

Bureau of Land Management

Reno, Nevada



Diuron Ecological Risk Assessment

Final Report

November 2005

**Bureau of Land Management Contract No. NAD010156
ENSR Document Number 09090-020-650**

Executive Summary

The United States Department of the Interior (USDI) Bureau of Land Management (BLM) 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 (US) 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 US 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 diuron, 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

Diuron is a broad spectrum, pre- and post-emergent herbicide for use against broad-leaf weeds and annual grasses. This chemical disrupts photosynthesis by blocking electron transport and the transfer of light energy. Diuron is used by the BLM for vegetation control in their Energy & Mineral Sites, Rights-of-Way, and Recreation programs. Ground applications are executed on foot or horseback with backpack sprayers or from all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The application rate of diuron is typically 6.0 pounds (lbs) a.i. per acre (a.i./ac), with a maximum rate of 20.0 lbs a.i./ac.

Ecological Risk Assessment Guidelines

The main objectives of this ERA were to evaluate the potential ecological risks from diuron 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-managed lands.

- Exposure pathway evaluation – The effects of diuron 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.
 - 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 (LD₅₀ and LC₅₀).
- Development of a CM – The purpose of the CM is to display working hypotheses about how diuron might pose hazards to ecosystems and ecological receptors. This is shown via a diagram of the possible exposure pathways and the receptors evaluated for each exposure pathway.

In the analysis phase of the ERA, 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 United States Environmental Protection Agency (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-managed lands, the use of mixtures of diuron with other herbicides (tank mixtures) or 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, diuron has been associated with 35 reported “ecological incidents” involving damage or mortality to non-target flora or fauna. It was listed as possible (19 incidents), probable (13 incidents), or highly probable (3 incidents) that registered use of diuron was responsible.

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for diuron to negatively directly or indirectly affect non-target taxa. This review was also used to identify or derive TRVs for use in

the ERA. The sources identified in this review indicate that diuron is not highly toxic to most terrestrial species. In mammals, diuron is considered to have low acute oral and dermal toxicity. Adverse effects have been demonstrated in mammals from long term exposure to diuron in the diet. Diuron is slightly toxic to birds and essentially non-toxic to honeybees (*Apis* spp.). Significant adverse effects were noted in non-target terrestrial plant species after 14 days exposure to concentrations as low as 0.08 lb a.i./ac. Toxicity tests indicate that diuron is toxic to fish species at concentrations as low as 0.71 milligram per liter (mg/L). Diuron has a low to moderate potential for bioconcentration in fish tissue. Aquatic invertebrates were affected by diuron concentrations of 0.16 mg a.i./L. Aquatic plants were affected at concentrations as low as 0.0013 mg a.i./L. Amphibians were less sensitive to diuron than any other aquatic taxa.

Ecological Risk Assessment Results

Based on the ERA conducted for diuron, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed lands. The following bullets summarize the risk assessment findings for diuron under each evaluated exposure scenario:

- Direct Spray – Risk to insects may occur when individuals or foliage are directly sprayed. Acute and chronic risks to terrestrial wildlife species may occur when contaminated food items are consumed. Risk to terrestrial and aquatic non-target plants, fish, and aquatic invertebrates is likely in accidental direct spray scenarios.
- Off-Site Drift – Risk to typical non-target terrestrial plant species was predicted within 100 feet (ft) of the application area (mostly at the maximum application rate), while risk to RTE terrestrial plant species may occur for any of the modeled ground application scenarios (maximum modeled distance was 900 ft). Risk to aquatic plants was predicted for all scenarios at the maximum application rate (except for acute risk in the stream with a buffer distance of 900 ft) and for distances less than or equal to 100 ft at the typical application rate (chronic risk in the pond also predicted at 900 ft for high boom application). Acute and chronic risks were predicted for fish within 25 ft of the application area (at maximum application rates). Risks were also predicted for aquatic invertebrates 25 ft from application with a low boom and 100 ft from application with a high boom. No risks were predicted for piscivorous birds.
- Surface Runoff – No risks to typical non-target terrestrial plants were predicted; risks to RTE terrestrial plants were predicted in watersheds with clay soils or clay loam soils and annual precipitation of at least 50 inches and in watersheds with loam soils and annual precipitation of at least 200 inches. Risks to aquatic species were not predicted for watersheds with very little precipitation (less than 5 inches per year). However, risks to aquatic plants and to pond-dwelling fish and aquatic invertebrates occur under most other modeled scenarios. In addition, acute risks to fish in the stream were predicted in several watersheds with at least 25 inches of rain per year (mostly at the maximum application rate), and acute risks to aquatic invertebrates were predicted at the typical and maximum application rates in watersheds with at least 10 inches of precipitation per year (effects were less likely in watersheds with loam soils). No chronic risk to fish or aquatic invertebrates were predicted in the stream, and no risks were predicted 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 fish, aquatic invertebrates, and non-target aquatic plants occurs when herbicides are spilled directly into the pond.

In addition, species that depend on non-target species for habitat, cover, and/or food (e.g., RTE salmonids) may be indirectly impacted by possible reductions in terrestrial or aquatic vegetation or effects on terrestrial and aquatic wildlife, particularly in accidental direct spray and spill scenarios.

Based on the results of the ERA, it is unlikely RTE species would be harmed by appropriate use (see following section) of the herbicide diuron on BLM-managed lands. Adherence to certain application guidelines (e.g., defined

application rates, equipment, herbicide mixture, and downwind distance to potentially sensitive habitat) can minimize the potential effects on non-target species from regular application.

