly	Grass	0	Unknown
2000	Home/Lawn	Undetermined	Probable	4	Treated Directly	Grass	0	90% of Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	80% of The Lawn
2000	Home/Lawn	Registered Use	Probable	4	Treated Directly	Grass	0	50% of Lawn
2000	Home/Lawn	Misuse (Accidental)	Probable	4	Treated Directly	Grass	0	Lawn
2000	Home/Lawn	Misuse (Accidental)	Probable	1	Treated Directly	Bluegrass	0	85% of Lawn
2000	Home/Lawn	Misuse (Accidental)	Probable	1	Treated Directly	Bluegrass	0	60-70% Dead
1999	Home/Tree	Registered Use	Probable	1	Treated Directly	Grass	0	NA
1990	NA	Misuse (Accidental)	Possible	2	Drift	Garden	NA	NA
1992	NA	Undetermined	Probable	1	NA	Prunes	NA	Not Given
1992	NA	Undetermined	Possible	2	Drift	Dogwood	Vicinity	Not Given
1992	NA	Undetermined	Probable	2	NA	Grape	NA	Not Given
1997	NA	Undetermined	Possible	1	Drift	Raspberry	Adjacent	NA
2000	NA	Undetermined	Unlikely	3	NA	Soybean	NA	75.9% of 830 Acres
2000	NA	Undetermined	Possible	2	Carryover	Sunflower	On Site	All 65 Acres
2000	NA	Registered Use	Probable	2	Carryover	Sunflower	On Site	All 118 Acres
2000	NA	Misuse (Accidental)	Possible	2	Drift	Soybean	NA	94% of The Crop
2001	NA	Undetermined	Probable	6	Drift	Soybeans	Vicinity	40 Acres
2001	NA	Misuse	Probable	6	Drift	Soybean	NA	110 Acres
2002	NA	Undetermined	Possible	6	Carryover	Sugar Beets	On Site	120 Acres
2002	NA	Misuse	Probable	6	Carryover	Sorghum	On Site	68 Acres
2002	NA	Misuse	Probable	6	Drift	Soybean	NA	112 Acres
2002	NA	Undetermined	Probable	6	Carryover	Sugar Beet	On Site	36 Acres
2002	NA	Undetermined	Probable	6	Drift	Soybean	Vicinity	40 Acres
2002	NA	Undetermined	Probable	6	Drift	Soybean	Vicinity	30 Acres
2002	NA	Misuse	Probable	6	Drift	Soybean	NA	65 Acres
2002	NA	Misuse	Probable	6	Drift	Soybean	NA	480 Acres
2002	NA	Misuse	Probable	6	Drift	Soybean	NA	160 Acres
1994	Ornamental	Undetermined	Probable	2	Drift	Ornamental	Vicinity	NA

TABLE 2-2 (Cont.)
Dicamba Ecological Incidents

Year	Application Area	Incident Type	Dicamba Certainty	Common Name	Exposure/ Dispersal Method	Organism	Distance From Application	Magnitude of Damage
1997	Rangeland	Registered Use	Probable	1	Drift, Spray	Cheery Tree	Vicinity	Unknown
1997	Rangeland	Registered Use	Probable	1	Drift, Spray	Ornamental	Vicinity	Not Given
1997	Right-of-Way	Registered Use	Probable	1	Drift, Spray	Beans	Vicinity	Not Given
1998	Right-of-Way	Registered Use	Probable	1	Drift	Trees	0	36 of 55 Trees
1999	Right-of-Way, Road	Misuse	Possible	1	Treated Directly	Pine Trees	0	Unknown
1998	Soybean	Misuse (Accidental)	Probable	3	Treated Directly	Soybean	0	124 Acres
2000	Soybean	Misuse (Accidental)	Possible	2	Treated Directly	Soybean	0	2/3 of 20-Acre Crop
2000	Soybean	Registered Use	Possible	2	Treated Directly	Soybeans	0	All 160 Acres
2003	Soybeans	Misuse	Probable	6	Treated Directly	Soybeans	0	300 Acres
2003	Sugar Beets	Misuse	Probable	6	Treated Directly	Sugar Beets	0	43 Acres
1992	Timothy Field	Registered Use	Possible	2	Drift, Spray	Caragans Plants	Vicinity	Not Given
2000	Turf, Residential	Registered Use	Possible	1	Treated Directly	Grass	0	2/3 Damaged
2000	Turf, Residential	Registered Use	Probable	1	Treated Directly	Grass	0	70%
2000	Turf, Residential	Registered Use	Possible	1	Treated Directly	Grass	0	Unknown
2000	Turf, Residential	Misuse (Accidental)	Possible	1	Treated Directly	Grass	0	75%
2000	Turf, Residential	Registered Use	Possible	1	Treated Directly	Grass	0	60%
1998	Wheat	Registered Use	Possible	1	Drift	Tree	Vicinity	Not Given
1998	Wheat	Registered Use	NA	1	Drift, Spray	Locus Trees	Vicinity	Not Given
2000	Agricultural Area	Undetermined	Possible	1	Drift	Perch	Vicinity	2000 Killed
1994	Athletic Fields	Undetermined	Possible	4	Runoff	Fish	Vicinity	Unknown
1992	Golf Course	Registered Use	Possible	2	Runoff	Bream	Vicinity	NA
2000	Home/Lawn	Undetermined	Possible	2	Runoff	Koi	Adjacent	2 Killed
1998	Turf, Residential	Registered Use	Possible	1	Runoff	None Given	Vicinity	2-Mile Stretch
1992	Around Paddock	Misuse (Accidental)	Unlikely	1	Drift	Forage/Hay	Vicinity	NA

NA = information not available in database

<u>Common names</u>
1 - Dicamba
2 - Dicamba with 2,4-D
3 - Dicamba, Diglycoamine Salt
4 - Dicamba, Dimethylamine Salt
5 - Dicamba, Potassium Salt
6 - Dicamba, Sodium Salt

3.0 HERBICIDE TOXICOLOGY, PHYSICAL-CHEMICAL PROPERTIES, AND ENVIRONMENTAL FATE

This section summarizes available herbicide toxicology information, describes how the information was obtained, and provides a basis for the LOC values selected for this risk assessment. Dicamba and diflufenzopyr physical-chemical properties and environmental fate are also discussed.

3.1 Herbicide Toxicology

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for dicamba, diflufenzopyr, and/or Overdrive® to negatively affect the environment and to derive TRVs for use in the ERA (provided in italics in sections 3.1.2 and 3.1.3). The process for the literature review and the TRV derivation is provided in the Methods Document (ENSR 2004c). This review generally included a review of published manuscripts and registration documents, information obtained through a Freedom of Information Act (FOIA) request to EPA, electronic databases (e.g., EPA pesticide ecotoxicology database, EPA's on-line ECOTOX database), and other internet sources. This review included both freshwater and marine/estuarine data, although the focus of the review was on the freshwater habitats more likely to occur on BLM lands.

Endpoints for aquatic receptors and terrestrial plants were reported based on exposure concentrations (milligrams/Liter [mg/L] and lbs/ac, respectively). Dose-based endpoints (e.g., LD_{50}s) were used for birds and mammals. When possible, dose-based endpoints were obtained directly from the literature. When dosages were not reported, dietary concentration data were converted to dose-based values (e.g., LC_{50} to LD_{50}) following the methodology recommended in USEPA risk assessment guidelines (Sample et al. 1996). Acute TRVs were derived first to provide an upper boundary for the remaining TRVs; chronic TRVs were always equivalent to, or less than, the acute TRV. The chronic TRV was established as the highest NOAEL value that was less than both the chronic lowest observed adverse effect level (LOAEL) and the acute TRV. When acute or chronic toxicity data was unavailable, TRVs were extrapolated from other relevant data using an uncertainty factor of 3, as described in the Methods Document (ENSR 2004c).

This section reviews the available information identified for dicamba, diflufenzopyr, and/or Overdrive® and presents the TRVs selected for this risk assessment (Tables 3-1 to 3-3). Appendix A presents a summary of the dicamba, diflufenzopyr, and Overdrive® data identified during the literature review. Section 4.2.2 describes how the TRVs were used in the ERA. Toxicity data is presented in the units presented in the reviewed study. In most cases this applies to the a.i. (e.g., dicamba and diflufenzopyr); however, some data corresponds to a specific product (e.g., Overdrive®) containing the a.i. under consideration, and potentially other ingredients (e.g., other a.i. or inert ingredients). This topic, and others related to the availability of toxicity data, is discussed in Section 7.1 of the Uncertainty section. The review of the toxicity data did not focus on the potential toxic effects of inert ingredients (inerts), adjuvants, surfactants, and degradates. Section 7.3 of the Uncertainty section discusses the potential impacts of these constituents in a qualitative manner.

Because Overdrive® is a recently approved herbicide; no Overdrive® toxicity data were identified. However, the herbicide Distinct® contains the same ratio of dicamba and diflufenzopyr, and several Distinct® studies were identified in the literature review. Therefore, the Distinct® toxicity data were used to identify the TRVs for Overdrive® in this risk assessment.

3.1.1 Overview

According to USEPA ecotoxicity classifications presented in registration materials[1], diflufenzopyr poses little to no acute toxicity hazard to mammals via dermal and oral exposure, while Distinct® herbicide poses a slight toxicity hazard to mammals. Dicamba is considered to be slightly toxic to mammals via dermal and oral exposures. Adverse effects to small mammals have been documented from long-term dietary exposure to technical grade diflufenzopyr. Long term exposures to dicamba did not show significant mortality, reproductive, or teratogenic effects at the tested levels (up to 25 mg/kg/day).

Diflufenzopyr and dicamba are considered practically non-toxic to birds. Diflufenzopyr causes slight toxicity to honeybees, but dicamba is considered non-toxic to honeybees. For terrestrial plants, adverse effects to non-target species occurred at diflufenzopyr concentrations as low as 0.0008 lb a.i./ac, at dicamba concentrations as low as 0.00027 lb a.i./ac, and at Distinct® concentrations as low as 0.0043 lb/ac.

Diflufenzopyr is moderately toxic to fish and aquatic invertebrates, while dicamba has only low toxicity to aquatic organisms. Diflufenzopyr was toxic to aquatic macrophytes, specifically duckweed, with Distinct® being more toxic than diflufenzopyr alone and dicamba being less toxic.

3.1.2 Toxicity to Terrestrial Organisms

3.1.2.1 Mammals

Dermal acute exposure studies with small mammals reported adverse effect concentrations (measured as the death of 50 percent of the test organisms, i.e., the LC_{50} value) to rabbits (*Leporidae* spp) from a 96.4% diflufenzopyr product or Distinct® in excess of 5,000 mg/kilogram (kg) body weight (BW) (USEPA 1999). The rabbit dermal LD_{50} value for dicamba was in excess of 5,050 mg/kg BW using a test product that was 21.06% dicamba (Kuhn 1998, MRID 44524404).

The dermal small mammal TRVs were established at >5,000 mg/kg BW for diflufenzopyr and Distinct®, and >5,050 mg/kg BW for dicamba.

Acute oral toxicity, measured as the LD_{50} value, was affected by the herbicide formulation. Technical-grade diflufenzopyr (99% a.i.) administered to rats (*Rattus norvegicus* spp.) in a single oral gavage resulted in an LD_{50} value of >5,000 mg/kg BW (USEPA 1999). When administered to rats as the manufacturing use product (a sodium salt; 93% a.i.), the diflufenzopyr LD_{50} was 3,300 mg/kg BW (USEPA 1999).

The dietary small mammal diflufenzopyr TRV based on the oral LD_{50} was 3,300 mg/kg BW for diflufenzopyr.

The dicamba acute oral toxicity LD_{50} value was 566 mg/kg BW in female mice using the sodium salt of dicamba (Edson and Sanderson 1965).

The dietary small mammal TRV based on the oral LD_{50} was 566 mg./kg BW for dicamba.

When administered as Distinct®, the LD_{50} value in rats was 1,600 mg/kg BW (USEPA 1999).

The dietary small mammal TRV based on the oral LD_{50} was 1,600 mg/kg BW for Distinct®.

Long-term dietary toxicity in small mammals was evaluated in several studies. In rats, a 2-generation study evaluated dietary exposure to technical diflufenzopyr. Dietary concentrations of 2,000 parts per million (ppm) diflufenzopyr (equivalent to 113.1 to 175.9 mg/kg BW-day) resulted in BW gains, increased food consumption, and increased

[1]Available at http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm#Ecotox

seminal vesicle weights (USEPA 1999). No adverse effects were observed at concentrations of 500 ppm diflufenzopyr (equivalent to 27.3 to 42.2 mg/kg BW-day) using 98.1% technical grade diflufenzopyr.

Based on the NOAEL, the chronic dietary small mammal TRV was established at 42.2 mg/kg BW-day for diflufenzopyr.

Oral dosing of female rabbits with technical dicamba during pregnancy resulted in adverse effects at concentrations as low as 10 mg/kg BW-day using 87.7% technical grade dicamba (Wazeter et al. 1977). In similar studies with the same tested product, no adverse effects were demonstrated in rabbits at concentrations of 3 mg/kg BW-day (Wazeter et al. 1977).

Based on these findings, the chronic dietary small mammal TRV was established at 3 mg/kg BW-day for dicamba.

No small mammal chronic studies were reported for Distinct® or Overdrive®, and therefore, no TRV could be developed.

Toxicity data for large mammals were more limited, but results were relatively comparable to those for small mammals. Diflufenzopyr chronic dietary exposure was evaluated in two chronic studies. In a one-year feeding trial using 98% diflufenzopyr, beagle dogs (*Canis familiaris*) exhibited changes in bone marrow and liver when fed dietary concentrations of 7,500 ppm (equivalent to 299 to 301 mg/kg BW-day), but no adverse effects occurred at 750 ppm (equivalent to 26 to 28 mg/kg BW-day) (USEPA 1999). In a 13-week feeding trial, similar adverse effects to the liver and bone marrow were seen in beagle dogs fed 10,000 ppm (equivalent to 403 to 423 mg/kg BW-day). No adverse effects occurred at 1,500 ppm diflufenzopyr (equivalent to 58 to 59 mg/kg BW-day) (USEPA 1999).

Because no large mammal LD_{50}s for diflufenzopyr, dicamba, or Distinct® were identified in the available literature, the small mammal LD_{50} were used as surrogate values. In addition, no large mammal chronic toxicity data were identified for Distinct® or Overdrive®, and consequently no TRV could be developed. Based on the available data, the large mammal dietary NOAEL TRV for diflufenzopyr was established at 59 mg/kg BW-day.

Dicamba chronic dietary exposure was evaluated using 90% dicamba in a two-year feeding trial with beagle dogs, where BW gain was reduced at doses of 0.75 mg/kg BW-day for males and 1.5 mg/kg BW-day for females (Davis et al. 1962; MRID 00028248). The systemic NOAEL values reported from these studies were 0.15 mg/kg BW-day for males and 0.75 mg/kg BW-day for females.

Based on these findings, the chronic large mammal dietary TRV was established at 0.15 mg/kg BW-day for dicamba.

3.1.2.2 Birds

Data from the available literature indicate that diflufenzopyr has low toxicity to birds. Similarly, dicamba is also classified as practically non-toxic to birds. TRVs were developed for both large and small birds, generally using mallard (*Anas platyrhynchos*) and quail data, respectively. When available, chronic studies were used to select the NOAEL-based TRV.

In a 14-day oral exposure, the LD_{50} was determined to be > 2,250 mg/kg BW-day following oral administration of diflufenzopyr to bobwhite quail (*Colinus virginianus*; USEPA 2003; MRID 44170132). Birds exposed to acute dietary concentrations of diflufenzopyr (containing 94.7% a.i.) for 8 days experienced no adverse effects, even at the highest dietary concentration tested, 5,620 ppm (equivalent to acute LD_{50} doses of >3,394 and >562 mg/kg BW-day for bobwhite quail and mallards, respectively) (USEPA 2003; MRID 44170131). In this dietary test, the test organisms were presented with the dosed food for 5 days, with 3 days of additional observations after the dosed food was removed. The endpoint reported for this assay is generally an LC_{50} representing mg/kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c). Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test. This resulted in LD_{50} values of >16,970 mg/kg BW and >2,810 mg/kg BW for the bobwhite quail and mallard, respectively.

The diflufenzopyr acute small bird dietary LD_{50} TRV was set at >16,970 mg/kg BW based on the bobwhite quail, and the acute large bird dietary LD_{50} TRV was set at >2,810 mg/kg BW.

Long-term exposure to 94.3% diflufenzopyr failed to elicit adverse effects in birds. After 21 weeks, no adverse effects were observed in mallards fed 1,050 ppm, equivalent to a dose of 105 mg/kg BW-day (USEPA 2003; MRID 45310903). In bobwhite quail, dietary exposure for 20 weeks failed to cause adverse effects at dietary concentrations of 1,050 ppm, equivalent to a dose level of 634 mg/kg BW-day (USEPA 2003; MRID 45310902).

The diflufenzopyr chronic small bird dietary NOAEL was set at 634 mg/kg BW-day, based on the bobwhite quail, and the large bird NOAEL was set at 105 mg/kg BW-day, based on the mallard.

In a 14-day oral exposure, no adverse effects were observed at 15.6 mg/kg BW-day following oral administration of 86.9% dicamba to bobwhite quail (USEPA 2003; MRID 42918001). The LD_{50} associated with this study was 216 mg/kg BW-day dicamba. In a similar 14-day oral exposure with chickens, the LD_{50} was 306 mg a.i./kg BW-day (Roberts et al. 1983). Mallard ducks exposed to dicamba for 14 days showed a NOAEL of <175 mg/kg BW-day using an 86.9% dicamba product (USEPA 2003; MRID 42774106). Birds exposed to acute dietary concentrations of 22% dicamba (as the sodium salt) for 8 days experienced no adverse effects, even at the highest dietary concentration tested, 10,000 ppm (equivalent to acute LD_{50} doses of >6,038 and >1,000 mg/kg BW-day for bobwhite quail and mallards, respectively) (USEPA 2003; MRID 00025328 and MRID 00030102). In this dietary test, the test organisms were presented with the dosed food for 5 days, with 3 days of additional observations after the dosed food was removed. The endpoint reported for this assay is generally an LC_{50} representing mg/kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c). Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test. This resulted in LD_{50} values of >30,190 mg/kg BW and >5,000 mg/kg BW for the bobwhite quail and mallard, respectively.

The dicamba acute small bird dietary LD_{50} was set at >30,190 mg/kg BW, based on the bobwhite quail, and the large bird LD_{50} was set at >5,000 mg/kg BW, based on the mallard.

Long-term exposure of birds to dicamba was also evaluated. After 21 weeks of exposure to an 86.9% dicamba product, adverse reproductive effects were observed in mallards fed 1,600 ppm, equivalent to a dose of 184 mg/kg BW-day, with no effects observed at 800 ppm, equivalent to a dose of 92 mg/kg BW-day (USEPA 2003; MRID 43814003). In a similar study using the same product with bobwhite quail, dietary exposure for 21 weeks failed to cause adverse effects at dietary concentrations of 1,600 ppm, equivalent to a dose level of 170 mg/kg BW-day (USEPA 2003; MRID 43814004).

The dicamba chronic small bird dietary NOAEL was set at 170 mg/kg BW-day, based on the bobwhite quail, and the large bird NOAEL was set at 92 mg/kg BW-day, based on the mallard.

Only one acute study was identified for Distinct®. In an 8-day oral exposure, no adverse effects were observed at 6,080 ppm (equivalent to an acute LD_{50} dose of >3,672 mg/kg BW-day) following oral administration of Distinct® to bobwhite quail (USEPA 2003; MRID 45040202). As described previously, in this dietary test, the test organisms were presented with the dosed food for 5 days, with 3 days of additional observations after the dosed food was removed. The endpoint reported for this assay is generally an LC_{50} representing mg/kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c). Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test. This resulted in an LD_{50} value of >18,360 mg/kg BW for the bobwhite quail.

The Distinct® acute small bird dietary LD_{50} was set at >18,360 mg/kg BW, based on the bobwhite quail. Because no chronic data were available, the 8-day NOAEL, 3,672 mg/kg BW-day, was used as the small bird NOAEL TRV. Due to a lack of additional data, no large bird TRVs were derived.

3.1.2.3 Terrestrial Invertebrates

A standard acute contact toxicity bioassay in honeybees is required for the USEPA pesticide registration process. In this study, the a.i. was directly applied to the bee's thorax and mortality was assessed during a 48-hr period. No honeybee data were identified for Distinct® or Overdrive®.

The data review identified an LD_{50} value of >25 micrograms (μg)/bee for 99.5% diflufenzopyr, with a no effect level of 25 μg/bee (USEPA 2003; MRID 44307428).

Because a suitable LD_{50} for diflufenzopyr could not be determined from the literature, the NOAEL was multiplied by an uncertainty factor of 3. The resulting honeybee dermal LD_{50} for diflufenzopyr was calculated to be 75 μg/bee. Based on a honeybee weight of 0.093 g., this TRV was expressed as 806 mg/kg BW. The uncertainty factor was selected based on a review of the application of uncertainty factors (Chapman et al. 1998), and the use of uncertainty factors for this assessment is described in the Methods Document (ENSR 2004c).

For dicamba, the 48 hour dermal LD_{50} value was >90.65 μg/bee. The no effect level was unclear, but < 90.65 μg/bee (USEPA 2003; MRID 00036935).

Because the NOAEL for dicamba was unclear, it was not used to estimate an alternative LD_{50}. The >90.65 μg/bee LD_{50},, expressed as 974 mg/kg BW, was conservatively used as the honeybee TRV.

3.1.2.4 Terrestrial Plants

Toxicity tests were conducted on numerous, non-target plant species. As no studies evaluating germination were found in the available literature, seed emergence assays were used in place of the germination endpoints for surface runoff TRVs. Seed emergence studies were conducted by applying the herbicide to soil containing newly sown seed. Endpoints in the terrestrial plant toxicity tests were generally related to seed germination, seed emergence, and sub-lethal (i.e. growth) impacts observed during vegetative vigor assays.

The diflufenzopyr effect concentrations (EC_{25}) for all endpoints ranged from 0.0008 lb a.i./ac for seed emergence in turnips (*Brassica rapa*; USEPA 1999) to 0.38 lb a.i./ac for vegetative vigor in ryegrass (*Lolium* spp.; USEPA 2003; MRID 45047301). No-effect concentrations for all endpoints ranged from 0.0001 lb a.i./ac for emergence in turnips (USEPA 2003; MRID 44307421) to 0.248 lb a.i./ac for vegetative vigor in ryegrass (USEPA 2003; MRID 45047301). The highest emergence-based no-effect concentration was 0.028 lb a.i./ac in tomatoes (*Lycopersicon esculentum*; USEPA 2003; MRID 44307421).

Because germination data were unavailable, the lowest and highest emergence-based NOAELs were selected to evaluate risk in surface runoff scenarios of the risk assessment. These diflufenzopyr TRVs were 0.0001 and 0.028 lb a.i./ac.

Two additional endpoints were used to evaluate other plant scenarios. These included an EC_{25} of 0.00027 lb a.i./ac and a NOAEL of 0.00009 lb a.i./ac (extrapolated from the EC_{25} by dividing by an uncertainty factor of 3).

Terrestrial plant toxicity testing for dicamba was conducted with either technical grade dicamba (with no % a.i. information provided) or an 89.5% dicamba acid product. The dicamba EC_{25}s for all endpoints ranged from 0.00027 lb a.i./ac for seed emergence in soybeans (Hoberg 1993; MRID 43538501) to >3.9 lb a.i./ac for vegetative vigor in corn (USEPA 2003; MRID 42846301). No-effect concentrations for all endpoints ranged from <0.0022 lb a.i./ac for emergence in soybeans (estimated value based on tomato EC_{25} to NOAEL ratios; Hoberg 1993; MRID 43538501) to 3.9 lb a.i./ac for vegetative vigor in corn (USEPA 2003; MRID 42846301). The highest emergence-based no-effect concentration was 0.53 lb a.i./ac in cabbage (*Brassica oleracea*; USEPA 2003; MRID 42846301).

Because germination data were unavailable, the lowest and highest emergence-based NOAELs were selected to evaluate risk in surface runoff scenarios of the risk assessment. These dicamba TRVs were <0.0022 and 0.53 lb a.i./ac. To evaluate other plant scenarios, two additional endpoints were used. These included the lowest dicamba

EC_{25} of 0.00027 lb a.i./ac and the highest NOAEL that was still below the selected $EC_{2.5}$. The only NOAEL that met this criteria was the <0.0022 lb a.i./ac germination value.

Using the Distinct® herbicide formulation, the EC_{25}s for all endpoints ranged from 0.0043 lb/ac for seed emergence in turnips (Health Canada 1999; USEPA 2003; MRID 44307452) to 0.37 lb/ac for shoot weight in ryegrass (USEPA 2003; MRID 45047301). No-effect concentrations for all endpoints ranged from 0.0016 lb/ac for emergence in cucumbers (*Cucumis sativus*; USEPA 2003; MRID 44307452) to 0.24 lb/ac for shoot weight in a 21 day vegetative vigor assay using ryegrass (USEPA 2003; MRID 45047301). The highest emergence-based no-effect concentration was 0.046 lb/ac in oats (USEPA 2003; MRID 44307452).

Because germination data were unavailable, the lowest and highest emergence-based NOAELs were selected to evaluate risk in surface runoff scenarios of the risk assessment. These Distinct® TRVs were 0.0016 and 0.046 lb/ac. To evaluate other plant scenarios, two additional endpoints were used. These included the lowest Distinct® EC_{25} of 0.0043 lb/ac and the highest NOAEL that was still below the selected EC_{25} of 0.004 lb./ac for vegetative vigor in tomatoes (USEPA 2003; MRID 45047301).

3.1.3 Toxicity to Aquatic Organisms

3.1.3.1 Fish

The toxicity of diflufenzopyr and dicamba to freshwater fish was evaluated by testing both cold- and warmwater fish species. The lower of the cold- and warmwater fish endpoints was selected as the TRVs for fish. No fish toxicity tests were identified for Distinct® or Overdrive®.

A rainbow trout (*Oncorhynchus mykiss*; coldwater species) study with 94.7% diflufenzopyr resulted in a 96-hour LC_{50} of 106 mg/L, with no adverse effects occurring at 80 mg/L (USEPA 2003; MRID 44170134). Similar acute toxicity tests were also conducted with warmwater fish species. In a study with bluegill sunfish (*Lepomis macrochirus*), the 96-hour LC_{50} was determined to be >135 mg/L, with a no-effect concentration of 16 mg/L using 97.4% diflufenzopyr (USEPA 2003; MRID 44170133).

Based on the data above, the selected fish TRVs for diflufenzopyr were established at 106 mg/L (warmwater LC_{50}) and 16 mg/L (coldwater NOAEL).

Dicamba tests were conducted with several coldwater species, including rainbow trout, cutthroat trout (*Oncorhynchus clarki clarki*), and coho salmon (*Oncorhynchus kisutch*). These tests resulted in 96-hour LC_{50}s ranging from 28 mg/L using an 88% dicamba product (USEPA 2003; MRID 40098001) to 558 mg/L using a 22% dicamba product (USEPA 2003; MRID 29623). No effects were observed in concentrations ranging from 49 mg/L using a 10% dicamba product (USEPA 2003; MRID 22539) to 110 mg a.i./L (Lorz 1979). All of the NOAELs were above the lowest LC_{50}, and therefore, an uncertainty factor of 3 was necessary to extrapolate a NOAEL-based TRV. The LC_{50} (28 mg/L) was divided by an uncertainty factor of 3, to result in a dicamba coldwater NOAEL of 9.3 mg/L.

Similar acute toxicity tests were also conducted with warmwater fish species, specifically bluegill sunfish, sheepshead minnow (*Cyprinodon variegatus variegatus*), and mosquito fish (*Gambusia affinis*). These tests resulted in LC_{50}s ranging from 130 mg/L (no % a.i. information provided) (Hurlburt 1975) to 706 mg/L using a 22% dicamba product (USEPA 2003; MRID 22539). No effects were observed in concentrations ranging from 56 mg a.i./L (Vilkas 1977) to 490 mg/L using a 22% dicamba product (USEPA 2003; MRID 22539). The highest NOAEL below the lowest LC_{50} was 100 mg/L using an 86.8% dicamba product (USEPA 2003; MRID 41272).

The selected fish TRVs for dicamba were established at 28 mg/L (coldwater LC_{50}) and 9.3 mg./L (estimated coldwater NOAEL).

No chronic toxicity studies on freshwater fish were found in the available literature, and therefore all TRVs are based on acute duration endpoints.

Based on diflufenzopyr's octanol-water coefficient (K_{ow}) and regression equations, the bioconcentration factor (BCF) for diflufenzopyr is 3.16, indicating that diflufenzopyr would not appreciably bioconcentrate in fish tissue (HSDB 2002). In contrast, the BCFs for dicamba range from 8 to 28, indicating that dicamba may bioconcentrate in fish tissue (HSDB 2002).

3.1.3.2 Amphibians

A single amphibian toxicity study was found during the literature review. The 96-hour toxicity test with dicamba (as the a.i. in Banvel), resulted in LC_{50}s of 106 and 185 mg a.i./L using tadpoles of two frog species (Johnson 1976). A NOAEL of 35.3 mg a.i./L was estimated by applying an uncertainty factor of 3 to the lowest $LC_{50.}$

3.1.3.3 Aquatic Invertebrates

Freshwater invertebrate toxicity tests are required for the USEPA pesticide registration process. In these acute studies, the statistical endpoint (median effective concentration; EC_{50}) is the concentration that immobilizes 50 percent of the test organisms after a certain duration (generally 48 to 96 hours). Median lethal concentrations (LC_{50}s) may also be determined.

One diflufenzopyr acute toxicity test using water fleas (e.g., *Daphnia magna*) was found in the literature. The EC_{50} reported in this study was 15 mg/L of diflufenzopyr, with a no-effect concentration of 9.7 mg/L using a 94.7% diflufenzopyr product (USEPA 2003; MRID 44170135).

Based on these findings, the selected invertebrate TRVs for diflufenzopyr were established at 15 mg/L (EC_{50}) and 9.7 mg/L (NOAEL).

Several dicamba aquatic invertebrate tests were identified, resulting in LC_{50}s ranging from 3.8 mg/L for the scud (*Hyallela* spp.; no % a.i. information provided) (Hurlbert 1975) to >1,000 mg/L for the water flea (*Daphnia magna*) using a 40.15% dicamba product (Forbis et al. 1985).

Because a suitable NOAEL for dicamba was not identified the literature, the selected dicamba LC_{50} (3.8 mg/L) was divided by an uncertainty factor of 3, to result in a dicamba NOAEL of 1.27 mg/L.

One 48-hour acute Distinct® water flea test was identified. No effects were observed at the highest tested concentration, 130 mg/L (USEPA 2003; MRID 45310903).

Because a suitable LD_{50} for Distinct® could not be determined from the literature, the NOAEL (130 mg/L) was multiplied by an uncertainty factor of 3, to result in a Distinct® EC_{50} of 390 mg/L.

No chronic toxicity studies on freshwater aquatic invertebrates were found in the available literature, and therefore, all TRVs are based on acute duration endpoints.

3.1.4 Aquatic Plants

Standard toxicity tests were conducted on aquatic plants, including aquatic macrophytes, freshwater diatoms, and algae.

In 14-day duckweed studies with technical diflufenzopyr, the EC_{50} was >0.35 mg/L using a 99.5% diflufenzopyr product (USEPA 2003; MRID 44307422). The lowest diflufenzopyr EC_{50} reported for aquatic plants was a value of 0.1 mg/L for green algae exposed to diflufenzopyr sodium (99.5% a.i.; USEPA 2003; MRID 44307425). No-effect concentrations for aquatic plants ranged from 0.0039 mg/L to 0.0078 mg/L using a 99.5% diflufenzopyr product (USEPA 2003; MRID 44307422 and MRID 44307425).

The green algae EC_{50} (0.1 mg/L) and NOAEL (0.0078 mg/L) were selected as the aquatic plant TRVs for diflufenzopyr.

Relevant dicamba studies were conducted with duckweed, freshwater algae, and freshwater diatoms. Reported EC_{50}s for these studies ranged from 0.1 mg a.i./L for the freshwater algae *Hormidium barlowi* (Cullimore 1975) to 36.4 mg a.i./L for the green algae *Selenastrum capricornutum* (Fairchild et al. 1997). A 14-day duckweed study with an 89.5% dicamba product resulted in an EC_{50} of >3.25 mg/L (USEPA 2003; MRID 42774111). No effect dicamba concentrations for freshwater aquatic plants ranged from 0.2 mg/L (USEPA 2003; MRID 4277411) to 100 mg a.i./L (Fairchild et al. 1997). All of these values were above the EC_{50} value; therefore, the NOAEL used for the TRVs was an extrapolated value based on an uncertainty factor.

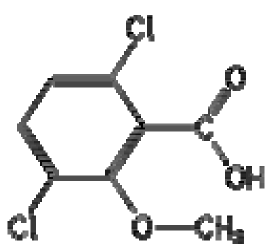
Because a suitable NOAEL for dicamba was not identified the literature, the selected dicamba EC_{50} (0.1 mg a.i./L) was divided by an uncertainty factor of 3, to result in a dicamba NOAEL of 0.033 mg a.i./L.

In 14-day duckweed studies with Distinct®, 50 percent of the duckweed plants were adversely affected by concentrations as low as 0.11 mg/L (i.e., the EC_{50}), with an associated no effect concentration of 0.0023 mg/L (Health Canada 1999). This study indicates that duckweed is more sensitive to Distinct® than to diflufenzopyr or dicamba alone.

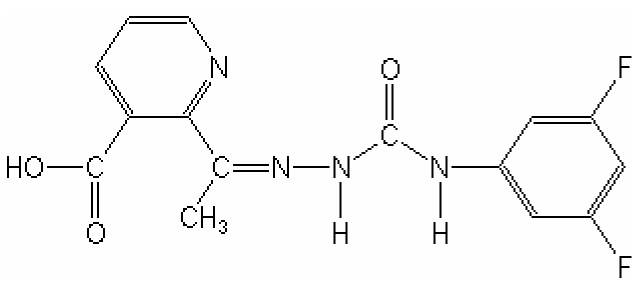
Based on the data above, the selected aquatic plant TRVs for Distinct® were established at 0.11 mg/L (EC_{50}) and 0.0023 mg/L (NOAEL)

3.2 Herbicide Physical-Chemical Properties

This section presents the physical-chemical properties of the two a.i. of the product Overdrive®, dicamba and diflufenzopyr. Properties of the product itself were not generally available and were not relevant since fate and transport modeling requiring these properties (i.e., GLEAMS) was conducted on the two a.i. and not the mixture. The chemical name of dicamba is 3,6-dichloro-2-methoxybenzoic acid or 3,6-dichloro-o-anisic acid. The chemical name of diflufenzopyr is 2-{1-[4-(3,5-difluorophyenyl)semicarbazono]ethyl}nicotinic acid. The chemical structures of dicamba and diflufenzopyr are shown below:



Dicamba Chemical Structure



Diflufenzopyr Chemical Structure

The physical/chemical properties and degradation rates critical to the environmental fate of dicamba and diflufenzopyr are listed in Table 3-2 and Table 3-3 respectively, which present the range of values encountered in the literature for these parameters. To complete Tables 3-2 and 3-3, available USEPA literature on the herbicide was obtained either from the Internet or through a FOIA request. Herbicide information that had not been cleared of confidential business information (CBI) was not provided by USEPA as part of the FOIA documents. Additional sources, both on-line and in-print, were consulted for information about the herbicide. These sources included:

- The British Crop Protection Council and the Royal Society of Chemistry. 1994. The Pesticide Manual Incorporating the Agrochemicals Handbook. Tenth Edition. Surrey and Cambridge, United Kingdom.
- Compendium of Pesticide Common Names. 2003. A website listing all International Organization for Standardization (ISO)-approved names of chemical pesticides. Available at: http://www.hclrss.demon.co.uk.
- California Department of Pesticide Registration (DPR 2003). USEPA/OPP Pesticide Related Database. Updated weekly. Available at: http://www.cdpr.ca.gov/docs/epa/epamenu.htm.
- Hazardous Substances Data Bank (HSDB). 2002. A toxicology data file on the National Library of Medicines Toxicology Data Network (TOXNET). Available at: http://toxnet.nlm.nih.gov.
- A Pesticide Information Project (PIP). 1996. Extension Toxicology Network (EXTOXNET): Dicamba Pesticide Information Profile. Prepared by the PIP of cooperative extension offices of Cornell University, Oregon State University, University of Idaho, University of California at Davis, and the Institute for Environmental Toxicology at Michigan State University. Available at: http://extoxnet.orst.edu/pips/dicamba.htm.
- Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. Springer-Verlag. New York.
- Mackay, D., S. Wan-Ying, and M. Kuo-ching. 1997. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III: Pesticides. Lewis Publishers, Chelsea, Minnesota.
- Montgomery, J.H. (ed.). 1997. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume V: Pesticide Chemicals. Lewis Publishers, Boca Raton, Florida.
- Tomlin, C. (ed.). 1994. The Agrochemicals Desk Reference 2nd Edition. Lewis Publishers, Boca Raton, Florida.

Information was also obtained from the BASF labels for Distinct® (BASF 1999) and Overdrive® (BASF 2003). The half-life in pond water was estimated using the physical-chemical properties listed in Tables 3-2 and 3-3 and the information reviewed concerning the environmental fate of the herbicide in aquatic systems. Values for foliar half-life and foliar washoff fraction were obtained from a database included in the GLEAMS computer model (U.S. Department of Agriculture [USDA] 1999). Residue rates were obtained from the Kenaga nomogram, as updated (Fletcher et al. 1994). Values selected for use in risk assessment calculations are shown in bold in Tables 3-2 and 3-3.

3.3 Herbicide Environmental Fate

This section summarizes the available fate and transport data for the two a.i. of the product Overdrive®, dicamba and difluenzopyr. This type of fate and transport data for the product itself was not generally available and was not relevant since fate and transport modeling requiring these data (i.e., GLEAMS) was conducted on the two a.i. and not the mixture.

Biodegradation, photolysis, and hydrolysis are important mechanisms in removing diflufenzopyr from soils. Soil biodegradation and photodegradation half-lives are reported to be 14 days or less (USEPA 1999). Hydrolysis may also occur in moist soils. The K_{oc}, or organic carbon-water partitioning coefficient, measures the affinity of a chemical to organic carbon relative to water. The higher the K_{oc}, the less soluble in water and the higher the affinity for organic carbon, an important constituent of soil particles. Therefore, the higher the K_{oc}, the less mobile the chemical.

Diflufenzopyr K_{oc} values range from 18 to 156 indicating that diflufenzopyr, under a variety of conditions, could have very high to medium mobility in soils. Based on its vapor pressure and its Henry's Law constant (the ratio of the chemical's distribution at equilibrium between the gas and liquid phases), volatilization from wet or dry soil surfaces should not represent an important loss pathway (Lyman et al. 1990, HSDB 2002). The field half-life for diflufenzopyr has been reported as 4 days (USEPA 1999).

Biodegradation, photolysis, and hydrolysis are also important mechanisms in removing diflufenzopyr from aquatic systems. Half-lives for hydrolysis, photolysis, and aerobic and anaerobic aquatic biodegradation are all less than one month (USEPA 1999), and hydrolysis and photolysis rates increase in acidic environments (USEPA 1999). Based on the Henry's Law constant, volatilization from aquatic systems should not represent an important loss pathway (Lyman et al. 1990, HSDB 2002). Based on an estimated BCF of 3.16, diflufenzopyr has little tendency to bioconcentrate in aquatic organisms (Franke et al. 1994). The aquatic dissipation half-life for diflufenzopyr has been reported as 25 to 26 days (aerobic) and 20 days (anaerobic; USEPA 1999).

Biodegradation is the most important mechanism for elimination of dicamba from soils. Volatilization and hydrolysis may not be important processes in dicamba degradation. Soil biodegradation half-lives range from 4 to 555 days, with a typical half-life of up to four weeks (Howard 1991). Biodegradation in soils increases with increased temperature and soil moisture. The half-life in aerobic soils is 20 days (Howard 1991). Dicamba K_{oc} values were 2 and 4.4 indicating that dicamba has very high mobility in soils (Howard 1991, PIP 1996). Based on the vapor pressure and Henry's Law constant, volatilization from wet or dry soil surfaces should not represent important loss pathways (Howard 1991).