Recommendations

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

- Select herbicide products carefully to minimize additional impacts from adjuvants and tank mixtures. This is especially important for application scenarios that already predict potential risk from the a.i..
- 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 to reduce risk for off-site drift and surface runoff exposures.
- Establish the following buffer zones during ground applications (using the typical application rates) to reduce impacts to aquatic areas due to off-site drift.
 - Application by low boom (spray boom height set at 20 inches above the ground) – more than 100 ft from pond or stream (no risk was predicted at 900 ft).
 - Application by high boom (spray boom height set at 50 inches above the ground) – more than 100 ft from stream (no risk was predicted at 900 ft).
 - Application by high boom – more than 1,000 ft from pond (chronic risk to aquatic plants is still predicted at 900 ft; simple regression analysis predicts an RQ of 1 for aquatic plants with a buffer zone of just over 1,000 ft at the maximum application rate).
- Limit the use of diuron in terrestrial habitats if potential impacts to RTE species are of concern.
- For all ground applications of diuron, a buffer zone of more than 1,000 ft from non-target terrestrial species is necessary to limit impacts to RTE terrestrial plants (risk to RTE plants is still predicted at 900 ft; simple regression analysis predicts an RQ of 1 for RTE plants with a buffer zone of just over 1,000 ft at the maximum application rate).
 - If no RTE species are present, terrestrial plants are protected by a buffer zone of 100 ft at the typical application rate and approximately 500 ft at the maximum rate (based on regression evaluation). Less risk is predicted from the use of a low boom for ground application at the typical application rate, and risk may be reduced if diuron is applied on foot or horseback with backpack sprayers.
- Application of diuron should be carefully limited to days without predicted winds.
- Limit the use of diuron in watersheds with downgradient ponds or streams (especially at the maximum application rate) if potential impacts to aquatic species are of concern (less risk predicted in streams than ponds). Carefully evaluate watershed characteristics when RTE salmonids are present in streams (low risk is only found with larger buffer zones in watersheds with low annual precipitation and in some watersheds with loam soils).

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 diuron to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1-1
1.1 Objectives of the Ecological Risk Assessment	1-1
2.0 BLM HERBICIDE PROGRAM DESCRIPTION.....	2-1
2.1 Problem Description	2-1
2.2 Herbicide Description	2-1
2.3 Herbicide Incident Reports	2-2
3.0 HERBICIDE TOXICOLOGY, PHYSICAL-CHEMICAL PROPERTIES, AND ENVIRONMENTAL FATE	3-1
3.1 Herbicide Toxicology	3-1
3.1.1 Overview	3-1
3.1.2 Toxicity to Terrestrial Organisms.....	3-2
3.1.2.1 Mammals	3-2
3.1.2.2 Birds.....	3-2
3.1.2.3 Terrestrial Invertebrates.....	3-3
3.1.2.4 Terrestrial Plants.....	3-3
3.1.3 Toxicity to Aquatic Organisms.....	3-3
3.1.3.1 Fish.....	3-3
3.1.3.2 Amphibians.....	3-4
3.1.3.3 Aquatic Invertebrates.....	3-4
3.1.4 Aquatic Plants.....	3-4
3.2 Herbicide Physical-Chemical Properties.....	3-5
3.3 Herbicide Environmental Fate	3-6
4.0 ECOLOGICAL RISK ASSESSMENT	4-1
4.1 Problem Formulation	4-1
4.1.1 Definition of Risk Assessment Objectives.....	4-1
4.1.2 Ecological Characterization	4-1
4.1.3 Exposure Pathway Evaluation	4-2
4.1.4 Definition of Data Evaluated in the ERA.....	4-2
4.1.5 Identification of Risk Characterization Endpoints	4-3
4.1.6 Development of the Conceptual Model.....	4-3
4.2 Analysis Phase	4-4
4.2.1 Characterization of Exposure.....	4-4
4.2.1.1 Direct Spray.....	4-6
4.2.1.2 Off-site Drift.....	4-6
4.2.1.3 Surface and Groundwater Runoff	4-7
4.2.1.4 Wind Erosion and Transport Off-site	4-7
4.2.1.5 Accidental Spill to Pond.....	4-7
4.2.2 Effects Characterization.....	4-7
4.3 Risk Characterization.....	4-8
4.3.1 Direct Spray.....	4-8
4.3.1.1 Terrestrial Wildlife	4-8
4.3.1.2 Non-target Plants – Terrestrial and Aquatic	4-9
4.3.1.3 Fish and Aquatic Invertebrates.....	4-9
4.3.2 Off-site Drift.....	4-9
4.3.2.1 Non-target Plants – Terrestrial and Aquatic	4-9