Biodegradation is also the major mechanism for dicamba degradation in water. Although photolysis is believed to contribute to degradation, it is not the major loss process. Hydrolysis, volatilization, and sediment adsorption are also not significant loss mechanisms (Howard 1991). The estimated BCF ranges from 8 to 28 (HSDB 2002).

TABLE 3-1
Selected Toxicity Reference Values for Diflufenzopyr

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
RECEPTORS INCLUDED IN FOOD WEB MODEL						
Terrestrial Animals						
Honeybee	75	ug/bee	48 h	LD_{50}		extrapolated from NOAEL;.99.4% a.i. product
Large bird	> 2,810	mg/kg bw	8 d	LD_{50}	mallard	94.7% a.i. product
Large bird	105	mg/kg bw-day	21 w	NOAEL	mallard	94.3% a.i. product
Large mammal	3,300	mg/kg bw		LD_{50}	rat	small mammal value
Large mammal	59	mg/kg bw-day	1 y	NOAEL	dog	no % a.i. listed
Piscivorous bird	105	mg/kg bw-day	8 d	NOAEL	mallard	94.7% a.i. product
Small bird	> 16,970	mg/kg bw	8 d	LD_{50}	bobwhite quail	94.7% a.i. product
Small bird	634	mg/kg bw-day	20 w	NOAEL	bobwhite quail	94.3% a.i. product
Small mammal	42.2	mg/kg bw-day	2 generation	NOAEL	rat	93% a.i. product
Small mammal - dermal	> 5,000	mg/kg bw		LD_{50}	rabbit	96.4% a.i. product
Small mammal - ingestion	3,300	mg/kg bw		LD_{50}	rat	water exposure; no diet available; 98.1% a.i. product
Terrestrial Plants						
Typical species – direct spray, drift, dust	0.0008	lb a.i./ac	14 d	EC_{25}	turnip	based on emergence
RTE species – direct spray, drift, dust	0.0003	lb a.i./ac	14 d	NOAEL	turnip	extrapolated from EC25
Typical species – surface runoff	0.028	lb a.i./ac	14 d	NOAEL	tomato	no germination data; based on emergence
RTE species – surface runoff	0.0001	lb a.i./ac	NR	NOAEL	turnip	no germination data; based on emergence
Aquatic Species						
Aquatic invertebrates	15	mg/L	48 h	EC_{50}	*D. magna*	94.7% a.i. product
Fish	106	mg/L	96 h	LC_{50}	rainbow trout	97.4% a.i. product
Aquatic plants and algae	0.1	mg/L	5 d	EC_{50}	green algae	99.5% a.i. product
Aquatic invertebrates	9.7	mg/L	48 h	NOAEL	*D. magna*	94.7% a.i. product
Fish	16	mg/L	96 h	NOAEL	bluegill sunfish	97.4% a.i. product
Aquatic plants and algae	0.0078	mg/L	5 d	NOAEL	green algae	99.5% a.i. product

TABLE 3-1 (Cont.)
Selected Toxicity Reference Values for Diflufenzopyr

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	no data					
Amphibian	no data					
Warmwater fish	> 135	mg/L	96 h	LC_{50}	bluegill sunfish	97.4% a.i. product
Warmwater fish	16	mg/L	96 h	NOAEL	bluegill sunfish	97.4% a.i. product
Coldwater fish	106	mg/L	96 h	LC_{50}	rainbow trout	97.4% a.i. product
Coldwater fish	80	mg/L	96 h	NOAEL	rainbow trout	97.4% a.i. product

Notes:
Toxicity endpoints for terrestrial animals
LD_{50} - to address acute exposure.
NOAEL - to address chronic exposure.
Toxicity endpoints for terrestrial plants
EC_{25} - to address direct spray, drift, and dust impacts on typical species.
EC_{05} or NOAEL - to address direct spray, drift, and dust impacts on threatened or endangered species.
Highest germination NOAEL - to address surface runoff impacts on typical species.
Lowest germination NOAEL - to address surface runoff impacts on threatened or endangered species.
Toxicity endpoints for aquatic receptors
LC_{50} or EC_{50} - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC_{50}).
MATC or NOAEL - to address chronic exposure.
Value for fish is the lower of the warmwater and coldwater values.

Piscivorous bird TRV = Large bird chronic TRV
Fish TRV = lower of coldwater and warm water fish TRVs
Durations:
h - hours
d - days
w - weeks
m - months
y - years
NR – Not reported
Units represent those presented in the reviewed study

TABLE 3-2
Selected Toxicity Reference Values for Dicamba

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
			RECEPTORS INCLUDED IN FOOD WEB MODEL			
Terrestrial Animals						
Honeybee	> 90.65	ug/bee	48 h	LD_{50}		no % a.i. listed
Large bird	> 5,000	mg/kg bw	8 d	LD_{50}	mallard	22% a.i. product
Large bird	92	mg a.i./kg bw-day	21 w	NOAEL	mallard	86.9% a.i. product
Large mammal	566	mg/kg bw	>7 d	LD_{50}	mouse	small mammal value; no % a.i. listed
Large mammal	0.15	mg/kg bw-day	2 y	NOAEL	dog	90% a.i. product
Piscivorous bird	92	mg a.i./kg bw-day	21 w	NOAEL	mallard	86.9% a.i. product
Small bird	> 30,190	mg/kg bw	8 d	LD_{50}	bobwhite quail	22% a.i. product
Small bird	170	mg a.i./kg bw-day	21 w	NOAEL	bobwhite quail	86.9% a.i. product
Small mammal	3	mg/kg bw-day	gestation	NOAEL	rabbit	87.7% a.i. product
Small mammal - dermal	> 5,050	mg/kg bw	14 d	LD_{50}	rabbit	21.06% a.i. product
Small mammal - ingestion	566	mg/kg bw	>7d	LD_{50}	mouse	water exposure; no diet available; no % a.i. listed
Terrestrial Plants						
Typical species – direct spray, drift, dust	0.00027	lb a.i./ac		EC_{25}	soybean	
RTE species – direct spray, drift, dust	< 0.000	lb a.i./ac		NOAEL	soybean	Extrapolated from EC_{25}
Typical species – surface runoff	0.53	lb a.i./ac	14 d	NOAEL	cabbage	no germination data; based on emergence
RTE species – surface runoff	< 0.0022	lb a.i./ac	14 d	NOAEL	soybean	no germination data; based on emergence
Aquatic Species						
Aquatic invertebrates	3.8	mg/L	96 h	LC_{50}	amphipod	no % a.i. listed
Fish	28	mg/L	96 h	LC_{50}	rainbow trout	21.06% a.i. product
Aquatic plants and algae	0.1	mg a.i./L	5 – 30 d	EC_{50}	freshwater algae	
Aquatic invertebrates	1.27	mg/L	96 h	NOAEL	amphipod	extrapolated from LC50
Fish	9.3	mg/L	96 h	NOAEL	rainbow trout	extrapolated from LC50
Aquatic plants and algae	0.033	mg a.i./L	5 – 30 d	NOAEL	freshwater algae	extrapolated from EC50

TABLE 3-2 (Cont.)
Selected Toxicity Reference Values for Dicamba

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	106	mg a.i./L	96 h	LC_{50}	frog tadpole	
Amphibian	35.3	mg a.i./L	96 h	NOAEL	frog tadpole	
Warmwater fish	130	mg/L	48 h	LC_{50}	bluegill sunfish	no % a.i. listed
Warmwater fish	100	mg/L	96 h	NOAEL	bluegill sunfish	86.8% a.i. product
Coldwater fish	28	mg/L	96 h	LC_{50}	rainbow trout	88% a.i. product
Coldwater fish	9.3	mg/L	96 h	NOAEL	rainbow trout	extrapolated from LC50

Notes:

Toxicity endpoints for terrestrial animals
LD_{50} - to address acute exposure.
NOAEL - to address chronic exposure.
Toxicity endpoints for terrestrial plants
EC_{25} - to address direct spray, drift, and dust impacts on typical species.
EC_{05} or NOAEL - to address direct spray, drift, and dust impacts on threatened or endangered species.
Highest germination NOAEL - to address surface runoff impacts on typical species.
Lowest germination NOAEL - to address surface runoff impacts on threatened or endangered species.
Toxicity endpoints for aquatic receptors
LC_{50} or EC_{50} - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC_{50}).
MATC or NOAEL - to address chronic exposure.
Value for fish is the lower of the warmwater and coldwater values.

Piscivorous bird TRV = Large bird chronic TRV
Fish TRV = lower of coldwater and warm water fish TRVs
Durations:
h - hours
d - days
w - weeks
m - months
y - years
NR – Not reported
Units represent those presented in the reviewed study

TABLE 3-3
Selected Toxicity Reference Values for Overdrive®

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
RECEPTORS INCLUDED IN FOOD WEB MODEL						
Terrestrial Animals						
Honeybee	no data					
Large bird	no data					
Large bird	no data					
Large mammal	1,600	mg/kg bw		LD_{50}	rat	small mammal value
Large mammal	no data					
Piscivorous bird	no data					
Small bird	> 18,360	mg/kg bw-day	8 d	LD_{50}	bobwhite quail	
Small bird	3,672	mg/kg bw-day	8 d	NOAEL	bobwhite quail	
Small mammal	no data					
Small mammal - dermal	> 5,000	mg/kg bw		LD_{50}	rabbit	
Small mammal - ingestion	1,600	mg/kg bw		LD_{50}	rat	
Terrestrial Plants						
Typical species – direct spray, drift, dust	0.0043	lb/ac	21 d	EC_{25}	tomato	based on vegetative vigor
RTE species – direct spray, drift, dust	0.004	lb/ac	21 d	NOAEL	tomato	based on vegetative vigor
Typical species – surface runoff	0.046	lb/ac	14 d	NOAEL	oat	no germination data; based on emergence
RTE species – surface runoff	0.0016	lb/ac	14 d	NOAEL	cucumber	no germination data; based on emergence
Aquatic Species						
Aquatic invertebrates	390	mg/L	48 h	EC_{50}	water flea	
Fish	no data					
Aquatic plants and algae	0.11	mg/L	14 d	EC_{50}	duckweed	
Aquatic invertebrates	130	mg/L	48 h	NOAEL	water flea	
Fish	no data					
Aquatic plants and algae	0.0023	mg/L	14 d	NOAEL	duckweed	

TABLE 3-3 (Cont.)
Selected Toxicity Reference Values for Overdrive®

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	no data					
Amphibian	no data					
Warmwater fish	no data					
Warmwater fish	no data					
Coldwater fish	no data					
Coldwater fish	no data					

Notes:

Toxicity endpoints for terrestrial animals
LD_{50} - to address acute exposure.
NOAEL - to address chronic exposure.

Toxicity endpoints for terrestrial plants
EC25 - to address direct spray, drift, and dust impacts on typical species.
EC_{05} or NOAEL - to address direct spray, drift, and dust impacts on threatened or endangered species.
Highest germination NOAEL - to address surface runoff impacts on typical species.
Lowest germination NOAEL - to address surface runoff impacts on threatened or endangered species.

Toxicity endpoints for aquatic receptors
LC_{50} or EC_{50} - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC_{50}).
MATC or NOAEL - to address chronic exposure.
Value for fish is the lower of the warmwater and coldwater values.

Piscivorous bird TRV = Large bird chronic TRV
Fish TRV = lower of coldwater and warm water fish TRVs
Durations:
h - hours
d - days
w - weeks
m - months
y - years
NR – Not reported
Units represent those presented in the reviewed study

TABLE 3-4
Physical-Chemical Properties of Diflufenzopyr

Parameter	Value
Herbicide family	Urea herbicide (Compendium of Pesticide Common Names 2003)
Mode of action	Auxin transport inhibitor (USEPA 1999)
Chemical Abstract Service number	109293-97-2 (parent acid), 109293-98-3 (sodium salt) (Compendium of Pesticide Common Names 2003)
Office of Pesticide Programs chemical code	005108 (DPR 2003)
Chemical name (International Union of Pure and Applied Chemistry [IUPAC])	2-{1-[4-(3,5-difluorophyenyl)semicarbazono]ethyl}nicotinic acid (Compendium of Pesticide Common Names 2003)
Empirical formula	$C_{15}H_{12}F_2N_4O_3$ (parent acid), $C_{15}H_{11}F_2N_4O_3Na$ (sodium salt) (Compendium of Pesticide Common Names 2003)
Molecular weight (MW)	**334.3** (parent acid), 356.3 (sodium salt) (HSDB 2002)
Appearance, ambient conditions	Off-white powder (USEPA 1999)
Acid / base properties	3.18 (pKa) (HSDB 2002)
Vapor pressure (millimeters of mercury [mmHg] at 25ºC)	7.5×10^{-7} (20ºC and 25ºC) (USEPA 1999); <7.5×10^{-8} (20ºC) (HSDB 2002)
Water solubility (mg/L at 25ºC)	63 (pH 5), **5,850 (pH 7)**, 10,546 (pH 9) (USEPA 1999)
Octanol-water partition coefficient (K_{ow}), unitless	1.09 (average K_{ow}, pH dependent)(1) (USEPA 1999)
Henry's Law constant (atm-m^3/mole)	5.24×10^{-10} (calculated from vapor pressure and water solubility) (HSDB 2002)
Soil / organic matter sorption coefficient (Kd/K_{oc})(2)	18 to 156 (K_{oc}) (USEPA 1999)
Bioconcentration factor (BCF)	**3.16** - Calculated from Log K_{ow} (HSDB 2002)
Field dissipation half-life	4 days (USEPA 1999)
Soil dissipation half-life(3)	4.5 days (average soil dissipation half-life) (HSDB 2002)
Aquatic dissipation half-life	Not available
Hydrolysis half-life	13 days (pH 5), 24 days (pH 7), and 26 days (pH 9) (USEPA 1999)
Photodegradation half-life in water	7 days (pH 5), 17 days (pH 7), and 13 days (pH 9) (USEPA 1999)
Photodegradation half-life in soil	14 days (USEPA 1999)
Soil biodegradation half-life(4)	8-10 days aerobic soil metabolism (USEPA 1999)
Aquatic biodegradation half-life	25-26 days (aerobic aquatic metabolism half-life), 20 days (anaerobic aquatic metabolism half-life) (USEPA 1999)
Foliar half-life	Not available(5)
Foliar wash-off fraction	Not available(6)
Half-life in pond(7)	**24 days** (estimated from herbicide's environmental behavior and values in this table)
Residue Rate for grass (8)	**197 ppm** (maximum) and **36 ppm** (typical) per lb a.i./ac
Residue Rate for vegetation (9)	**296 ppm** (maximum) and **35 ppm** (typical)
Residue Rate for insects (10)	**350 ppm** (maximum) and **45 ppm** (typical)
Residue Rate for berries (11)	**40.7 ppm** (maximum) and **5.4 ppm** (typical)

TABLE 3-4 (Cont.)
Physical-Chemical Properties of Diflufenzop

Notes:

Values presented in bold were used in risk assessment calculations.

(1) HSDB (2002) lists *Log* K_{ow} = 1.09, while USEPA (1999) lists K_{ow} = 1.09.

(2) A K_{oc} value of **87** was used in risk assessment calculations. This value represents the average of the multiple K_{oc} values presented in USEPA (1999).

(3) Some studies listed in this category may have been performed under field conditions, but insufficient information was provided in the source material to make this determination.

(4) A soil half-life value of **9 days** was used in risk assessment calculations. This value represents the average of aerobic soil biodegradation half-lives reported in USEPA (1999).

(5) The value for soil photodegradation half-life (**14 days**) was used as a conservative estimate of foliar half-life.

(6) A value of **1** was used as a conservative estimate of the foliar washoff fraction in risk assessment calculations.

(7) Used in risk assessments to calculate aqueous herbicide concentration in pond water that receives herbicide laden runoff.

(8) Residue rates selected are the high and mean values for long grass. Fletcher et al. (1994).

(9) Residue rates selected are the high and mean values for leaves and leafy crops. Fletcher et al. (1994).

(10) Residue rates selected are the high and mean values for forage such as legumes. Fletcher et al. (1994).

(11) Residue rates selected are the high and mean values for fruit (includes both woody and herbaceous). Fletcher et al. (1994).

TABLE 3-5
Physical-Chemical Properties of Dicamba

Parameter	Value
Herbicide family	Benzoic acid herbicide (Compendium of Pesticide Common Names 2003)
Mode of action	Synthetic auxin (Retzinger and Mallory-Smith 1997)
Chemical Abstract Service number	1918-00-9 (parent acid), 1982-69-0 (sodium salt) (Compendium of Pesticide Common Names 2003)
Office of Pesticide Programs chemical code	029801 (DPR 2003)
Chemical name (IUPAC)	3,6-dichloro-o-anisic acid (Compendium of Pesticide Common Names 2003)
Empirical formula	$C_8H_6Cl_2O_3$ (parent acid) (Compendium of Pesticide Common Names 2003)
Molecular weight (MW)	**221.04** (parent acid) (HSDB 2002)
Appearance, ambient conditions	Colorless solid (HSDB 2002)
Acid / base properties	1.87 (pKa) (HSDB 2002)
Vapor pressure (mmHg at 25ºC)	3.4×10^{-5} (25ºC) (HSDB 2002)
Water solubility (mg/L at 25ºC)	6,500 (HSDB 2002)
Octanol-water partition coefficient (log K_{ow}), unitless	2.21 (HSDB 2002), -0.67 unionized at pH 7 (average value from Tomlin 1994 and Fostiak and Yu 1989)
Henry's Law constant (atm-m^3/mole)	9.0×10^{-7} (HSDB 2002)
Soil / organic matter sorption coefficient (Kd/K_{oc})(1)	**2** to 4.4 (K_{oc}) (PIP 1993; HSDB 2002)
Bioconcentration factor (BCF)	8-28 Calculated from Log K_{ow} (HSDB 2002)
Soil dissipation half-life	4-555 days, typical half-life of up to four weeks (Howard 1991)
Aquatic dissipation half-life	not available
Soil biodegradation half-life	20 days aerobic soil metabolism (Howard 1991)
Aquatic biodegradation half-life	<7 days (USEPA 2002)
Foliar half-life	Average 9 days (USEPA 2002)
Foliar wash-off fraction	Not available(2)
Half-life in pond(3)	**24 days** (estimated from herbicide's environmental behavior and values in this table)
Residue Rate for grass (4)	**197 ppm** (maximum) and **36 ppm** (typical) per lb a.i./ac
Residue Rate for vegetation (5)	**296 ppm** (maximum) and **35 ppm** (typical)
Residue Rate for insects (6)	**350 ppm** (maximum) and **45 ppm** (typical)
Residue Rate for berries (7)	**40.7 ppm** (maximum) and **5.4 ppm** (typical)
Half-life in pond(3)	**24 days** (estimated from herbicide's environmental behavior and values in this table)

Notes:
Values presented in bold were used in risk assessment calculations.
(1) A K_{oc} value of **2** was used in risk assessment calculations.
(2) A value of **1** was used as a conservative estimate of the foliar washoff fraction in risk assessment calculations.
(3) Used in risk assessments to calculate aqueous herbicide concentration in pond water that receives herbicide laden runoff.
(4) Residue rates selected are the high and mean values for long grass. Fletcher et al. (1994).
(5) Residue rates selected are the high and mean values for leaves and leafy crops. Fletcher et al. (1994).
(6) Residue rates selected are the high and mean values for forage such as legumes. Fletcher et al. (1994).
(7) Residue rates selected are the high and mean values for fruit (includes both woody and herbaceous). Fletcher et al. (1994).

4.0 ECOLOGICAL RISK ASSESSMENT

This section presents a screening-level evaluation of the risks to ecological receptors from potential exposure to the herbicide Overdrive®. The general approach and analytical methods for conducting the Overdrive® ERA were based on the USEPA's Guidelines for ERA (hereafter referred to as the "Guidelines;" USEPA 1998).

The ERA is a structured evaluation of all currently available scientific data (exposure chemistry, fate and transport, toxicity, etc.) that leads to quantitative estimates of risk from environmental stressors to non-human organisms and ecosystems. The current Guidelines for conducting ERAs include three primary phases: problem formulation, analysis, and risk characterization. These phases are discussed in detail in the Methods Document (ENSR 2004c) and briefly in the following sub-sections.

4.1 Problem Formulation

Problem formulation is the initial step of the standard ERA process and provides the basis for decisions regarding the scope and objectives of the evaluation. The problem formulation phase for the Overdrive® assessment included:

- definition of risk assessment objectives;
- ecological characterization;
- exposure pathway evaluation;
- definition of data evaluated in the ERA;
- identification of risk characterization endpoints; and
- development of a conceptual model.

4.1.1 Definition of Risk Assessment Objectives

The primary objective of this ERA was to evaluate the potential ecological risks from Overdrive® to the health and welfare of plants and animals and their habitats. This analysis is part of the process used by the BLM to determine which of the proposed treatment alternatives evaluated in the EIS should be used on BLM lands.

An additional goal of this process was to provide risk managers with a tool that develops a range of generic risk estimates that vary as a function of site conditions. This tool primarily consists of Excel spreadsheets (presented in the ERA Worksheets; Appendix B), which may be used to calculate exposure concentrations and evaluate potential risks in the risk assessment. A number of the variables included in the worksheets can be modified by BLM land managers for future evaluations.

4.1.2 Ecological Characterization

As described in Section 2.2, Overdrive® is planned for use by the BLM for the management of vegetation in their Rangeland, Energy and Mineral Sites, Rights-of-Way, and Recreation programs. The proposed BLM program could apply herbicides on under 1 million acres of public lands annually in 17 western states in the continental US and Alaska. These applications have the potential to occur in a wide variety of ecological habitats that could include: deserts, forests, prairie land, and many others. It is not feasible to characterize all of the potential habitats within this report; however, this ERA was designed to address generic receptors, including RTE species (see Section 6.0) that could occur within a variety of habitats.

4.1.3 Exposure Pathway Evaluation

The following ecological receptor groups were evaluated in this evaluation:

- terrestrial animals;
- non-target terrestrial plants; and
- aquatic species (fish, invertebrates, and non-target aquatic plants).

These groups of receptor species were selected for evaluation because they: 1) are potentially exposed to herbicides within the BLM management areas; 2) play key roles in site ecosystems; 3) have complex life cycles; 4) represent of a range of trophic levels; and 5) represent surrogates species for other species likely to be found on BLM lands.

The exposure scenarios considered in the ERA were primarily organized by potential exposure pathways. In general, the exposure scenarios describe how a particular receptor group may be exposed to the herbicide as a result of a particular exposure pathway. These exposure scenarios were developed to address potential acute and chronic impacts to receptors under a variety of exposure conditions that may occur within BLM lands. These exposure conditions include normal application situations and associated off-site transport (via drift or wind erosion of dust), as well as accidental spills, and long-term overland flow to off-site soils and waterbodies (primarily via surface runoff and root-zone groundwater flow). Overdrive® is a terrestrial herbicide; therefore, as discussed in detail in the Methods Document (ENSR 2004c), the following exposure scenarios were considered:

- direct contact with the herbicide or a contaminated waterbody;
- indirect contact with contaminated foliage;
- ingestion of contaminated food items;
- off-site drift of spray to terrestrial areas and waterbodies;
- surface runoff from the application area to off-site soils or waterbodies;
- wind erosion resulting in deposition of contaminated dust; and
- accidental spills to waterbodies.

Two generic waterbodies were considered in this ERA: 1) a small pond (1/4 acre pond of 1 meter [m] depth, resulting in a volume of 1,011,715 L), and 2) a small stream representative of Pacific Northwest low-order streams that provide habitat for critical life-stages of anadromous salmonids. The stream size was established at 2 m wide and 0.2 m deep with a mean water velocity of approximately 0.3 meters per second, resulting in a base flow discharge of 0.12 cubic meters per second (cms).

4.1.4 Definition of Data Evaluated in the ERA

Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM (Table 2-1). These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). Some of these calculations were fairly straightforward and required only simple algebraic calculations (e.g., water concentrations from direct aerial spray), but others required more complex computer models (e.g., aerial deposition rates, transport from soils).

The AgDRIFT® computer model was used to estimate off-site herbicide transport due to spray drift. AgDRIFT® Version 2.0.05 (SDTF 2002) is a product of the Cooperative Research and Development Agreement between the USEPA's Office of Research and Development and the Spray Drift Task Force (SDTF, a coalition of pesticide registrants). The GLEAMS computer model was used to estimate off-site transport of herbicide in surface runoff and root-zone groundwater. Groundwater Loading Effects of Agricultural Management Systems is able to estimate a wide range of potential herbicide exposure concentrations as a function of site-specific parameters, such as soil characteristics and annual precipitation. The USEPA's guideline air quality California Puff (CALPUFF) air pollutant dispersion model was used to predict the transport and deposition of herbicides sorbed to wind-blown dust. CALPUFF "lite" version 5.7 was selected because of its ability to screen potential air quality impacts within and beyond 50 kilometers and its ability to simulate plume trajectory over several hours of transport, based on limited meteorological data.

4.1.5 Identification of Risk Characterization Endpoints

Assessment endpoints and associated measures of effect were selected to evaluate whether populations of ecological receptors are potentially at risk from exposure to proposed BLM applications of Overdrive®. The selection process is discussed in detail in the Methods Document (ENSR 2004c), and the selected endpoints are presented below.

Assessment Endpoint 1: Acute mortality to mammals, birds, invertebrates, non-target plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LD_{50} and LC_{50}) from acute toxicity tests on target organisms or suitable surrogates.

Assessment Endpoint 2: Acute mortality to fish, aquatic invertebrates, and aquatic plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LC_{50} and EC_{50}) from acute toxicity tests on target organisms or suitable surrogates (e.g., data from other coldwater fish to represent threatened and endangered salmonids).

Assessment Endpoint 3: Adverse direct effects on growth, reproduction, or other ecologically important sublethal processes

- **Measures of Effect** included standard chronic toxicity test endpoints such as the NOAEL for both terrestrial and aquatic organisms. Depending on the data available for a given herbicide, chronic endpoints reflect either individual-impacts (e.g., individual growth, physiological impairment or behavior), or population-level impacts (e.g., reproduction; Barnthouse 1993). For salmonids, careful attention was paid to smoltification (i.e., development of tolerance to seawater and other changes of parr (freshwater stage salmonids) to adulthood), thermoregulation (i.e., ability to maintain body temperature), migratory behavior, etc., if such data were available. With the exception of non-target plants, standard acute and chronic toxicity test endpoints were used for estimates of direct herbicide effects on RTE species. To add conservatism to the RTE assessment, LOCs for RTE species were lower than for typical species. Lowest available germination NOAELs were used to evaluate non-target RTE plants. Impacts to RTE species are discussed in more detail in Section 6.0.

Assessment Endpoint 4: Adverse indirect effects on the survival, growth, or reproduction of salmonid fish

- **Measures of Effect** for this assessment endpoint depended on the availability of appropriate scientific data. Unless literature studies were found that explicitly evaluated the indirect effects of the target herbicides to salmonids and their habitat, only qualitative estimates of indirect effects were possible. Such qualitative estimates were limited to a general evaluation of the potential risks to food (typically represented by acute and/or chronic toxicity to aquatic invertebrates) and cover (typically represented by potential for destruction of riparian vegetation). Similar approaches are already being applied by USEPA OPP for Endangered Species Effects Determinations and Consultations (http://www.epa.gov/oppfead1/endanger/effects).

4.1.6 Development of the Conceptual Model

The Overdrive® conceptual model (Figure 4-1) is presented as a series of working hypotheses regarding how Overdrive® might pose hazards to the ecosystem and ecological receptors. The conceptual model indicates the possible exposure pathways for the herbicide, and thus which types of surrogate species (i.e., receptors) were evaluated for each exposure pathway. Figure 4-2 presents the trophic levels and receptor groups evaluated in the ERA.

The conceptual model for herbicide application on BLM lands is designed to display potential herbicide exposure through several pathways, although all pathways may not exist for all locations. The exposure pathways and ecological receptor groups considered in the conceptual model are also described in Section 4.1.3.

The terrestrial herbicide conceptual model (Figure 4-1) presents five mechanisms for the release of an herbicide into the environment: direct spray, off-site-drift, wind erosion, surface runoff, and accidental spills. These release mechanisms may occur as the terrestrial herbicide is applied to the application area by aerial or ground methods.

As indicated in the conceptual model figure, direct spray may result in herbicide exposure for wildlife, non-target terrestrial plants or waterbodies adjacent to the application area. Receptors like wildlife or terrestrial plants may be directly sprayed during the application, or herbicide exposure may be the result of contact with the contaminated water in the pond or steam (i.e., aquatic plants, fish, and aquatic invertebrates). Terrestrial wildlife may also be exposed to the herbicide by brushing against sprayed vegetation or by ingesting contaminated food items.

Off-site drift may occur when herbicides are applied under normal conditions and a portion of the herbicide drifts outside of the treatment area. In these cases, the herbicide may deposit onto non-target receptors such as non-target terrestrial plants or nearby waterbodies. This results in potential direct exposure to the herbicide for terrestrial and aquatic plants, fish, and aquatic invertebrates. Piscivorous birds may also be impacted by ingesting contaminated fish from an exposed pond.

Wind erosion describes the transport mechanism in which dry conditions and wind allow movement of the herbicide from the application area as wind-blown dust. This may result in the direct exposure of non-target plants to the herbicide that is deposited on the plant itself.

Precipitation may result in the transport of herbicides via surface runoff and root-zone groundwater. The seeds of terrestrial plants may be exposed to the herbicide in the runoff or root-zone groundwater. Herbicide transport to the adjacent waterbodies may also occur through these mechanisms. This may result in the exposure of aquatic plants, fish, and aquatic invertebrates to impacted water. Piscivorous birds may also be impacted by ingesting contaminated fish from an exposed pond.

Accidental spills may also occur during normal herbicide applications. Spills represent the worst-case transport mechanism for herbicide exposure. An accidental spill to a waterbody would result in exposure for aquatic plants, fish, and aquatic invertebrates to impacted water.

4.2 Analysis Phase

The analysis phase of an ERA consists of two principal steps: the characterization of exposure, and the characterization of ecological effects. The exposure characterization describes the source, fate, and distribution of the herbicides using standard models that predict concentrations in various environmental media (e.g., GLEAMS, etc.). All EECs predicted by the models are presented in Appendix B. The ecological effects characterization consists of compiling exposure-response relationships from all available toxicity studies off the herbicide.

4.2.1 Characterization of Exposure

The BLM uses herbicides in a variety of programs (e.g., maintenance of rights-of-way and recreational sites) with several different application methods (e.g., application by truck or backpack sprayer). In order to assess the potential ecological impacts of these herbicide uses, a variety of exposure scenarios were considered. These scenarios were selected based on actual BLM herbicide usage under a variety of conditions and are described in Section 4.1.3.

When considering the exposure scenarios and the associated predicted concentrations, it is important to recall that the frequency and duration of the various scenarios are not equal. For example, exposures associated with accidental spills will be very rare, while off-site drift associated with application will be relatively common. Similarly, off-site drift events will be short-lived (i.e., migration occurs within minutes) while erosion of herbicide containing soil may occur over weeks or months following application. The ERA has generally treated these differences in a conservative manner (i.e., potential risks are presented despite their likely rarity and/or transience). Thus, tables and figures summarizing RQs may present both relatively common and very rare exposure scenarios. Additional perspective on frequency and duration of exposures are provided in the narrative below.

As described in Section 4.1.3, the following ecological receptor groups were selected to address the potential risks due to unintended exposure to the Overdrive®: terrestrial animals, terrestrial plants, and aquatic species. A set of generic terrestrial animal receptors were selected to cover a variety of species and feeding guilds that might be found on BLM lands. Unless otherwise noted, receptor BWs were selected from the *Wildlife Exposure Factors Handbook* (USEPA 1993a). This list includes surrogate species, although not all species will be present within each actual application area:

- A pollinating insect with a BW of 0.093 grams (g). The honeybee (*Apis mellifera*) was selected as the surrogate species to represent pollinating insects. This BW was based on the estimated weight of receptors required for testing in 40CFR158.590.

- A small mammal with a BW of 20 g that feeds on fruit (e.g., berries). The deer mouse (*Peromyscus maniculatus*) was selected as the surrogate species to represent small mammalian omnivores consuming berries.

- A large mammal with a BW of 70 kg that feeds on plants. The mule deer (*Odocolieus hemionus*) was selected as the surrogate species to represent large mammalian herbivores, including wild horses and burros (Hurt and Grossenheider 1976).

- A large mammal with a BW of 12 kg that feeds on small mammals. The coyote (*Canis latrans*) was selected as the surrogate species to represent large mammalian carnivores (Hurt and Grossenheider 1976).

- A small bird with a BW of 80 g that feeds on insects. The American robin (*Turdus migratorius*) was selected as the surrogate species to represent small avian insectivores.

- A large bird with a BW of approximately 3.5 kg that feeds on vegetation. The Canada goose (*Branta canadensis*) was selected as the surrogate species to represent large avian herbivores.

- A large bird with a BW of approximately 5 kg that feeds on fish in the pond. The Northern subspecies of the bald eagle (*Haliaeetus leucocephalus alascanus*) was selected as the surrogate species to represent large avian piscivores (Brown and Amadon 1968[2]).

In addition, potential impacts to non-target terrestrial plants were considered by evaluating two plant receptors: the “typical” non-target species, and the RTE non-target species. Typical species are meant to represent non-endangered, non-target plant species that may be impacted during the application of an herbicide to a nuisance species. Turnip, soybean, cabbage, tomato, and oat (*Avena sativa*) were the surrogate species selected to represent typical terrestrial plants, and turnip, tomato, soybean and cucumber were used as the surrogates for RTE terrestrial plants (toxicity data are only available for vegetable crop species). It is possible that rangeland and noncropland plants and grasses are not as sensitive to Overdrive® as the selected surrogate plant species.

Aquatic exposure pathways were evaluated using fish, aquatic invertebrates, and non-target aquatic plants in a pond or stream habitat (as defined in Section 4.1.3). Rainbow trout and the bluegill sunfish were surrogates for fish, the water flea and an amphipod were the surrogates for aquatic invertebrates, and aquatic plants and algae were represented by freshwater algae and duckweed.

[2] As cited on the Virginia Tech Conservation Management Institute Endangered Species Information System website (http://fwie.fw.vt.edu/WWW/esis/).

Section 3.0 of the Methods Document (ENSR 2004c) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for Overdrive®.

4.2.1.1 Direct Spray

Plant and wildlife species may be unintentionally impacted during normal application of a terrestrial herbicide as a result of direct spray of the receptor or the waterbody inhabited by the receptor, indirect contact with dislodgeable foliar residue after herbicide application, or consumption of food items sprayed during application. These exposures may occur within the application area (consumption of food items) or outside of the application area (waterbodies accidentally sprayed during application of terrestrial herbicide). Generally, impacts outside of the intended application area are accidental exposures that are not typical of BLM application practices. The following direct spray scenarios were evaluated:

Exposure Scenarios Within the Application Area

- Direct Spray of Terrestrial Wildlife
- Indirect Contact With Foliage After Direct Spray
- Ingestion of Food Items Contaminated by Direct Spray
- Direct Spray of Non-Target Terrestrial Plants

Exposure Scenarios Outside the Application Area

- Accidental Direct Spray Over Pond
- Accidental Direct Spray Over Stream

4.2.1.2 Off-Site Drift

During normal application of herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target receptors. To simulate off-site herbicide transport as spray drift, AgDRIFT® software was used to evaluate a number of possible scenarios. Only boom placements for ground application scenarios were evaluated for dicamba; dicamba is not dispersed through aerial application by the BLM. Ground applications were modeled using either a high boom (spray boom height set at 50 inches above the ground) or a low boom (spray boom height set at 20 inches above the ground). Deposition rates vary by the height of the boom (the higher the spray boom, the greater the off-target drift). Drift deposition was modeled at 25, 100, and 900 ft from the application area. The AgDRIFT® model determined the fraction of the application rate that is deposited off-site without considering herbicide degradation. Because the amount of herbicide carried in drift is related to particle size and not chemical property, it was assumed that both a.i. of Overdrive® (diflufenzopyr and dicamba) would drift equally. Therefore, the ratio of diflufenzopyr to dicamba in the AgDrift modeled EECs would not differ from the ratio of these a.i. in Overdrive® as it is applied. The following off-site drift scenarios were evaluated:

- Off-Site Drift to Plants
- Off-Site Drift to Pond
- Off-Site Drift to Stream
- Consumption of Fish From Contaminated Pond

4.2.1.3 Surface and Groundwater Runoff

Precipitation may result in the transport of herbicides bound to soils from the application area via surface runoff and root-zone groundwater flow. This transport to off-site soils or waterbodies was modeled using GLEAMS software. It should be noted that both surface runoff (i.e., soil erosion and soluble-phase transport) and loading in root-zone groundwater were assumed to affect the waterbodies in question.

In the application of GLEAMS, it was assumed that root-zone loading of herbicide would be transported directly to a nearby waterbody. This is a feasible scenario in several settings but is very conservative in situations in which the depth to the water table might be many feet. In particular, it is common in much of the arid and semi-arid western states for the water table to be well below the ground surface and for there to be little, if any, groundwater discharge to surface water features.

The GLEAMS variables include soil type, annual precipitation, size of application area, hydraulic slope, surface roughness, and vegetation type. These variables were altered to predict soil concentrations of the herbicides in various watershed types at both the typical and maximum application rates. The following surface runoff scenarios were evaluated:

- Surface Runoff to Off-Site Soils
- Surface Runoff to Off-Site Pond
- Surface Runoff to Off-Site Stream
- Consumption of Fish From Contaminated Pond

4.2.1.4 Wind Erosion and Transport Off-Site

Dry conditions and wind may also allow transport of the herbicide from the application area as wind-blown dust onto non-target plants some distance away. This transport due to wind erosion of the surface soil was modeled using CALPUFF software. Five distinct watersheds were modeled using CALPUFF to determine herbicide concentrations in dust deposited on plants after a wind event with dust deposition estimates calculated 1.5 to 100 km from a 1,000 acre application area. Because the amount of herbicide transported in dust is related to particle size and not chemical property, it was assumed that both a.i. of Overdrive® (diflufenzopyr and dicamba) would drift equally. Therefore, the ratio of diflufenzopyr to dicamba in the CALPUFF modeled EECs would not differ from the ratio of these a.i. in Overdrive® as it is applied.

4.2.1.5 Accidental Spill to Pond

To represent worst-case potential impacts to the pond, a spill scenario was considered with a truck spilling an entire load (200 gallons [gal]) of herbicide mixed for the maximum application rate into the 1/4 acre, 1 m deep pond.

4.2.2 Effects Characterization

The ecological effects characterization phase entails a compilation and analysis of the stressor-response relationships and any other evidence of adverse impacts from exposure to Overdrive®. For the most part, available data consisted of the toxicity studies conducted in support of USEPA pesticide registration and were described in Section 3.1. Since registration testing is generally conducted on the a.i. of a product, more information was identified for diflufenzopyr and dicamba than for Overdrive®. TRVs selected for use in the ERA are presented in Table 3-1. Appendix A presents the full set of toxicity information identified for diflufenzopyr, dicamba, and Overdrive®.

In order to address potential risks to ecological receptors, RQs were calculated by dividing the EEC for each of the previously described scenarios by the appropriate TRV presented in Table 3-1. An RQ was calculated by dividing the EEC for a particular scenario by an herbicide specific TRV. The TRV may be a surface water or surface soil effects concentration, or a species-specific toxicity value derived from the literature. The equation used to derive the RQ is shown below:

Risk Quotient (unitless) = Estimated Exposure Concentration / Toxicity Reference Value

When available, TRVs derived for the product Overdrive® were selected for a given pathway. In these cases, the RQ was calculated by dividing the modeled Overdrive® EEC (sum of the diflufenzopyr and dicamba EECs) by the Overdrive® TRV. When Overdrive® TRVs were not available, the diflufenzopyr and dicamba components were evaluated separately with individual diflufenzopyr and dicamba TRVs, and the resulting RQs were summed to represent the Overdrive® RQ.

For the GLEAMS modeling of surface water runoff concentrations, the two component a.i. were modeled separately based on their individual chemical properties. Because of the different fate and transport properties of diflufenzpyr and dicamba, these two herbicides are not likely to remain in the same ratio following the GLEAMS modeling. In fact, the ratio of the herbicides modeled using GLEAMS varied greatly, changing significantly from the original ratio. While using an Overdrive® TRV is preferable, if the ratio of the herbicides varied far from the original ratio, it is more technically defensible to look at potential risks from a mix of the individual herbicide components of Overdrive® (i.e., diflufenzopyr and dicamba), rather than from Overdrive®. Therefore, to estimate the EECs from the GLEAMS model, the following rules were followed:

- In Overdrive®, the ratio of diflufenzopyr to dicamba is 0.4. If the ratio of diflufenzopyr to dicamba at the exposure point was within 100 times the ratio of the two a.i. as applied, the Overdrive® TRV and the sum of the two a.i. EECs were used to calculate the Overdrive® RQ.

- If the ratio of diflufenzopyr to dicamba at the exposure point varied > 100 times the ratio of the two a.i., the TRVs and the EECs for the individual a.i. were used to calculate individual RQs, and the resulting RQs were summed to obtain the Overdrive® RQ.

The RQs were then compared to LOCs established by the USEPA OPP to assess potential risk to non-target organisms. Table 4-1 presents the LOCs established for this assessment. Distinct USEPA LOCs are currently defined for the following risk presumption categories:

- **Acute high risk -** the potential for acute risk is high.

- **Acute restricted use -** the potential for acute risk is high, but may be mitigated through a restricted use designation.

- **Acute endangered species** – the potential for acute risk to endangered species is high.

- **Chronic risk -** the potential for chronic risk is high.

Additional uncertainty factors may also be applied to the standard LOCs to reflect uncertainties inherent in extrapolating from surrogate species toxicity data to obtain RQs (see Sections 6.3 and 7.0 for a discussion of uncertainty). A "chronic endangered species" risk presumption category for aquatic animals was added for this risk assessment. The LOC for this category was set to 0.5 to reflect the conservative two-fold difference in contaminant sensitivity between RTE and surrogate test fishes (Sappington et al. 2001). Risk quotients predicted for acute scenarios (e.g., direct spray, accidental spill) were compared to the three acute LOCs, and the RQs predicted for chronic scenarios (e.g., long term ingestion) were compared to the two chronic LOCs. If all RQs were less than the most conservative LOC for a particular receptor, comparisons against other, more elevated LOCs were not necessary.

The RQ approach used in this ERA provides a conservative measure of the potential for risk based on a snapshot of environmental conditions (e.g., rainfall, slope) and receptor assumptions (e.g., BW, ingestion rates). Sections 6.3 and 7.0 discuss several of the uncertainties inherent in the RQ methodology.

To specifically address potential impacts to RTE species, two types of RQ evaluations were conducted. For RTE terrestrial plant species, the RQ was calculated using different toxicity endpoints, but keeping the same LOC (set at 1) for all scenarios. The plant toxicity endpoints were selected to provide extra protection to the RTE species. In the direct spray, spray drift, and wind erosion scenarios, the selected toxicity endpoints were an EC_{25} for typical species and a NOAEL for RTE species. In runoff scenarios, high and low germination NOAELs were selected to evaluate exposure for typical and RTE species, respectively.

The evaluation of RTE terrestrial wildlife and aquatic species was addressed using a second type of RQ evaluation. The same toxicity endpoint was used for both typical and RTE species in all scenarios, but the LOC was lowered for RTE species.

4.3 Risk Characterization

The ecological risk characterization integrates the results of the exposure and effects phases of work (i.e., risk analysis), and presents an integrated approach to provide estimates of actual or potential risks to ecological receptors. Risk quotients are summarized in Tables 4-2 to 4-5 and presented graphically in Figures 4-3 to 4-18 at the end of this section. The results are discussed below for each of the evaluated exposure scenarios.

Box plots are used to graphically display the range of RQs obtained from evaluating each receptor and exposure scenario combination (Figures 4-3 to 4-18). These plots illustrate how RQ data are distributed about the mean and their relative relationships with LOCs. Outliers (data points outside the 90^{th} or 10^{th} percentile) were not discarded in this ERA; all RQ data presented in these plots were included in the risk assessment.

4.3.1 Direct Spray

As described in Section 4.2.1, potential impacts from direct spray were evaluated for exposure that could occur within the terrestrial application area (direct spray of terrestrial wildlife and non-target terrestrial plants, indirect contact with foliage, ingestion of contaminated food items) and outside the intended application area (accidental direct spray over pond and stream). Table 4-2 presents the RQs for the following scenarios (according to the receptors listed below): direct spray of terrestrial wildlife, indirect contact with foliage after direct spray, ingestion of contaminated food items by terrestrial wildlife, direct spray of non-target terrestrial plants, and accidental direct spray over a pond or stream. Figures 4-3 to 4-7 present graphic representations of the range of RQs and associated LOCs.

4.3.1.1 Terrestrial Wildlife

RQs for terrestrial wildlife (Figure 4-3) were all below the most conservative LOC of 0.1 (acute endangered species), indicating that direct spray impacts are not likely to pose a risk to terrestrial animals. RQs for chronic ingestion scenarios were below the associated LOC of 1 for all scenarios, except the ingestion of contaminated food items by the large mammalian herbivore. The scenario predicted elevated RQs of 1.4 and 12.8 at the typical and maximum application rates, repectively.

This evaluation indicates that direct spray impacts may pose a risk to large herbivorous mammals, primarily when the maximum application rate is used. Risks to insects, birds, small mammals, and carnivorous mammals is not predicted.

4.3.1.2 Non-target Plants – Terrestrial and Aquatic

RQs for non-target terrestrial plants (Figure 4-4) ranged from 61.0 to 273 and RQs for non-target aquatic plants (Figure 4-5) ranged from 0.267 to 107.

All of the terrestrial plant RQs were above the plant LOC of 1, indicating that direct spray impacts may pose a risk to these receptors. Aquatic plant RQs were below the plant LOC in the acute pond scenarios and above the plant LOC in all other pond and stream scenarios, indicating the potential for acute risk in the stream and long-term risk of harm in the pond and stream.

It may be noted that these aquatic scenarios are particularly conservative because they evaluate an instantaneous concentration and do not consider flow, adsorption to particles, or degradation that may occur over time within the pond or stream. The herbicide concentration in the pond and stream represents the instantaneous concentration at the moment of the direct spray. The volume of the pond and the impacted segment of the stream were calculated and the mass of herbicide was calculated based on the surface area of the waterbody. Potential dilution due to degradation or stream flow was not calculated. In addition, it is assumed that the pond and stream are adjacent to the herbicide application area.

4.3.1.3 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figure 4-6 and 4-7) were below the most conservative LOC of 0.05 (acute endangered species), indicating that direct spray impacts are not likely to pose a risk to these aquatic species. In addition, all chronic toxicity RQs for fish and aquatic invertebrates were well below the LOC for chronic risk to endangered species (0.5). These results indicate that impacts from direct spray are generally not likely to pose acute or chronic risk to these aquatic species.

4.3.2 Off-site Drift

As described in Section 4.2.1, AgDRIFT® software was used to evaluate a number of possible scenarios in which a portion of the applied herbicide drifts outside of the treatment area and deposits onto non-target receptors. Ground applications of Overdrive® were modeled using both a low- and high-placed boom (spray boom height set at 20 and 50 inches above the ground, respectively) and drift deposition was modeled at 25, 100, and 900 ft from the application area.

Table 4-3 presents the RQs for the following scenarios (according to the receptors listed below): off-site drift to off-site soil, off-site drift to pond, off-site drift to stream, and consumption of fish from the contaminated pond. Figures 4-8 to 4-12 present graphic representations of the range of RQs and associated LOCs.

4.3.2.1 Non-target Plants – Terrestrial and Aquatic

Most of the RQs for typical species of non-target terrestrial plants (Figure 4-8) affected by off-site drift to off-site soils were below the plant LOC of 1. RQs for typical non-target terrestrial plants were elevated (ranging from 1.30 to 2.14, depending on the testing scenario) when located 25 ft from ground application with a low boom at the maximum application rate and with a high boom at the typical or maximum application rate. RQs for several application scenarios with RTE plant species did exceed the LOC, with RQs between 1.09 and 5.74. At the typical application rate, elevated RQs for RTE species were predicted 25 ft from ground application with a low boom and 100 ft from ground application with a high boom. At the maximum application rate, elevated RQs for RTE species were predicted 100 ft from ground application with a low or high boom. These results indicate the potential for risk to typical and RTE species located at least 25 to 100 ft from the application area, depending on the boom height and application rate.

All RQs for non-target aquatic plants (Figure 4-9) affected by off-site drift were below the plant LOC of 1, indicating this transport mechanism is not likely to impact these receptors.

4.3.2.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figures 4-10 and 4-11) were all below the most conservative LOC of 0.05 (acute endangered species). All chronic RQs were well below the LOC for chronic risk to endangered species (0.5). These results indicate that impacts from off-site drift are not likely to pose acute or chronic risk to these aquatic species.

4.3.2.3 Piscivorous Birds

Risk to piscivorous birds was assessed by evaluating impacts from consumption of fish from a pond contaminated by off-site drift. RQs for the piscivorous bird (Figure 4-12) were all well below the most conservative terrestrial animal LOC (0.1), indicating that this scenario is not likely to pose a risk to piscivorous birds.

4.3.3 Surface Runoff

As described in Section 4.2.1, surface runoff and root-zone groundwater transport of herbicides from the application area to off-site soils and waterbodies was modeled using GLEAMS software. A total of 42 combinations of GLEAMS variables (i.e., soil type, annual precipitation, size of application area, hydraulic slope, surface roughness, and vegetation type) were modeled to account for a wide range of possible watersheds encountered on BLM lands.

Table 4-4 presents the RQs for the following scenarios: surface runoff to off-site soils, overland flow to the off-site pond, overland flow to the off-site stream, and consumption of fish from the contaminated pond. Figures 4-13 to 4-17 present graphic representations of the range of RQs and associated LOCs. A number of the GLEAMS scenarios, primarily those with minimal precipitation (e.g., 5 inches of precipitation per year), resulted in no predicted herbicide transport from the application area. Accordingly, because these conditions do not produce any off-site transport, they do not result in associated off-site risk. RQs are discussed below for those scenarios predicting off-site transport and RQs greater than zero.

4.3.3.1 Non-target Plants – Terrestrial and Aquatic

RQs for typical non-target terrestrial plant species affected by surface runoff to off-site soil (Figure 4-13) were all below the plant LOC of 1, indicating that transport due to surface runoff is not likely to pose a risk to these receptors. Most RQs for RTE non-target terrestrial plant species were also below the plant LOC of 1. However, several scenarios did result in elevated RQs at the typical and maximum application rates. These scenarios included the base watershed with clay soils and more than 25 inches of precipitation per year (250 inches per year was the maximum precipitation modeled) and three variations on the base watershed with 50 inches of precipitation per year (silt loam, silt, and clay loam soil).This indicates the potential for risk to RTE plant species in selected watersheds dominated by clay soils, at the typical and maximum application rates with > 25 inches annual precipitation, with additional risk associated with soils dominated by silt and clay under situations exceeding 50 inches annual precipitation.

Acute and chronic RQs for non-target aquatic plants in the stream impacted by overland flow of herbicide (Figure 4-14) were all below the plant LOC of 1. Acute RQs for non-target aquatic plants in the pond were also below the plant LOC, with one exception. An RQ of 1.04 was predicted at the maximum application rate in the base watershed with sandy soil and 150 inches of precipitation per year. However, this LOC exceedance was minimal and in general these results indicate that this transport mechanism is not likely to pose a risk to aquatic plant species under these conditions.

Chronic RQs exceeded the LOC for several pond scenarios. Elevated RQs ranged from 1.02 to 3.74 at the typical application rate and from 1.15 to 4.06 at the maximum application rate. RQs above the plant LOC of 1 were predicted in 14 scenarios at the typical application rate and 16 scenarios at the maximum application rate. Potential risk scenarios occur in watersheds with 50 inches or more of annual precipitation and sand, clay, and silt soils (risk is also predicted in watersheds with clay soils and 25 inches of annual precipitation and loam soils with 250 inches of precipitation. The maximum RQ was predicted in the base watershed with clay soils and 50 inches of precipitation per year.

4.3.3.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figure 4-15 and Figures 4-16) were all below the most conservative LOC of 0.05 (acute endangered species) for all pond and stream scenarios, indicating that impacts from surface runoff are not likely to pose a risk to these aquatic species.

Chronic risk RQs were well below the LOC for chronic risk to endangered species (0.5), indicating that these scenarios are not likely to result in long-term risk to aquatic animals in the stream or pond.

4.3.3.3 Piscivorous Birds

Risk to piscivorous birds (Figure 4-17) was assessed by evaluating impacts from consumption of fish from a pond contaminated by surface runoff. RQs for the piscivorous bird were all well below the most conservative terrestrial animal LOC (0.1), indicating that this scenario is not likely to pose a risk to piscivorous birds.

4.3.4 Wind Erosion and Transport Off-site

As described in Section 4.2.1, five distinct watersheds were modeled using CALPUFF to determine herbicide concentrations in dust deposited on plants after a wind event with dust deposition estimates calculated at 1.5, 10, and 100 km from the application area. Deposition results for Winnemucca, NV and Tucson, AZ were not listed because the meteorological conditions (i.e., wind speed) that must be met to trigger particulate emissions for the land cover conditions assumed for these sites did not occur for any hour of the selected year. Therefore, it was assumed herbicide migration by windblown soil would not occur at those locations during that year.

The soil type assumed for Winnemucca, NV and Tuscon, AZ was undisturbed sandy loam, which has a higher friction velocity (i.e., is harder for wind to pick up as dust) than the soil types of the other locations. As further explained in Section 5.3, friction velocity is a function of the measured wind speed and the surface roughness, a property affected by land use and vegetative cover. The threshold friction velocities at the other three sites (103 or 150 centimeters per second [cm/sec]) were much lower, based on differences in the assumed soil types. At these sites, wind and land cover conditions combined to predict that the soil would be eroded on several days. Soils of similar properties at Winnemucca and Tucson, if present, would also have been predicted to be subject to erosion under weather conditions encountered there.

Table 4-5 summarizes the RQs for typical and RTE terrestrial plant species exposed to contaminated dust within the four remaining watersheds at typical and maximum application rates. Figure 4-18 presents a graphic representation of the range of RQs and associated LOCs. RQs for typical and RTE terrestrial plants were all well below the plant LOC (1), indicating that wind erosion is not likely to pose a risk to non-target terrestrial plants.

4.3.5 Accidental Spill to Pond

As described in Section 4.2.1, one spill scenario was considered. The herbicide concentration in the pond was the instantaneous concentration at the moment of the 200 gal truck spill. The volume of the pond was determined and the volume of herbicide in the truck was mixed into the pond volume.

Risk quotients for the spill scenario (Table 4-2) were 0.0040 for aquatic invertebrates, 0.043 for fish (Figure 4-6 and 4-7) and 14.3 for non-target aquatic plants (Figure 4-5). These scenarios are highly conservative and represent unlikely and worst case conditions (limited waterbody volume, tank mixed for maximum application). Spills of this magnitude are possible, but are not likely to occur. However, potential risk to non-target aquatic plants was indicated for the truck spill mixed for the maximum application rate.

4.3.6 Potential Risk to Salmonids from Indirect Effects

In addition to direct effects of herbicides on salmonids and other fish species in stream habitats (i.e., mortality due to herbicide concentrations in surface water), reduction in vegetative cover or food supply may indirectly impact individuals or populations. No literature studies were identified that explicitly evaluated the indirect effects of Overdrive® to salmonids and their habitat; therefore, only qualitative estimates of indirect effects are possible. This was accomplished by discussing predicted impacts to food items and vegetative cover in the stream scenarios evaluated above. These scenarios include accidental direct spray over the stream and transport to the stream via off-site drift and surface runoff. An evaluation of impacts to non-target terrestrial plants was also included as part of the discussion of vegetative cover within the riparian zone. Prey items for salmonids and other potential RTE species may include other fish species, aquatic invertebrates, or aquatic plants. Additional discussion of RTE species is provided in Section 6.0.

4.3.6.1 Qualitative Evaluation of Impacts to Prey

Fish species were evaluated directly in the ERA using acute and chronic TRVs based on the most sensitive warm- or cold-water species identified during the literature search. Salmonid species were included in the derivation of the TRVs and rainbow trout were the basis of the selected acute TRVs for both diflufenzopyr and dicamba and the chronic TRV for dicamba. The chronic fish TRV for diflufenzopyr was based on a warmwater species, the bluegill sunfish. The selected chronic TRV was five times higher than the rainbow trout chronic indicating that chronic direct impacts of diflufenzopyr to salmonids may be overestimated in the risk assessment.

Aquatic invertebrates were also evaluated directly using acute and chronic TRVs based on sensitive aquatic invertebrate species. Direct impacts to prey items (i.e., mortality to fish and aquatic invertebrates resulting from herbicide exposure) may result in indirect impacts on the salmonid population. No RQs in excess of the appropriate acute or chronic LOCs were observed for fish or aquatic invertebrates in any of the stream scenarios. Because fish and aquatic invertebrates are not predicted to be directly impacted by herbicide concentrations in the stream, their availability as prey item populations is not likely to be impacted, and there is not likely to be an indirect effect on salmonids due to a lack of prey.

4.3.6.2 Qualitative Evaluation of Impacts to Vegetative Cover

A qualitative evaluation of indirect impacts to salmonids resulting from destruction of riparian vegetation and reduction of available cover was made by considering impacts to terrestrial and aquatic plants. Acute and chronic aquatic plant RQs for accidental direct spray scenarios were above the plant LOC at both the typical and maximum application rates, indicating the potential for a reduction in the aquatic plant community. However, this is an extremely conservative scenario in which it is assumed that a stream is accidentally directly sprayed by a terrestrial herbicide. This is unlikely to occur as a result of BLM pesticide management practices and represents a worst-case scenario. In addition, no reduction in herbicide concentration due to stream flow is calculated in this scenario. Stream flow would likely dilute the herbicide concentration and reduce potential impacts. Nevertheless, if the stream is accidentally sprayed, there is the potential for indirect impacts to salmonids as a result of reduction in available cover.

No RQs in excess of the LOC were observed for aquatic plant species in the stream for any of the off-site drift or surface runoff scenarios.

Although not specifically evaluated in the stream scenarios of the ERA, terrestrial plants were evaluated for their potential to provide overhanging cover for salmonids. A reduction in riparian cover has the potential to indirectly impact salmonids within the stream. RQs for terrestrial plants were elevated above the LOC for accidental direct spray scenarios at both the typical and maximum application rates, indicating the potential for a reduction in this plant community. However, as discussed above, this scenario is unlikely to occur as a result of BLM pesticide management practices and represents a worst-case scenario in which the riparian zone is directly sprayed with the terrestrial herbicide.

RQs for non-target typical and RTE terrestrial plants were also observed above the plant LOC as a result of off-site drift. At the typical application rate, elevated RQs were predicted 25 ft from ground application with a low boom and 100 ft from ground application with a high boom. At the maximum application rate, elevated RQs were predicted 100 ft from ground application with a low or high boom. RQs in excess of the LOC were also predicted for RTE terrestrial plants due to surface runoff in clay watersheds with at least 25 inches of precipitation per year and in clay-loam, silt-loam, and silt watersheds with at least 50 inches of precipitation per year. These results indicate the potential for a reduction in riparian cover under selected conditions as a result of off-site drift and/or surface runoff.

4.3.6.3 Conclusions

This qualitative evaluation indicates that salmonids are not likely to be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). However, a reduction in vegetative cover may occur under limited conditions. Accidental direct spray, off-site drift during ground applications, and surface runoff in selected watersheds may negatively impact terrestrial or aquatic plants, reducing the cover available to salmonids within the stream. However, increasing the buffer zone or reducing the application rate and avoiding accidental applications to non-target or wet areas would reduce the likelihood of these impacts.

In addition, the effects of terrestrial herbicides in water are expected to be relatively transient and stream flow is likely to reduce herbicide concentrations over time. In a review of potential impacts of another terrestrial herbicide to threatened and endangered salmonids, the USEPA OPP indicated that "for most pesticides applied to terrestrial environment, the effects in water, even lentic water, will be relatively transient" (Turner 2003). Only very persistent pesticides would be expected to have effects beyond the year of their application. The OPP report indicated that if a listed salmonid is not present during the year of application, there would likely be no concern (Turner 2003). Therefore, it is expected that potential adverse impacts to food and cover would not occur beyond the season of application (except for cover provided by impacted riparian plants).

TABLE 4-1
Levels of Concern

Risk Presumption		RQ	LOC
Terrestrial Animals [1]			
Birds	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Wild Mammals	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Aquatic Animals [2]			
Fish and Aquatic Invertebrates	Acute High Risk	EEC/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/NOAEL	1
	Chronic Risk, Endangered Species	EEC/ NOAEL	0.5
Plants [3]			
Terrestrial/Semi-Aquatic Plants	Acute High Risk	EEC/EC_{25}	1
	Acute Endangered Species	EEC/ NOAEL	1
Aquatic Plants	Acute High Risk	EEC/EC_{50}	1
	Acute Endangered Species	EEC/ NOAEL	1

[1] Estimated Environmental Concentration (EEC) is in mg prey/kg bw for acute scenarios and mg prey/kg bw/day for chronic scenarios.
[2] EEC is in mg/L.
[3] EEC is in lbs/ac.

TABLE 4-2
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Animals	**Typical Application Rate**		**Maximum Application Rate**	
Direct Spray of Terrestrial Wildlife				
Small mammal - 100% absorption	3.42E-04	[a]	5.69E-04	[a]
Pollinating insect - 100% absorption	4.52E-02	[b]	7.05E-02	[b]
Small mammal - 1st order dermal adsorption	3.38E-05	[a]	5.59E-05	[a]
Indirect Contact With Foliage After Direct Spray				
Small mammal - 100% absorption	3.42E-05	[a]	5.69E-05	[a]
Pollinating insect - 100% absorption	4.52E-03	[b]	7.05E-03	[b]
Small mammal - 1st order dermal adsorption	3.38E-06	[a]	5.59E-06	[a]
Ingestion of Food Items Contaminated by Direct Spray				
Small mammalian herbivore - acute exposure	3.17E-04	[a]	3.98E-03	[a]
Small mammalian herbivore - chronic exposure	1.57E-02	[b]	1.95E-01	[b]
Large mammalian herbivore - acute exposure	2.03E-03	[a]	1.86E-02	[a]
Large mammalian herbivore - chronic exposure	**1.40E+00**	[b]	**1.28E+01**	[b]
Small avian insectivore - acute exposure	2.92E-04	[a]	3.78E-03	[a]
Small avian insectivore - chronic exposure	1.08E-04	[a]	1.40E-03	[a]
Large avian herbivore - acute exposure	5.51E-04	[b]	7.12E-03	[b]
Large avian herbivore - chronic exposure	5.24E-03	[b]	7.00E-02	[b]
Large mammalian carnivore - acute exposure	1.32E-03	[a]	2.21E-03	[a]
Large mammalian carnivore - chronic exposure	5.43E-01	[b]	9.05E-01	[b]

TABLE 4-2 (Cont.)
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Plants	Typical Species				Rare, Threatened, and Endangered Species			
	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Direct Spray of Non-Target Terrestrial Plants								
Accidental direct spray	**6.10E+01**	[a]	**1.02E+02**	[a]	**1.64E+02**	[a]	**2.73E+02**	[a]

Aquatic Species	Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
	Typical Application		Maximum Application		Typical Application		Maximum Application		Typical Application		Maximum Application	
Accidental Direct Spray Over Pond												
Acute	8.30E-04	[b]	1.36E-03	[b]	7.54E-05	[a]	1.26E-04	[a]	2.67E-01	[a]	4.46E-01	[a]
Chronic	2.79E-03	[b]	4.47E-03	[b]	2.26E-04	[a]	3.77E-04	[a]	**1.28E+01**	[a]	**2.13E+01**	[a]
Accidental Direct Spray Over Stream												
Acute	4.15E-03	[b]	6.78E-03	[b]	3.77E-04	[a]	6.29E-04	[a]	**1.34E+00**	[a]	**2.23E+00**	[a]
Chronic	1.39E-02	[b]	2.23E-02	[b]	1.13E-03	[a]	1.89E-03	[a]	**6.40E+01**	[a]	**1.07E+02**	[a]
Accidental spill												
Truck spill into pond	--		4.34E-02	[b]	--		4.02E-03	[a]	--		**1.43E+01**	[a]

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates (LOC for chronic risk to endangered species).
Shading and boldface indicates terrestrial animal acute scenario RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1 (LOC for chronic risk).
[a] RQ derived using Overdrive® EEC and TRV.
[b] RQ derived using sum of RQs derived using dicamba and diflufenzopyr EECs and TRVs.
[c] RQ derived using Overdrive® EEC and TRV, and RQ derived using dicamba and diflufenzopyr EECs and TRVs are equal.

TABLE 4-3
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Non-Target Terrestrial Plants										
Mode of Application	**Application Height or Type**	**Distance From Receptor (ft)**	**Typical Species**				**Rare, Threatened, and Endangered Species**			
			Typical Application Rate		**Maximum Application Rate**		**Typical Application Rate**		**Maximum Application Rate**	
Spray Drift to Off-Site Soil										
Ground	Low Boom	25	7.33E-01	[a]	**1.32E+00**	[a]	**1.97E+00**	[a]	**3.55E+00**	[a]
Ground	Low Boom	100	2.44E-01	[a]	4.07E-01	[a]	6.56E-01	[a]	**1.09E+00**	[a]
Ground	Low Boom	900	4.16E-02	[a]	6.94E-02	[a]	1.12E-01	[a]	1.86E-01	[a]
Ground	High Boom	25	**1.30E+00**	[a]	**2.14E+00**	[a]	**3.50E+00**	[a]	**5.74E+00**	[a]
Ground	High Boom	100	4.07E-01	[a]	7.12E-01	[a]	**1.09E+00**	[a]	**1.91E+00**	[a]
Ground	High Boom	900	5.33E-02	[a]	8.88E-02	[a]	1.43E-01	[a]	2.39E-01	[a]

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Fish: Typical Application		Fish: Maximum Application		Aquatic Invertebrates: Typical Application		Aquatic Invertebrates: Maximum Application		Non-Target Aquatic Plants: Typical Application		Non-Target Aquatic Plants: Maximum Application	
Potential Risk to Aquatic Receptors														
Off-Site Drift to Pond Acute Toxicity														
Ground	Low Boom	25	5.04E-06	[b]	8.26E-06	[b]	4.59E-07	[a]	7.65E-07	[a]	1.63E-03	[a]	2.71E-03	[a]
Ground	Low Boom	100	2.76E-06	[b]	4.53E-06	[b]	2.51E-07	[a]	4.20E-07	[a]	8.91E-04	[a]	1.49E-03	[a]
Ground	Low Boom	900	5.34E-07	[b]	8.74E-07	[b]	4.86E-08	[a]	8.10E-08	[a]	1.72E-04	[a]	2.87E-04	[a]
Ground	High Boom	25	8.10E-06	[b]	1.32E-05	[b]	7.37E-07	[a]	1.22E-06	[a]	2.61E-03	[a]	4.34E-03	[a]
Ground	High Boom	100	4.27E-06	[b]	6.98E-06	[b]	3.89E-07	[a]	6.47E-07	[a]	1.38E-03	[a]	2.29E-03	[a]
Ground	High Boom	900	6.78E-07	[b]	1.11E-06	[b]	6.17E-08	[a]	1.03E-07	[a]	2.19E-04	[a]	3.64E-04	[a]
Off-Site Drift to Pond Chronic Toxicity														
Ground	Low Boom	25	1.69E-05	[b]	2.72E-05	[b]	1.38E-06	[a]	2.30E-06	[a]	7.78E-02	[a]	1.30E-01	[a]
Ground	Low Boom	100	9.28E-06	[b]	1.49E-05	[b]	7.54E-07	[a]	1.26E-06	[a]	4.26E-02	[a]	7.11E-02	[a]
Ground	Low Boom	900	1.79E-06	[b]	2.88E-06	[b]	1.46E-07	[a]	2.43E-07	[a]	8.23E-03	[a]	1.37E-02	[a]
Ground	High Boom	25	2.72E-05	[b]	4.34E-05	[b]	2.21E-06	[a]	3.67E-06	[a]	1.25E-01	[a]	2.07E-01	[a]
Ground	High Boom	100	1.43E-05	[b]	2.30E-05	[b]	1.17E-06	[a]	1.94E-06	[a]	6.59E-02	[a]	1.10E-01	[a]
Ground	High Boom	900	2.28E-06	[b]	3.65E-06	[b]	1.85E-07	[a]	3.08E-07	[a]	1.05E-02	[a]	1.74E-02	[a]

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Aquatic Receptors														
Mode of Application	**Application Height or Type**	**Distance From Receptor (ft)**	**Fish**				**Aquatic Invertebrates**				**Non-Target Aquatic Plants**			
			Typical Application		**Maximum Application**		**Typical Application**		**Maximum Application**		**Typical Application**		**Maximum Application**	
Off-Site Drift to Stream Acute Toxicity														
Ground	Low Boom	25	9.08E-06	[b]	1.48E-05	[b]	8.26E-07	[a]	1.38E-06	[a]	2.93E-03	[a]	4.88E-03	[a]
Ground	Low Boom	100	2.66E-06	[b]	4.35E-06	[b]	2.42E-07	[a]	4.03E-07	[a]	8.57E-04	[a]	1.43E-03	[a]
Ground	Low Boom	900	2.75E-07	[b]	4.50E-07	[b]	2.50E-08	[a]	4.17E-08	[a]	8.88E-05	[a]	1.48E-04	[a]
Ground	High Boom	25	1.52E-05	[b]	2.49E-05	[b]	1.38E-06	[a]	2.30E-06	[a]	4.90E-03	[a]	8.17E-03	[a]
Ground	High Boom	100	4.31E-06	[b]	7.04E-06	[b]	3.92E-07	[a]	6.53E-07	[a]	1.39E-03	[a]	2.31E-03	[a]
Ground	High Boom	900	3.64E-07	[b]	5.95E-07	[b]	3.31E-08	[a]	5.52E-08	[a]	1.17E-04	[a]	1.96E-04	[a]
Off-Site Drift to Stream Chronic Toxicity														
Ground	Low Boom	25	3.05E-05	[b]	4.89E-05	[b]	2.48E-06	[a]	4.13E-06	[a]	1.40E-01	[a]	2.33E-01	[a]
Ground	Low Boom	100	8.93E-06	[b]	1.43E-05	[b]	7.26E-07	[a]	1.21E-06	[a]	4.10E-02	[a]	6.84E-02	[a]
Ground	Low Boom	900	9.24E-07	[b]	1.48E-06	[b]	7.51E-08	[a]	1.25E-07	[a]	4.25E-03	[a]	7.08E-03	[a]
Ground	High Boom	25	5.10E-05	[b]	8.19E-05	[b]	4.15E-06	[a]	6.91E-06	[a]	2.34E-01	[a]	3.91E-01	[a]
Ground	High Boom	100	1.45E-05	[b]	2.32E-05	[b]	1.17E-06	[a]	1.96E-06	[a]	6.64E-02	[a]	1.11E-01	[a]
Ground	High Boom	900	1.22E-06	[b]	1.96E-06	[b]	9.93E-08	[a]	1.65E-07	[a]	5.61E-03	[a]	9.35E-03	[a]

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond						
Mode of Application	**Application Height or Type**	**Distance From Receptor (ft)**	**Application Rate**			
			Typical		**Maximum**	
Ground	Low Boom	25	3.28E-06	[b]	5.43E-06	[b]
Ground	Low Boom	100	1.80E-06	[b]	2.98E-06	[b]
Ground	Low Boom	900	3.47E-07	[b]	5.75E-07	[b]
Ground	High Boom	25	5.27E-06	[b]	8.68E-06	[b]
Ground	High Boom	100	2.78E-06	[b]	4.60E-06	[b]
Ground	High Boom	900	4.41E-07	[b]	7.30E-07	[b]

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates (LOC for chronic risk to endangered species).
Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1 (LOC for chronic risk).
[a] RQ derived using Overdrive® EEC and TRV.
[b] RQ derived using sum of RQs derived using dicamba and diflufenzopyr EECs and TRVs.
[c] RQs derived using Overdrive® EEC and TRV, and RQ derived using dicamba and diflufenzopyr EECs and TRVs are equal.

TABLE 4-4
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Non-Target Terrestrial Plants														
							Typical Species				Rare, Threatened, and Endangered Species			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Surface Runoff to Off-Site Soils														
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.40E-06	[b]	2.33E-06	[b]	3.36E-04	[b]	5.60E-04	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.04E-09	[b]	1.73E-09	[b]	2.50E-07	[b]	4.16E-07	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.38E-03	[b]	4.51E-03	[b]	9.46E-01	[b]	**1.26E+00**	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.98E-09	[b]	3.31E-09	[b]	4.78E-07	[b]	7.97E-07	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.16E-02	[b]	2.88E-02	[b]	**6.06E+00**	[b]	**8.08E+00**	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-03	[b]	1.40E-03	[b]	2.94E-01	[b]	3.92E-01	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.45E-09	[a]	2.42E-09	[a]	4.18E-08	[a]	6.97E-08	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	6.42E-02	[b]	8.56E-02	[b]	**1.80E+01**	[b]	**2.40E+01**	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.90E-03	[b]	2.53E-03	[b]	5.31E-01	[b]	7.08E-01	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.73E-02	[b]	1.03E-01	[b]	**2.16E+01**	[b]	**2.88E+01**	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.13E-03	[b]	2.85E-03	[b]	5.98E-01	[b]	7.97E-01	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	7.70E-02	[b]	1.03E-01	[b]	**2.16E+01**	[b]	**2.87E+01**	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.68E-03	[b]	2.25E-03	[b]	4.72E-01	[b]	6.29E-01	[b]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	7.47E-02	[b]	9.96E-02	[b]	**2.09E+01**	[b]	**2.79E+01**	[b]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.20E-03	[b]	1.60E-03	[b]	3.37E-01	[b]	4.49E-01	[b]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Non-Target Terrestrial Plants															
							Typical Species				Rare, Threatened, and Endangered Species				
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Surface Runoff to Off-Site Soils															
50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.02E-03	[b]	1.37E-03	[b]	2.87E-01	[b]	3.82E-01	[b]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.03E-03	[b]	1.38E-03	[b]	2.89E-01	[b]	3.85E-01	[b]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.05E-03	[b]	1.39E-03	[b]	2.93E-01	[b]	3.91E-01	[b]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.02E-03	[b]	1.36E-03	[b]	2.87E-01	[b]	3.82E-01	[b]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.02E-03	[b]	1.36E-03	[b]	2.87E-01	[b]	3.82E-01	[b]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.02E-03	[b]	1.37E-03	[b]	2.87E-01	[b]	3.82E-01	[b]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.04E-03	[b]	1.39E-03	[b]	2.91E-01	[b]	3.88E-01	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	9.27E-03	[b]	1.24E-02	[b]	**2.60E+00**	[b]	**3.46E+00**	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	8.41E-03	[b]	1.12E-02	[b]	**2.36E+00**	[b]	**3.14E+00**	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.90E-02	[b]	2.53E-02	[b]	**5.31E+00**	[b]	**7.08E+00**	[b]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.03E-03	[b]	1.37E-03	[b]	2.88E-01	[b]	3.84E-01	[b]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.35E-03	[b]	1.81E-03	[b]	3.79E-01	[b]	5.06E-01	[b]

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TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Overland Flow to Off-Site Pond																		
Acute Toxicity																		
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.43E-04	[b]	4.05E-04	[b]	1.79E-03	[b]	2.98E-03	[b]	6.80E-02	[b]	1.13E-01	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	8.01E-07	[b]	1.33E-06	[b]	5.90E-06	[b]	9.84E-06	[b]	2.24E-04	[b]	3.74E-04	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.27E-06	[b]	8.78E-06	[b]	3.88E-05	[b]	6.47E-05	[b]	1.47E-03	[b]	2.46E-03	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	9.78E-04	[b]	1.63E-03	[b]	7.21E-03	[b]	1.20E-02	[b]	2.74E-01	[b]	4.57E-01	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.27E-04	[b]	2.02E-04	[b]	3.58E-05	[a]	5.96E-05	[a]	1.27E-01	[a]	2.11E-01	[a]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	4.39E-04	[b]	7.31E-04	[b]	3.23E-03	[b]	5.39E-03	[b]	1.23E-01	[b]	2.05E-01	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.16E-03	[b]	1.93E-03	[b]	1.21E-04	[a]	2.02E-04	[a]	4.29E-01	[a]	7.15E-01	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	4.16E-04	[b]	6.45E-04	[b]	1.63E-04	[a]	2.72E-04	[a]	5.79E-01	[a]	9.65E-01	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.21E-05	[a]	8.69E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.23E-03	[b]	2.03E-03	[b]	1.67E-04	[a]	2.78E-04	[a]	5.91E-01	[a]	9.85E-01	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	4.46E-04	[b]	7.14E-04	[b]	1.19E-04	[a]	1.98E-04	[a]	4.22E-01	[a]	7.03E-01	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	6.04E-04	[b]	1.01E-03	[b]	6.23E-05	[a]	1.04E-04	[a]	2.21E-01	[a]	3.68E-01	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.14E-03	[b]	1.88E-03	[b]	1.75E-04	[a]	2.92E-04	[a]	6.22E-01	[a]	**1.04E+00**	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	4.16E-04	[b]	6.81E-04	[b]	7.28E-05	[a]	1.21E-04	[a]	2.58E-01	[a]	4.30E-01	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	6.52E-04	[b]	1.09E-03	[b]	6.62E-05	[a]	8.00E-03	[b]	2.35E-01	[a]	3.05E-01	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	9.78E-04	[b]	1.61E-03	[b]	1.58E-04	[a]	2.63E-04	[a]	5.60E-01	[a]	9.33E-01	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	4.27E-04	[b]	7.00E-04	[b]	7.18E-05	[a]	1.20E-04	[a]	2.55E-01	[a]	4.24E-01	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	5.83E-04	[b]	9.72E-04	[b]	5.93E-05	[a]	9.89E-05	[a]	2.10E-01	[a]	3.51E-01	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	9.42E-04	[b]	1.55E-03	[b]	1.57E-04	[a]	2.62E-04	[a]	5.57E-01	[a]	9.28E-01	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.36E-04	[b]	7.12E-04	[b]	8.15E-05	[a]	1.36E-04	[a]	2.89E-01	[a]	4.82E-01	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	4.97E-04	[b]	8.28E-04	[b]	5.13E-05	[a]	8.54E-05	[a]	1.82E-01	[a]	3.03E-01	[a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Overland Flow to Off-Site Pond																		
Acute Toxicity																		
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.18E-04	[b]	3.64E-04	[b]	2.26E-05	[a]	3.77E-05	[a]	8.03E-02	[a]	1.34E-01	[a]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	5.64E-04	[b]	9.40E-04	[b]	5.83E-05	[a]	9.72E-05	[a]	2.07E-01	[a]	3.44E-01	[a]
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	5.66E-04	[b]	9.42E-04	[b]	5.84E-05	[a]	9.74E-05	[a]	2.07E-01	[a]	3.45E-01	[a]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.84E-01	[a]	3.07E-01	[a]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.21E-05	[a]	8.68E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.21E-05	[a]	8.69E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.84E-01	[a]	3.07E-01	[a]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.84E-01	[a]	3.07E-01	[a]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.84E-01	[a]	3.07E-01	[a]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.21E-05	[a]	8.68E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.12E-04	[b]	6.73E-04	[b]	7.50E-05	[a]	1.25E-04	[a]	2.66E-01	[a]	4.43E-01	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.83E-04	[b]	6.28E-04	[b]	6.64E-05	[a]	1.11E-04	[a]	2.35E-01	[a]	3.92E-01	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.68E-04	[b]	5.89E-04	[b]	9.90E-05	[a]	1.65E-04	[a]	3.51E-01	[a]	5.85E-01	[a]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	4.81E-04	[b]	8.00E-04	[b]	5.20E-05	[a]	8.67E-05	[a]	1.85E-01	[a]	3.08E-01	[a]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	5.10E-04	[b]	8.48E-04	[b]	5.51E-05	[a]	9.19E-05	[a]	1.95E-01	[a]	3.26E-01	[a]