4.3.2.2	Fish and Aquatic Invertebrates.....	4-10
4.3.2.3	Piscivorous Birds.....	4-10
4.3.3	Surface Runoff	4-10
4.3.3.1	Non-target Plants – Terrestrial and Aquatic	4-10
4.3.3.2	Fish and Aquatic Invertebrates.....	4-11
4.3.3.3	Piscivorous Birds.....	4-12
4.3.4	Wind Erosion and Transport Off-site	4-12
4.3.5	Accidental Spill to Pond.....	4-12
4.3.6	Potential Risk to Salmonids from Indirect Effects	4-12
4.3.6.1	Qualitative Evaluation of Impacts to Prey	4-13
4.3.6.2	Qualitative Evaluation of Impacts to Vegetative Cover.....	4-13
4.3.6.3	Conclusions.....	4-14
5.0	SENSITIVITY ANALYSIS.....	5-1
5.1	GLEAMS.....	5-1
5.1.1	GLEAMS Sensitivity Variables.....	5-1
5.1.2	GLEAMS Results.....	5-2
5.2	AgDRIFT®	5-3
5.3	CALPUFF	5-4
6.0	RARE, THREATENED, AND ENDANGERED SPECIES	6-1
6.1	Use of LOCs and TRVs to Provide Protection to RTE Species	6-2
6.2	Use of Species Traits to Provide Protection to RTE Species.....	6-2
6.2.1	Identification of Surrogate Species.....	6-3
6.2.1.1	Species Selected in Development of TRVs	6-3
6.2.1.2	Species Selected as Surrogates in the ERA	6-4
6.2.2	Surrogates Specific to Taxa of Concern	6-4
6.2.3	Biological Factors Affecting Impact from Herbicide Exposure	6-6
6.3	Review of Extrapolation Methods Used to Calculate Potential Exposure and Risk.....	6-6
6.3.1	Uncertainty Factors	6-7
6.3.2	Allometric Scaling.....	6-7
6.3.3	Recommendations	6-8
6.4	Indirect Effects on Salmonids.....	6-8
6.4.1	Biological Disturbance.....	6-8
6.4.2	Physical Disturbance.....	6-9
6.5	Conclusions	6-10
7.0	UNCERTAINTY IN THE ECOLOGICAL RISK ASSESSMENT.....	7-1
7.1	Toxicity Data Availability	7-1
7.2	Potential Indirect Effects on Salmonids	7-3
7.3	Ecological Risks of Degradates, Inert Ingredients, Adjuvants, and Mixtures.....	7-3
7.3.1	Degradates	7-3
7.3.2	Inerts	7-4
7.3.3	Adjuvants and Tank Mixtures.....	7-5
7.3.3.1	Adjuvants.....	7-5
7.3.3.2	Tank Mixtures.....	7-6
7.4	Uncertainty Associated with Herbicide Exposure Concentration Models	7-7
7.4.1	AgDRIFT®	7-7
7.4.2	GLEAMS.....	7-7
7.4.2.1	Herbicide Loss Rates	7-8
7.4.2.2	Root-Zone Groundwater.....	7-8
7.4.3	CALPUFF	7-9
7.5	Summary of Potential Sources of Uncertainty	7-9

8.0 SUMMARY	8-1
8.1 Recommendations	8-2
9.0 REFERENCES	9-1

APPENDIXES

Appendix A – Summary of Available and Relevant Toxicity Data for Diuron / Ecological Risk Assessment Literature Review – Diuron

 Appendix A.1 – Bibliography List

 Appendix A.2 – Tier II and III Literature Review Forms

 Appendix A.3 – Spreadsheet of Toxicity Data for Diuron TRV

Appendix B – Ecological Risk Assessment Worksheets

Appendix C – Species Listed Under the Endangered Species Act for 17 BLM States

Appendix D – Review of Confidential Business Information Memo

Appendix E – Summary of Tank Mix Risk Quotients

LIST OF TABLES

2-1	BLM Diuron Use Statistics.....	2-3
2-2	Diuron Incident Report Summary.....	2-4
3-1	Selected Toxicity Reference Values for Diuron.....	3-7
3-2	Physical-Chemical Properties of Diuron.....	3-9
4-1	Levels of Concern.....	4-15
4-2	Risk Quotients for Direct Spray and Spill Scenarios.....	4-16
4-3	Risk Quotients for Off-Site Drift Scenarios.....	4-18
4-4	Risk Quotients for Surface Runoff Scenarios.....	4-22
4-5	Risk Quotients for Wind Erosion and Transport Off-Site Scenarios.....	4-34
5-1	Relative Effects of GLEAMS Input Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate.....	5-6
5-2	Relative Effects of Soil and Vegetation Type on Herbicide Exposure Concentrations using Typical BLM Application Rate.....	5-7
5-3	Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis	5-8
6-1	Surrogate Species Used to Derive Diuron TRVs	6-11
6-2	Surrogate Species Used in Quantitative ECOLOGICAL RISK ASSESSMENT Evaluation	6-11
6-3	RTE Birds and Selected Surrogates	6-12
6-4	RTE Mammals and Selected Surrogates.....	6-13
6-5	RTE Reptiles and Selected Surrogates.....	6-14
6-6	RTE Amphibians and Selected Surrogates	6-15
6-7	Species and Organism Traits That May Influence Herbicide Exposure and Response	6-16
6-8	Summary of Findings: Interspecific Extrapolation Variability	6-17
6-9	Summary of Findings: Intraspecific Extrapolation Variability	6-17
6-10	Summary of Findings: Acute-to-Chronic Extrapolation Variability.....	6-17
6-11	Summary of Findings: LOAEL-to-NOAEL Extrapolation Variability	6-17
6-12	Summary of Findings: Laboratory to Field Extrapolations.....	6-18
7-1	Potential Sources of Uncertainty in the ERA Process	7-11
7-2	Changes in RQs Exceeding LOCs for Tank Mixtures	7-14
7-3	Herbicide Loss Rates Predicted by the GLEAMS Model.....	7-14
8-1	Typical Risk Level Resulting from Diuron Application.....	8-3

LIST OF FIGURES

4-1	Conceptual Model for Terrestrial Herbicides	4-35
4-2	Simplified Food Web	4-36
4-3	Direct Spray - Risk Quotients for Terrestrial Animals.....	4-37
4-4	Direct Spray - Risk Quotients for Non-Target Terrestrial Plants.....	4-38
4-5	Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants.....	4-39
4-6	Accidental Direct Spray and Spills - Risk Quotients for Fish.....	4-40
4-7	Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates.....	4-41
4-8	Off-Site Drift - Risk Quotients for Non-Target Terrestrial Plants	4-42
4-9	Off-Site Drift - Risk Quotients for Non-Target Aquatic Plants	4-43
4-10	Off-Site Drift - Risk Quotients for Fish	4-44
4-11	Off-Site Drift - Risk Quotients for Aquatic Invertebrates	4-45
4-12	Off-Site Drift - Risk Quotients for Piscivorous Birds	4-46
4-13	Surface Runoff - Risk Quotients for Non-Target Terrestrial Plants	4-47
4-14	Surface Runoff - Risk Quotients for Non-Target Aquatic Plants	4-48
4-15	Surface Runoff - Risk Quotients for Fish	4-49
4-16	Surface Runoff - Risk Quotients for Aquatic Invertebrates	4-50
4-17	Surface Runoff - Risk Quotients for Piscivorous Birds.....	4-51
4-18	Wind Erosion and Transport Off-Site - Risk Quotients for Non-Target Terrestrial Plants.....	4-52