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TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Overland Flow to Off-Site Pond																		
Chronic Toxicity																		
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.38E-04	[b]	3.97E-04	[b]	1.75E-03	[b]	2.91E-03	[b]	6.72E-02	[b]	1.12E-01	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.70E-07	[b]	2.84E-07	[b]	1.25E-06	[b]	2.08E-06	[b]	4.80E-05	[b]	8.00E-05	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.11E-06	[b]	8.52E-06	[b]	3.75E-05	[b]	6.24E-05	[b]	1.44E-03	[b]	2.40E-03	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	6.60E-04	[b]	1.10E-03	[b]	4.83E-03	[b]	8.05E-03	[b]	1.86E-01	[b]	3.10E-01	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.46E-04	[b]	2.39E-04	[b]	1.80E-05	[a]	3.01E-05	[a]	**1.02E+00**	[a]	**1.70E+00**	[a]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	5.38E-04	[b]	8.97E-04	[b]	3.94E-03	[b]	6.56E-03	[b]	1.52E-01	[b]	2.53E-01	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.12E-04	[b]	6.86E-04	[b]	4.26E-05	[a]	7.10E-05	[a]	**3.74E+00**	[a]	**4.01E+00**	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	3.62E-04	[b]	5.96E-04	[b]	4.31E-05	[a]	7.18E-05	[a]	**2.43E+00**	[a]	**4.06E+00**	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.93E-04	[b]	4.75E-04	[b]	4.19E-05	[a]	6.98E-05	[a]	**2.37E+00**	[a]	**3.94E+00**	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	3.02E-04	[b]	5.01E-04	[b]	3.27E-05	[a]	5.45E-05	[a]	**1.85E+00**	[a]	**3.08E+00**	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	2.39E-04	[b]	3.98E-04	[b]	1.75E-03	[b]	2.92E-03	[b]	6.76E-02	[b]	1.13E-01	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	2.11E-04	[b]	3.34E-04	[b]	3.85E-05	[a]	6.42E-05	[a]	**2.18E+00**	[a]	**3.63E+00**	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.66E-04	[b]	4.43E-04	[b]	2.77E-05	[a]	4.61E-05	[a]	**1.56E+00**	[a]	**2.61E+00**	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.86E-04	[b]	3.10E-04	[b]	1.36E-03	[b]	2.27E-03	[b]	5.29E-02	[b]	8.80E-02	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.83E-04	[b]	2.90E-04	[b]	3.44E-05	[a]	5.74E-05	[a]	**1.95E+00**	[a]	**3.24E+00**	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.44E-04	[b]	4.06E-04	[b]	2.55E-05	[a]	4.24E-05	[a]	**1.44E+00**	[a]	**2.40E+00**	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.44E-04	[b]	2.41E-04	[b]	1.47E-05	[a]	2.45E-05	[a]	8.31E-01	[a]	**1.39E+00**	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.81E-04	[b]	2.89E-04	[b]	3.10E-05	[a]	5.16E-05	[a]	**1.75E+00**	[a]	**2.92E+00**	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	2.29E-04	[b]	3.81E-04	[b]	2.43E-05	[a]	4.05E-05	[a]	**1.37E+00**	[a]	**2.29E+00**	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-04	[b]	1.96E-04	[b]	1.22E-05	[a]	2.04E-05	[a]	6.92E-01	[a]	**1.15E+00**	[a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application		Maximum Application		Typical Application		Maximum Application		Typical Application		Maximum Application	
Overland Flow to Off-Site Pond																		
Chronic Toxicity																		
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.08E-04	[b]	3.46E-04	[b]	1.52E-03	[b]	2.53E-03	[b]	5.94E-02	[b]	9.86E-02	[b]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	3.59E-04	[b]	5.98E-04	[b]	2.63E-03	[b]	4.38E-03	[b]	1.01E-01	[b]	1.69E-01	[b]
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	3.63E-04	[b]	6.06E-04	[b]	2.66E-03	[b]	4.43E-03	[b]	1.03E-01	[b]	1.71E-01	[b]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.39E-04	[b]	5.63E-04	[b]	3.55E-05	[a]	5.92E-05	[a]	**2.01E+00**	[a]	**3.35E+00**	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.02E-04	[b]	5.02E-04	[b]	3.15E-05	[a]	5.24E-05	[a]	**1.78E+00**	[a]	**2.96E+00**	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.33E-04	[b]	5.51E-04	[b]	3.70E-05	[a]	6.17E-05	[a]	**2.09E+00**	[a]	**3.48E+00**	[a]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	3.20E-04	[b]	5.34E-04	[b]	2.34E-03	[b]	3.90E-03	[b]	9.11E-02	[b]	1.51E-01	[b]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	3.10E-04	[b]	5.17E-04	[b]	2.27E-03	[b]	3.79E-03	[b]	8.82E-02	[b]	1.47E-01	[b]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Fish: Typical Application Rate		Fish: Maximum Application Rate		Aquatic Invertebrates: Typical Application Rate		Aquatic Invertebrates: Maximum Application Rate		Non-Target Aquatic Plants: Typical Application Rate		Non-Target Aquatic Plants: Maximum Application Rate	
Potential Risk to Aquatic Receptors																		
Overland Flow to Off-Site Stream																		
Acute Toxicity																		
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	9.80E-06	[b]	1.63E-05	[b]	7.22E-05	[b]	1.20E-04	[b]	2.74E-03	[b]	4.57E-03	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	2.61E-08	[b]	4.36E-08	[b]	1.93E-07	[b]	3.21E-07	[b]	7.32E-06	[b]	1.22E-05	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	9.52E-08	[b]	1.59E-07	[b]	7.01E-07	[b]	1.17E-06	[b]	2.66E-05	[b]	4.44E-05	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	7.53E-05	[b]	1.25E-04	[b]	5.55E-04	[b]	9.24E-04	[b]	2.11E-02	[b]	3.51E-02	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	2.21E-06	[b]	3.38E-06	[b]	9.87E-07	[a]	1.64E-06	[a]	3.50E-03	[a]	5.83E-03	[a]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.78E-05	[b]	4.64E-05	[b]	2.05E-04	[b]	3.42E-04	[b]	7.79E-03	[b]	1.30E-02	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	8.72E-05	[b]	1.45E-04	[b]	8.97E-06	[a]	1.49E-05	[a]	3.18E-02	[a]	5.30E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.12E-05	[b]	1.70E-05	[b]	5.54E-06	[a]	9.24E-06	[a]	1.97E-02	[a]	3.28E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.73E-06	[a]	7.88E-06	[a]	1.68E-02	[a]	2.79E-02	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.10E-04	[b]	1.82E-04	[b]	1.48E-05	[a]	2.46E-05	[a]	5.23E-02	[a]	8.72E-02	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.27E-05	[b]	3.37E-05	[b]	1.28E-05	[a]	2.14E-05	[a]	4.55E-02	[a]	7.58E-02	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	6.24E-05	[b]	1.04E-04	[b]	6.57E-06	[a]	1.10E-05	[a]	2.33E-02	[a]	3.88E-02	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.12E-04	[b]	1.84E-04	[b]	1.93E-05	[a]	3.21E-05	[a]	6.83E-02	[a]	1.14E-01	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.37E-05	[b]	3.54E-05	[b]	1.29E-05	[a]	2.15E-05	[a]	4.58E-02	[a]	7.63E-02	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	6.63E-05	[b]	1.10E-04	[b]	6.94E-06	[a]	1.16E-05	[a]	2.46E-02	[a]	4.10E-02	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.14E-04	[b]	1.86E-04	[b]	2.16E-05	[a]	3.60E-05	[a]	7.67E-02	[a]	1.28E-01	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.16E-05	[b]	3.25E-05	[b]	1.12E-05	[a]	1.87E-05	[a]	3.98E-02	[a]	6.63E-02	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	8.18E-05	[b]	1.36E-04	[b]	8.41E-06	[a]	1.40E-05	[a]	2.98E-02	[a]	4.97E-02	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.27E-04	[b]	2.08E-04	[b]	2.32E-05	[a]	3.87E-05	[a]	8.23E-02	[a]	1.37E-01	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	2.07E-05	[b]	3.13E-05	[b]	9.96E-06	[a]	1.66E-05	[a]	3.53E-02	[a]	5.89E-02	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	8.85E-05	[b]	1.47E-04	[b]	9.02E-06	[a]	1.50E-05	[a]	3.20E-02	[a]	5.33E-02	[a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Overland Flow to Off-Site Stream																		
Acute Toxicity																		
50	1	0.05	0.015	0.401	Weeds (78)	Loam	6.30E-06	[b]	1.05E-05	[b]	6.57E-07	[a]	1.09E-06	[a]	2.33E-03	[a]	3.88E-03	[a]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.64E-04	[b]	2.74E-04	[b]	1.75E-05	[a]	2.91E-05	[a]	6.19E-02	[a]	1.03E-01	[a]
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	3.39E-04	[b]	5.64E-04	[b]	3.55E-05	[a]	5.92E-05	[a]	1.26E-01	[a]	2.10E-01	[a]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.73E-06	[a]	7.88E-06	[a]	1.68E-02	[a]	2.79E-02	[a]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.68E-02	[a]	2.79E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.83E-05	[b]	4.64E-05	[b]	4.69E-06	[a]	7.81E-06	[a]	1.66E-02	[a]	2.77E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.38E-05	[b]	5.57E-05	[b]	5.05E-06	[a]	8.42E-06	[a]	1.79E-02	[a]	2.98E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.62E-05	[b]	2.55E-05	[b]	5.30E-06	[a]	8.83E-06	[a]	1.88E-02	[a]	3.13E-02	[a]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	4.49E-05	[b]	7.48E-05	[b]	4.72E-06	[a]	7.87E-06	[a]	1.67E-02	[a]	2.79E-02	[a]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	4.34E-05	[b]	7.22E-05	[b]	4.62E-06	[a]	7.70E-06	[a]	1.64E-02	[a]	2.73E-02	[a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors																		
							Fish				Aquatic Invertebrates				Non-Target Aquatic Plants			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Overland Flow to Off-Site Stream																		
Chronic Toxicity																		
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[b]	0.00E+00	[b]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]	0.00E+00	[c]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	4.35E-07	[b]	7.26E-07	[b]	3.19E-06	[b]	5.31E-06	[b]	1.23E-04	[b]	2.05E-04	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	6.87E-10	[b]	1.14E-09	[b]	5.03E-09	[b]	8.38E-09	[b]	1.94E-07	[b]	3.23E-07	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	7.72E-09	[b]	1.29E-08	[b]	5.65E-08	[b]	9.42E-08	[b]	2.17E-06	[b]	3.62E-06	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	5.19E-06	[b]	8.65E-06	[b]	3.80E-05	[b]	6.34E-05	[b]	1.46E-03	[b]	2.44E-03	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	6.19E-07	[b]	1.02E-06	[b]	7.88E-08	[a]	1.31E-07	[a]	4.45E-03	[a]	7.42E-03	[a]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.56E-06	[b]	4.26E-06	[b]	1.87E-05	[b]	3.12E-05	[b]	7.20E-04	[b]	1.20E-03	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	6.57E-06	[b]	1.09E-05	[b]	6.66E-07	[a]	1.11E-06	[a]	3.77E-02	[a]	6.28E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	3.33E-06	[b]	5.45E-06	[b]	4.37E-07	[a]	7.29E-07	[a]	2.47E-02	[a]	4.12E-02	[a]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	5.19E-06	[b]	8.64E-06	[b]	5.24E-07	[a]	6.32E-05	[b]	2.96E-02	[a]	2.47E-03	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	8.09E-06	[b]	1.33E-05	[b]	9.96E-07	[a]	1.66E-06	[a]	5.63E-02	[a]	9.39E-02	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	5.92E-06	[b]	9.63E-06	[b]	8.29E-07	[a]	1.38E-06	[a]	4.69E-02	[a]	7.81E-02	[a]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	6.35E-06	[b]	1.06E-05	[b]	6.43E-07	[a]	1.07E-06	[a]	3.63E-02	[a]	6.06E-02	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	8.75E-06	[b]	1.42E-05	[b]	1.30E-06	[a]	2.16E-06	[a]	7.32E-02	[a]	1.22E-01	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	6.73E-06	[b]	1.10E-05	[b]	9.15E-07	[a]	1.53E-06	[a]	5.17E-02	[a]	8.62E-02	[a]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	6.60E-06	[b]	1.10E-05	[b]	6.68E-07	[a]	1.11E-06	[a]	3.78E-02	[a]	6.29E-02	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	8.92E-06	[b]	1.43E-05	[b]	1.49E-06	[a]	2.48E-06	[a]	8.40E-02	[a]	1.40E-01	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	7.08E-06	[b]	1.16E-05	[b]	9.29E-07	[a]	1.55E-06	[a]	5.25E-02	[a]	8.75E-02	[a]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	6.58E-06	[b]	1.10E-05	[b]	6.67E-07	[a]	1.11E-06	[a]	3.77E-02	[a]	6.29E-02	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	8.86E-06	[b]	1.41E-05	[b]	1.58E-06	[a]	2.63E-06	[a]	8.91E-02	[a]	1.49E-01	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	7.32E-06	[b]	1.20E-05	[b]	9.44E-07	[a]	1.57E-06	[a]	5.34E-02	[a]	8.89E-02	[a]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	6.44E-06	[b]	1.07E-05	[b]	6.56E-07	[a]	1.09E-06	[a]	3.71E-02	[a]	6.18E-02	[a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Fish: Typical Application Rate	Fish: Maximum Application Rate	Aquatic Invertebrates: Typical Application Rate	Aquatic Invertebrates: Maximum Application Rate	Non-Target Aquatic Plants: Typical Application Rate	Non-Target Aquatic Plants: Maximum Application Rate
Overland Flow to Off-Site Stream												
Chronic Toxicity												
50	1	0.05	0.015	0.401	Weeds (78)	Loam	6.08E-07 [b]	1.01E-06 [b]	6.13E-08 [a]	7.40E-06 [b]	3.47E-03 [a]	2.89E-04 [b]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.81E-05 [b]	4.69E-05 [b]	2.06E-04 [b]	3.43E-04 [b]	8.03E-03 [b]	1.33E-02 [b]
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	7.73E-05 [b]	1.29E-04 [b]	5.66E-04 [b]	9.43E-04 [b]	2.20E-02 [b]	3.65E-02 [b]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.24E-06 [b]	7.03E-06 [b]	4.65E-07 [a]	7.75E-07 [a]	2.63E-02 [a]	4.38E-02 [a]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	4.29E-06 [b]	7.11E-06 [b]	4.65E-07 [a]	7.75E-07 [a]	2.63E-02 [a]	4.38E-02 [a]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.40E-06 [b]	5.58E-06 [b]	4.25E-07 [a]	7.08E-07 [a]	2.40E-02 [a]	4.00E-02 [a]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	5.19E-06 [b]	8.64E-06 [b]	5.24E-07 [a]	6.32E-05 [b]	2.96E-02 [a]	2.47E-03 [b]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	5.48E-06 [b]	9.13E-06 [b]	5.54E-07 [a]	9.24E-07 [a]	3.13E-02 [a]	5.22E-02 [a]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond										
							Application Rate			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical		Maximum	
Consumption of Fish from Contaminated Pond										
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	[b]	0.00E+00	[b]
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	[b]	0.00E+00	[b]
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	[b]	0.00E+00	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Sand	5.48E-05	[b]	9.14E-05	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Clay	3.92E-08	[b]	6.53E-08	[b]
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-06	[b]	1.96E-06	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.52E-04	[b]	2.53E-04	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.15E-05	[b]	5.24E-05	[b]
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.24E-04	[b]	2.06E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Sand	9.41E-05	[b]	1.57E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Clay	7.92E-05	[b]	1.32E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Sand	6.01E-05	[b]	9.96E-05	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Clay	6.80E-05	[b]	1.13E-04	[b]
100	10	0.05	0.015	0.401	Weeds (78)	Loam	5.50E-05	[b]	9.16E-05	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Sand	3.85E-05	[b]	6.34E-05	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Clay	6.07E-05	[b]	1.01E-04	[b]
150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.28E-05	[b]	7.13E-05	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Sand	3.29E-05	[b]	5.42E-05	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Clay	5.56E-05	[b]	9.26E-05	[b]
200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.31E-05	[b]	5.51E-05	[b]
250	10	0.05	0.015	0.401	Weeds (78)	Sand	3.42E-05	[b]	5.66E-05	[b]
250	10	0.05	0.015	0.401	Weeds (78)	Clay	5.19E-05	[b]	8.65E-05	[b]
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.68E-05	[b]	4.47E-05	[b]

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond										
							Application Rate			
Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical		Maximum	
Consumption of Fish from Contaminated Pond										
50	1	0.05	0.015	0.401	Weeds (78)	Loam	4.77E-05	[b]	7.95E-05	[b]
50	100	0.05	0.015	0.401	Weeds (78)	Loam	8.25E-05	[b]	1.37E-04	[b]
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	8.36E-05	[b]	1.39E-04	[b]
50	10	0.05	0.015	0.05	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.015	0.2	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.015	0.5	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.023	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.046	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.15	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.005	0.015	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.01	0.015	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.1	0.015	0.401	Weeds (78)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	7.69E-05	[b]	1.28E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Silt	6.87E-05	[b]	1.14E-04	[b]
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	7.44E-05	[b]	1.24E-04	[b]
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	7.36E-05	[b]	1.23E-04	[b]
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	7.13E-05	[b]	1.19E-04	[b]

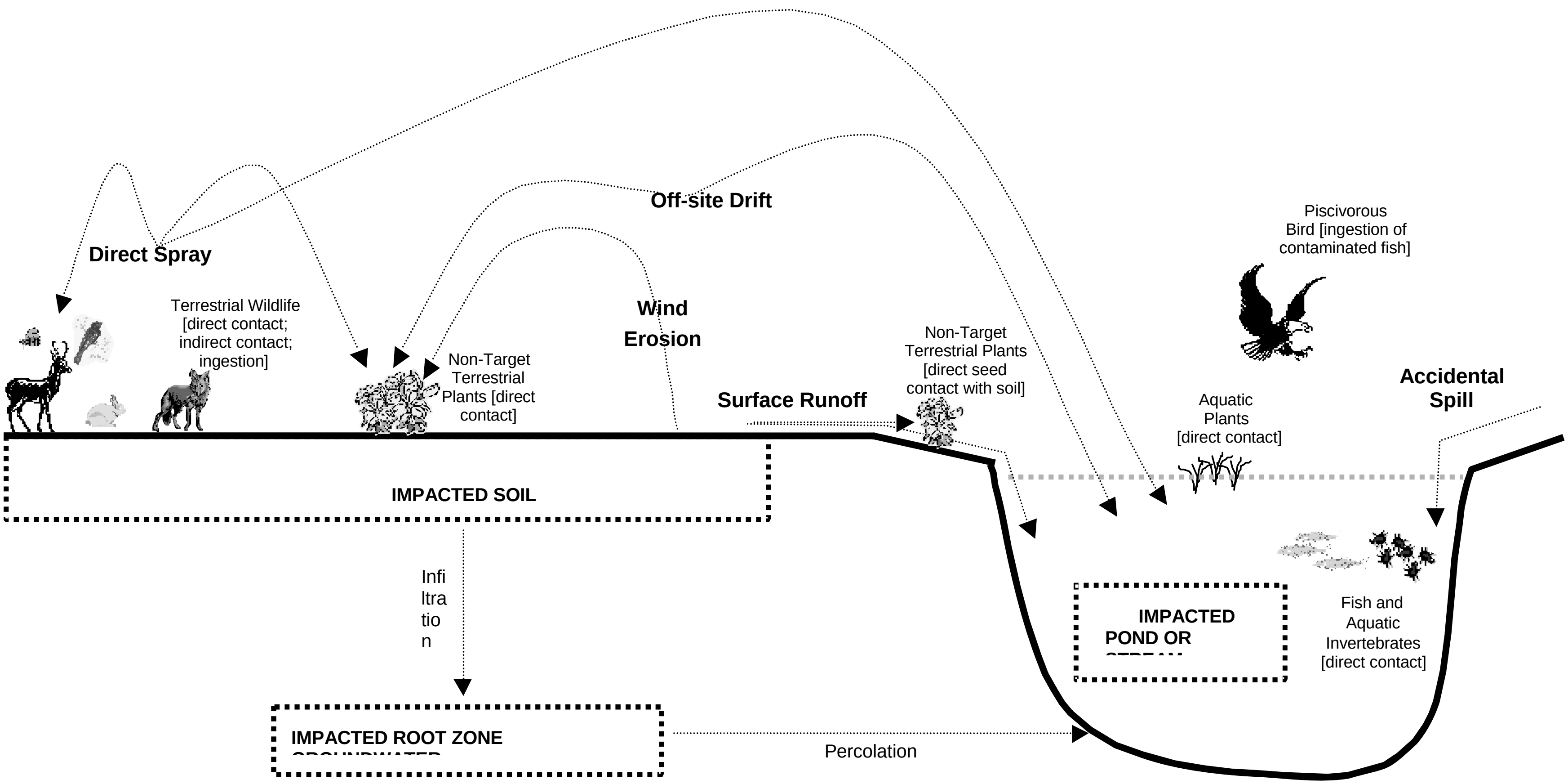
[1]USLE=Universal Soil Loss Equation
Shading and boldface indicates plant RQs greater than 1.
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates.
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates.
Shading and boldface indicates chronic terrestrial animal RQs greater than 1.
[a] RQ derived using Overdrive® EEC and TRV.
[b] RQ derived using sum of RQs derived using dicamba and diflufenzopyr EECs and TRVs.
[c] RQs derived using Overdrive® EEC and TRV, and RQ derived using dicamba and difluenzopyr EECs and TRVs are equal.

TABLE 4-5
Risk Quotients for Wind Erosion and Transport Off-Site Scenarios

Transport of wind-blown dust to off-site soil: potential risk to non-target terrestrial plants									
		Typical Species				Rare, Threatened and Endangered Species			
Watershed Location	Distance from Receptor (km)	Typical Application Rate		Maximum Application Rate		Typical Application Rate		Maximum Application Rate	
Montana	1.5	3.28E-04	[a]	5.47E-04	[a]	8.82E-04	[a]	1.47E-03	[a]
Montana	10	1.86E-04	[a]	3.10E-04	[a]	5.00E-04	[a]	8.33E-04	[a]
Montana	100	2.23E-08	[a]	4.18E-08	[a]	5.98E-08	[a]	1.12E-07	[a]
Oregon	1.5	1.88E-04	[a]	3.13E-04	[a]	5.05E-04	[a]	8.42E-04	[a]
Oregon	10	7.16E-05	[a]	1.19E-04	[a]	1.93E-04	[a]	3.21E-04	[a]
Oregon	100	2.52E-08	[a]	4.20E-08	[a]	6.78E-08	[a]	1.13E-07	[a]
Wyoming	1.5	3.71E-05	[a]	6.19E-05	[a]	9.98E-05	[a]	1.66E-04	[a]
Wyoming	10	2.56E-05	[a]	4.27E-05	[a]	6.88E-05	[a]	1.15E-04	[a]
Wyoming	100	6.30E-09	[a]	1.05E-08	[a]	1.69E-08	[a]	2.82E-08	[a]

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
[a] RQ derived using Overdrive® EEC and TRV.
[b] RQ derived using sum of RQs derived using dicamba and diflufenzopyr EECs and TRVs.
[c] RQs derived using Overdrive® EEC and TRV, and RQ derived using dicamba and diflufenzopyr EECs and TRVs are equal.

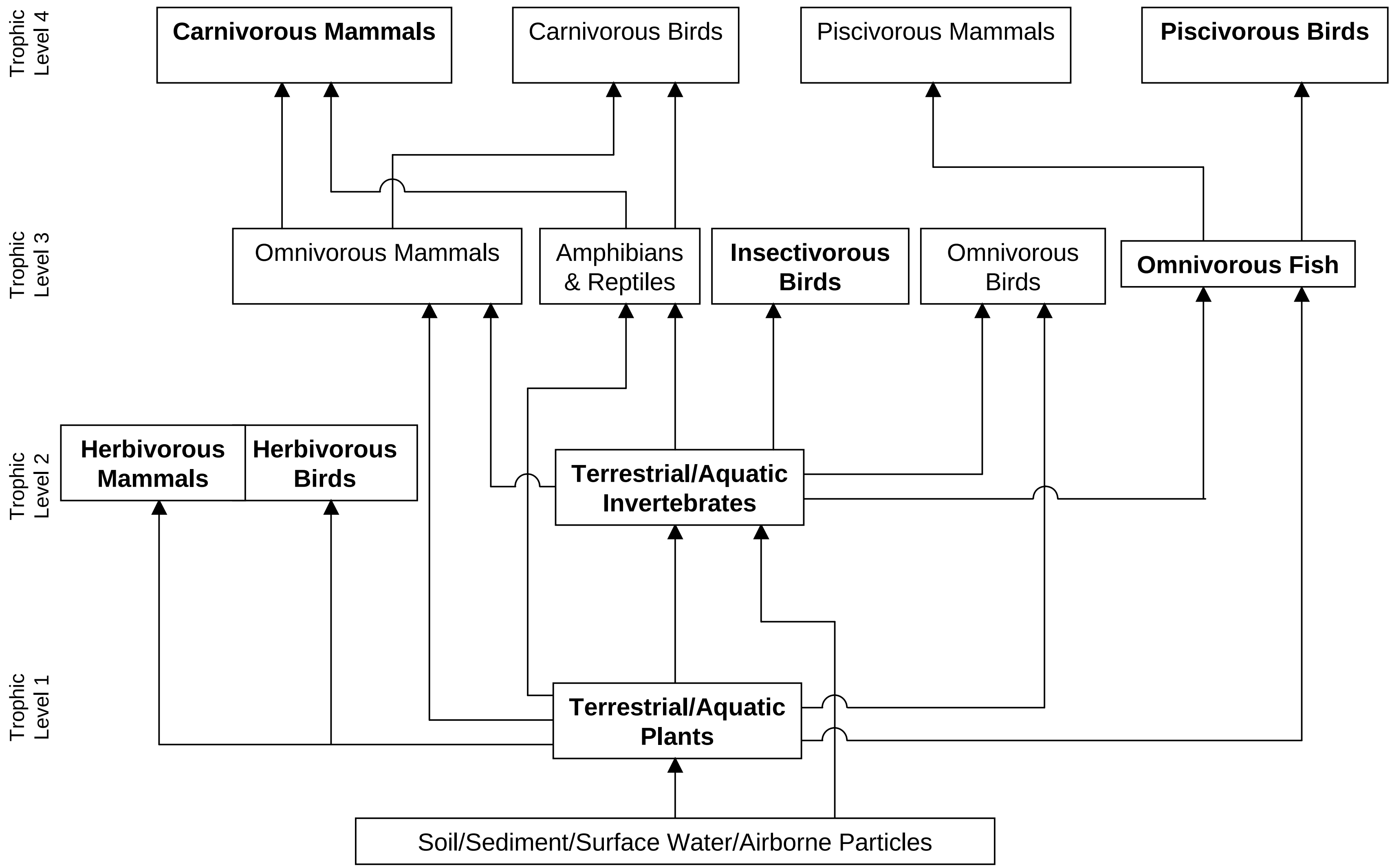
FIGURE 4-1 Conceptual Model for Terrestrial Herbicides



Application of terrestrial herbicides may occur by aerial (i.e., plane, helicopter) or ground (I.e., truck, backpack)

See Figure 4-2 for simplified food web & evaluated receptors.

FIGURE 4-2 Simplified Food Web



Receptors in **bold** type quantitatively assessed in the BLM herbicide ERAs.