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ac	-	acres
a.i.	-	active ingredient
BA	-	Biological Assessment
BCF	-	Bioconcentration Factor
BLM	-	Bureau of Land Management
BO	-	Biological Opinion
BW	-	Body Weight
CBI	-	Confidential Business Information
CM	-	Conceptual Model
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)
Ed.	-	Edition
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
K _d	-	Partition coefficient
kg	-	kilogram
km	-	kilometer
K _{oc}	-	Organic carbon-water partition coefficient
K _{ow}	-	Octanol-water partition coefficient
L	-	Liters
LAI	-	Leaf Area Index
lb(s)	-	pound(s)
LC ₅₀	-	Median Lethal Concentration
LD ₅₀	-	Median Lethal Dose
LOAEL	-	Lowest Observed Adverse Effect Level
LOC(s)	-	Level(s) of Concern
Log	-	Common logarithm (base 10)
m	-	meters
m ³	-	cubic meter
mg	-	milligrams

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

mg/kg	-	milligrams per kilogram
mg/L	-	milligrams per liter
mmHg	-	millimeters of mercury
MRID	-	Master Record Identification Number
MSDS	-	Material Safety Data Sheet
MW	-	Molecular Weight
NASQAN	-	National Stream Quality Accounting Network
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 Library
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 the 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 the Interior (USDI), is proposing a program to treat vegetation on up to six million ac of public lands annually in 17 western states of the continental US 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 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 US and Alaska (USDI BLM 2005). As part of the EIS, several ERAs and a Human Health Risk Assessment (HHRA; ENSR 2005a) were conducted on several herbicides used, or proposed for use, by the BLM. These risk assessments evaluate potential risks to the environment and human health from exposure to these herbicides both during and after treatment of public lands. For the ERAs, the herbicide active ingredients 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 active ingredients (sulfometuron-methyl, imazapic, diflufenzopyr, dicamba, diquat, and fluridone) because the other active ingredients were already quantitatively evaluated in previous EISs (e.g., BLM 1991). [Note that in the HHRA, Overdrive® was evaluated as its two separate components, dicamba and diflufenzopyr, as these two active ingredients have different toxicological endpoints, indicating that their effects on human health are not additive.] The purpose of this document is to summarize results of the ERA for the herbicide diuron.

Updated risk assessment methods were developed for both the HHRA and ERA and are described in a separate document, *Vegetation Treatments Programmatic EIS ERA Methodology* (hereafter referred to as the “Methods Document;” ENSR 2005b). 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 ten 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 Biological Opinion (BO), 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 diuron, 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 diuron 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 ac 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 manage invasive plants. Management techniques may be biological, mechanical, chemical, or cultural. 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 use of the herbicide diuron for the management of vegetation 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. Diuron application rates and methods discussed in this section are based on past and predicted BLM herbicide use and are in accordance with herbicide labels approved by the USEPA. The BLM should be aware of all state-specific label requirements and restrictions. In addition, new USEPA approved herbicide labels may be 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.

Diuron, a broad-spectrum herbicide, can be applied both pre- and post-emergence for use against broad-leaf weeds and annual grasses. The mechanism of activity associated with this a.i. is the disruption of photosynthesis by blocking

electron transport and the transfer of light energy. Diuron is available in both liquid and dry formulations and is used by the BLM for vegetation control in their Energy & 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 on foot or horseback with backpack sprayers or from all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The application rate of diuron is typically 6.0 lbs (a.i./ac), with a maximum rate of 20.0 lbs (a.i./ac). Details regarding expected diuron usage by the 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, USEPA was requested to provide all available incident reports in the EIIS that listed diuron as a potential source of the observed ecological damage.

The USEPA EIIS contained 35 incident reports involving diuron. Seventeen of the 35 incidents involved the use of additional pesticides. Three incident reports indicated that it was “highly probable” that the use of diuron resulted in the observed effects. One of these three incidents (taking place in 1998) implicated the registered use of both diuron and bromacil in damage to grasses as a result of drift and runoff. Another incident (in 1997) implicated the misuse of both diuron and imazapic, which resulted in the mortality of birch and willow trees from drift and direct contact. In the third incident (occurring in 1975), runoff of diuron following accidental use is believed to have caused the mortality of 1000 fish. Additionally, the USEPA lists diuron as the “probable” cause in 13 incidents and the “possible” cause in 19 incidents. Effects range from unknown and partial dieback of flora to mortality of multiple species of fish. A summary of these incidents is provided in Table 2-2 at the end of this section.

TABLE 2-1
BLM Diuron Use Statistics

Program	Scenario	Vehicle	Method	Used?	Application Rate	
					Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)
Rangeland	Aerial	Plane	Fixed Wing	No		
		Helicopter	Rotary	No		
	Ground	Human	Backpack	No		
			Horseback	No		
		ATV	Spot	No		
			Boom/Broadcast	No		
		Truck	Spot	No		
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		
Energy & Mineral Sites	Aerial	Plane	Fixed Wing	No		
		Helicopter	Rotary	No		
	Ground	Human	Backpack	Yes	6.0	20.0
			Horseback	Yes	6.0	20.0
		ATV	Spot	Yes	6.0	20.0
			Boom/Broadcast	Yes	6.0	20.0
		Truck	Spot	Yes	6.0	20.0
Rights-of-way	Aerial	Plane	Fixed Wing	No		
		Helicopter	Rotary	No		
	Ground	Human	Backpack	Yes	6.0	20.0
			Horseback	Yes	6.0	20.0
		ATV	Spot	Yes	6.0	20.0
			Boom/Broadcast	Yes	6.0	20.0
		Truck	Spot	Yes	6.0	20.0
Recreation	Aerial	Plane	Fixed Wing	No		
		Helicopter	Rotary	No		
	Ground	Human	Backpack	Yes	6.0	20.0
			Horseback	Yes	6.0	20.0
		ATV	Spot	Yes	6.0	20.0
			Boom/Broadcast	Yes	6.0	20.0
		Truck	Spot	Yes	6.0	20.0
Aquatic			Boom/Broadcast	Yes	6.0	20.0
				No		

TABLE 2-2
Diuron Incident Report Summary

Year	Application Area	Incident Type	Diuron Certainty	Other ¹	Dispersal	Organism	Distance ²	Magnitude of Damage
1972	Right-of-way	Undetermined	Possible	Yes	Drift	Tomato, Squash, Pepper	Vicinity	98 tomato, 6 squash, 70 pepper
1973	Right-of-way	Accident	Probable	Yes	Drift	Pumpkin, Cantaloupe, Watermelon, Peppers	125 yds	Plant damage
1975	Municipal Operation	Accident	Highly Probable	No	Runoff	Fish	Adjacent	Mortality - 1000
1982	NA	Undetermined	Probable	NA	NA	Bass, Bream	NA	Mortality - 20 Bass, 15 Bream
1992	Pond	Accident	Possible	No	Direct	Fish	0	Mortality - large numbers
1992	Fence Row	Undetermined	Probable	Yes	Drift	Birds/Fish	2-85'	NA
1993	Pond	Accident	Possible	No	Direct	Fish	0	Mortality - 250
1995	Pond	Accident	Possible	No	Direct	Unknown	0	Mortality - unknown
1995	Pond	Undetermined	Possible	No	Direct	Catfish	0	Mortality - unknown
1995	Pond	Accident	Possible	No	Direct	Unknown	0	Mortality - unknown
1995	Pond	Accident	Possible	No	Direct	Unknown	0	Mortality - unknown
1995	Pond	Intentional Misuse	Possible	No	Direct	Bass, Trout	0	Mortality - unknown
1996	Pond	Accident	Possible	No	Direct	Unknown	0	Mortality - Unknown
1996	Pond	Accident	Possible	No	Direct	Bass, Catfish, Bream	0	Mortality - unknown
1996	Pond	Intentional Misuse	Possible	No	Direct	Bass	0	Mortality - Hundreds
1996	Agricultural	Undetermined	Probable	No	Runoff	Bass, Catfish	Adjacent	Mortality - 6 Bass, 6 Catfish
1996	Agricultural	Undetermined	Probable	Yes		Fish	Adjacent	Mortality - 3000
1997	Driveway	Misuse	Highly Probable	Yes	Drift, Direct	Birch and Willow Trees	On site	Mortality
1997	Pond	Intentional Misuse	Possible	No	Direct	Bass, Bream, Catfish	0	Mortality - unknown
1997	Pond	Intentional Misuse	Possible	No	Direct	Bass, Catfish	0	Mortality - unknown
1997	Pond	Intentional Misuse	Possible	No	Direct	Catfish	0	Mortality - 12
1997	Pond	Undetermined	Possible	No	Direct	White perch	0	Mortality - 75
1997	Plant Site	Registered Use	Probable	Yes	Runoff	Oak	50'	3 partial dieback
1997	Utility Plant	Accident	Probable	Yes	Runoff	Grass, Bullrush	Adjacent	Unknown
1997	Agricultural	Accident	Probable	Yes	Runoff	Corn	Vicinity	Unknown
1997	Pond	Accident	Probable	No	Direct	Bass, Catfish, Bluegill	Adjacent	Mortality - several
1998	Home exterior	Registered Use	Highly Probable	Yes	Drift, Runoff	Grass	Adjacent	Plant damage
1998	Utility Plant	Registered Use	Possible	Yes	NA	Catfish	Adjacent	Some - Mortality

**TABLE 2-2 (Cont.)
Diuron Incident Report Summary**

Year	Application Area	Incident Type	Diuron Certainty	Other¹	Dispersal	Organism	Distance²	Magnitude of Damage
1998	Right-of-way	Registered Use	Possible	Yes	Drift	Evergreen	NA	Unknown
1998	Yard	Registered Use	Probable	Yes	Runoff	Grass seed	Vicinity	NA
2002	Right-of-way	Undetermined	Possible	Yes	Drift	Sugar beet	Vicinity	10 ac. Plant damage
2002	Right-of-way	Registered Use	Possible	Yes	Runoff	Grass	Vicinity	Mortality - 1/3 of backyard
2002	Cotton	Misuse	Probable	Yes	Drift	Lettuce	NA	Plant damage - 50 ac
NA	Pasture	Accident	Probable	Yes	NA	Alfalfa, Oats, Hay	Adjacent	Mortality - part of 3 ac
NA	Driveway	Intentional Misuse	Probable	Yes	Drift	Willow, Spruce	NA	Mortality - Unknown
(1) Other = other chemicals used in conjunction with diuron (yes/no)								
(2) Distance = estimated distance from application area								
NA = information not available								

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

This section summarizes available herbicide toxicology information, describes how this information was obtained, and provides a basis for the LOC values selected for this risk assessment. Diuron's 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 diuron to negatively effect 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 2005b). 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 (mg/L and lbs/ac, respectively). Dose-based endpoints (e.g., LD₅₀s) 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., LC₅₀ to LD₅₀) 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 2005b).