FIGURE 4-3 Direct Spray - Risk Quotients for Terrestrial Animals

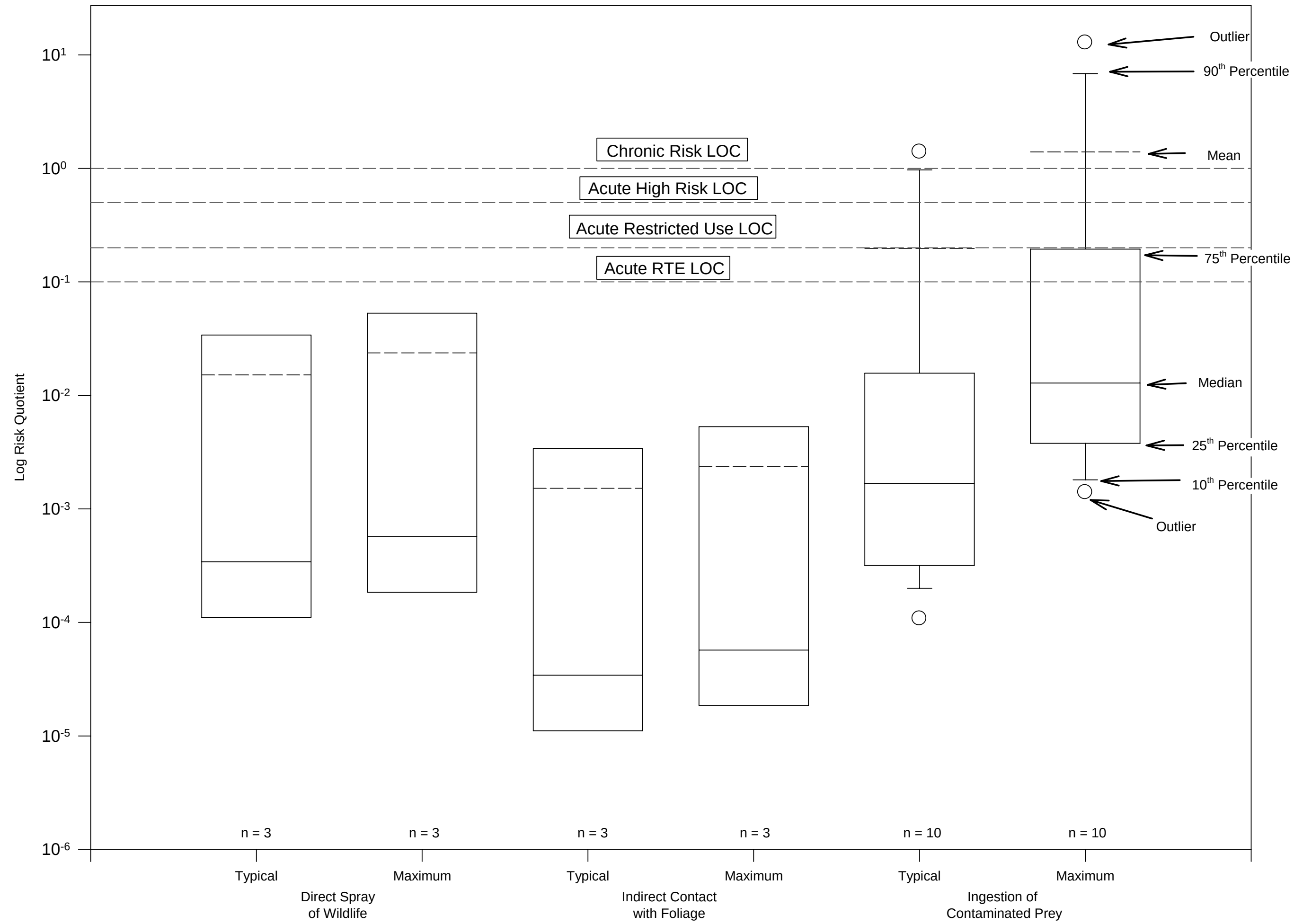


FIGURE 4-4 Direct Spray - Risk Quotients for Non-Target Terrestrial Plants

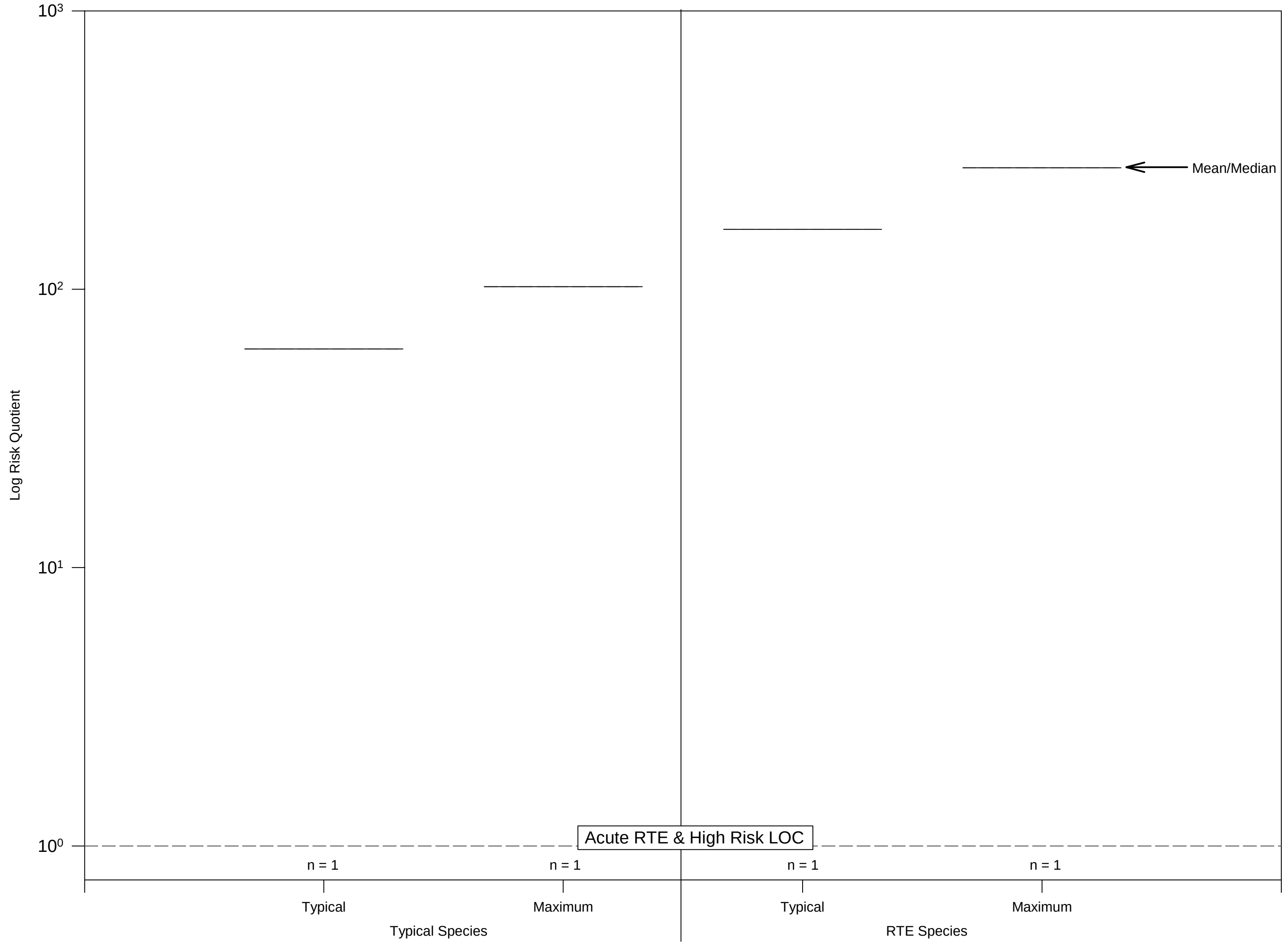


FIGURE 4-5 Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants

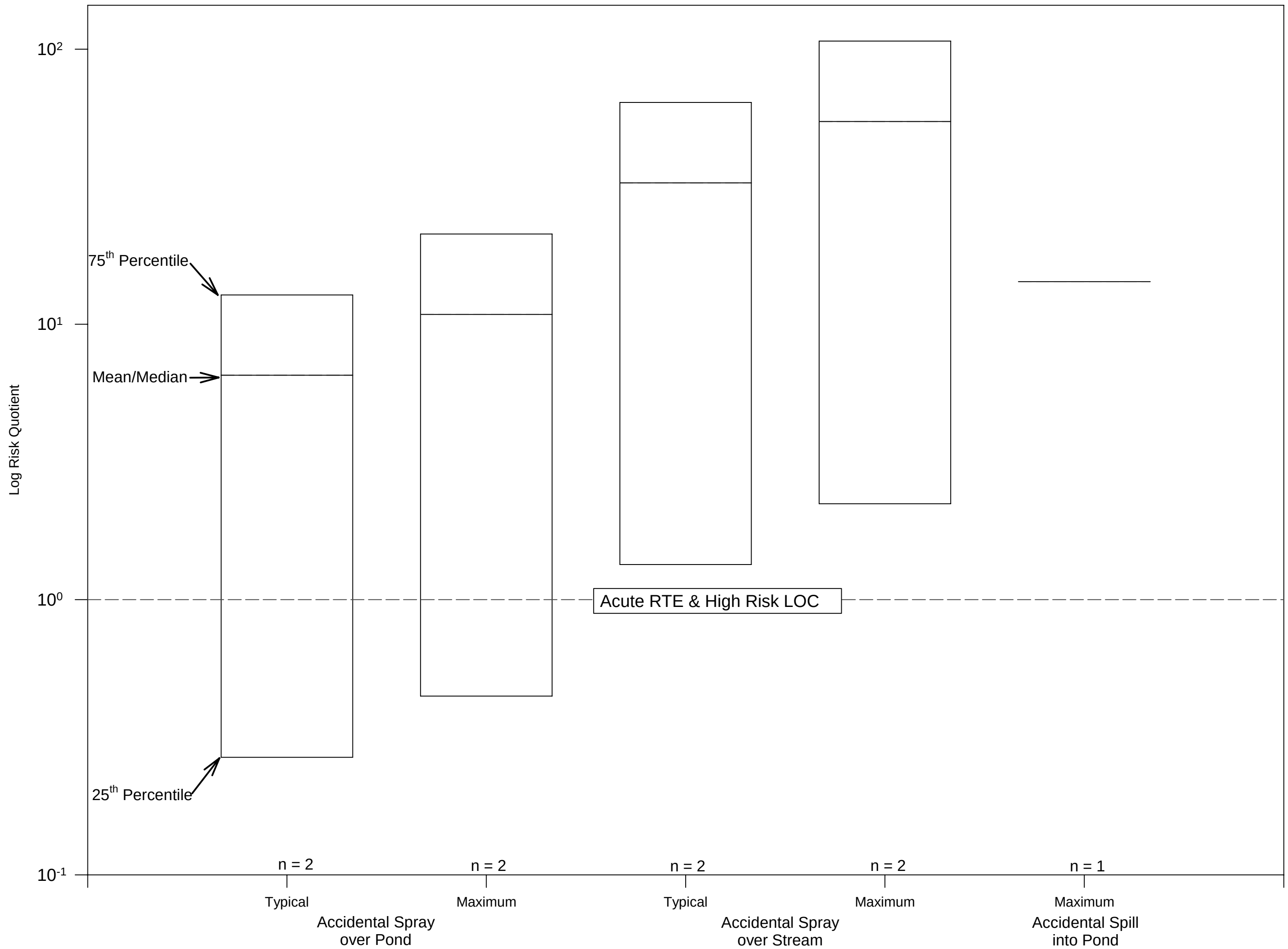


FIGURE 4-6 Accidental Direct Spray and Spills - Risk Quotients for Fish

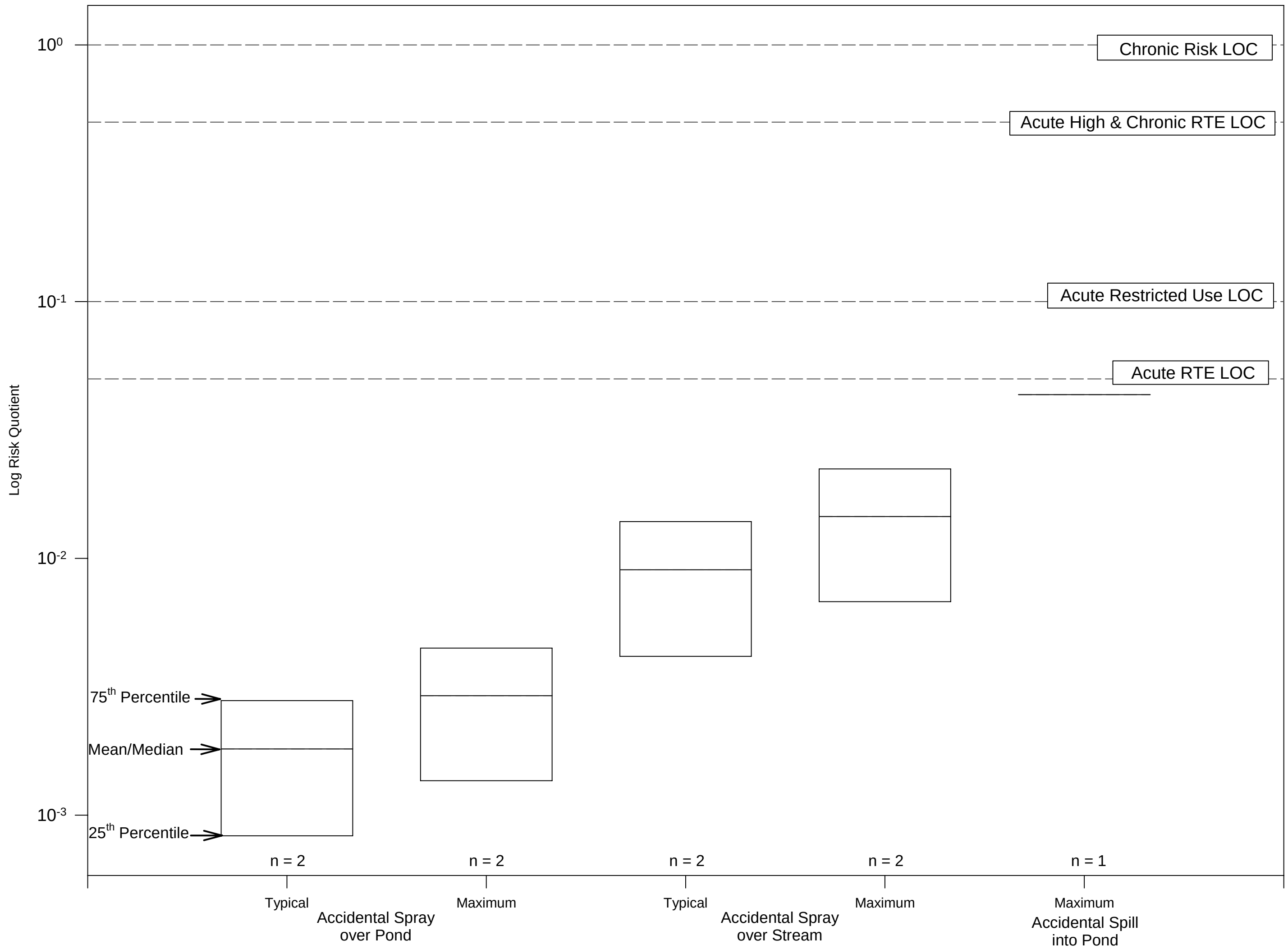


FIGURE 4-7 Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates

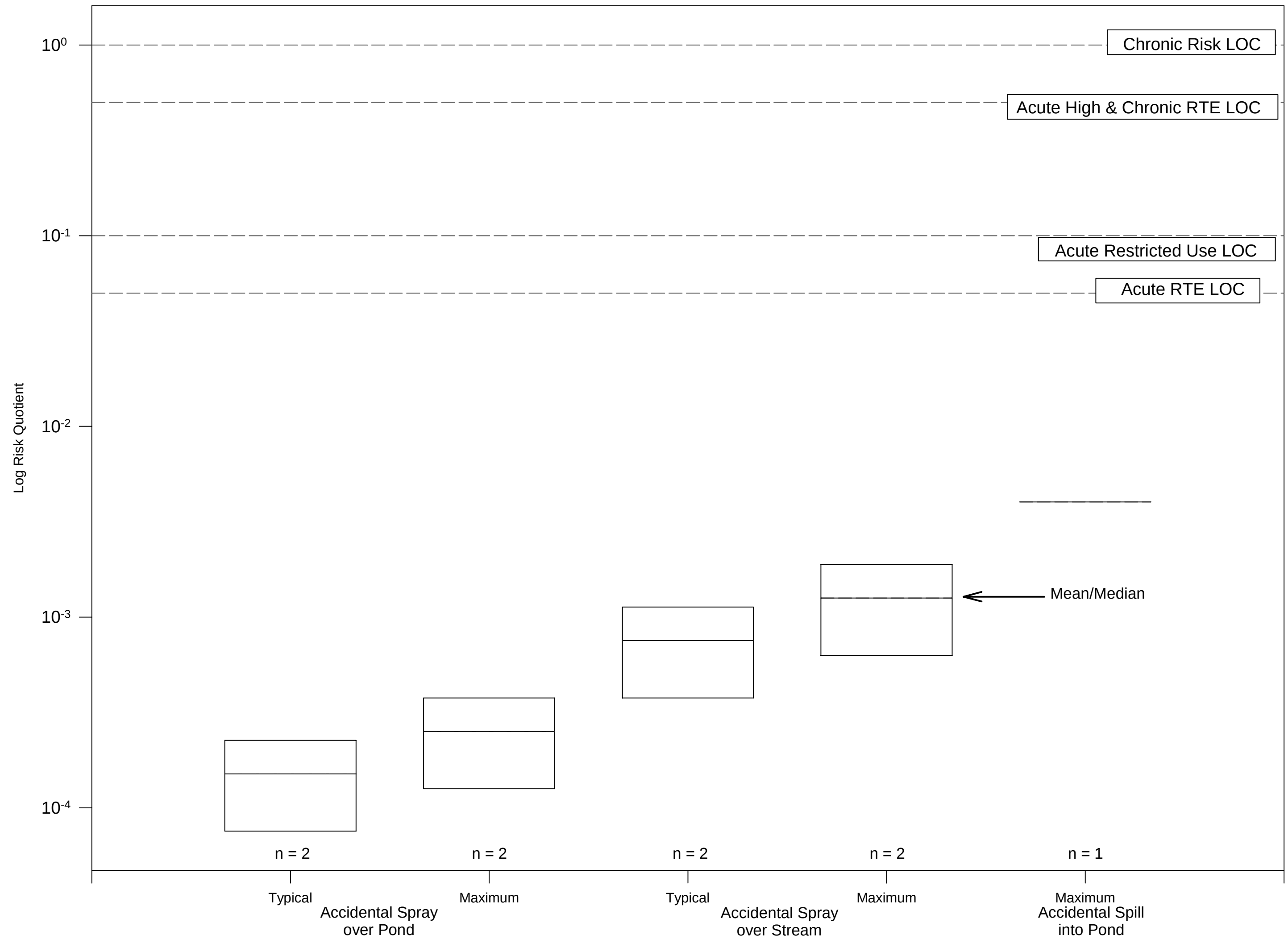


FIGURE 4-8 Off-Site Drift - Risk Quotients for Non-Target Terrestrial Plants

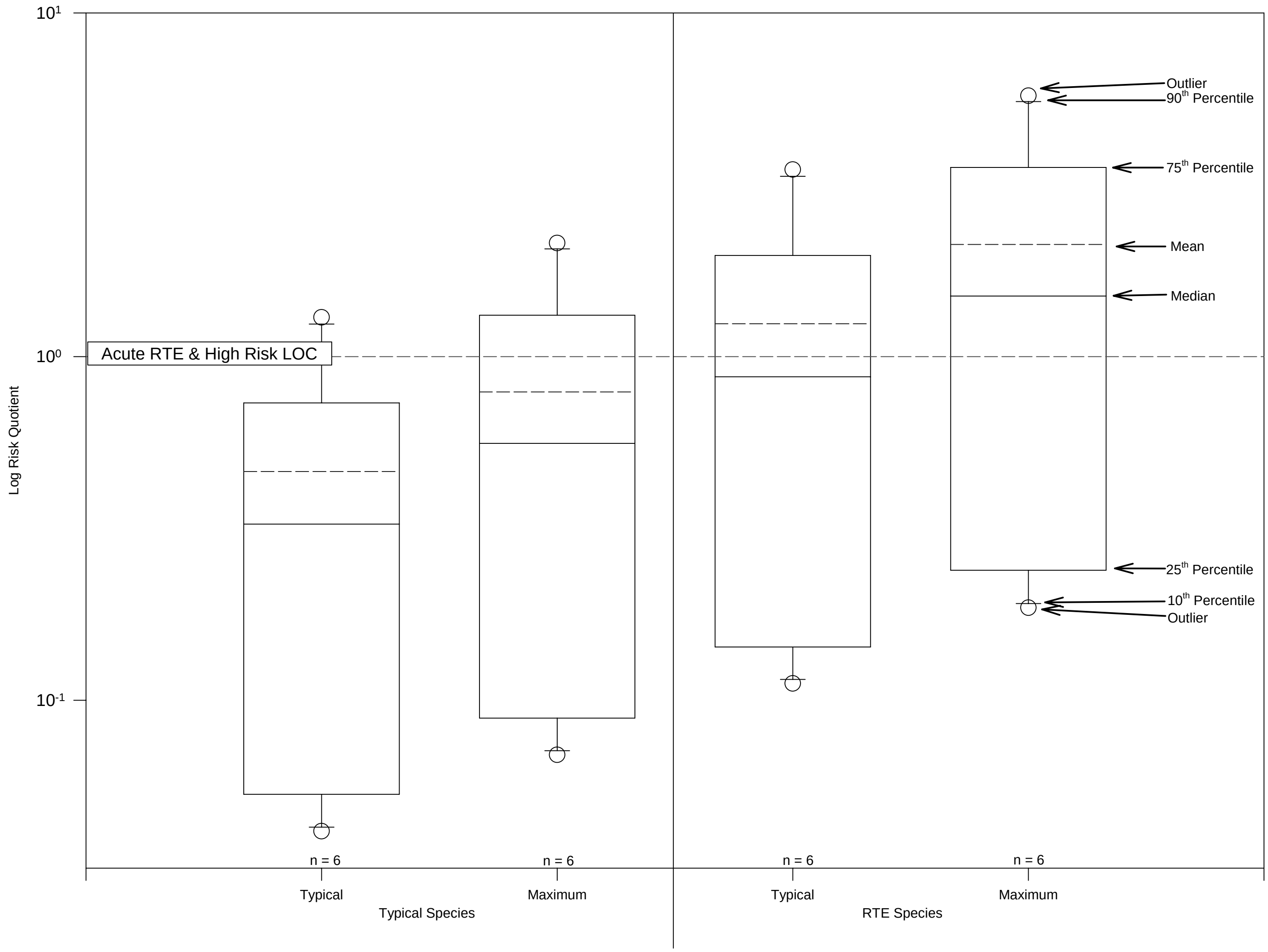


FIGURE 4-9 Off-Site Drift - Risk Quotients for Non-Target Aquatic Plants

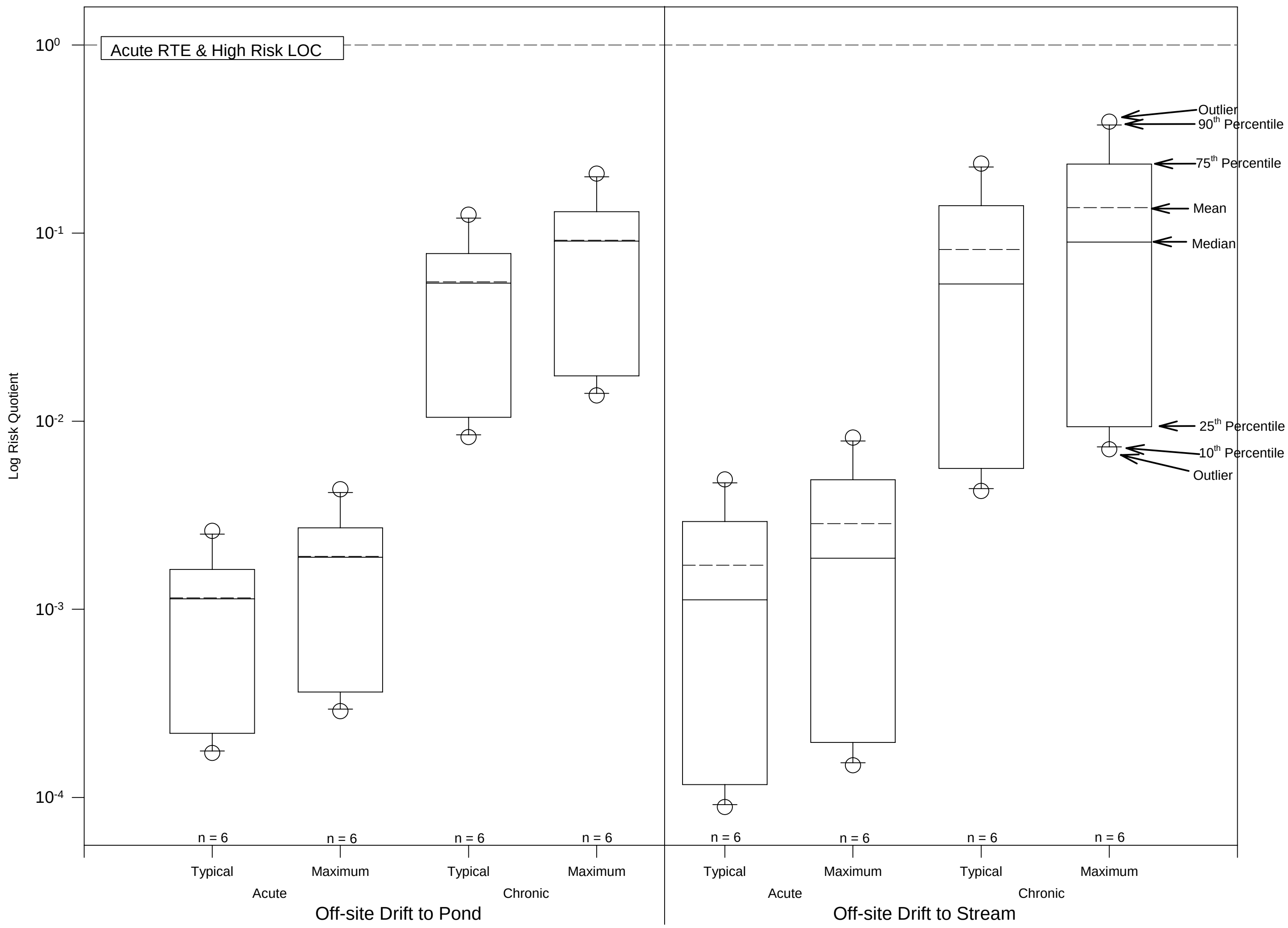


FIGURE 4-10 Off-Site Drift - Risk Quotients for Fish

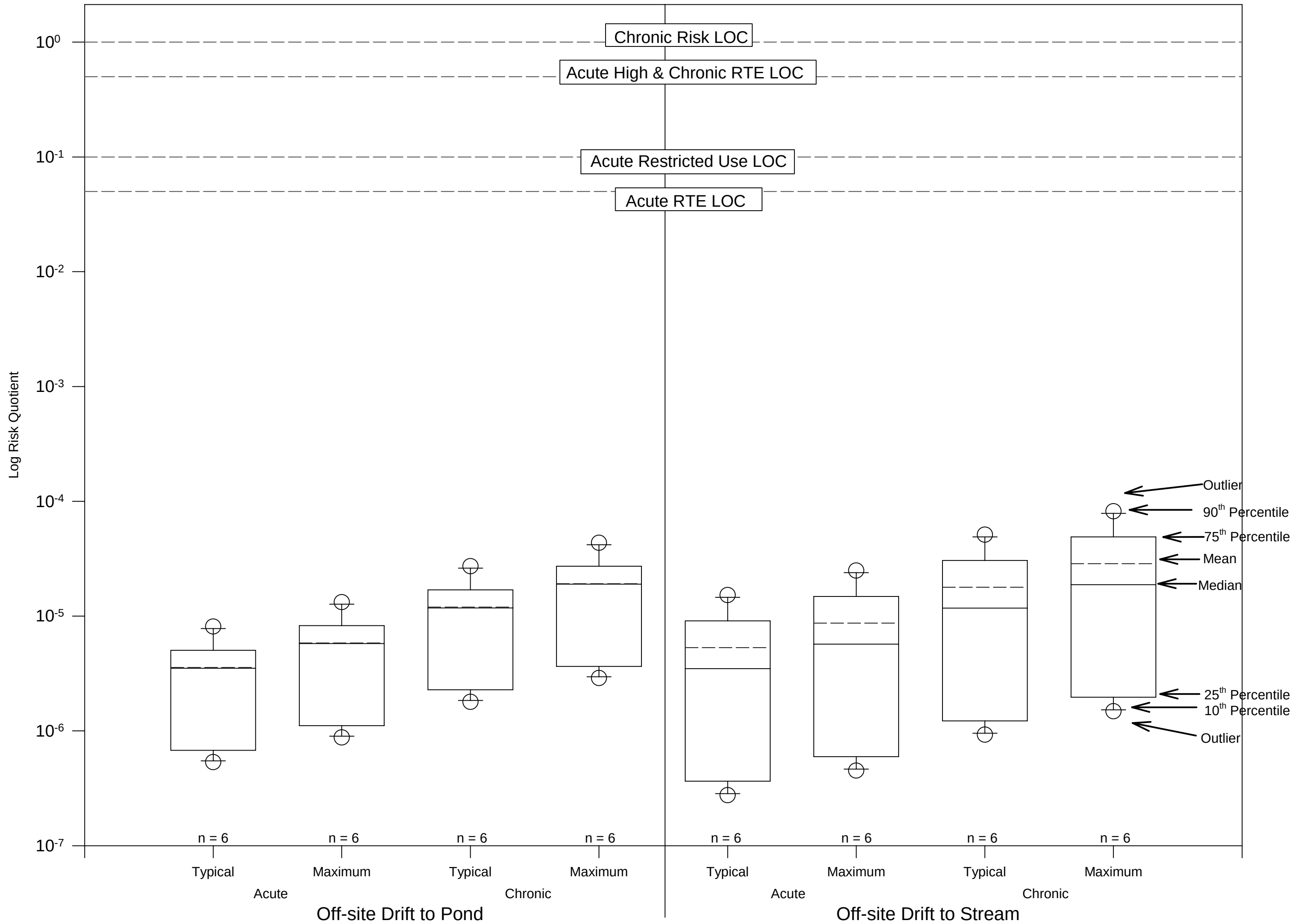


FIGURE 4-11 Off-Site Drift - Risk Quotients for Aquatic Invertebrates

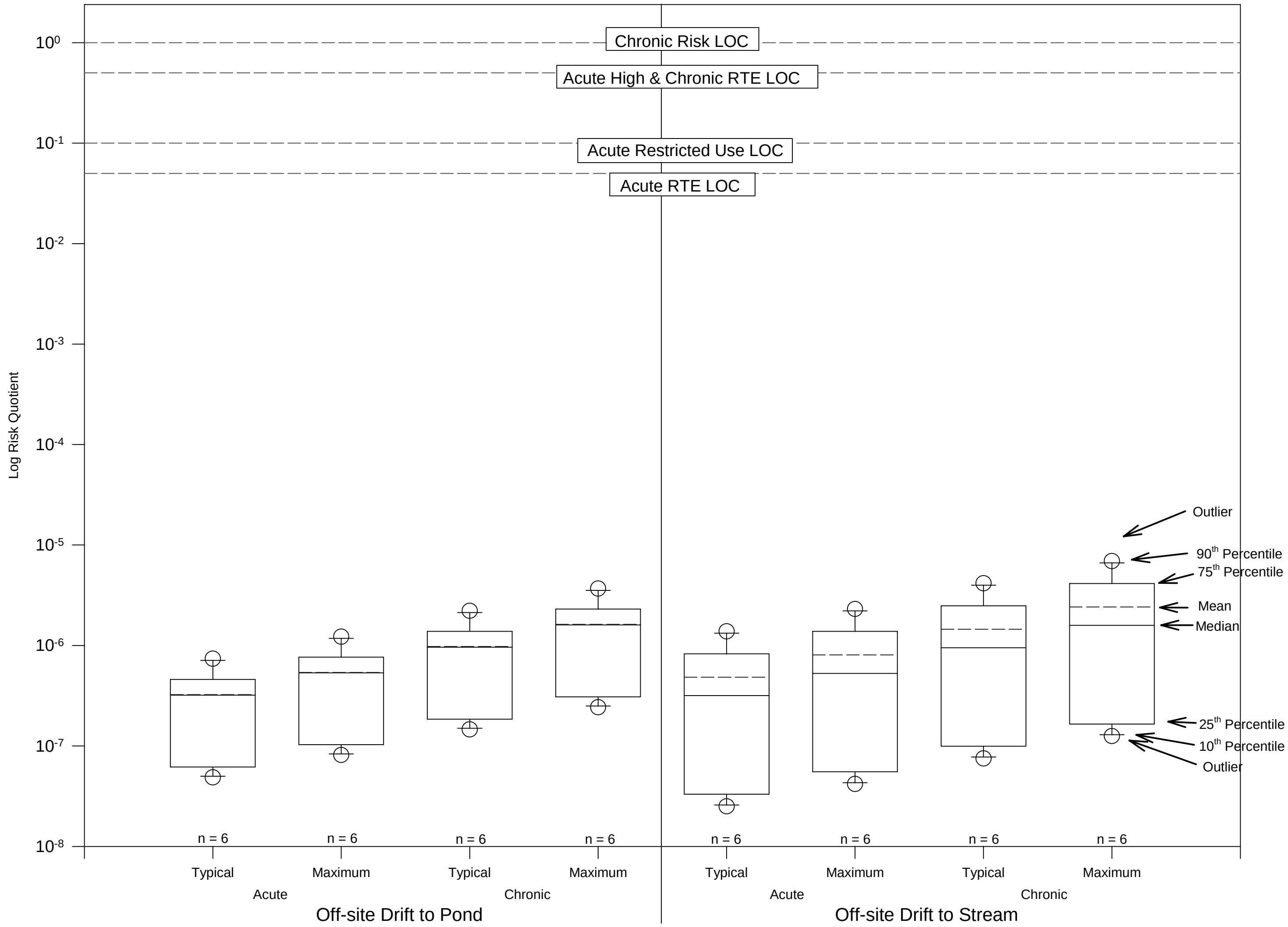


FIGURE 4-12 Off-Site Drift - Risk Quotients for Piscivorous Birds

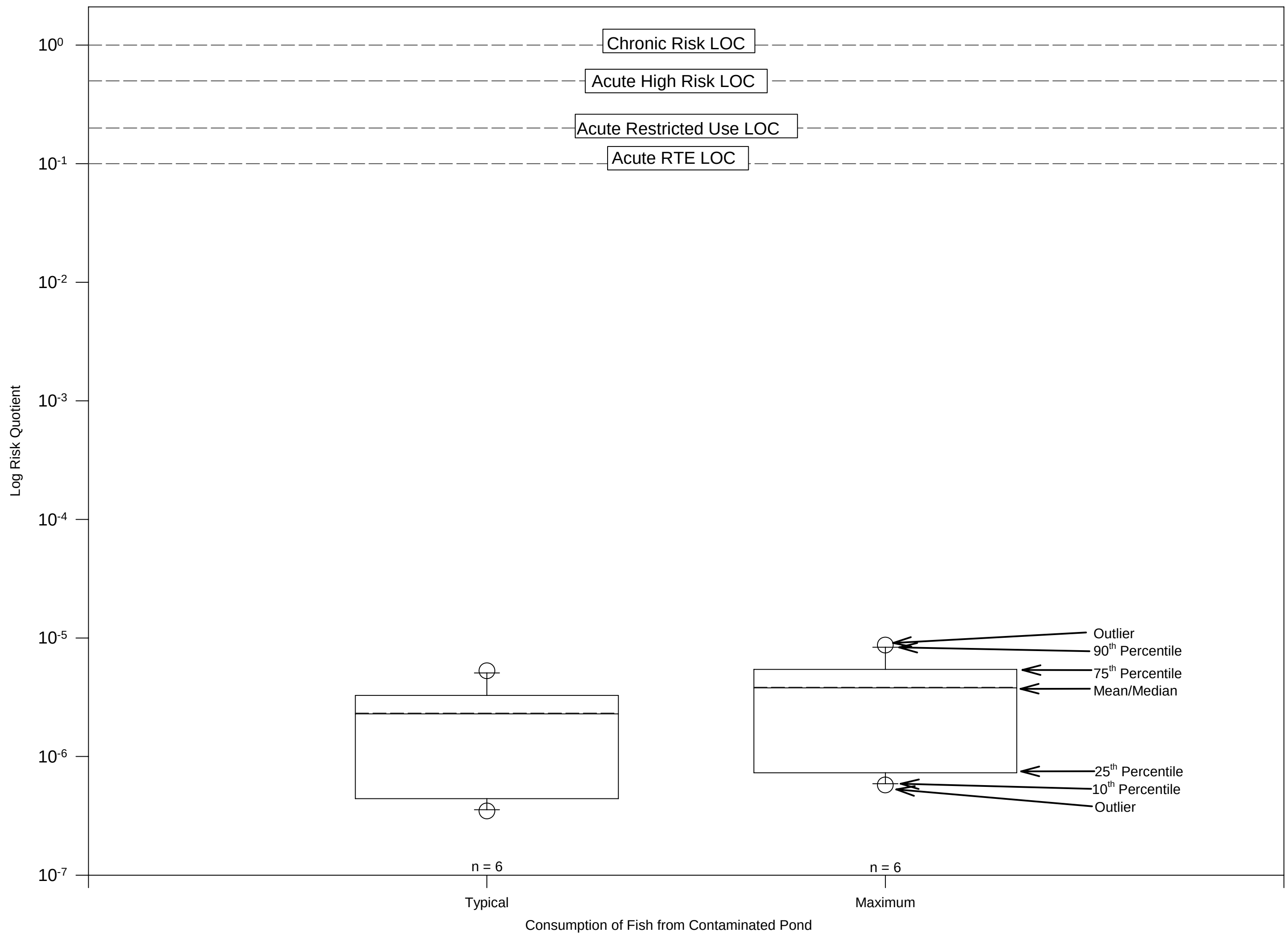


FIGURE 4-13 Surface Runoff - Risk Quotients for Non-Target Terrestrial Plants

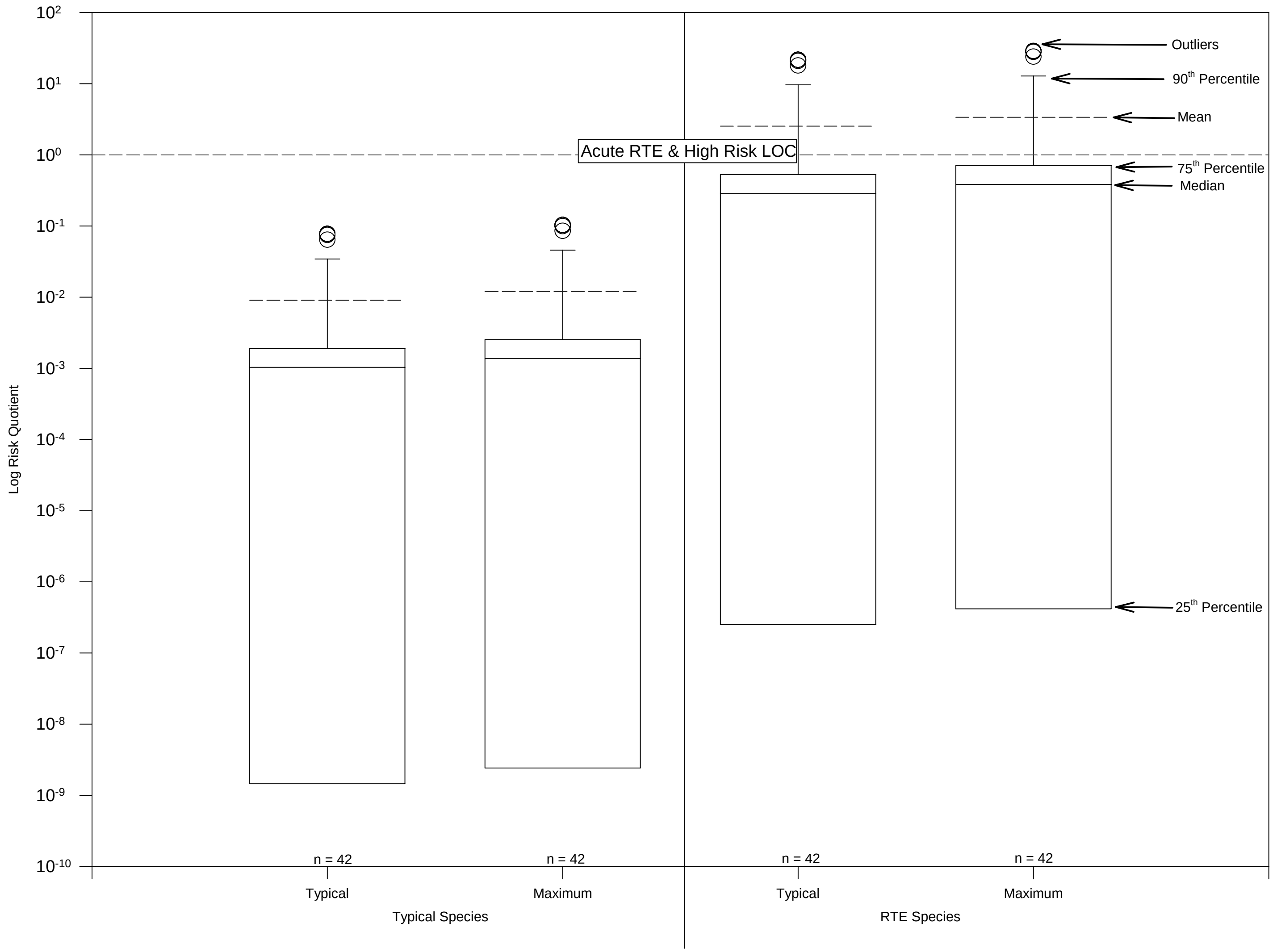


FIGURE 4-14 Surface Runoff - Risk Quotients for Non-Target Aquatic Plants

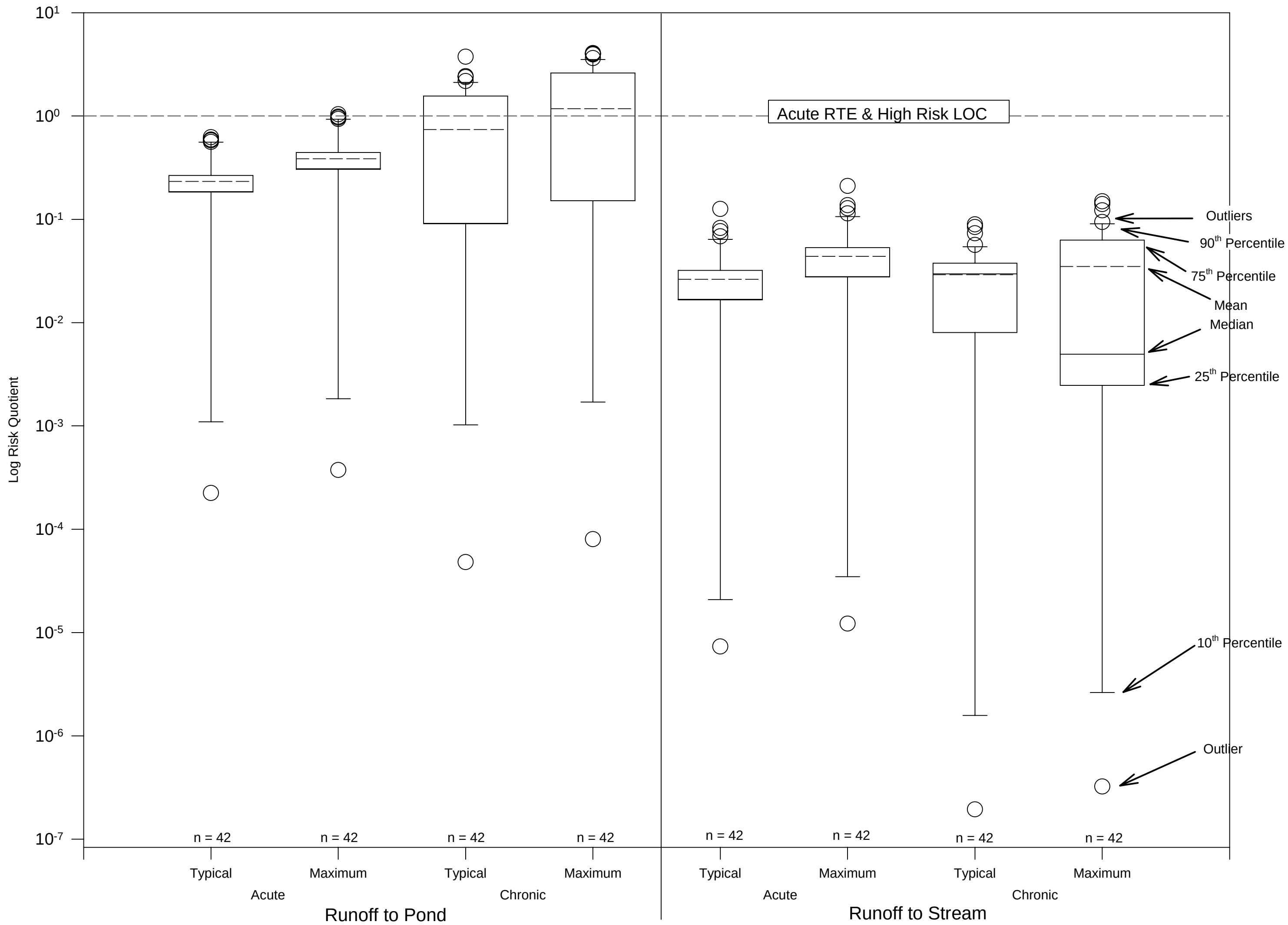


FIGURE 4-15 Surface Runoff - Risk Quotients for Fish

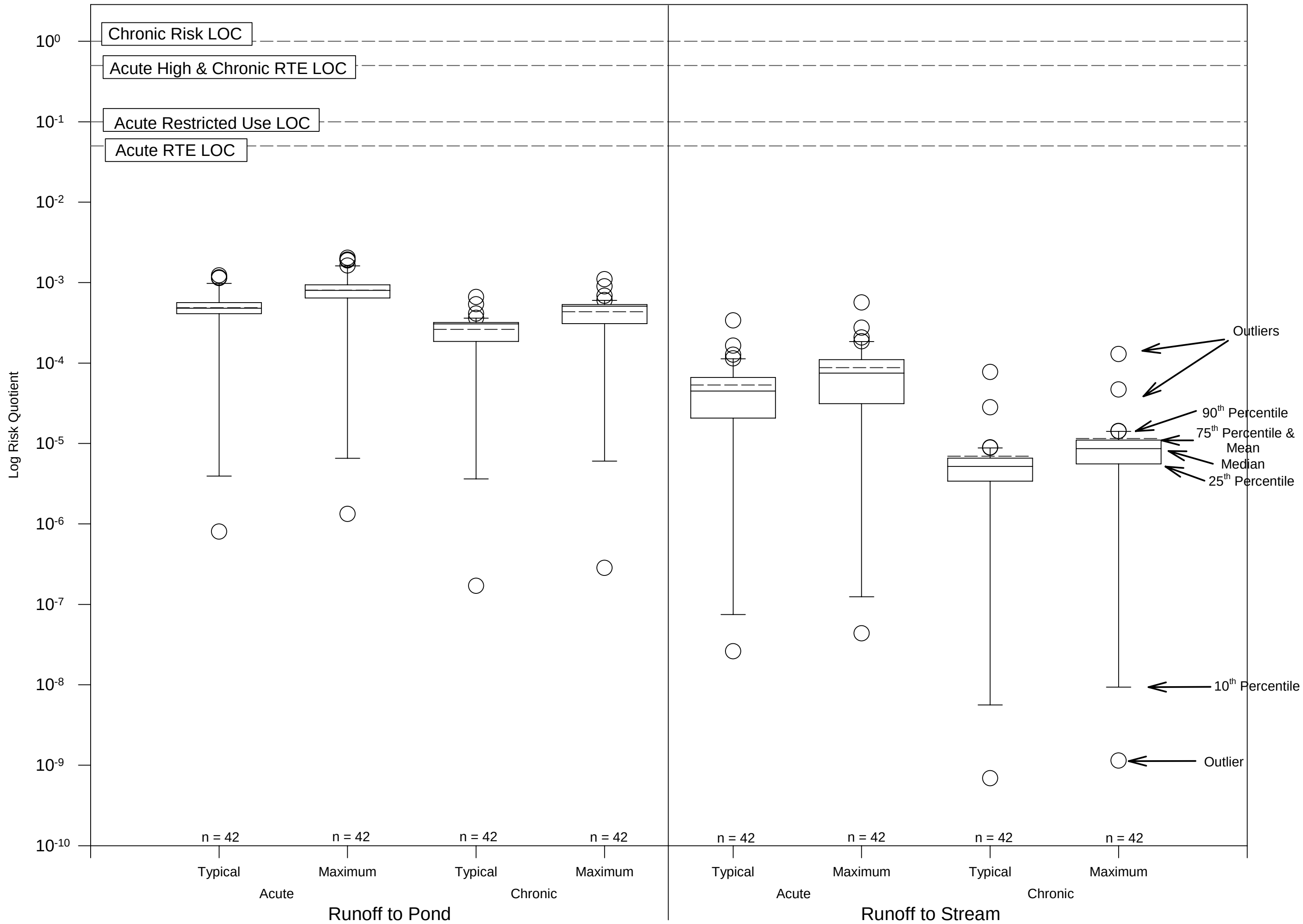


FIGURE 4-16 Surface Runoff - Risk Quotients for Aquatic Invertebrates

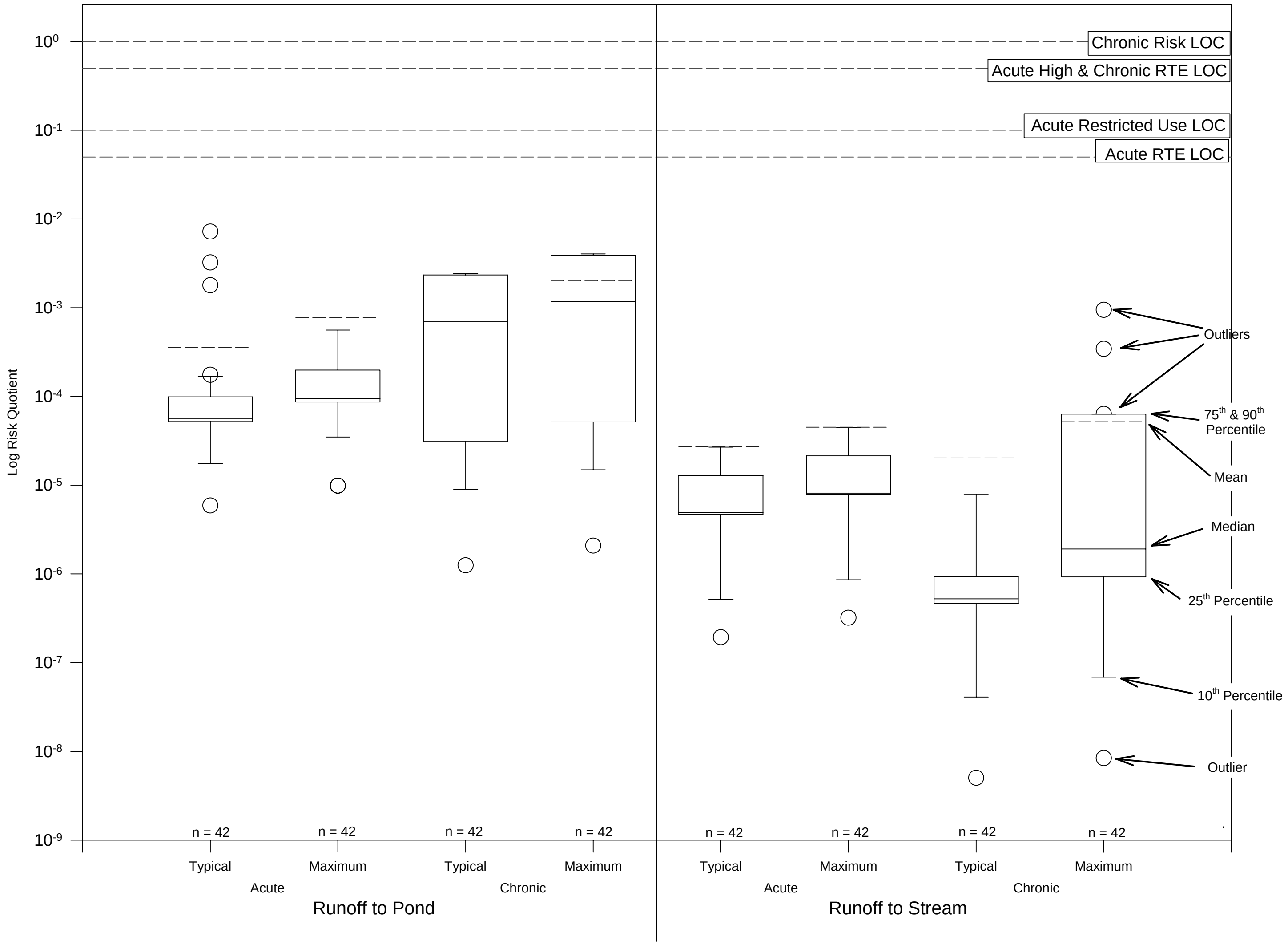


FIGURE 4-17 Surface Runoff - Risk Quotients for Piscivorous Birds

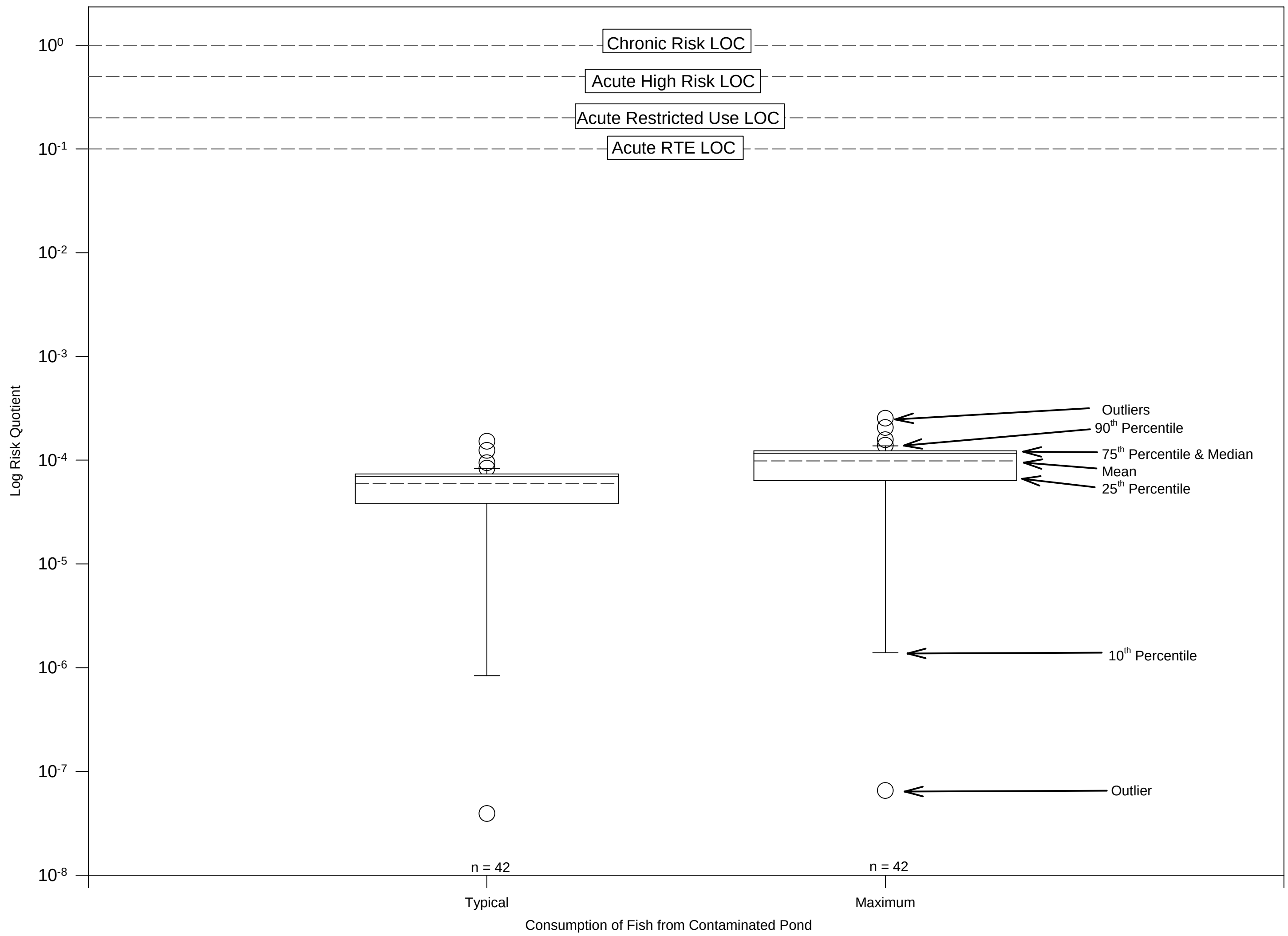
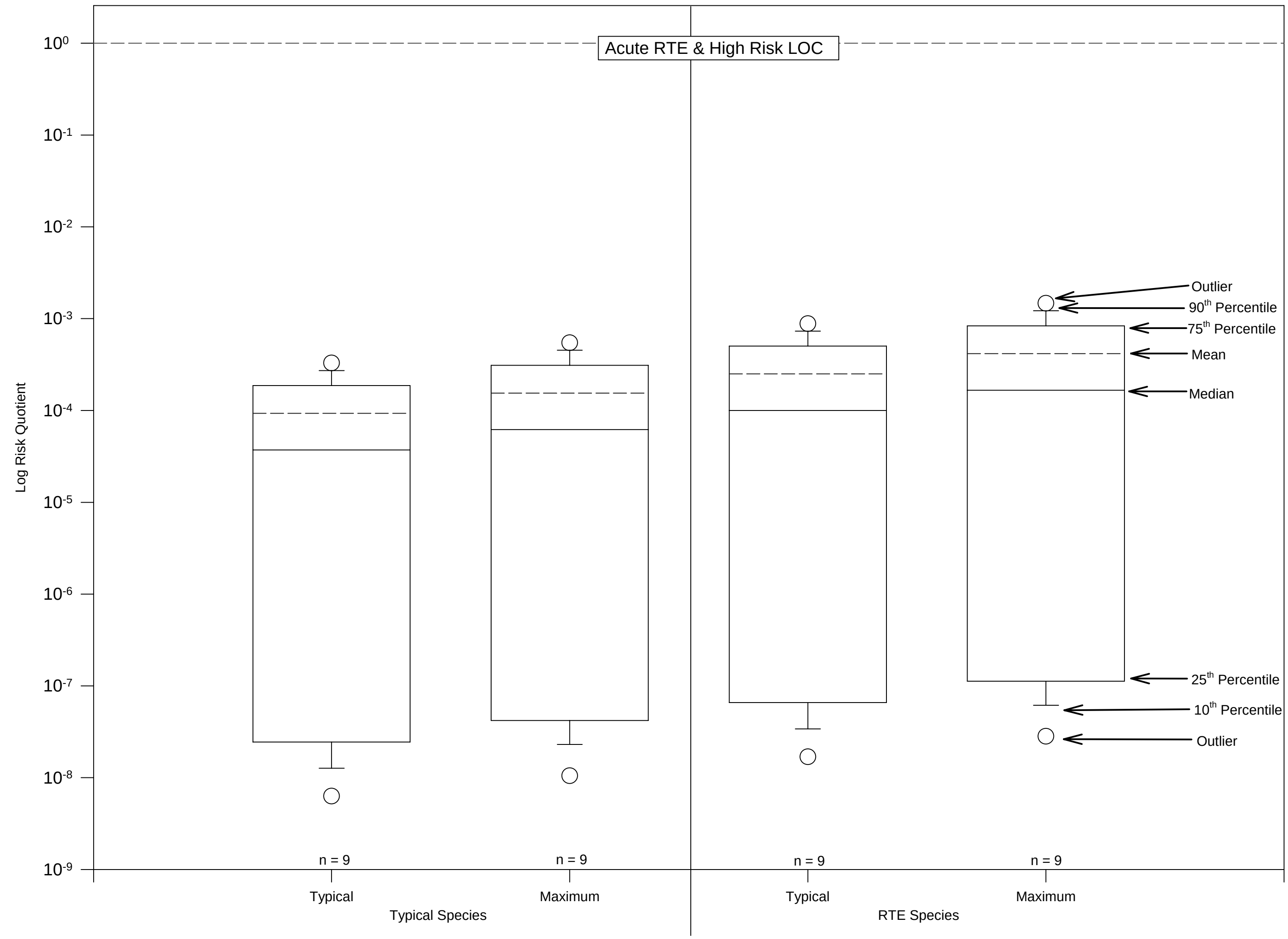


FIGURE 4-18 Wind Erosion and Transport Off-Site - Risk Quotients for Non-Target Terrestrial Plants



5.0 SENSITIVITY ANALYSIS

The sensitivity analysis was designed to determine which factors, from the three models used to predict exposure concentrations (GLEAMS, AgDRIFT®, and CALPUFF), most greatly affect exposure concentrations. A base case for each model was established. Input factors were changed independently, thereby resulting in an estimate of importance of that factor on exposure concentrations.

Information regarding each model, their specific use and any inputs and assumptions made during the application of these models are provided in the Methods Document (ENSR 2004c). This section provides information specific to the sensitivity of each of these models to select input variables.

5.1 GLEAMS

Groundwater Loading Effects of Agricultural Management Systems is a model developed for field-sized areas to evaluate the effects of agricultural management systems on the movement of agricultural chemicals within and through the plant root zone (Leonard et al. 1987). The model simulates surface runoff and groundwater flow of herbicide resulting from edge-of-field and bottom-of-root-zone loadings of water, sediment, pesticides, and plant nutrients stemming from complex climate-soil-management interactions. Agricultural pesticides are simulated by GLEAMS using three major components: hydrology, erosion, and pesticides. This section describes the sensitivity of model output variables controlling environmental conditions (i.e., precipitation, soil type). The goal of the sensitivity analysis was to investigate the control that measurable watershed variables have on the predicted outcome of a GLEAMS simulation.

5.1.1 GLEAMS Sensitivity Variables

A total of eight variables were selected for the sensitivity analysis of the GLEAMS model. The variables were selected because of their potential to affect the outcome of a simulation and the likelihood that these variables would change from site to site. These variables are generally those that have the greatest variability in field application areas. The following is list of parameters that were included in the model sensitivity analysis.

1. *Annual Precipitation* - The effect of variation in annual precipitation on herbicide export rates was investigated to determine the effect of runoff on predicted stream and pond concentrations. It is expected that the greater the amount of precipitation, the greater the expected exposure concentration. However, this relationship is not linear because it is influenced by additional factors, such as evapotranspiration. The lowest and highest precipitation values evaluated were 25 and 100 inches per year, respectively (this represents one half and two times the precipitation level considered in the base watershed in the ERA).

2. *Application Area* – The effect of variation in field size on herbicide export rates was investigated to determine its influence on predicted stream and pond concentrations. The lowest and highest values for application areas evaluated were 1 and 1,000 acres, respectively.

3. *Field Slope* – Variation in field slope was investigated during the sensitivity analysis to determine its effect on herbicide export. The slope of the application field affects predicted runoff, percolation, and the degree of sediment erosion resulting from rainfall events. The lowest and highest values for slope evaluated were 0.005 and 0.1 (unitless), respectively.

4. *Surface Roughness* – The Manning Roughness value, a measure of surface roughness, is used in the GLEAMS model to predict runoff intensity and erosion of sediment. The Manning Roughness value is not measured directly but can be estimated using the general surficial characteristics of the application area. The lowest and highest values for surface roughness evaluated were 0.015 and 0.15 (unitless), respectively.

5. *Erodibility* – Variation in soil erodibility was investigated during the sensitivity analysis to determine its effect on predicted river and pond concentrations. The soil erodibility factor is a lumped parameter representing an integrated average annual value of the total soil and soil profile reaction to a large number of erosion and hydrologic processes. These processes consist of soil detachment and transport by raindrop impact and surface flow, localized redeposition due to topography and tillage-induced roughness, and rainwater infiltration into the soil profile. The lowest and highest values for erodibility evaluated were 0.05 and 0.5 (tons per acre per English EI), respectively.

6. *Pond Volume or Stream Flow Rate* – The effect of variability in pond volume and stream flow on herbicide concentrations was evaluated. The lowest and highest pond volumes evaluated were 0.41 and 1,640 cubic meters, respectively. The lowest and highest stream flow values evaluated were 0.05 and 100 cms, respectively.

7. *Soil Type* – The influence that soil characteristics have on predicted herbicide export rates and concentrations was investigated by simulating different soil types within the application area. In this sensitivity analysis, clay, loam, and sand soil types were evaluated.

8. *Vegetation Type* – Because vegetation cover strongly affects the evapotranspiration rate, this parameter was expected to have a large influence on the hydrologic budget. Plants that cover a greater proportion of the application area for longer periods of the growing season will remove more water from the subsurface, and therefore, will result in diminished percolation rates through the soil. Vegetation types included in this sensitivity analysis were weeds, shrubs, rye grass, and conifers and hardwoods.

5.1.2 GLEAMS Results

The effects of the eight different input model variables were evaluated to determine the relative effect of each variable on model output concentrations. A base case was established using the following values:

- annual precipitation rate of 50 inches per year;
- application area of 10 acres;
- slope of 0.05;
- roughness of 0.015;
- erodibility of 0.401 tons per acre per English EI;
- vegetation type of weeds; and
- loam soils.

While certain parameters used in the base case for the GLEAMS sensitivity analysis may not be representative of typical BLM lands, the base case values were selected to maximize changes in the other variables during the sensitivity analysis.

For each variable, Table 5-1 provides the difference in predicted exposure concentrations in the stream and the pond using the highest and the lowest input values, with all other variables held constant. Any increase in herbicide concentration results in an increase in RQs and ecological risk. The ratio of herbicide concentrations represents the relative increase/decrease in ecological risk, where values > 1.0 denote a positive relationship between herbicide concentration and the variable (increase in RQ) and values < 1.0 denote a negative relationship (decrease in RQ). A similar table was created for the non-numerical variables soil and vegetation type (Table 5-2). This table presents the difference in concentration under different soil and vegetation types relative to the base case. A ratio was created by dividing the adjusted variable concentration by the base case concentration. Values farther away from 1.0, either positive or negative, indicate that predicted concentrations are more susceptible to changes within that particular variable.

Two separate results are presented 1) relative change in average annual stream or pond concentration and 2) relative change in maximum three day average concentration. Precipitation, application area, slope and erodibility are positively correlated with herbicide exposure concentrations; as these factors increase, so do concentrations and ecological risk. There was one exception, however, average annual pond concentrations decreased with application area. Increased roughness and flow or pond volume result in decreased concentrations and ecological risk. Changing from loam soils to sand, clay, clay loam, silt loam, or silt produced increased concentration under all scenarios (stream/pond, average annual concentration/maximum three day average concentration) with the exception of sand soils for maximum three day average concentrations. Herbicide concentration under this scenario was predicted to be less than the base case loam scenario (i.e., ecological risk decreased). Changing from loam soils to clay soils resulted in the highest increase in concentrations of all soil types. Increasing precipitation, application area, and changing soil type result in the highest increase in herbicide exposure concentrations. The remaining variables resulted in moderate to negligible effects.

5.2 AgDRIFT®

Changes to individual input parameters of predictive models have the potential to substantially influence the results of an analysis, such as that conducted in this ERA. This is particularly true for models such as AgDRIFT®, which are intended to represent complex problems such as the prediction of off-site spray drift of herbicides. Predicted off-site spray drift and downwind deposition can be substantially altered by a number of variables intended to represent the herbicide application process including, but not limited to, nozzle type used in the spray application of an herbicide mixture, ambient wind speed, release height (application boom height), and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. This section will present the changes that occur to the EEC with changes to important input parameters and assumptions used in the AgDRIFT® model. It is important to note that changes in the EEC directly affect the estimated RQ. Thus, this information is presented to help local land managers understand the factors that are likely to be related to higher potential ecological risk. Table 5-3 summarizes the relative change in exposure concentrations, and therefore ecological risk, based on specific model input parameters (e.g., mode of application, application rate).

Factors that are thought to have the greatest influence on downwind drift and deposition are spray drop-size distribution, release height, and wind speed (Teske and Barry 1993; Teske and Thistle 1999, *as cited in SDTF 2002*; Teske et al. 1998). To better quantify the influence of these and other parameters, a sensitivity analysis was undertaken by the SDTF and documented in the AgDRIFT® user's manual. In this analysis AgDRIFT® Tier II model input parameters (model input parameters are discussed in Appendix B of the HHRA) were varied by 10% above and below the default assumptions (four different drop-size distributions were evaluated). The findings of this analysis indicate the following:

- The largest variation in predicted downwind drift and deposition patterns occurred as a result of changes in the shape and content of the spray drop size distribution.
- The next greatest change in predicted downwind drift and deposition patterns occurred as a result of changes in boom height (the release height of the spray mixture).
- Changes in spray boom length resulted in significant variations in drift and deposition within 200 ft downwind of the hypothetical application area.
- Changes in the assumed ambient temperature and relative humidity resulted in small variation in drift and deposition at distances > 200 ft downwind of the hypothetical application area.
- Varying the assumed number of application swaths (aircraft flight lines), application swath width, and wind speed resulted in little change in predicted downwind drift and deposition.
- Variation in nonvolatile fraction of the spray mixture showed no effect on downwind drift and deposition.

These results, except for the minor to negligible influence of varying wind speed and nonvolatile fraction, were consistent with previous observations. The 10% variation in wind speed and nonvolatile fraction was likely too small to produce substantial changes in downwind drift and deposition. It is expected that varying these by a larger percentage would eventually produce some effect. In addition, changes in wind speed resulted in changes in application swath width and swath offset, which masked the effect of wind speed alone on downwind drift and deposition.

Based on these findings, and historic field observations, the hierarchy of parameters that have the greatest influence on downwind drift and deposition patterns is as follows:

1. Spray drop size distribution
2. Application boom height
3. Wind speed
4. Spray boom length
5. Relative humidity
6. Ambient temperature
7. Nonvolatile fraction

An additional limitation of the AgDRIFT® user's manual sensitivity analysis is the focus on distances < 200 ft downwind of a hypothetical application area. From a land management perspective, distance downwind from the point of deposition may be considered to represent a hypothetical buffer zone between the application area and a potentially sensitive habitat. In this ERA, distances as great as 900 ft downwind of a hypothetical application were considered. In an effort to expand on the existing AgDRIFT® sensitivity analysis provided in the user's manual, the sensitivity of mode of application, application height or vegetation type, and application rate were evaluated. Results of this supplemental analysis are provided in Table 5-3.

The results of the expanded sensitivity analysis indicate that deposition and corresponding ecological risk drop off substantially between 25 and 900 ft downwind of hypothetical application area. Thus, from a land management perspective, the size of a hypothetical buffer zone (the downwind distance from a hypothetical application area to a potentially sensitive habitat) may be the single most controllable variable (other than the application rate, equipment, and herbicide mixtures chosen) that has a substantial impact on ecological risk (Table 5-3).

The most conservative case at the typical application rate (using the smallest downwind distance measured in this ERA – 25 ft) was then evaluated using two different boom heights (20 and 50 inches above the ground). Predicted concentrations were greater with high vs. low boom height (Table 5-3); ecological risk, therefore, increases with boom height. The effect of application rate (maximum vs. typical) was also tested, and, as expected, predicted concentrations (and ecological risk) increase with increased application rates (Table 5-3). Concentrations were approximately three times greater using maximum application rates than using typical application rates. Mode of application scenarios were not tested in this sensitivity analysis as only ground applications are used by the BLM to disperse Overdrive®. In general, the evaluation presented in Table 5-3 indicates that there is a decrease in herbicide migration and associated ecological risk, with increased downward distance (i.e., buffer zone) and an increase in herbicide migration with increasing application height.

5.3 CALPUFF

To determine the downwind deposition of herbicide that might occur as a result of dust-borne herbicide migration, the CALPUFF model was used with one year of meteorological data for selected example locations: Glasgow, Montana; Medford, Oregon; and Lander, Wyoming. For this analysis, certain meteorological triggers were considered to determine whether herbicide migration was possible (ENSR 2004c). Herbicide migration is not likely during periods of sub-freezing temperatures, precipitation events, and periods with snow cover. For example, it was assumed herbicide migration would not be possible if the hourly ambient temperature was at or below 28 degrees Fahrenheit because the local ground would be frozen and would be very resistant to soil erosion. Deposition rates predicted by the model are most affected by the meteorological conditions and the surface roughness or land use at each of the sites.

Higher surface roughness lengths (a measure of the height of obstacles to the wind flow) result in higher deposition simply because deposition is more likely to occur on obstacles to wind flow (e.g., trees) than on a smooth surface. Therefore, the type of land use affects deposition as predicted by CALPUFF. In addition, a disturbed surface (e.g., through activities such as bulldozing) is more subject to wind erosion because the surface soil is exposed and loosened. The surface roughness in the CALPUFF analysis has been selected to represent bare or poorly vegetated soils. This leads to relatively high estimates of ground level wind speed in the application area. Such an assumption is likely to be reasonable in recently burned areas or sparsely vegetated rangeland. In grasslands, scrub habitat, and forests such an assumption likely leads to an over-prediction of herbicide scour and subsequent deposition.

CALPUFF uses hourly meteorological data, in conjunction with the site surface roughness, to calculate deposition velocities that are used to determine deposition rates at downwind distances. The amount of deposition at a particular distance is especially dependent on the "friction velocity." The friction velocity is the square root of the surface shearing stress divided by the air density (a quantity with units of wind speed). Surface shearing stress is related to the vertical transfer of momentum from the air to the Earth's surface. Shearing stress, and therefore friction velocity, increases with increasing wind speed and with increased surface roughness. Higher friction velocities result in higher deposition rates. Because the friction velocity is calculated from hourly observed wind speeds, meteorological conditions at a particular location greatly influence deposition rates as predicted by CALPUFF.