This section reviews the available information identified for diuron and presents the TRVs selected for this risk assessment (Table 3-1). Appendix A presents a summary of the diuron data identified during the literature review. Toxicity data are presented in the units used in the reviewed study. In most cases this applies to the a.i. itself (e.g., diuron); however, some data correspond to a specific product or applied mixture (e.g., Karmex) containing the a.i. under consideration, and potentially other ingredients (e.g., other active ingredients 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.

3.1.1 Overview

According to USEPA ecotoxicity classifications presented in registration materials¹, diuron is not highly toxic to most terrestrial species. In mammals, diuron is considered to have low acute oral and dermal toxicity. Adverse effects have been demonstrated in mammals from long term exposure to diuron in the diet. Diuron is slightly toxic to birds and

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

essentially non-toxic to honeybees. For terrestrial plants, vegetative vigor was the most sensitive indicator of plant toxicity. Significant adverse effects were noted in non-target plant species after 14 days exposure to concentrations as low as 0.08 lb (a.i./ac).

Diuron is classified as moderately toxic to fish and highly toxic to aquatic plants and aquatic invertebrates. Toxicity tests indicate that diuron is toxic to fish species at concentrations as low as 0.71 milligram per liter (mg/L). Diuron has a low to moderate potential for bioconcentration in fish tissue. Amphibians were less sensitive to diuron than any other aquatic taxa. Aquatic invertebrates were affected by diuron concentrations of 0.16 mg/L. Aquatic plants were affected at concentrations as low as 0.0013 mg./L (about 0.02 percent of the typical application rate).

3.1.2 Toxicity to Terrestrial Organisms

3.1.2.1 Mammals

As part of the pesticide reregistration process, several mammalian toxicological studies are required. Oral doses of diuron to male and female rats (*Rattus* spp.) resulted in LD₅₀s of 1,258 mg a.i./kilogram (kg) body weight (BW) in males and 1,182 mg a.i./kg BW in females (Gaines and Linder 1986). The reregistration reports summarized several acute oral toxicity studies conducted in small mammals. These studies found acute exposure to diuron caused adverse effects at oral doses of 1,017 mg a.i./kg BW (PIP 1993). Acute dermal exposure studies found no adverse effects to mammals exposed to 2,500 mg a.i./kg BW (Gaines and Linder 1986). However, diuron caused adverse effects in subchronic oral studies when animals were dosed during pregnancy. Fetal toxicity (bone deformities) occurred in rats exposed daily oral doses of 250 mg a.i./kg BW-day during pregnancy, while no toxic effects were reported at 125 mg a.i./kg BW-day (PIP 1996). Because fairly large single doses of diuron are required before adverse effects are noted, diuron is considered to have low acute toxicity to mammals.

In chronic dietary studies, rats fed 500 parts per million (ppm) (25 mg a.i./kg BW-day) of diuron exhibited adverse effects after 3 months of exposure, while no adverse effects were observed in rats fed 50 ppm (2.5 mg a.i./kg BW-day; Integrated Risk Information System [IRIS] 2003, Master Record Identification number [MRID] 00068036). In a longer feeding trail, rats exposed to diuron for three generations showed adverse effects (decreased pup weight) when dietary concentrations were 125 ppm (equivalent to 6.25 mg a.i./kg BW-day; IRIS 2003, MRID 00017763 and MRID 00080899).

Based on these findings, the oral LD₅₀ (death of 50 percent of the test organisms; 1,017 mg a.i./kg BW) and chronic dietary NOAEL (2.5 mg a.i./kg BW-day) were selected as the dietary small mammal TRVs. The dermal small mammal TRV was established at >2,500 mg a.i./kg BW.

Data for large mammals is limited to a single study. In a two-year feeding trial, systemic effects were observed in beagle dogs (*Canis familiaris*) fed 125 ppm (equivalent to 3.125 mg a.i./kg BW-day) (IRIS 2003, MRID 00017763 and MRID 0091192). No adverse effects were observed in dogs fed 25 ppm (equivalent to 0.625 mg a.i./kg BW-day).

Since no large mammal LD₅₀s were identified in the available literature, the small mammal acute LD₅₀ (1,017 mg a.i./kg BW) was used as a surrogate value. The large mammal dietary chronic NOAEL TRV was established at 0.6 mg a.i./kg BW-day.

3.1.2.2 Birds

The USEPA pesticide registration process also requires information related to avian exposure to diuron. While no adverse effects were observed in mallards (*Anas platyrhynchos*) acutely dosed with 2,000 mg/kg BW-day of a 95% diuron product (USEPA 2003a, MRID 00160000), 50 percent of the bobwhite quail (*Colinus virginianus*) dosed with 940 mg/kg BW in water died when exposed to a 92.8% diuron product (USEPA 2003a, MRID 50150170). In this same study, bobwhite quail also exhibited adverse effects when administered dose levels of 292 mg/kg BW in water, the lowest dose tested. Dietary studies documented adverse effects in large and small birds fed diets containing 1,730 ppm diuron in 8 day studies (equivalent to 173 and 1,045 mg/kg BW-day in mallards and bobwhite quail, respectively) (USEPA no date, MRID 00022923; USEPA 2003a, MRID 00022923). In these dietary tests, the test

organism was 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 LC₅₀ representing mg/kg food. This concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2005b). Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD₅₀ value representing the full herbicide exposure over the course of the test. This resulted in LD₅₀ values of 5,225 mg/kg BW and 865 mg/kg BW for the bobwhite quail and mallard, respectively.

Based on these findings, the bobwhite quail dietary LD₅₀ (5,225 mg/kg BW-day) and the mallard dietary LD₅₀ (865 mg/kg BW-day) were selected as the small and large bird dietary TRVs. Since no chronic dietary data were available, the acute LD₅₀s were divided by an uncertainty factor of 3 to derive NOAEL TRVs of 348 and 58 mg /kg BW-day for small and large birds, respectively (based on the dietary concentrations converted to daily doses of 1,045 and 173 mg/kg BW-day). This 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 2005b). These NOAEL TRVs are highly conservative since they are based on short term, not chronic, dietary studies.

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, technical grade diuron was directly applied to the bee's thorax and mortality was assessed during a 48-hr period. The USEPA reports an LD₅₀ of 145.03 µg/bee (USEPA no date, MRID 00036935).

The honeybee dermal LD₅₀ TRV was set at 145.03 µg/bee. Based on a honeybee weight of 0.093 g, this TRV was expressed as 1,560 mg/kg BW.

3.1.2.4 Terrestrial Plants

Toxicity tests were conducted on numerous, non-target plant species (tests were performed only on vegetable crop species and not western rangeland or forest species; USEPA 1996, 2003). 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. While no studies evaluated germination as an endpoint, seed emergence and vegetative vigor were examined. Seed emergence studies were conducted by applying the herbicide to soil containing newly sown seed. Tomato (*Lycopersicon esculentum*) plants were the most sensitive species tested, with adverse effects to 25% of the plants (i.e., the Effect Concentration [EC₂₅]) occurring in 14-days of exposure to concentrations of 0.08 lb a.i./ac (USEPA 2003a, MRID 44113401). No adverse effects on tomatoes were reported at concentrations of 0.047 lb a.i./ac. Seed emergence NOAEL values for various non-target species ranged from 0.047 to 12 lb a.i./ac (USEPA 2003a, MRID 44113401). Compared to seed emergence, vigor was a more sensitive indicator of toxicity, with EC₅₀ (i.e., the concentration that causes adverse effects to 50 % of the plants) values as low as 0.002 lb a.i./ac for tomatoes. The no observed adverse effect concentration for vegetative vigor was 0.001 lb a.i./ac (USEPA 2003a, MRID 44113401).

In accordance with the Methods Document (ENSR 2005b), the lowest and highest germination-based NOAELs were selected to evaluate risk in surface runoff scenarios. Since germination data were not available for diuron, the emergence TRVs of 0.047 and 12 lb a.i./ac were selected instead. Two additional endpoints were used to evaluate other plant scenarios. These included a seed emergence EC₂₅ of 0.08 lb a.i./ac and a vegetative vigor NOAEL of 0.001 lb a.i./ac.

3.1.3 Toxicity to Aquatic Organisms

3.1.3.1 Fish

The effects of diuron were examined in both cold- and warmwater fish species. In acute toxicity tests with a 95% diuron product, the 96-hour LC₅₀ values were 0.71 mg/L and 2.8 mg/L for cold- and warmwater fish, respectively (USEPA 2003a, MRID 40098001). Chronic exposure of fathead minnow (*Pimephales promelas*) larvae for 64 days

showed adverse impacts on survival at concentrations of 0.078 mg a.i./L, while the no observed adverse effect concentration was 0.033 mg a.i./L (Call et al. 1987). Consequently, the USEPA classifies diuron as moderately toxic to fish. No chronic toxicity tests with cold-water fish were identified.

The lower of the cold- and warmwater fish endpoints were selected as the TRVs for fish. Therefore the coldwater 96-hour LC₅₀ of 0.71 mg/L was selected as the acute TRV, and the warmwater fish NOAEL of 0.033 mg a.i./L was used as the TRV for chronic effects.

Based on diuron's octanol-water coefficient (K_{ow}) and regression equations, the bioconcentration factor (BCF) was estimated to be 64. Common carp exposed for 6 weeks to diuron had experimental BCF values ranging from 3.4 to 4.9 (0.5 mg/L exposure) and from <3 to 74 (0.05 mg/L exposure) (HSDB 2003). Consequently the bioconcentration potential for diuron was considered low to moderate.

3.1.3.2 Amphibians

Numerous toxicity tests were conducted on various amphibian species with a 99.8% diuron product. Toxicity was observed after 21 days in amphibians exposed to diuron concentrations of 12.7 mg/L (Schuytema and Nebeker 1998). In chronic toxicity tests, adverse effects on growth were observed at concentrations of 14.5 mg/L, with no effects observed at 7.6 mg/L (Schuytema and Nebeker 1998).

The LC₅₀ (12.7 mg/L) was selected as an amphibian acute TRV and the NOAEL (7.6 mg/L) was selected as the chronic TRV.

3.1.3.3 Aquatic Invertebrates

Diuron is considered to have relatively high toxicity to aquatic invertebrates. In 96-hour aquatic toxicity tests, acute toxicity was observed in aquatic invertebrates exposed to concentrations as low as 0.16 mg/L using a 95% diuron product (USEPA 2003a, MRID 40094602). Chronic studies were also conducted with several species of aquatic invertebrates (e.g., amphipod, midge, water fleas [*Daphnia magna*]) with no effect levels as high as 13.4 mg a.i./L (Schuytema and Nebeker 1998).

The LC₅₀ (0.16 mg/L) was selected as the invertebrate acute TRV. Since none of the observed chronic NOAEL values were below the selected acute TRV, the chronic LOAEL from a 28 day daphnid assay (0.2 mg/L using a 98% diuron product; USEPA 2003a) was divided by an uncertainty factor of 3 to estimate a chronic NOAEL TRV of 0.067 mg a.i./L.