The threshold friction velocity is that ground level wind speed (accounting for surface roughness) that is assumed to lead to soil (and herbicide) scour. The threshold friction velocity is a function of the vegetative cover and soil type. Finer grained, less dense, and poorly vegetated soils tend to have lower threshold friction velocities. As the threshold friction velocity declines, wind events capable of scouring soil become more common. In fact, given the typical temporal distributions of wind speed, scour events would be predicted to be much more common as the threshold friction velocity declines from rare events to relatively common ones. The threshold wind speeds selected for the CALPUFF modeling effort are based on typical, un-vegetated soils in the example areas. In the event that very fine soils or ash are present at the site, the threshold wind speed could be lower and scouring wind events more common. This, in turn, would lead to greater soil and herbicide erosion with greater subsequent downwind deposition.

The size of the treatment area also impacts the predicted herbicide migration and deposition results. The size of the treatment area is directly proportional to the total amount of herbicide that can be moved via soil erosion. Because a fixed amount of herbicide per unit area is required for treatment, a larger treatment area would yield a larger amount of herbicide that could migrate. In addition, increased herbicide mass would lead to increased downwind deposition.

In summary:

- Herbicide migration does not occur unless the surface wind speed is high enough to produce a friction velocity that can lift soil particles into the air.
- The presence of surface "roughness elements" (buildings, trees and other vegetation) has an effect upon the deposition rate. Areas of higher roughness will result in more intense vertical eddies that can mix down suspended particles more effectively than smoother surfaces can. Thus, higher deposition of suspended soil and herbicide are predicted for areas with high roughness.
- Disturbed surfaces, such as areas recently burned, and large treatment areas will experience greater herbicide migration and deposition.

TABLE 5-1
Relative Effects of GLEAMS Input Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate

Stream Scenarios

Input Variable	Units	Input Low Value (L)	Input High Value (H)	Low Value Predicted Concentration		High Value Predicted Concentration		Concentration $_H$ / Concentration $_L$		Relative Change in Concentration	
				Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream
Precipitation	inches	25	100	0.00E+00	0.00E+00	3.17E-07	3.73E-05	NA	NA	+	+
Area	acres	1	1,000	2.42E-08	2.95E-06	1.52E-06	1.85E-04	62.6162	62.5731	+	+
Slope	unitless	0.005	0.1	2.09E-07	2.54E-05	2.23E-07	2.72E-05	1.0683	1.0685	+	+
Erodibility	tons/acre per English EI	0.05	0.5	2.09E-07	2.54E-05	2.13E-07	2.60E-05	1.0216	1.0215	+	+
Roughness	unitless	0.015	0.15	2.14E-07	2.61E-05	2.09E-07	2.55E-05	0.9762	0.9761	-	-
Flow Rate	m^3/sec	0.05	100	4.34E-07	5.29E-05	2.96E-10	3.61E-08	0.0007	0.0007	-	-

Pond Scenarios

Input Variable	Units	Input Low Value (L)	Input High Value (H)	Low Value Predicted Concentration		High Value Predicted Concentration		Concentration $_H$ / Concentration $_L$		Relative Change in Concentration	
				Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond
Precipitation	inches	25	100	0.00E+00	0.00E+00	2.08E-06	1.91E-04	NA	NA	+	+
Area	acres	1	1,000	7.09E-06	8.78E-05	1.61E-06	1.97E-04	0.2279	2.2408	-	+
Slope	unitless	0.005	0.1	7.34E-06	4.63E-04	7.85E-06	4.95E-04	1.0681	1.0687	+	+
Erodibility	tons/acre per English EI	0.05	0.5	7.35E-06	4.63E-04	7.51E-06	4.73E-04	1.0216	1.0215	+	+
Roughness	unitless	0.015	0.15	7.54E-06	4.76E-04	7.36E-06	4.64E-04	0.9765	0.9760	-	-
Pond Volume	ac/ft	0.05	100	4.14E-06	3.73E-04	4.42E-08	4.49E-07	0.0107	0.0012	-	-

Concentrations were based on the average application rate.
NA – Not applicable; due to herbicide chemical and physical properties, there was no export of this herbicide at this low precipitation rate.
"+" = Increase in concentration from low to high input value = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration from low to high input value = decrease in RQ = decrease in ecological risk.

TABLE 5-2
Relative Effects of Soil and Vegetation Type on Herbicide Exposure Concentrations using Typical BLM Application Rate

	Predicted Concentration				**Concentration $_{X\ Soil\ Type}$ / Concentration $_{Loam}$**				**Relative Change in Concentration**			
Soil Type	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**
***Loam*[1]**	***2.14E-07***	***2.61E-05***	***7.54E-06***	***4.76E-04***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Sand	4.04E-07	2.50E-05	6.28E-05	5.64E-04	1.8896	0.9575	8.3333	1.1855	+	-	+	+
Clay	5.02E-06	5.51E-04	3.32E-04	1.52E-02	23.4338	21.1153	44.0100	31.9035	+	+	+	+
Clay Loam	4.19E-06	4.68E-04	1.81E-04	7.91E-03	19.5830	17.9506	24.0199	16.6220	+	+	+	+
Silt Loam	1.98E-06	2.34E-04	7.94E-05	4.27E-03	9.2572	8.9681	10.5274	8.9686	+	+	+	+
Silt	1.75E-06	2.11E-04	6.13E-05	3.54E-03	8.1955	8.0684	8.1264	7.4531	+	+	+	+

	Predicted Concentration				**Concentration $_{X\ Veg\ Type}$ / Concentration $_{Weeds}$**				**Relative Change in Concentration**			
Vegetation Type	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**
***Weeds*[1]**	***2.14E-07***	***2.61E-05***	***7.54E-06***	***4.76E-04***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Conifer + Hardwood	2.74E-07	3.34E-05	6.25E-06	4.93E-04	1.2803	1.2805	0.8290	1.0364	+	+	-	+
Shrubs	2.14E-07	2.61E-05	7.54E-06	4.76E-04	1.0000	1.0000	1.0000	1.0000	No Change	No Change	No Change	No Change
Rye Grass	2.14E-07	2.61E-05	7.54E-06	4.76E-04	1.0000	1.0000	1.0000	1.0000	No Change	No Change	No Change	No Change

[1] *Base Case*
Concentrations were based on the average application rate.
NA = Not applicable, no comparison.
"+" = Increase in concentration from base case = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration from base case = decrease in RQ = decrease in ecological risk.

TABLE 5-3
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Mode of Application	Application Height/Veg. Type	Minimum Downwind Distance (ft)	Maximum Downwind Distance (ft)	Minimum Downwind Distance Concentration			Maximum Downwind Distance Concentration		
				Terrestrial (lb/ac)	Stream (mg/L)	Pond (mg/L)	Terrestrial (lb/ac)	Stream (mg/L)	Pond (mg/L)
Typical Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	9.00E-04	4.69E-04	5.11E-05	5.11E-05	1.42E-05	5.41E-06
	High Boom	25	900	1.60E-03	7.86E-04	8.21E-05	6.55E-05	1.88E-05	6.87E-06
Maximum Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	1.30E-03	6.26E-04	6.82E-05	6.82E-05	1.90E-05	7.22E-06
	High Boom	25	900	2.10E-03	1.05E-03	1.09E-04	8.73E-05	2.51E-05	9.16E-06

Effect of Downwind Distance

Mode of Application	Application Height or Vegetation Type	Minimum Buffer	Maximum Buffer	Concentration $_{900}$/ Concentration $_{25\ or\ 100}$			Relative Change in Concentration		
				Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Typical Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	0.0568	0.0303	0.1059	-	-	-
	High Boom	25	900	0.0409	0.0239	0.0837	-	-	-
Maximum Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	0.0525	0.0303	0.1059	-	-	-
	High Boom	25	900	0.0416	0.0239	0.0840	-	-	-

TABLE 5-3 (Cont.)
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Effect of Application Vegetation or Boom Height

Mode of Application	Application Height or Vegetation Type	Vegetation Type or Boom Height[1]			Relative Change in Concentration		
		Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Typical Application Rate							
Plane	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Ground	High/Low Boom	1.7778	1.6749	1.6067	+	+	+
Maximum Application Rate							
Plane	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Ground	High/Low Boom	1.6154	1.6749	1.5982	+	+	+

Effect of Application Rate

	Application Rate[2]			Relative Change in Concentration		
	Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Maximum vs. Typical	1.3125	1.3333	1.3276	+	+	+

(1) using minimum buffer width concentrations.
(2) using ground dispersal, minimum buffer width, and high boom concentrations.
"+" = Increase in concentration = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration = decrease in RQ = decrease in ecological risk.

6.0 RARE, THREATENED, AND ENDANGERED SPECIES

Rare, threatened, and endangered (RTE) species have the potential to be impacted by herbicides applied for vegetation control. RTE species are of potential increased concern to screening-level ERAs, which utilize surrogate species and generic assessment endpoints to evaluate potential risk, rather than examining site- and species-specific effects to individual RTE species. Several factors complicate our ability to evaluate site- and species-specific effects:

- Toxicological data specific to the species (and sometimes even class) of organism are often absent from the literature.
- The other assumptions involved in the ERA (e.g., rate of food consumption, surface-to-volume ratio) may differ for RTE species relative to selected surrogates, and/or data for RTE species may be unavailable.
- The high level of protection afforded RTE species by regulation and policy suggests that secondary effects (e.g., potential loss of prey or cover), as well as site-specific circumstances that might result in higher rates of exposure, should receive more attention.

A common response to these issues is to design screening-level ERAs, including this one, to be highly conservative. This includes assumptions such as 100% exposure to a constituent by simulating scenarios where the organism lives year-round in the most affected area (i.e., area of highest concentration) or where the organism consumes only food items that have been impacted by the herbicide. The Overdrive® screening-level ERA has additional conservatism in the assumptions used in the herbicide concentration models such as GLEAMS (Appendix B of the Methods Document; ENSR 2004c). Even with highly conservative assumptions in the ERA, concern may still exist over the potential risk to specific RTE species.

To help address this potential concern, the following section will discuss the ERA assumptions as they relate to the protection of RTE species. The goals of this discussion are as follows:

- Present the methods the ERA employs to account for risks to RTE species and the reasons for their selection.
- Define the factors that might motivate a site- and/or species-specific evaluation[3] of potential herbicide impacts to RTE species and provide perspective useful for such an evaluation.
- Present information that is relevant to assessing the uncertainty in the conclusions reached by the ERA with respect to RTE species.

The following sections describe information used in the ERA to provide protection to RTE species, including mammals, birds, plants, reptiles, amphibians, and fish (e.g., salmonids) potentially occurring on BLM-managed lands. It includes a discussion of the quantitative and qualitative factors used to provide additional protection to RTE species and a discussion of potential secondary effects of herbicide use on RTE species.

Section 6.1 provides a review of the selection of LOCs and TRVs with respect to providing additional protection to RTE species. Section 6.2 provides a discussion of species-specific traits and how they relate to the RTE protection strategy in this ERA. Section 6.2 also includes discussion of the selection of surrogate species (6.2.1), the RTE taxa of concern, and the surrogates used to represent them (6.2.2), and the biological factors that affect the exposure to and

[3] Such an evaluation might include site-specific estimation of exposure point concentrations using one or more models, more focused consideration of potential risk to individual RTE species; and/or more detailed assessment of indirect effects to RTE species, such as those resulting from impacts to habitat.

response of organisms to herbicides (6.2.3). This includes a discussion of how the ERA was defined to assure that consideration of these factors resulted in a conservative assessment. Mechanisms for extrapolating toxicity data from one taxon to another are briefly reviewed in Section 6.3. The potential for impacts, both direct and secondary, to salmonids is discussed in Section 6.4. Section 6.5 provides a summary of the section.

6.1 Use of LOCs and TRVs to Provide Protection

Potential direct impacts to receptors, including RTE species, are the measures of effect typically used in screening-level ERAs. Direct impacts, such as those resulting from direct or indirect contact or ingestion were assessed in the Overdrive® ERA by comparing calculated RQs to receptor-specific LOCs. As described in the methodology document for this ERA (ENSR 2004c), RQs are calculated as the potential dose or EEC divided by the TRV selected for that pathway. An RQ greater than the LOC indicates the potential for risk to that receptor group via that exposure pathway. As described below, the selection of TRVs and the use of LOCs were pursued in a conservative fashion in order to provide a greater level of protection for RTE species.

The LOCs used in the ERA (Table 4-1) were developed by the USEPA for the assessment of pesticides (LOC information obtained from Michael Davy, USEPA OPP on 13 June 2002). In essence, the LOCs act as uncertainty factors often applied to TRVs. For example, using an LOC of 1.0 provides the same result as dividing the TRV by 10. The LOC for avian and mammalian RTE species is 0.1 for acute and 1.0 for chronic exposures. For RTE fish and aquatic invertebrates, acute and chronic LOCs were 0.05 and 0.5, respectively. Therefore, up to a 20-fold uncertainty factor has been included in the TRVs for animal species. As noted below, such uncertainty factors provide a greater level of protection to the RTE species to account for the factors listed in the introduction to this section.

For RTE plants, the exposure concentration, TRVs, and LOCs provided a direct assessment of potential impacts. For all exposure scenarios, both the typical and maximum modeled concentrations were used as the exposure concentrations. The TRVs used for RTE plants were selected based on highly sensitive endpoints, such as germination, rather than direct mortality of seedlings or larger plants. Conservatism has been built into the TRVs during their development (Section 3.1); the lowest suitable endpoint concentration available was used as the TRV for RTE plant species. Therefore, the RQ calculated for RTE plant exposure is intrinsically conservative. Given the conservative nature of the RQ, and consistent with USEPA policy, no additional levels of protection were required for the LOC (i.e., all plant LOCs are 1).

6.2 Use of Species Traits to Provide Protection to RTE Species

Over 500 RTE species currently listed under the Federal Endangered Species Act (ESA) have the potential to occur in the 17 states covered under this Programmatic ERA. These species include 287 plants, 80 fish, 30 birds, 47 mammals, 15 reptiles, 13 amphibians, 34 insects, 10 arachnids (spiders), and 22 aquatic invertebrates (12 mollusks and 10 crustaceans)[4]. Some marine mammals are included in the list of RTE species; but due to the limited possibility these species would be exposed to herbicides applied to BLM-managed lands, no surrogates specific to marine species are included in this ERA. However, the terrestrial mammalian surrogate species identified for use in the ERA include species that can be considered representative of these marine species as well. The complete list is presented in Appendix D.

Of the over 500 species potentially occurring in the 17 states, just over 300 species may occur on lands treated by the BLM. These species include 7 amphibians, 19 birds, 6 crustaceans, 65 fish, 30 mammals, 10 insects, 13 mollusks, 5 reptiles, and 151 plants[4]. Protection of these species is an integral goal of the ERA and EIS, and they are the focus of the RTE evaluation for the ERA and EIS. These species are different from one another in regards to home range, foraging strategy, trophic level, metabolic rate, and other species-specific traits. Several methods were used in the ERA to take these differences into account during the quantification of potential risk. Despite this precaution, these traits are reviewed in order to provide a basis for potential site- and species-specific risk assessment. Review of these

[4] The number of RTE species for each taxa may have changed slightly since the writing of this document.

factors provides a supplement to other sections of the ERA that discuss the uncertainty in the conclusions specific to RTE species.

6.2.1 Identification of Surrogate Species

Use of surrogate species in a screening ERA is necessary to address the broad range of species likely to be encountered on BLM-managed lands as well as to accommodate the fact that toxicity data may be restricted to a limited number of species. In this ERA, surrogates were selected to account for variation in the nature of potential herbicide exposure (e.g., direct contact, food chain) as well as to ensure that different taxa, and their behaviors, are considered. As described in Section 3.0 of the Methods Document (ENSR 2004c), surrogate species were selected to represent a broad range of taxa in several trophic guilds that could potentially be impacted by herbicides on BLM-managed lands. Generally, the surrogate species that were used in the ERA are species commonly used as representative species in ERAs. Many of these species are common laboratory species, or are described in USEPA (1993a) Exposure Factors Handbook for Wildlife. Other species were included in the California Wildlife Biology, Exposure Factor, and Toxicity Database (CA OEHHA 2003),[5] or are those recommended by USEPA OPP for tests to support pesticide registration. Surrogate species were used to derive TRVs, and in exposure scenarios that involve organism size, weight, or diet, surrogate species were exposed to the herbicide in the models to represent potential impact to other species that may be present on BLM lands.

Toxicity data from surrogate species were used in the development of TRVs because few, if any, data are available that demonstrate the toxicity of chemicals to RTE species. Most reliable toxicity tests are performed under controlled conditions in a laboratory, using standardized test species and protocols; RTE species are not used in laboratory toxicity testing. In addition, field-generated data, which are very limited in number but may include anecdotal information about RTE species, are not as reliable as laboratory data because uncontrolled factors may complicate the results of the tests (e.g., secondary stressors such as unmeasured toxicants, imperfect information on rate of exposure).

As described below, inter-species extrapolation of toxicity data often produces unknown bias in risk calculations. This ERA approached the evaluation of higher trophic level species by life history (e.g., large animals vs. small animals, herbivore vs. carnivores). Then surrogate species were used to evaluate all species of similar life history potentially found on BLM-managed lands, including RTE species. This procedure was not done for plants, invertebrates, and fish, as most exposure of these species to herbicides is via direct contact (e.g., foliar deposition, dermal deposition, dermal/gill uptake) rather than ingestion of contaminated food items. Therefore, altering the life history of these species would not result in more or less exposure.

The following subsections describe the selection of surrogate species used in two separate contexts in the ERA.

6.2.1.1 Species Selected in Development of TRVs

As presented in Appendix A of the ERA, limited numbers of species are used for toxicity testing of chemicals, including herbicides. Species are typically selected because they tolerate laboratory conditions well. The species used in laboratory tests have relatively well-known response thresholds to a variety of chemicals. Growth rates, ingestion rates, and other species-specific parameters are known; therefore, test duration and endpoints of concern (e.g., mortality, germination) have been established in protocols for many of these laboratory species. Data generated during a toxicity test, therefore, can be compared to data from other tests and relative species sensitivity can be compared. Of course, in the case of RTE species, it would be unacceptable to subject individuals to toxicity tests.

The TRVs used in this ERA were selected after reviewing available ecotoxicological literature for diflufenzopyr and dicamba. Test quality was evaluated, and tests with multiple substances were not considered for the TRV. For most receptor groups, the lowest value available for an appropriate endpoint (e.g., mortality, germination) was selected as the TRV. Using the most sensitive species provides a conservative level of protection for all species. The surrogate species used in the Overdrive® TRVs are presented in Table 6-1.

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[5] On-line http://www.oehha.org/cal_ecotox/default.htm

6.2.1.2 Species Selected as Surrogates in the ERA

Plants, fish, insects, and other aquatic invertebrates were evaluated on a generic level. That is, the surrogate species evaluated to create the TRVs were selected to represent all potentially exposed species. For vertebrate terrestrial animals, in addition to these surrogate species, specific species were selected to represent the populations of similar species. The species used in the ERA are presented in Table 6-2.

The surrogate terrestrial vertebrate species selected for the ERA include species from several trophic levels that represent a variety of foraging strategies. Whenever possible, the species selected are found throughout the range of land included in the EIS; all species selected are found in at least a portion of the range. The surrogate species are common species whose life histories are well documented (USEPA 1993 a, b; CA OEHHA 2003). Because species-specific data, including BW and food ingestion rates, can vary for a single species throughout its range, data from studies conducted in western states or with western populations were selected preferentially. As necessary, site-specific data can be used to estimate potential risk to species known to occur locally.

6.2.2 Surrogates Specific to Taxa of Concern

Protection levels for different species and individuals vary. Some organisms are protected on a community level; that is, slight risk to individual species may be acceptable if the community of organisms (e.g., wildflowers, terrestrial insects) is protected. Generally, community level organisms include plants and invertebrates. Other organisms are protected on a population level; that is, slight risk to individuals of a species may be acceptable if the population, as a whole, is not endangered. However, RTE species are protected as individuals; risk to any single organism is considered unacceptable. This higher level of protection motivates much of the conservative approach taken in this ERA. Surrogate species were grouped by general life strategy: sessile (i.e., plants), water dwelling (i.e., fish), and mobile terrestrial vertebrates (i.e., birds, mammals, and reptiles). The approach to account for RTE species was divided along the same lines.

Plants, fish, insects, and aquatic invertebrates were assessed using TRVs developed from surrogate species. All species from these taxa (identified in Appendix C) were represented by the surrogate species presented in Table 6-1. The evaluation of terrestrial vertebrates used surrogate species to develop TRVs and to estimate potential risk using simple food chain models. Tables 6-3 and 6-4 present the listed birds and mammals found on BLM-managed lands and their appropriate surrogate species.

Very few laboratory studies have been conducted using reptiles or amphibians. Therefore, data specific to the adverse effects of a chemical on species of these taxa are often unavailable. These animals, being cold-blooded, have very different rates of metabolism than mammals or birds (i.e., they require lower rates of food consumption). Nonetheless, mammals and birds were used as the surrogate species for reptiles and adult amphibians because of the lack of data for these taxa. Fish were used as surrogates for juvenile amphibians. For each trophic level of RTE reptile or adult amphibian, a comparable mammal or bird was selected to represent the potential risks. Table 6-5 presents the 7 listed reptiles found on BLM-managed lands and the surrogate species chosen to represent them in the ERA. Table 6-6 presents the listed amphibians found on BLM-managed lands and their surrogate species.

The sensitivity of reptiles and amphibians relative to other species is generally unknown. Some information about reptilian exposures to pesticides, including herbicides, is available. The following provides a brief summary of the data (as cited in Sparling et al. 2000), including data for pesticides not evaluated in this ERA:

- Mountain garter snakes (*Thamnophis elegans elegans*) were exposed to the herbicide thiobencarb in the field and in the laboratory. No effects were noted in the snakes fed contaminated prey or those caged and exposed directly to treated areas.

- No adverse effects to turtles were noted in a pond treated twice with the herbicide Kuron (2,4,5-T).

- Tortoises in Greece were exposed in the field to atrazine, paraquat, Kuron, and 2,4-D. No effects were noted on the tortoises exposed to atrazine or paraquat. In areas treated with Kuron and 2,4-D, no tortoises were noted following the treatment. The authors of the study concluded it was a combination of direct toxicity (tortoises were noted with swollen eyes and nasal discharge) and loss of habitat (much of the vegetation killed during the treatment had provided important ground cover for the tortoises).

- Reptilian LD_{50} values from six organochlorine pesticides were compared to avian LD_{50} values. Of the six pesticides, five lizard LD_{50}s were higher, indicating lower sensitivity. Overlapping data were available for turtle exposure to one organochlorine pesticide; the turtle was less sensitive than the birds or lizards.

- In general, reptiles were found to be less sensitive than birds to cholinesterase inhibitors.

Unfortunately, these observations do not provide any sort of rigorous review of dose and response. On the other hand, there is little evidence that reptiles are more sensitive to pesticides than other, more commonly tested organisms.

As with reptiles, some toxicity data are available describing the effects of herbicides on amphibians. The following provides a brief summary of the data (as cited in Sparling et al. 2000):

- Leopard frog *(Rana pipiens)* tadpoles exposed to up to 0.075 mg/L atrazine showed no adverse effects.

- In a field study, it was noted that frog eggs in a pond where atrazine was sprayed nearby suffered 100% mortality.

- Common frog (*Rana temporaria)* tadpoles showed behavioral and growth effects when exposed to 0.2 to 20 mg/L cyanatryn.

- Caged common frog and common toad (*Bufo bufo)* tadpoles showed no adverse effects when exposed to 1.0 mg/L diquat or 1.0 mg/L dichlobenil.

- All leopard frog eggs exposed to 2.0 to 10 mg/L diquat or 0.5 to 2.0 mg/L paraquat hatched normally, but showed adverse developmental effects. It was noted that commercial formulations of paraquat were more acutely toxic than technical grade paraquat. Tadpoles, however, showed significant mortality when fed paraquat-treated parrot feather watermilfoil (*Myriophyllum).*

- 4-chloro-2-methylphenoaxyacetic acid (MCPA) is relatively non-toxic to the African clawed frog (*Xenopus laevis)* with an LC_{50} of 3,602 mg/L and slight growth retardation at 2,000 mg/L.

- Approximately 86% of juvenile toads died when exposed to monosodium methanearsonate (ANSAR 259® HC) at 12.5% of the recommended application rate.

- Embryo hatch success, tadpole mortality, growth, paralysis, and avoidance behavior were studied in three species of ranid frogs (*Rana* sp.) exposed to hexazinone and triclopyr. No effects were noted in hexazinone exposure up to 100 mg/L. Two species showed 100% mortality at 2.4 mg/L triclopyr; no significant mortality was observed in the third species.

No conclusions can be drawn regarding the sensitivity of amphibians to exposure to Overdrive® relative to the surrogate species selected for the ERA. Amphibians are particularly vulnerable to changes in their environment (chemical and physical) because they have skin with high permeability, making them at risk to dermal contact, and have complex life styles, making them vulnerable to developmental defects during the many stages of metamorphosis. Although there are very low risks to most animals in the modeled exposures, the effects of regular usage of Overdrive® are uncertain. It should be noted that certain amphibians have been shown to be sensitive to pesticides and consideration should be given to careful evaluation of site- and species-specific risk assessment in the event that amphibian RTE species are present near a site of application.

Although the uncertainties associated with the potential risk to RTE mammals, birds, reptiles, and amphibians are valid, the vertebrate RQs generated in the ERA for Overdrive® are all low (Section 4.3). With the exception of chronic exposure to large mammalian herbivores, none of the RQs exceed respective LOCs. Most vertebrate RQs, including fish exposure to accidental spills, were lower than respective LOCs by several orders of magnitude.

6.2.3 Biological Factors Affecting Impact from Herbicide Exposure

The potential for ecological receptors to be exposed to, and affected by, herbicide is dependent upon many factors. Many of these factors are independent of the biology or life history of the receptor (e.g., timing of herbicide use, distance to receptor). These factors were explored in the ERA by simulating scenarios that vary these factors (ENSR 2004c); these scenarios are discussed in Section 5.0 of this document. However, there are differences in life history among and between receptors that also influence the potential for exposure. Therefore, individual species have a different potential for exposure as well as response. In order to provide perspective on the assumptions made here, as well as the potential need to evaluate alternatives, receptor traits that may influence species-specific exposure and response were examined. These traits are presented and discussed in Table 6-7.

In addition to providing a review of the approach used in the ERA, the factors listed in Table 6-7 can be evaluated to assess whether a site- and species-specific ERA should be considered to address potential risks to a given RTE species. They also provide perspective on the uncertainty associated with applying the conclusions of the ERA to a broad range of RTE species.

6.3 Review of Extrapolation Methods Used to Calculate Potential Exposure and Risk

Ecological risk assessment relies on extrapolation of observations from one system to another (e.g., between species, between toxicity endpoints; see Table 6-7). While every effort has been made to anticipate bias in these extrapolations and to use them to provide an overestimate of risk, it is worth evaluating alternative approaches.

Toxicity Extrapolations in Terrestrial Systems (Fairbrother and Kaputska 1996) is an opinion paper that describes the difficulties associated with trying to quantitatively evaluate a particular species when toxicity data for that species, and/or for the endpoint of concern, are not available. The authors provide an overview of uncertainty factors and methods of data extrapolation used in terrestrial organism TRV development, and suggest an alternative approach to establishing inter-species TRVs. The following subsections summarize their findings for relevant methods of extrapolation.

6.3.1 Uncertainty Factors

Uncertainty factors are used often in both human health and ERA. The uncertainty factor most commonly used in ERAs is 10. This value has little empirical basis, but was developed and adopted by the risk assessment community because it seemed conservative and was "simple to use."[6] Six situations in which uncertainty factors may be applied in ecotoxicology were identified: (1) accounting for intraspecific heterogeneity, (2) supporting interspecific extrapolation, (3) converting acute to chronic endpoints and vice versa, (4) estimating LOAEL from NOAEL, (5) supplementing professional judgement, and (6) extrapolating laboratory data to field conditions. No extrapolation of toxicity data among Classes (i.e., among birds, mammals, and reptiles) was discussed. The methods to extrapolate available laboratory toxicity data to suit the requirements of the TRVs in this ERA are discussed in Section 3. For this reason, extrapolation used to develop TRVs is not discussed in this section.

Empirical data for each of the situations discussed in the Fairbrother and Kaputska paper (as applicable) are presented in Tables 6-8 through 6-12. In each of these tables, the authors have presented the percentage of the available data that is included within a stated factor. For example, 90% of the observed LD_{50}s for bird species lie within a factor of ten (i.e., the highest LD_{50} within the central 90% of the population is 10-fold higher than the lowest value). This approach

[6] Section 2, Fairbrother and Kaputska 1996. Page 7.

can be compared to the approach used in this ERA. For example, for aquatic invertebrates, an LOC of 0.05 was defined, which is analogous to application of an uncertainty factor of 20 to the relevant TRV. In this case, the selected TRV is not the highest or the mid-point of the available values, but a value at the lower end of the available range. Thus, dividing the TRV by a factor of 20 is very likely to place it well below any observed TRV. With this perspective, the ranges (or uncertainty factors) provided by Fairbrother and Kaputska (1996) generally appear to support the approach used in the ERA (i.e., select low TRVs and consider comparison to an LOC <1.0).

6.3.2 Allometric Scaling

Allometric scaling provides a formula based on BW that allows translation of doses from one animal species to another. In this ERA, allometric scaling was used to extrapolate the terrestrial vertebrate TRVs from the laboratory species to the surrogate species used to estimate potential risk. The Environmental Sciences Division of the Oak Ridge National Laboratory (ORNL) (Opresko et al. 1994 and Sample et al. 1996) has used allometric scaling for many years to establish benchmarks for vertebrate wildlife. The USEPA has also used allometric scaling in development of wildlife water quality criteria in the Great Lakes Water Quality Initiative (USEPA 1995) and in the development of ecological soil screening levels (USEPA 2000).

The theory behind allometric scaling is that metabolic rate is proportional to body size.[7] However, assumptions are made that toxicological processes are dependent on metabolic rate, and that toxins are equally bioavailable among species. Similar to other types of extrapolation, allometric scaling is sensitive to the species used in the toxicity test selected to develop the TRV. Given the limited amount of data, using the lowest value available for the most sensitive species is the best approach[4], although the potential remains for site-specific receptors to be more sensitive to the toxin. Further uncertainty is introduced to allometric scaling when the species-specific parameters (e.g., BW, ingestion rate) are selected. Interspecies variation of these parameters can be considerable, especially among geographic regions. Allometric scaling is not applicable between classes of organisms (i.e., bird to mammal). However, given these uncertainties, allometric scaling remains the most reliable easy-to-use means to establish TRVs for a variety terrestrial vertebrate species (Fairbrother and Kaputska 1996).

6.3.3 Recommendations

Fairbrother and Kaputska (1996) provided a critical evaluation of the existing, proposed, and potential means for intraspecies toxicity value extrapolation. The paper they published describes the shortcomings of many methods of intraspecific extrapolation of toxicity data for terrestrial organisms. Using uncertainty factors or allometric scaling for extrapolation can often over- or underpredict the toxic effect to the receptor organism. Although using physiologically-based models may be a more scientifically correct way to predict toxicity, the logistics involved with applying them to an ERA on a large-scale make them impractical. In this ERA, extrapolation was performed using techniques most often employed by the scientific risk assessment community. These techniques included the use of uncertainty factors (i.e., potential use of LOC <1.0) and allometric scaling.

6.4 Indirect Effects on Salmonids

In addition to the potential direct toxicity associated with herbicide exposure, organisms may be harmed from indirect effects, such as habitat degradation or loss of prey. Under Section 9 of the ESA of 1973, it is illegal to take an endangered species of fish or wildlife. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (16 USC 1532(19)). The National Marine Fisheries Service (NMFS, NOAA 1999) published a final rule clarifying the definition of "harm" as it relates to take of endangered species in the ESA. NOAA Fisheries defines "harm" as any act that injures or kills fish and wildlife. Acts may include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by

[7] In the 1996 update to the ORNL terrestrial wildlife screening values document (Sample et al. 1996), studies by Mineau et al. (1996) using allometric scaling indicated that, for 37 pesticides studied, avian LD_{50}s varied from 1 to 1.55, with a mean of 1.148. The LD_{50} for birds is now recommended to be 1 across all species.

significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering." To comply with the ESA, potential secondary effects to salmonids were evaluated to ensure that use of Overdrive® on BLM-managed lands would not cause harm to these endangered fish.

Adverse effects caused by herbicides can be cumulative, both in terms of toxicity stress from break-down products and other chemical stressors that may be present, and in terms of the use of herbicide on lands already stressed on a larger scale. Cumulative watershed effects (CWEs) often arise in conjunction with other land use practices, such as prescribed burning. In forested areas, herbicides are generally used in areas that have been previously altered, such as cut or burned, during vegetative succession when invasive species may dominate. The de-vegetation of these previously stressed areas can delay the stabilization of the substrate, increasing the potential for erosion and resulting sedimentation in adjacent waterbodies.

Indirect effects can generally be categorized into effects caused by biological or physical disturbance. Biological disturbance includes impacts to the food chain; physical disturbance includes impacts to habitat[8] (Freeman and Boutin 1994). NOAA Fisheries (2002) has internal draft guidance for their Section 7 pesticide evaluations. The internal draft guidance describes the steps that should be taken in an ERA to ensure salmonids are addressed appropriately. The following subsections describe how, consistent with internal draft guidance from NOAA Fisheries, the Overdrive® ERA dealt with the indirect effects assessment.

6.4.1 Biological Disturbance

Potential direct effects to salmonids were evaluated in the ERA. Sensitive endpoints were selected for the RTE species RQ calculations, and worst-case scenarios were assumed. No Overdrive® RQs for fish exceeded the respective RTE LOC (Section 4.3). Indirect effects caused by disturbance to the surrounding biological system were evaluated by looking at potential damage to the food chain.

The majority of the salmonid diet is aquatic invertebrates and other fish. Sustaining the aquatic invertebrate population is vital to minimizing biological damage from herbicide use. Consistent with ERA guidance (USEPA 1997, 1998), protection of non-RTE species, such as the aquatic invertebrates and fish serving as prey to salmonids, is to the population or community level, not the individual. Sustainability of the numbers (population) or types (community) of aquatic invertebrates and fish is the assessment endpoint. Therefore, unless acute risks are present, it is unlikely the herbicide will cause harm to the prey base of salmonids from direct damage to the aquatic invertebrates and fish. As discussed in Section 4.3, no aquatic invertebrate or fish acute or chronic scenario RQs exceeded respective LOCs, suggesting that direct impacts to the forage of salmonids are unlikely.

As primary producers and the food base of aquatic invertebrates, disturbance to the aquatic vegetation may affect the aquatic invertebrate population, thereby affecting salmonids. As presented in Section 4.3, risk to aquatic vegetation may occur under selected exposure scenarios. The greatest potential for risk to aquatic vegetation would occur with accidental direct spray or spill of a terrestrial herbicide in to an aquatic system. In fact, RQs generally exceeded LOCs, although by less than an order of magnitude, under the spill and accidental spray scenarios. This suggests that the potential for impacts to aquatic vegetation and resulting indirect effects on salmonids from the use of the herbicide is likely to be restricted to only a few scenarios including accidental direct spraying.

The actual food items of many aquatic invertebrates, however, are not leafy aquatic vegetation, but detritus or benthic algae. Should aquatic vegetation be affected by an accidental herbicide exposure, the detritus in the stream should increase. Benthic algae are often the principle primary producers in streams. As such, disturbance of algal communities would cause an indirect effect (i.e., reduction in biomass at the base of the food chain) on all organisms living in the waterbody, including salmonids. Few data are available for the herbicide toxicity to benthic algae. Of the

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[8] Physical damage to habitat may also be covered under an evaluation of critical habitat. Because all reaches of streams and rivers on BLM-managed land may not be listed as critical habitat, a generalized approach to potential damage to any habitat was conducted. This should satisfy a general evaluation of critical habitats. Any potential for risk due to physical damage to habitat should be addressed specifically for areas deemed critical habitat.

algae data available for Overdrive®, the closest species to benthic algae is duckweed (*Lemna gibba*). This species was used to derive the TRVs used in the ERA (0.11 and 0.0023 mg/L for EC_{50} and NOAEL data, respectively). Because the RQs for most scenarios were lower than the LOC using a TRV based on duckweed, it suggests that impacts to algae and attending secondary effects are unlikely.

Based on an evaluation of the RQs calculated for this ERA, it is unlikely RTE fish, including salmonids, would be at risk from the indirect effects of this herbicide. Exceptions to this include potential acute effects to aquatic life from accidental spills, an extreme and unlikely scenario considered in this ERA to add conservatism to the risk estimates. Appropriate and careful use of Overdrive® should preclude such an incident.

6.4.2 Physical Disturbance

The potential for indirect effects to salmonids due to physical disturbance is less easy to define. Any modifications to habitat could be interpreted as a physical disturbance that may result in adverse effects to salmonids. The killing of instream and riparian vegetation likely would cause the most important physical disturbances resulting from herbicide application. The potential adverse effects could include, but are not necessarily limited to: loss of primary producers (Section 4.6.1); loss of overhead cover, which may serve as refuge from predators or shade to provide cooling to the waterbodies; and increased sedimentation due to loss of riparian vegetation.

Salmonids have distinct habitat requirements. Alteration to the coldwater streams in which they spawn and live until returning to the ocean as adults can be detrimental to the salmonid population. Such alterations are not directly related to loss of vegetation, but loss of vegetation can alter their habitat.

Adverse effects caused by herbicides can be cumulative, both in terms of toxicity stress from break-down products and other chemical stressors that may be present, and in terms of the use of herbicide on lands already stressed on a larger scale. Cumulative watershed effects often arise in conjunction with other land use practices, such as prescribed burning. In forested areas, herbicides are generally used in areas that have been previously altered, such as cut or burned, during vegetative succession when invasive species may dominate. The de-vegetation of these previously stressed areas can delay the stabilization of the substrate, increasing the potential for erosion and resulting sedimentation in adjacent waterbodies.[9]

Based on the results of the ERA, there is potential for non-target terrestrial and aquatic plant risk in extreme circumstances, such as incidents of spills or accidental direct spray (Sections 4.3.1 and 4.3.5). However, under the majority of exposure scenarios, no apparent risk to non-target aquatic plants is predicted. Terrestrial plants may be at risk from runoff and drift under certain circumstances (e.g., drift closer than 300 ft or runoff from clay soils). Use of Overdrive® may cause slight potential risk to RTE species due to impact to riparian vegetation. Because of this risk, land managers should consider the proximity of salmonid habitat to potential application areas. In addition, it may be productive to develop a more site- and/or species-specific ERA in order to assure that the proposed herbicide application will not result in secondary impacts to salmonids especially associated with loss of riparian cover.

6.5 Conclusions

The Overdrive® ERA evaluated the potential risks to many species using many exposure scenarios. Some exposure scenarios are likely to occur, whereas others are unlikely to occur but were included to provide a level of conservatism to the ERA. Individual RTE species were not directly evaluated. Instead, surrogate species toxicity data were used to indirectly evaluate RTE species exposure. Higher trophic level receptors were also evaluated based on their life history strategies; RTE species were represented by one of several avian or mammalian species commonly used in ERAs. To provide a layer of conservatism to the evaluation, lower LOCs and TRVs were used to assess the potential impacts to RTE species.

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[9] The Nature of Cumulative Watershed Effects Related to Forest Herbicides: Draft. Available on-line: http://www.humbolt1.com/~heyenga/Herb.Drft.8_12_99.html

Uncertainty factors and allometric scaling were used to adjust the toxicity data on a species-specific basis when they were likely to improve applicability and/or conservatism. As discussed in Section 3.1, TRVs were developed using the best available data, and uncertainty factors were applied to toxicity data consistent with recommendation of Chapman et al. (1998).

Potential secondary effects of herbicide use should be of primary concern for the protection of RTE species. Habitat disturbance and disruptions in the food chain are often the cause of population declines of species. For RTE species, habitat or food chain disruptions should be avoided to the extent practical. Some relationships among species are mutualistic, commensalistic, or otherwise symbiotic. For example, many species rely on a particular food source or habitat. Without that food or habitat species, the dependent species may be unduly stressed or extirpated. For RTE species, these obligatory habitats are often listed by USFWS as critical habitats. Critical habitats are afforded certain protection under the ESA. All listed critical habitat, as well as habitats that would likely support RTE species, should be avoided, as disturbance to the habitat may have an indirect adverse effect on RTE species.

Herbicides, by targeting plants, may reduce riparian zones or harm primary producers in the waterbodies. The results of the ERA indicate that non-target terrestrial and aquatic plants may be at risk from Overdrive® when accidents occur, such as spills or accidental spraying, or when herbicides are applied from the air too close to non-target receptors.

Based on the results of the ERA, it is unlikely RTE species would be harmed by appropriate and responsible use of the herbicide Overdrive® on BLM lands. Certain application guidelines and restrictions (e.g., application rate, buffer distance, avoidance of designated critical habitat) for appropriate and responsible use of the herbicide on BLM-managed lands can reduce any possible risk (see Section 8).

TABLE 6-1
Surrogate Species Used to Derive Overdrive, Diflufenzopyr, and Dicamba TRVs

Species in Laboratory/Toxicity Studies						Surrogate for
Overdrive®		Diflufenzopyr		Dicamba		
NA	NA	Honeybee	*Apis mellifera*	Honeybee	*Apis mellifera*	Pollinating insects
Rat	*Rattus norvegicus* spp.	Rat	*Rattus norvegicus* spp.	Mouse		Mammals
NA	NA	Dog	*Canis familiaris*	Dog	*Canis familiaris*	Mammals
Rabbit	*Leporidae sp*	Rabbit	*Leporidae sp*	Rabbit	*Leporidae sp*	Mammals
NA	NA	Mallard	*Anas platyrhynchos*	Mallard	*Anas platyrhynchos*	Birds
Bobwhite Quail	*Colinus virginianus*	Bobwhite Quail	*Colinus virginianus*	Bobwhite Quail	*Colinus virginianus*	Birds
Cucumber	*Cucumis sativus*	Turnip	*Brassica rapa*	Soybean	*Glycine max*	Non-target terrestrial plants
Oat	*Avena sativa*	Tomato	*Lycopersicon esculentum*	Cabbage	*Brassica oleracea*	Non-target terrestrial plants
Tomato	*Lycopersicon esculentum*	NA	NA	NA	NA	Non-target terrestrial plants
NA	NA	Bluegill sunfish	*Lepomis macrochirus*	Rainbow trout	*Oncorhynchus mykiss*	Fish
Daphnid	*Daphnia sp*	Daphnid	*Daphnia magna*	Amphipod	*Gammarus lacustris*	Aquatic invertebrates
NA	NA	Rainbow trout	*Oncorhynchus mykiss*	Rainbow trout	*Oncorhynchus mykiss*	Fish/Salmonids
Duckweed	*Lemna gibba*	Green algae	*Selanastrum capricornutum*	Freshwater algae	*Hormidium barlowi*	Non-target aquatic plants

TABLE 6-2
Surrogate Species Used in Quantitative ERA Evaluation

Species		Trophic Level/Guild	Pathway Evaluated
American robin	*Turdus migratorius*	Avian invertivore/vermivore/insectivore	Ingestion
Canada goose	*Branta canadensis*	Avian granivore/herbivore	Ingestion
Deer mouse	*Peromyscus maniculatus*	Mammalian frugivore/herbivore	Direct contact and ingestion
Mule deer	*Odocolieus hemionus*	Mammalian herbivore/gramivore	Ingestion
Bald eagle (northern)	*Haliaeetus leucocephalus alascanus*	Avian carnivore/piscivore	Ingestion
Coyote	*Canis latrans*	Mammalian carnivore	Ingestion

TABLE 6-3
Rare, Threatened, and Endangered Birds and Selected Surrogates

RTE Avian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
Marbled murrelet	*Brachyramphus marmoratus marmoratus*	Piscivore	Bald eagle
Western snowy plover	*Charadrius alexandrinus nivosus*	Insectivore/piscivore	American robin
Piping plover	*Charadrius melodus*	Insectivore	American robin
Mountain plover	*Charadrius montanus*	Insectivore	American robin
Southwestern willow flycatcher	*Empidonax traillii extimus*	Insectivore	American robin
Northern aplomado falcon	*Falco femoralis septentrionalis*	Carnivore	Bald eagle Coyote
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	Carnivore	Bald eagle Coyote
Whooping crane	*Grus Americana*	Piscivore	Bald eagle
California condor	*Gymnogyps californianus*	Carnivore	Bald eagle Coyote
Bald eagle	*Haliaeetus leucocephalus*	Piscivore	Bald eagle
Brown pelican	*Pelecanus occidentalis*	Piscivore	Bald eagle
Inyo California towhee	*Pipilo crissalis eremophilus*	Omnivore [Granivore/insectivore]	Canada goose American robin
Coastal California gnatcatcher	*Polioptila californica californica*	Insectivore	American robin
Stellar's eider	*Polysticta stelleri*	Piscivore	Bald eagle
Yuma clapper rail	*Rallus longirostris yumanensis*	Carnivore	Bald eagle Coyote
Spectacled eider	*Somateria fischeri*	Omnivore [Insectivore/herbivore]	American robin Canada goose
Least tern	*Sterna antillarum*	Piscivore	Bald eagle
Northern spotted owl	*Strix occidentalis caurina*	Carnivore	Bald eagle Coyote
Mexican spotted owl	*Strix occidentalis lucida*	Carnivore	Bald eagle Coyote
Least Bell's vireo	*Vireo bellii pusillus*	Insectivore	American robin

TABLE 6-4
Rare, Threatened, and Endangered Mammals and Selected Surrogates

RTE Mammalian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
Sonoran pronghorn	*Antilocapra americana sonoriensis*	Herbivore	Mule deer
Pygmy rabbit	*Brachylagus idahoensis*	Herbivore	Mule deer
Marbled murrelet	*Brachyramphus marmoratus marmoratus*	Piscivore	Bald eagle
Gray wolf	*Canis lupus*	Carnivore	Coyote
Utah prairie dog	*Cynomys parvidens*	Herbivore	Deer mouse
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*	Omnivore [Herbivore/ Insectivore]	Deer mouse American robin
Giant kangaroo rat	*Dipodomys ingens*	Granivore/herbivore	Deer mouse
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	Granivore/herbivore	Deer mouse
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	Granivore/herbivore	Deer mouse
Stephens' kangaroo rat	*Dipodomys stephensi (incl. D. cascus)*	Granivore	Deer mouse
Southern sea otter	*Enhydra lutris nereis*	Carnivore/piscivore	Coyote Bald eagle
Steller sea-lion	*Eumetopias jubatus*	Carnivore/piscivore	Coyote Bald eagle
Sinaloan jaguarundi	*Herpailurus (=Felis) yaguarundi tolteca*	Carnivore	Coyote
Ocelot	*Leopardus (=Felis) pardalis*	Carnivore	Coyote
Lesser long-nosed bat	*Leptonycteris curosoae yerbabuenae*	Frugivore/nectivore	Deer mouse
Mexican long-nosed bat	*Leptonycteris nivalis*	Herbivore	Deer mouse
Canada lynx	*Lynx canadensis*	Carnivore	Coyote
Amargosa vole	*Microtus californicus scirpensis*	Herbivore	Deer mouse
Hualapai Mexican vole	*Microtus mexicanus hualpaiensis*	Herbivore	Deer mouse
Black-footed ferret	*Mustela nigripes*	Carnivore	Coyote
Riparian (=San Joiquin Valley) woodrat	*Neotoma fuscipes riparia*	Herbivore	Deer mouse
Columbian white-tailed deer	*Odocolieus virginianus leucurus*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis californiana*	Herbivore	Mule deer
Jaguar	*Panthera onca*	Carnivore	Coyote
Woodland caribou	*Rangifer tanandus caribou*	Herbivore	Mule deer
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Herbivore	Deer mouse
Grizzly bear	*Ursus arctos horribilis*	Omnivore [herbivore/ insectivore/piscivore]	American robin Mule deer Bald eagle
San Joaquin kit fox	*Vulpes macrotis mutica*	Carnivore	Coyote
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Omnivore [herbivore/ insectivore]	Deer mouse American robin

Note: Four whales and one seal are also listed species in the 17 states evaluated in this ERA. However, it is unlikely any exposure to herbicide would occur to marine species.

TABLE 6-5
Rare, Threatened, and Endangered Reptiles and Selected Surrogates

RTE Reptilian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
New Mexican ridge-nosed rattlesnake	*Crotalus willardi obscurus*	Carnivore/insectivore	Coyote Bald eagle American robin
Blunt-nosed leopard lizard	*Gambelia silus*	Carnivore/insectivore	Coyote Bald eagle American robin
Desert tortoise	*Gopherus agassizii*	Herbivore	Canada goose
Giant garter snake	*Thamnophis gigas*	Carnivore/insectivore/piscivore	Coyote American robin Bald eagle
Coachella Valley fringe-toed lizard	*Uma inornata*	Insectivore	American robin
Note: Five sea turtles are also listed species in the 17 states evaluated in this ERA. However, it is unlikely any exposure to herbicide would occur to marine species.			

TABLE 6-6
Rare, Threatened, and Endangered Amphibians and Selected Surrogates

RTE Amphibious Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
California tiger salamander	*Ambystoma californiense*	Invertivore[1] Vermivore[2]	Bluegill sunfish Rainbow trout[3] American robin[4]
Sonoran tiger salamander	*Ambystoma tigrinum stebbinsi*	Invertivore/insectivore[1] Carnivore/ranivore[2]	Bluegill sunfish Rainbow trout[3] American robin[4]
Desert slender salamander	*Batrachoseps aridus*	Invertivore	American robin[4,5]
Wyoming toad	*Bufo baxteri*	Insectivore	Bluegill sunfish Rainbow trout[3] American robin[4]
Arroyo toad (=Arroyo southwestern toad)	*Bufo californicus*	Herbivore[1] Invertivore[2]	Bluegill sunfish Rainbow trout[3] American robin[4]
California red-legged frog	*Rana aurora draytonii*	Herbivore[1] Invertivore[2]	Bluegill sunfish Rainbow trout[3] American robin[4]
Chiricahua leopard frog	*Rana chiricahuensis*	Herbivore[1] Invertivore[2]	Bluegill sunfish Rainbow trout[3] American robin[4]

[1] Diet of juvenile (larval) stage.
[2] Diet of adult stage.
[3] Surrogate for juvenile stage.
[4] Surrogate for adult stage.
[5] *Bratrachoseps aridus* is a lungless salamander that has no aquatic larval stage, and is terrestrial as an adult.

TABLE 6-7
Species and Organism Traits That May Influence Herbicide Exposure and Response

Characteristic	Mode of Influence	ERA Solution
Body size	Larger organisms have more surface area potentially exposed during a direct spray exposure scenario. However, larger organisms have a smaller surface area to volume ratio, leading to a lower per body weight dose of herbicide per application event.	To evaluate potential impacts from direct spray, small organisms were selected (i.e., honeybee and deer mouse).
Habitat preference	Not all of BLM-managed lands are subject to nuisance vegetation control.	It was assumed that all organisms evaluated in the ERA were present in habitats subject to herbicide treatment.
Duration of potential exposure/ home range	Some species are migratory or present during only a fraction of year, and larger species have home ranges that likely extend beyond application areas, thereby reducing exposure duration.	It was assumed that all organisms evaluated in the ERA were present within the zone of exposure full-time.
Trophic level	Many chemical concentrations increase in higher trophic levels.	Although the herbicides evaluated in the ERA have very low potential to bioaccumulate, BCFs were selected to estimate uptake to trophic level 3 fish (prey item for the piscivores), and several trophic levels (primary producers through top-level carnivore) were included in the ERA.
Food preference	Certain types of food or prey may be more likely to attract and retain herbicide.	It was assumed that all types of food were susceptible to high deposition and retention of herbicide.
Food ingestion rate	On a mass ingested per body weight basis, organisms with higher food ingestion rates (e.g., mammals versus reptiles) are more likely to ingest large quantities of food (therefore, herbicide).	Surrogate species were selected that consume large quantities of food, relative to body size. When ranges of ingestion rates were provided in the literature, the upper end of the values was selected for use in the ERA.
Foraging strategy	The way an organism finds and eats food can influence its potential exposure to herbicide. Organisms that consume insects or plants that are underground are less likely to be exposed via ingestion than those that consume exposed food items, such as grasses and fruits.	It was assumed all food items evaluated in the ERA were fully exposed to herbicide during spray or runoff events.
Metabolic and excretion rate	While organisms with high metabolic rates may ingest more food, they may also have the ability to excrete herbicides quickly, lowering the potential for chronic impact.	It was assumed that no herbicide was excreted readily by any organism in the ERA.
Rate of dermal uptake	Different organisms will assimilate herbicides across their skins at different rates. For example, thick scales and shells of reptiles and the fur of mammals are likely to present a barrier to uptake relative to bare skin.	It was assumed that uptake across the skin was unimpeded by scales, shells, fur, or feathers.
Sensitivity to herbicide	Species respond to chemicals differently; some species may be more sensitive to certain chemicals.	The literature was searched and the lowest values from appropriate toxicity studies were selected as TRVs. Choosing the sensitive species as surrogates for the TRV development provides protection to more species.
Mode of toxicity	Response sites to chemical exposure may not be the same among all species. For instance, the presence of aryl hydrocarbon (Ah) receptors in an organism increases its susceptibility to compounds that bind to proteins or other cellular receptors. However, not all species, even within a given taxonomic group (e.g., mammals) have Ah receptors.	Mode of toxicity was not specifically addressed in the ERA. Rather, by selecting the lowest TRVs, it was assumed that all species evaluated in the ERA were also sensitive to the mode of toxicity.

TABLE 6-8
Summary of Findings: Interspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within a Factor of:								
	2	4	10	15	20	50	100	250	300
Bird LD_{50}	--	--	90	--	--	--	99	100	--
Mammal LD_{50}	--	58	--	--	90	--	96	--	--
Bird and Mammal Chronic	--	--	--	--	--	94	--	--	--
Plants	93[a] 80[b]	--	--	80[c]	--	--	--	--	80[d]

(a) Intra-genus extrapolation.
(b) Intra-family extrapolation.
(c) Intra-order extrapolation.
(d) Intra-class extrapolation.

TABLE 6-9
Summary of Findings: Intraspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
490 probit log-dose slopes	92	Dourson and Starta, *1983 as cited in Abt Assoc., Inc.* 1995
Bird LC_{50}:LC_1	95	Hill et al. 1975
Bobwhite quail LC_{50}:LC_1	71.5	Shirazi et al. 1994

TABLE 6-10
Summary of Findings: Acute-to-chronic Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
Bird and mammal dietary toxicity NOAELs (n=174)	90	Abt Assoc., Inc. 1995

TABLE 6-11
Summary of Findings: LOAEL-to-NOAEL Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of:		Citation from Fairbrother and Kaputska, 1996
	6	10	
Bird and mammal LOAELs and NOAELs	80	97	Abt Assoc., Inc. 1995

TABLE 6-12
Summary of Findings: Laboratory to Field Extrapolations

Type of Data	Response	Citation from Fairbrother and Kaputska 1996
Plant EC_{50} Values	3 of 20 EC_{50} lab study values were 2-fold higher than field data 3 of 20 EC_{50} values from field data were 2-fold higher than lab study data	Fletcher et al. 1990
Bobwhite quail	Shown to be more sensitive to cholinesterase-inhibitors when cold-stressed (i.e., more sensitive in the field)	Maguire and Williams 1987
Gray-tailed vole and deer mouse	Laboratory data overpredicted risk	Edge et al. 1995

7.0 UNCERTAINTY IN THE ECOLOGICAL RISK ASSESSMENT

Every time an assumption is made, some level of uncertainty is introduced into the risk assessment. A thorough description of uncertainties is a key component that serves to identify possible weaknesses in the ERA analysis, and to elucidate what impact such weaknesses might have on the final risk conclusions. This uncertainty analysis lists the uncertainties, with a discussion of what bias—if any—the uncertainty may introduce into the risk conclusions. This "bias" is represented in qualitative terms that best describe whether the uncertainty might 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or whether it cannot be determined without additional study.

Uncertainties in the ERA process are summarized in Table 7-1. Several of the uncertainties outlined in Table 7-1 warrant further evaluation and are discussed below. In general, the assumptions made in this risk assessment have been designed to yield a conservative evaluation of the potential risks to the environment from herbicide application.

7.1 Toxicity Data Availability

The majority of the available toxicity data were obtained from studies conducted as part of the USEPA pesticide registration process. There are a number of uncertainties related to the use of this limited data set in the risk assessment. In general, it would often be preferable to base any ecological risk analysis on reliable field studies that clearly identify and quantify the amount of potential risk from particular exposure concentrations of the chemical of concern. However, in most risk assessments it is more common to extrapolate the results obtained in the laboratory to the receptors found in the field. It should be noted, however, that laboratory studies often overestimate risk relative to field studies (Fairbrother and Kapustka 1996).

One diflufenzopyr incident report and over a hundred dicamba-related incident reports were available from the USEPA's Environmental Fate and Effects Division (EFED). These reports can be used to validate both exposure models and hazards to ecological receptors. The diflufenzopyr report, described in Section 2.3, indicated that damage to corn plants might be, in part, due to unintended exposure to diflufenzopyr, applied as part of a multiple pesticide mixture including atrazine, chlorpyrifos, dicamba, and 2,4-D. Over half of the listed incidents for dicamba indicated that dicamba was the 'probable' cause of plant damage to crops and grasses. Risk to non-target plants was predicted in the ERA as a result of accidental direct spray and off-site drift resulting from some ground applications of Overdrive®. However, because the incident reports provide limited information and no Overdrive®-specific incidents were identified, it is impossible to correlate the impacts predicted in the ERA with the incident reports.

Species for which toxicity data are available (i.e., those included in the registration requirements) may not necessarily be the most sensitive species to a particular herbicide. The chosen surrogate species were selected as laboratory test organisms because they are generally sensitive to stressors, yet they can be maintained under laboratory conditions. Furthermore, the selection of the most appropriately sensitive surrogate species, as well as the most appropriate toxicity value, for a given receptor was based on a thorough review of the available data by qualified toxicologists. Because of the selection limitations, surrogate species are not exact matches to the wildlife receptors included in the ERA. For example, the only avian data available are for two primarily herbivorous birds, the mallard duck and the bobwhite quail. However, TRVs based on these receptors were also used to evaluate risk to insectivorous and piscivorous birds, even though species with alternative feeding habits or species from different taxonomic groups may be more or less sensitive to the herbicide than species tested in the laboratory.

In general, the most sensitive available endpoint for the appropriate surrogate test species was used to derive TRVs. This is a conservative approach because there may be a wide range of data and effects for different species. For example, two diflufenzopyr EC_{50}s were available for the aquatic invertebrates. The EC_{50}s were >130 mg a.i./L and 15 mg a.i./L, both for 48-hour daphnid studies. Accordingly, 15 mg a.i./L was selected as the aquatic invertebrate TRV, even though observed results were well above this value. A similar situation occurred with the terrestrial plants, which had diflufenzopyr EC_{25}s ranging from 0.0008 lb a.i./ac to 0.38 lb a.i./ac. In general, this selection criterion for TRVs has the potential to overestimate risk within the ERA. In some cases, chronic data were unavailable and chronic TRVs were extrapolated from acute toxicity data, adding an additional level of uncertainty.

There is also some uncertainty in the conversion of food concentration-based toxicity values (mg herbicide per kg food) to dose-based values (mg herbicide per kg BW) for birds and mammals. Converting the concentration-based endpoint to a dose-based endpoint is dependent upon certain assumptions, specifically the test animal ingestion rate and test animal BW. Default ingestion rates for different test species were used in the conversions unless test-specific values were measured and given. The ingestion rate was assumed to be constant throughout a test. However, it is possible that a test chemical may positively or negatively affect ingestion, thus resulting in an over- or underestimation of total dose.

For the purposes of pesticide registration, tests are conducted according to specific test protocols. For example, in the case of an avian oral LD_{50} study, test guidance follows the harmonized Office of Pollution Prevention and Toxic Substances (OPPTS) protocol 850.2100, Avian Acute Oral Toxicity Test or its Toxic Substances Control Act (TSCA) or FIFRA predecessor (e.g, 40 CFR 797.2175 and OPP 71-1). In this test the bird is given a single dose, by gavage, of the chemical and the test subject is observed for a minimum of 14 days. The LD_{50} derived from this test is the true dose (mg herbicide per kg BW). However, dietary studies were selected preferentially for this ERA and historical dietary studies followed 40 CFR 797.2050, OPP 71-2, or OECD 205, the procedures for which are harmonized in OPPTS 850.2200, Avian Dietary Toxicity Test. In this test, the test organism is presented with the dosed food for 5 days, with 3 days of additional observations after the chemical-laden food is removed. The endpoint for this assay is reported as an LC_{50} representing mg herbicide per kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c)[10]. Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test.

In addition, several of the toxicity tests conducted during the registration process were not conducted with 100% of the a.i. As indicated in Appendix A, some formulations contain other ingredients. As indicated in Section 3.1, the toxicity data within the ERAs are presented in the units used in the reviewed studies. Attempts were not made to adjust toxicity data to the % a.i. since it was not consistently provided in all reviewed materials. In most cases the toxicity data applies to the a.i. itself; however, some data corresponds to a specific product containing the a.i. under consideration, and potentially other ingredients (e.g., other a.i. or inert ingredients). The assumption has been made that the toxicity observed in the tests is due to the a.i. under consideration. However, it is possible that the additional ingredients in the different formulations also had an effect. The OPP's Ecotoxicity Database (a source of data for the ERAs) does not adjust the toxicity data to the % a.i. and presents the data directly from the registration study in order to capture the potential effect caused by various inerts, additives, or other a.i. in the tested product. In many cases the tested material represents the highest purity produced and higher exposure to the a.i. would not be likely.

Toxicity data indicate that the product Overdrive®, which is the primary diflufenzopyr-containing product used by BLM, is generally more toxic than the diflufenzopyr alone. Overdrive® contains approximately 21.4% sodium salt of diflufenzopyr, 55% of a second a.i. (sodium salt of 3,6-dichloro-o-anisic acid, also referred to as dicamba), and 23.6% inert ingredients (BASF 2003). When available, Overdrive® TRVs were used to evaluate toxicity in the ERA. When Overdrive® toxicity data were not available, toxicity data for the two a.i. were identified. When available, TRVs derived for the product Overdrive® were selected for a given pathway. When Overdrive® TRVs were not available, the diflufenzopyr and dicamba components were evaluated separately with individual diflufenzopyr and dicamba TRVs. Sufficient toxicity data was identified to evaulate all of the receptor and exposure scenario combinations.

For diflufenzopyr, the % a.i., listed in Appendix A when available from the reviewed study, ranged from 20% to 99.6%. The studies selected for TRV derivation generally contained at least 90% a.i. so adjusting the TRV to the %

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[10] Dose-based endpoint $_{(mg/kg\ BW/day)}$ = [Concentration-based endpoint $_{(mg/kg\ food)}$ x Food Ingestion Rate $_{(kg\ food/day)}$]/BW $_{(kg)}$

a.i.would result in only minimal RQ increases. For dicamba, the % a.i. ranged from 10% to 99.8% with the lowest percentage actually used in the TRV derivation being 21.1% used for the mammalian dermal TRV. Adjusting the TRV to 100% of the a.i. (by multiplying the TRV by the % a.i. in the study) would lower the dermal TRV from >5,050 mg/kg BW to >1,066 mg/kg BW. Although this would increase the dermal RQs, it would not result in any additional LOC exceedances. The remaining TRVs are based on studies with at least 85% a.i., so the RQ changes would be minimal

7.2 Potential Indirect Effects on Salmonids

No actual field studies or ecological incident reports related to the effects of Overdrive® on salmonids were identified during the ERA. Therefore, any discussion of indirect impacts to salmonids was limited to qualitative estimates of potential impacts on salmonid populations and communities. As described previously, salmonid species were included in the derivation of the TRVs and rainbow trout were the basis of the selected acute TRVs for both diflufenzopyr and dicamba and the chronic TRV for dicamba. The chronic fish TRV for diflufenzopyr was based on a warmwater species, the bluegill sunfish. The selected chronic TRV was five times higher than the rainbow trout chronic TRV, indicating that chronic direct impacts to salmonids may be overestimated in the risk assessment. A discussion of the potential indirect impacts to salmonids is presented in Section 4.3.6, and Section 6.6 provides a discussion of RTE salmonid species. These evaluations indicated that salmonids are not likely to be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). However, a reduction in vegetative cover may occur under limited conditions, which could indirectly affect aquatic invertebrates and salmon.

It is anticipated that these qualitative evaluations overestimate the potential risk to salmonids due to the conservative selection of TRVs for salmonid prey and vegetative cover, application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species, and the use of conservative stream characteristics in the exposure scenarios (i.e., low order stream, relatively small instantaneous volume, limited consideration of herbicide degradation or absorption in models).

7.3 Ecological Risks of Degradates, Inerts, and Adjuvants

In a detailed herbicide risk assessment, it is preferable to estimate risks not just from the a.i. of an herbicide, but also the cumulative risks from the a.i., inert ingredients, adjuvants, and degradates. Other pesticides may also factor into the risk estimates, as many herbicides are applied in mixtures with other pesticides to address multiple concerns with one application. However, it is only practical, using currently available models (e.g., GLEAMS), to perform deterministic risk calculations (i.e., exposure modeling, effects assessment, and RQ calculations) for a single a.i.

In addition, information on inerts, adjuvants, surfactants, and degradates is often limited by the availability of, and access to, reliable toxicity data for these constituents. The sections below present a qualitative evaluation of potential risks from the degradates, inert ingredients, and adjuvants contained in Overdrive®.

7.3.1 Degradates

The potential toxicity of degradates, also called herbicide transformation products (TPs), should be considered when selecting an herbicide. However, such discussion is beyond the scope of this ERA. Degradates may be more or less mobile and more or less toxic in the environment than their source herbicides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent herbicides and TPs makes prediction of potential TP impacts challenging. For example, a less toxic, but more mobile bioaccumulative, or persistent TP may have the potential to have a greater adverse impact on the environment resulting from residual concentrations in the environment. A recent study indicated that 70% of TPs had either similar or reduced toxicity to fish, daphnids, and algae than the parent pesticide. However, 4.2% of the TPs were more than an order of magnitude more toxic than the parent pesticide, with a few instances of acute toxicity values below 1 mg/L (Sinclair and Boxall 2003). No evaluation of impacts to terrestrial species was conducted in this study. The lack of data on the toxicity of degradates of Overdrive® represents a source of uncertainty in the risk assessment.

7.3.2 Inerts

Pesticide products contain both active and inert ingredients. The terms "active ingredient" and "inert ingredient" have been defined by Federal law—the FIFRA—since 1947. An a.i. is one that prevents, destroys, repels, or mitigates a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the a.i. must be identified by name on the label along with its percentage by weight. An inert ingredient is simply any ingredient in the product that is not intended to affect a target pest. For example, isopropyl alcohol may be an a.i. and antimicrobial pesticide in some products; however, in other products, it is used as a solvent and may be considered an inert ingredient. The law does not require inert ingredients to be identified by name and percentage on the label, but the total percentage of such ingredients must be declared.

In September 1997, the USEPA issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" as a heading for the inert ingredients in the ingredient statement. The USEPA made this change after learning the results of a consumer survey on the use of household pesticides. Many consumers are mislead by the term "inert ingredient," believing it to mean "harmless." Because neither the federal law nor the regulations define the term "inert" on the basis of toxicity, hazard, or risk to humans, non-target species, or the environment, it should not be assumed that all inert ingredients are non-toxic. Whether referred to as "inerts" or "other ingredients," these components within an herbicide have the potential to be toxic.

BLM scientists received clearance from USEPA to review CBI on inert compounds in the following herbicides under consideration in the ERAs: bromacil, chlorsulfuron, diflufenzopyr, Overdrive®, diquat, diuron, fluridone, imazapic, sulfometuron-methyl, and tebuthiuron. The information received listed the inert ingredients, their chemical abstract number, supplier, USEPA registration number, percentage of the formulation, and purpose in the formulation. This information is confidential (including the name of the ingredients), and therefore, is not disclosed in this document. A review of the data available for the herbicides is included in Appendix D.

The USEPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into four lists. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- List 1 – Inert Ingredients of Toxicological Concern: None.
- List 2 – Potentially Toxic Inert Ingredients: None.
- List 3 – Inerts of Unknown Toxicity. 12.
- List 4 – Inerts of Minimal Toxicity. Over 50.

Nine inerts were not found on EPA's lists.

Toxicity information was also searched via the following sources:

- TOMES (a proprietary toxicological database including EPA's Integrated Risk Information System [IRIS], the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- EPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
- Material Safety Data Sheets (MSDSs) from suppliers.
- Other sources, such as the Farm Chemicals Handbook.

- Other cited literature sources.

Relatively little toxicity information was found. A few acute studies on aquatic or terrestrial species were reported. No chronic data, no cumulative effects data, and almost no indirect effects data (food chain species) were found for the inerts in the herbicides.

A number of the List 4 compounds (Inerts of Minimal Toxicity) are naturally-occurring earthen materials (e.g. clay materials or simple salts) that would produce no toxicity at applied concentrations. However, some of the inerts, particularly the List 3 inert compounds and unlisted compounds, may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

As a tool to evaluate List 3 and unlisted inerts in the ERA, the exposure concentration of the inert compound was calculated and compared to toxicity information. As described in more detail in Appendix D, the GLEAMS model was set up to simulate the effects of a generalized inert compound in the previously described “base-case” watershed with a sand soil type. Toxicity information from the above sources was used in addition to the work of Dorn et al. (1997), Wong et al. (1997), Lewis (1991), and Muller (1980) concerning aquatic toxicity of surfactants. These sources generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1-10 mg/L, and that chronic toxicity ranged as low as 0.1 mg/L.

Appendix D presents the following general observation for diflufenzopyr and dicamba: low application rates for both active ingrdients resulted in low exposure concentrations of inerts of much < 1 mg/L in all modeled cases. This indicates that inerts associated with the application of diflufenzopyr and dicamba are not predicted to occur at levels that would cause acute toxicity to aquatic life. However, due to the lack of specific inert toxicity data, it is not possible to state that the inerts associated with diflufenzopyr and dicamba will not result in adverse ecological impacts. It is assumed that toxic inerts would not represent a substantial percentage of the herbicide and that minimal impacts to the environment would result from these inert ingredients.

7.3.3 Adjuvants

Adjuvants, such as surfactants or fertilizers, may be mixed with the herbicide during application to increase or aid in the effect of the herbicide itself. Without product specific toxicity data, it is impossible to quantify the potential impacts of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific evidence exists to determine whether the joint action of the mixture is either additive, synergistic, or antagonistic. Such evidence is not likely to exist unless the mode of action is common among the chemicals and receptors.

Adjuvants generally function to enhance or prolong the activity of an a.i. For terrestrial herbicides, adjuvants aid in the absorption of the a.i. into plant tissue. Adjuvant is a broad term and includes surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration guidelines as pesticides, and the USEPA does not register or approve the labeling of spray adjuvants. Individual herbicide labels identify which adjuvants are approved for use with the particular herbicide.

In reviewing the labels for Distinct® and Overdrive® (BASF 1999; 2003), the following adjuvants were identified on the labels (literature for both products indicates that adjuvants must be used to achieve consistent weed control):

- Methylated seed oil or vegetable oil concentrates – used to aid in the deposition and uptake of the herbicide on hard-to-control perennials, waxy leaf species, or plants under moisture or temperature stress. A methylated vegetable-based seed oil concentrate may be used at a rate of 1.5 to 2 pints per acre with Overdrive®, but not Distinct®.

- Nonionic surfactants – used to aid in the surface activity of the applied herbicide. The Overdrive® label (BASF 2003) recommendation is 1 quart of an 80% active nonionic spray surfactant per 100 gal of water. The Distinct® label (BASF 1999) also indicates that the nonionic surfactant (at 1 quart in 100 gal of water) should be mixed with either urea ammonium nitrate at 1.25% v/v or spray grade ammonium sulfate at 8.5 to 17 pounds per 100 gal of spray solution as a nitrogen source.

- Agriculturally approved drift-reducing additives may be used.

In general, adjuvants compose a relatively small portion of the volume of herbicide applied. However, it is recommended that an adjuvant with low toxic potential be selected. For example, the toxicity of most seed oils is classified as List 3 (unknown toxicity) or List 4 (minimal toxicity). Potential toxicity of any material should be considered prior to its use as an adjuvant.

Following the same procedure used to address inerts in Section 7.3.2 and Appendix D, the GLEAMS model was used to estimate the potential portion of an adjuvant that might reach an adjacent waterbody via surface runoff. The chemical characteristics of the generalized inert/adjuvant compound were set at extremely high/low values to describe it as a very mobile and stable compound. The application rate of the inert/adjuvant compound was fixed at 1 lb a.i./ac; the watershed was the “base case” used in the risk assessment with sandy soil and precipitation set at 50 inches per year. Under these conditions, the maximum predicted ratio of inert concentration to herbicide application rate was 0.69 mg/L per lb a.i./ac (3 day maximum in the pond).

As described in Section 7.3.2, sources (Muller 1980; Lewis 1991; Dorn et al. 1997; Wong et al. 1997) generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1 to 10 mg/L, and that chronic toxicity ranged as low as 0.1 mg/L. At the maximum application rates recommended for diflufenzopyr (0.10 lb a.i./ac) and dicamba (0.4375 lb a.i./ac), and the application rate recommended for nonionic surfactants (0.25% v/v, based on 1 quart / 100 gal) the maximum predicted concentrations would be 0.0001725 mg/L, and 0.0007546 mg/L, respectively. This value is well below the chronic toxicity value for nonionic surfactants, 0.1 mg/L, and even the range for behavioral and physiological effects, 0.002 to 40.0 mg/L (Lewis 1991).

This evaluation indicates that adjuvants may not add significant uncertainty to the level of risk predicted for Overdrive® itself. However, more specific modeling and toxicity data would be necessary to define the level of uncertainty. Selection of adjuvants is under the control of BLM land managers, and it is recommended that land managers follow all label instructions and abide by any warnings. Selection of adjuvants with limited toxicity and low volumes is recommended to reduce the potential for the adjuvant to influence the toxicity of the herbicide.

7.4 Uncertainty Associated with Herbicide Exposure Concentration Models

The ERA relies on different models to predict the off-site impacts of herbicide use. These models have been developed and applied in order to develop a conservative estimate of herbicide loss from the application area to the off-site locations.

As in any screening or higher-tier ERA, a discussion of potential uncertainties from fate and exposure modeling is necessary to identify potential overestimates or underestimates of risk. In particular, the uncertainty analysis focused on which environmental characteristics (e.g., soil type, annual precipitation) exert the biggest numeric impact on model outputs. This has important implications not only for the uncertainty analysis itself, but also for the ability to apply risk calculations to different site characteristics from a risk management point of view.

7.4.1 AgDRIFT®

Off-site spray drift and resulting terrestrial deposition rates and waterbody concentrations (hypothetical pond or stream) were predicted using the computer model, AgDRIFT® Version 2.0.05 (SDTF 2002). As with any complex ERA model, a number of simplifying assumptions were made to ensure that the risk assessment results would be protective of most environmental settings encountered in the BLM land management program.

Predicted off-site spray drift and downwind deposition can be substantially altered by a number of variables intended to simulate the herbicide application process including, but not limited to: nozzle type used in the spray application of an herbicide mixture; ambient wind speed; release height (application boom height); and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. Recognizing the lack of absolute knowledge regarding all of the scenarios likely to be encountered in the BLM land management program, these assumptions were developed to be conservative and likely result in overestimation of actual off-site spray drift and environmental impacts.

7.4.2 GLEAMS

The GLEAMS model was used to predict the loading of herbicide to nearby soils, ponds, and streams from overland or surface runoff, erosion, and root-zone groundwater runoff. The GLEAMS model conservatively assumes that the soil, pond, and stream are directly adjacent to the application area. The use of buffer zones would reduce potential herbicide loading to the exposure areas.

7.4.2.1 Herbicide Loss Rates

The trends in herbicide loss rates (herbicide loss computed as a percent of the herbicide applied within the watershed) and water concentrations predicted by the GLEAMS model echo trends that have been documented in a wide range of streams located in the Midwestern U.S. A recently published study (Lerch and Blanchard 2003) recognized that factors affecting herbicide transport to streams can be organized into four general categories:

- Intrinsic factors – soil and hydrologic properties and geomorphologic characteristics of the watershed
- Anthropogenic factors – land use and herbicide management
- Climate factors – particularly precipitation and temperature
- Herbicide factors – chemical and physical properties and formulation

These findings were based on the conclusions of several prior investigations, data collected as part of the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) program, and the results of runoff and baseflow water samples collected in 20 streams in northern Missouri and southern Iowa. The investigation concluded that the median runoff loss rates for atrazine, cyanazine, acetochlor, alachlor, metolachlor, and metribuzin ranged from 0.33 to 3.9% of the mass applied—loss rates that were considerably higher than in other areas of the U.S. Furthermore, the study indicated that the runoff potential was a critical factor affecting herbicide transport. Table 7-2 is a statistical summary of the GLEAMS predicted total loss rates and runoff loss rates for several herbicides. The median total loss rates range from 0.27 to 36%, and the median runoff loss rates range from 0 to 0.27%.

The results of the GLEAMS simulations indicate trends similar to those identified in the Lerch and Blanchard (2003) study. First, the GLEAMS simulations demonstrated that the most dominant factors controlling herbicide loss rates are soil type and precipitation; both are directly related to the amount of runoff from an area following a herbicide application. This was demonstrated in each of the GLEAMS simulations that considered the effect of highly variable annual precipitation rates and soil type on herbicide transport. In all cases, the GLEAMS predicted runoff loss rate was positively correlated with both precipitation rate and soil type.

Second, consistent with the conclusion reached by Lerch and Blanchard ([2003] i.e., that runoff potential is critical to herbicide transport) and the GLEAMS model results, estimating the groundwater discharge concentrations by using the predicted root-zone concentrations as a surrogate is extremely conservative.

For example, while the median runoff loss rates range from 0 to 0.27%, confirming the Lerch and Blanchard (2003) study, the median total loss rates predicted using GLEAMS are substantially higher. This may be due to the differences between the watershed characteristics in the field investigation and those used to describe the GLEAMS simulations. It is probably at least in part due to the conservative nature of the baseflow predictions.

Based on the results and conclusions of prior investigations, the runoff loss rates predicted by the GLEAMS model are approximately equivalent to loss rates determined within the Mississippi River watershed and elsewhere in the U.S, and the percolation loss rates are probably conservatively high. This confirms that our GLEAMS modeling approach either approximates or overestimates the rate of loadings observed in the field.

7.4.2.2 Root-Zone Groundwater

In the application of GLEAMS, it was assumed that root-zone loading of herbicide would be transported directly to a nearby waterbody. This is a feasible scenario in several settings, but is very conservative in situations in which the depth to the water table might be many ft. In particular, it is common in much of the arid and semi-arid western states for the water table to be well below the ground surface and for there to be little, if any, groundwater discharge to surface water features. Some ecological risk scenarios were dominated by the conservatively-estimated loading of herbicide by groundwater discharge to surface waters. Again, while possible, this is likely to be an overestimate of likely impacts in most settings on BLM-managed lands.

7.4.3 CALPUFF

The USEPA's CALPUFF air pollutant dispersion model was used to predict impacts from the potential migration of the herbicide between 1.5 and 100 km from the application area by windblown soil (fugitive dust). Several assumptions were made that could overpredict or underpredict the deposition rates obtained from this model.

The use of flat terrain could underpredict deposition for mountainous areas. In these areas, hills and mountains would likely focus wind and deposition into certain areas, resulting in pockets of increased risk. The use of bare, undisturbed soil results in less uptake and transport than disturbed (i.e., tilled) soil. However, the BLM does not apply herbicides to agricultural areas, so this assumption may be appropriate for BLM lands.

The modeling conservatively assumed that all of the herbicide would be present in the soil at the commencement of a windy event, and that no reduction due to vegetation interception/uptake, leaching, solar or chemical half-life would have occurred since the time of aerial application. This likely over predicts the deposition rates unless the herbicide is taken by the wind as soon as it is applied. It is more likely that a portion of the applied herbicide would be sorbed to plants or degraded over time.

Assuming a 1-mm penetration depth is also conservative and likely overestimates impacts. This penetration depth is less than the depth used in previous herbicide risk assessments (SERA 2001; SERA 2003) and the depth assumed in the GLEAMS model (1 cm surface soil).

The surface roughness in the vicinity of the application site directly affects the deposition rates predicted by CALPUFF. The surface roughness length used in the CALPUFF model is a measure of the height of obstacles to wind flow and varies by land-use types. Forested areas and urban areas have the highest surface roughness lengths (0.5 m to 1.3 m) while grasslands have the lowest (0.001 m to 0.10 m).

Predicted deposition rates are likely to be higher near the application area and lower at greater distances if the surface roughness in the area is relatively high (above 1 m, such as in forested areas). Therefore, overestimation of the surface roughness could overpredict deposition within about 50 km of the application area and underpredict deposition beyond 50 km. Overestimation of the surface roughness could occur if, for example, prescribed burning was used to treat a typically forested area prior to planned herbicide treatment.

The surface roughness in the vicinity of the application site also affects the calculated "friction velocity" used to determine deposition velocities, which in turn are used by CALPUFF to calculate the deposition rate. Friction velocity increases with increasing wind speed and also with increased surface roughness. Higher friction velocities result in higher deposition velocities and likewise higher deposition rates, particularly within about 50 km of the emission source.

The CALPUFF modeling assumes that the data from the selected National Weather Service stations is representative of meteorological conditions in the vicinity of the application sites. Site-specific meteorological data (e.g., from an on-site meteorological tower) could provide slightly different wind patterns, possibly due to local terrain, which could impact the deposition rates as well as locations of maximum deposition.

7.5 Summary of Potential Sources of Uncertainty

The analysis presented in this section has identified several potential sources of uncertainty that may introduce bias into the risk conclusions. This bias has the potential to 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or be undetermined without additional study. In general, few of the sources of uncertainty in this ERA are likely to underestimate risk to ecological receptors. Risk is more likely to be overestimated or the impacts of the uncertainty may be neutral or impossible to predict.

The following bullets summarize the potential impacts on the risk predictions based on the analysis presented above:

- Toxicity Data Availability – Although the species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide, the TRV selection methodology has focused on identifying conservative toxicity values that are likely to be protective of most species. The use of various LOCs contributes an additional layer of protection for species that may be more sensitive than the tested species (i.e., RTE species).

- Potential Indirect Effects on Salmonids – Only a qualitative evaluation of indirect risk to salmonids was possible because no relevant studies or incident reports were identified. It is likely that this qualitative evaluation overestimates the potential risk to salmonids as a result of the numerous conservative assumptions related to TRVs and exposure scenarios and the application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species.

- Ecological Risks of Degradates, Inerts, and Adjuvants – Only limited information is available regarding the toxicological effects of degradates, inerts, and adjuvants. In general, it is unlikely that highly toxic degradates or inerts are present in approved herbicides. Also, selection of adjuvants is under the control of BLM land managers, and to reduce uncertainties and potential risks products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected.

- Uncertainty Associated with Herbicide Exposure Concentration Models – Environmental characteristics (e.g., soil type, annual precipitation) will impact the three models used to predict the off-site impacts of herbicide use (i.e., AgDRIFT, GLEAMS, CALPUFF); in general, the assumptions used in the models were developed to be conservative and likely result in overestimation of actual off-site environmental impacts.

- General ERA Uncertainties – The general methodology used to conduct the ERA is more likely to overestimate risk than to underestimate risk because of the use of conservative assumptions (i.e., entire home range and diet is assumed to be impacted, aquatic waterbodies are relatively small, herbicide degradation over time is not applied in most scenarios).

TABLE 7-1
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Physical-chemical properties of the active ingredient	Unknown	Available sources were reviewed for a variety of parameters. However, not all sources presented the same value for a parameter (i.e., water solubility) and some values were estimated.
Food chain assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different exposure pathways have been included, but additional pathways may occur within management areas.
Receptors included in food chain model assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different receptors have been included, but alternative receptors may occur within management areas.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters (e.g., body weight, food ingestion rates) were obtained from the literature and some were estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Assumption that receptor species will spend 100% of time in impacted area (waterbody or terrestrial application area) (home range = application are)	Overestimate	These model exposure assumptions do not take into consideration the ecology of the wildlife receptor species. Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures. Species are not restricted to one location within the application area, may migrate freely off-site, may undergo seasonal migrations (as appropriate) and are likely to respond to habitat quality in determining foraging, resting, nesting and nursery activities. A likely overly conservative assumption has been made that wildlife species obtain all their food items from the application area.
Waterbody characteristics	Overestimate	The pond and stream were designed with conservative assumptions resulting in relatively small volumes. Larger waterbodies are likely to exist within application areas.
Extrapolation from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference may vary with species. It should be noted, though, that in most cases, laboratory studies actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).
Consumption of contaminated food	Unknown	Toxicity to prey receptors may result in sickness or mortality. Fewer food items would be available for predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or conversely, select contaminated prey.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
No evaluation of inhalation exposure pathways	Underestimate	The inhalation exposure pathways are generally considered insignificant due to the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Assumption of 100% drift for chronic ingestion scenarios	Overestimate	It is unlikely that 100% of the application rate would be deposited on a plant or animal used as food by another receptor. As indicated with the AgDRIFT® model, off-site drift is only a fraction of the applied amount.
Ecological exposure concentration	Overestimate	It is unlikely any receptor would be exposed continuously to full predicted EEC.
Over-simplification of dietary composition in the food web models	Unknown	Assumptions were made that contaminated food items (i.e., vegetation, fish) were the primary food items for wildlife. In reality, other food items are likely consumed by these organisms.
Degradation or adsorption of herbicide	Overestimate	Risk estimates for direct spray and off-site drift scenarios generally do not consider degradation or adsorption. Concentrations will tend to decrease over time from degradation. Organic carbon in water or soil/sediment may bind to herbicide and reduce bioavailability.
Bioavailability of herbicides	Overestimate	Most risk estimates assume a high degree of bioavailability. Environmental factors (e.g. binding to organic carbon, weathering) may reduce bioavailability.
Limited evaluation of dermal exposure pathways	Unknown	The dermal exposure pathway is generally considered insignificant due to natural barriers found in fur and feathers of most ecological receptors. However, under certain conditions, these exposure pathways may occur.
Amount of receptor's body exposed to dermal exposure	Unknown	More or less than ½ of the honeybee or small mammal may be affected in the accidental direct spray scenarios.
Lack of toxicity information for amphibian and reptile species	Unknown	Information is not available on the toxicity of herbicides to reptile and amphibian species resulting from dietary or direct contact exposures.
Lack of toxicity information for RTE species	Unknown	Information is not available on the toxicity of herbicides to RTE species resulting from dietary or direct contact exposures. Uncertainty factors have been applied to attempt to assess risk to RTE receptors. See Section 7.2 for additional discussion of salmonids.
Safety factors applied to TRVs	Overestimate	Assumptions regarding the use of 3-fold uncertainty factors are based on precedent, rather than scientific data.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Use of lowest toxicity data to derive TRVs	Overestimate	The lowest data point observed in the laboratory may not be representative of the actual toxicity which might occur in the environment. Using the lowest reported toxicity data point as a benchmark concentration is a very conservative approach, especially when there is a wide range in reported toxicity values for the relevant species. See Section 7.1 for additional discussion.
Use of NOAELs	Overestimate	Use of NOAELs may over-estimate effects because this measurement endpoint does not reflect any observed impacts. LOAELs may be orders of magnitudes above observed literature-based NOAELs, yet NOAELs were generally selected for use in the ERA.
Use of chronic exposures to estimate effects of herbicides on receptors	Overestimate	Chronic toxicity screening values assume that ecological receptors experience continuous, chronic exposure. Exposure in the environment is unlikely to be continuous for many species that may be transitory and move in and out of areas of maximum herbicide concentration.
Use of measures of effect	Overestimate	Although an attempt was made to have measures of effect reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measures of effect that may overestimate assessment endpoints.
Lack of toxicity information for mammals or birds	Unknown	TRVs for certain receptors were based on a limited number of studies conducted primarily for pesticide registration. Additional studies may indicate higher or lower toxicity values. See Section 7.1 for additional discussion.
Lack of seed germination toxicity information	Unknown	TRVs were based on a limited number of studies conducted primarily for pesticide registration. A wide range of germination data were not always available. Emergence or other endpoints were also used and may be more or less sensitive to the herbicide.
Species used for testing in the laboratory assumed to be equally sensitive to herbicide as those found within application areas.	Unknown	Laboratory toxicity tests are normally conducted with species that are highly sensitive to contaminants in the media of exposure. Guidance manuals from regulatory agencies contain lists of the organisms that they consider to be sensitive enough to be protective of naturally occurring organisms. However, reaction of all species to herbicides is not known, and species found within application areas may be more or less sensitive than those used in the laboratory toxicity testing. See Section 7.1 for additional discussion.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Use of chronic screening values to estimate effects of herbicide on receptors	Unknown	Chronic toxicity screening values assume that ecological receptors experience continuous, chronic exposure. Exposure in the environment is unlikely to be continuous for many species that may be transitory and move in and out of areas of maximum herbicide concentration.
Risk evaluated for individual receptors only	Overestimate	Effects on individual organisms may occur with little population or community level effects. However, as the number of affected individuals increases, the likelihood of population-level effects increases.
Lack of predictive capability	Unknown	The RQ approach provides a conservative estimate of risk based on a "snapshot" of conditions; the hazard quotient approach has no predictive capability.
Unidentified stressors	Unknown	It is possible that physical stressors other than those measured may affect ecological communities.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions predicts high risk to ecological receptors.
Predictions of off-site transport	Overestimate	Assumptions are implicit in each of the software models used in the ERA (AgDRIFT®, GLEAMS, and CALPUFF). These assumptions have been made in a conservative manner when possible. These uncertainties are discussed further in Section 7.4.
Impact of the other ingredients (e.g., inerts, adjuvants) in the application of the herbicide	Unknown	Only the active ingredient has been investigated in the ERA. Inerts and adjuvants may add or negate the impacts of the active ingredient. These uncertainties are discussed further in Section 7.3.

TABLE 7-2
Herbicide Loss Rates Predicted by the GLEAMS Model

Herbicide	Total Loss Rate			Runoff Loss Rate		
	Median	90th	Maximum	Median	90th	Maximum
Diflufenzopyr	0.27%	22%	54%	0.27%	6.0%	22%
Imazapic	4.5%	40%	79%	0.10%	4.1%	32%
Sulfometuron	0.49%	19%	37%	0.02%	1.6%	6.6%
Tebuthiuron	18%	56%	92%	0.23%	8.0%	23%
Diuron	3.7%	27%	40%	0.22%	5.0%	24%
Bromacil	36%	60%	66%	0.02%	1.7%	8.5%
Chlorsulfuron	1.9%	21%	68%	0.03%	3.9%	10%
Dicamba	26%	38%	42%	0.00%	0.0%	0.1%

8.0 SUMMARY

Based on the ERA conducted for Overdrive®, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM lands. Table 8-1 summarizes the relative magnitude of risk predicted for ecological receptors for each route of exposure. This was accomplished by comparing the RQs against the most conservative LOC, and ranking the results for each receptor-exposure route combination from 'no potential' to 'high potential' for risk. As expected due to the mode of action of terrestrial herbicides, the highest risk is predicted for non-target terrestrial and aquatic plant species, generally under accidental exposure scenarios (i.e., direct spray and accidental spills). Minimal risk was predicted for terrestrial animals, fish, and aquatic invertebrates.

The following bullets further summarize the risk assessment findings for Overdrive®:

- Direct Spray – Moderate risk to terrestrial and aquatic non-target plants may occur when plants or waterbodies are accidentally sprayed. No risks were predicted for terrestrial wildlife; fish, or aquatic invertebrates.

- Off-Site Drift – Low risk to typical non-target terrestrial plant species may occur within 25 ft of ground applications. Low risk to RTE terrestrial plant species may occur at the typical application rate within 25 ft of ground application with a low boom, within 100 ft of ground application with a high boom, and at the maximum application rate within 100 ft of ground application with a low or high boom. No risks were predicted for aquatic plants, fish, aquatic invertebrates, or piscivorous birds.

- Surface Runoff – Low to moderate risk to RTE terrestrial plant species may occur in the base watershed with clay soils and more than 50 inches of precipitation per year and in three variations of the base watershed (silt loam, silt, or clay loam soils with 50 inches of precipitation per year). Low chronic risks to aquatic plant species in the pond may occur in selected watersheds (primarily with clay or loam soils and more than 25 inches of precipitation per year, with sandy soils and more than 10 inches of precipitation per year, and in the base watershed with silt-loam, silt, or clay-loam soils and 50 inches of precipitation per year). Essentially no acute risks were predicted for aquatic plants in the pond. No risks were predicted for typical terrestrial plant species, aquatic plants in the stream, fish, invertebrates in the pond or stream, or piscivorous birds.

- Wind Erosion and Transport Off-Site – No risks were predicted for non-target terrestrial plants under any of the evaluated conditions.

- Accidental Spill to Pond – Moderate risk to non-target aquatic plants may occur when herbicides are spilled directly into the pond. No risks were predicted for fish or aquatic invertebrates.

Based on the results of the ERA, it is unlikely RTE species would be harmed by appropriate use of the herbicide Overdrive® on BLM lands. The potential impacts of inerts and adjuvants were impossible to quantify in the risk assessment. However, each of these chemicals has the potential to increase the predicted toxicity of the a.i.

8.1 Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from Overdrive®:

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the most significant potential impacts.

- Use the typical application rate, and not the maximum application rate, to reduce risk for off-site drift and surface runoff exposures.

- Establish the following buffer zones during ground applications to reduce impacts to terrestrial plants due to off-site drift:

  - Application by low boom (spray boom height set at 20 inches above the ground) and typical application rate – 100 ft from RTE terrestrial plants

  - Application by low boom and maximum application rate – 100 ft from typical species and 900 ft from RTE terrestrial plants

  - Application by high boom (spray boom height set at 50 inches above the ground) and typical or maximum application rate – 100 ft from typical species and 900 ft from RTE terrestrial plants

- To reduce potential impacts to RTE terrestrial plants due to surface runoff, use of Overdrive® within watersheds composed of clay, silt, silt-loam, or clay-loam soils with annual precipitation 50 inches or greater (or 25 inches or greater at the maximum application rate) should be limited.

- To reduce potential chronic impacts to aquatic plants in downgradient ponds, use of Overdrive® in watersheds composed of sand or clay soils with annual precipitation > 25 inches, in watersheds composed of silt-loam, silt, or clay-loam soils, and at the maximum application rate in watersheds with annual precipitation > 200 inches should be limited.

- Care must be taken when selecting adjuvants and tank mixtures because these have the potential to increase the level of toxicity above that predicted for the herbicide product alone. Herbicide labels provide recommendations for adjuvants and tank mixtures that must be considered. This is especially important for application scenarios that already predict potential risk from the product itself (e.g., off-site drift from high-boom applications with buffer zones of < 25 ft).

The results from this ERA contribute to the evaluation of proposed alternatives in the EIS and to the development of a BA, specifically addressing the potential impacts to proposed and listed RTE species on western BLM treatment lands. Furthermore, this ERA will inform BLM field offices on the proper application of Overdrive® to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

TABLE 8-1
Typical Risk Level Resulting from Overdrive® Application

	Direct Spray/Spill		Off-Site Drift		Surface Runoff		Wind Erosion	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Terrestrial Animals	0 [15: 16]	0 [15: 16]	NA	NA	NA	NA	NA	NA
Terrestrial Plants (Typical Species)	M [1: 1]	H [1: 1]	0 [5: 6]	0 [4: 6]	0 [42: 42]	0 [42: 42]	0 [9: 9]	0 [9: 9]
Terrestrial Plants (RTE Species)	H [1: 1]	H [1: 1]	L [3: 6]	L [4: 6]	0 [34: 42]	0 [33: 42]	0 [9: 9]	0 [9: 9]
Fish In The Pond	0 [2: 2]	0 [3: 3]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Fish In The Stream	0 [2: 2]	0 [2: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Aquatic Invertebrates In The Pond	0 [2: 2]	0 [3: 3]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Aquatic Invertebrates In The Stream	0 [2: 2]	0 [2: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Aquatic Plants In The Pond	M [1: 2]	L [2: 3]	0 [12: 12]	0 [12: 12]	0 [70: 84]	0 [67: 84]	NA	NA
Aquatic Plants In The Stream	M [1: 2]	H [1: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Piscivorous Bird	NA	NA	0 [6: 6]	0 [6: 6]	0 [42: 42]	0 [42: 42]	NA	NA

Risk Levels:
0 = No Potential for Risk (majority of RQs < most conservative LOC).
L = Low Potential for Risk (majority of RQs 1-10 times the most conservative LOC).
M = Moderate Potential for Risk (majority of RQs 10-100 times the most conservative LOC).
H = High Potential for Risk (majority of RQs >100 times the most conservative LOC). The reported Risk Level is based on the risk level of the majority of the RQs for each exposure scenario within each of the above receptor groups and exposure categories (i.e., direct spray/spill, off-site drift, surface runoff, wind erosion). As a result, risk may be higher than the reported risk category for some scenarios within each category. The reader should consult the risk tables in Section 4 to determine the specific scenarios that result in the displayed level of risk for a given receptor group.
Number in brackets represents Number of RQs in the Indicated Risk Level: Number of Scenarios Evaluated.
NA = Not applicable. No RQs calculated for this scenario.
In cases of a tie, the more conservative (higher) risk level was selected.

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