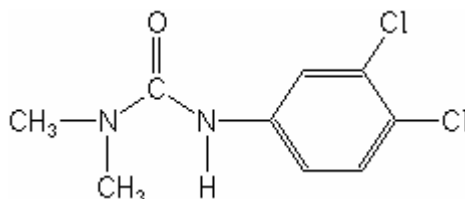
3.1.4 Aquatic Plants

Standard toxicity tests were conducted on aquatic plants, including aquatic macrophytes, algae, and diatoms. Diuron was most toxic to green algae. In studies with green algae, adverse effects to 50 percent of the algae were observed at concentrations of 0.0013 mg/L (reduced growth; Ma et al. 2001). The no observed adverse effect concentrations ranged from 0.00044 mg/L using a 96.8% diuron product to 0.01 mg/L using a 95% diuron product (USEPA 2003a, MRID 42218401; Schafer et al. 1994).

The EC₅₀ (0.0013 mg/L) was selected as the aquatic plant acute TRV and the NOAEL (0.00044 mg/L) was selected as the chronic TRV.

3.2 Herbicide Physical-Chemical Properties

The chemical formula for diuron is 3-(3,4-dichlorophenyl)-1,1-dimethylurea. The chemical structure of diuron is shown below:



Diuron Chemical Structure

The physical-chemical properties and degradation rates critical to diuron's environmental fate are listed in Table 3-2 which presents the range of values encountered in the literature for these parameters. To complete Table 3-2, available USEPA literature on diuron 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:

- The British Crop Protection Council and the Royal Society of Chemistry. 1994. The Pesticide Manual Incorporating the Agrochemicals Handbook. Tenth Edition. 1994. 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). A toxicology data file on the National Library of Medicines Toxicology Data Network (TOXNET). Available at: <http://toxnet.nlm.nih.gov>.
- Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. Springer-Verlag, New York.
- Howard, P (ed.). 1991. Handbook of Physical Properties of Organic Chemicals. CRC Lewis Publishers. Boca Raton. Florida.
- 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.

The half-life in pond water was estimated using the physical-chemical properties listed in Table 3-2 and the information reviewed concerning the environmental fate of diuron in aquatic systems. Values for foliar half-life and foliar washoff fraction were obtained from a database included in the GLEAMS computer model (United States

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 Table 3-2.

3.3 Herbicide Environmental Fate

Diuron is a persistent chemical in the environment (Howard 1991; USEPA 2001a). In terrestrial systems, biodegradation appears to be the primary loss mechanism (USEPA 2001a; Table 3-2). Biodegradation occurs faster in aerobic soils (half-life 372 days) than under anaerobic soil conditions (half-life 1000 days) (USEPA 2001a). 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 affinity for organic carbon, an important constituent of soil particles. Therefore, the higher the K_{oc} , the less mobile the chemical. The estimated mobility range of diuron is wide, with K_{oc} values ranging from 15 to 1666; although, most K_{oc} values were greater than 100. The wide range of K_{oc} values indicates that, under a variety of conditions, diuron could have very high to low mobility in soils (Swann et al. 1983; Table 3-2). Diuron is stable to hydrolysis, and based on its Henry's Law constant (the ratio of the chemical's distribution at equilibrium between the gas and liquid phases), it is unlikely to volatilize from wet soils (Lyman et al. 1990; Mackay et al. 1997; USEPA 2001a). Field half-lives reported for diuron range from 73 to over 330 days (Table 3-2).

In aquatic systems, biodegradation and photodegradation appear to be the primary loss mechanisms for diuron. An aquatic biodegradation half-life of 33 days has been reported for aerobic systems, and an aquatic half-life of 5 days has been reported for anaerobic systems (USEPA 2001a). An aquatic photodegradation half-life of 43 days has been estimated from laboratory experiments (USEPA 2001a). As in terrestrial systems, diuron is stable to hydrolysis, and based on the Henry's Law constant, it is also unlikely to volatilize from aquatic systems (USEPA 2001a; Mackay et al. 1997; Lyman et al. 1990). Based on reported BCFs of <1 to 74, diuron has a low to moderate tendency to bioaccumulate in aquatic organisms (Franke et al. 1994; Mackay et al. 1997; HSDB 2003). Aquatic dissipation half-lives have been reported ranging from 3 to 10 days in anaerobic pond sediment to 177 days in a drainage ditch (Table 3-2).

TABLE 3-1
Selected Toxicity Reference Values for Diuron

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
RECEPTORS INCLUDED IN FOOD WEB MODEL						
Terrestrial Animals						
Honeybee	145.03	µg/bee	48 h	LD ₅₀		technical grade; no % a.i. listed
Large bird	865	mg/kg bw	8 d	LD ₅₀	mallard	no % a.i. listed
Large bird	58	mg/kg bw-day	8 d	NOAEL	mallard	no % a.i. listed; extrapolated from LD ₅₀
Large mammal	1017	mg a.i./kg bw	NR	LD ₅₀	rat	small mammal value
Large mammal	0.6	mg a.i./kg bw-day	2 y	NOAEL	dog	
Piscivorous bird	58	mg/kg bw-day	8 d	NOAEL	mallard	no % a.i. listed; extrapolated from LD ₅₀
Small bird	5225	mg/kg bw	8 d	LD ₅₀	bobwhite quail	no % a.i. listed
Small bird	348	mg/kg bw-day	8 d	NOAEL	bobwhite quail	no % a.i. listed; extrapolated from LD ₅₀
Small mammal	2.5	mg a.i./kg bw-day	3 m	NOAEL	rat	
Small mammal - dermal	> 2500	mg a.i./kg bw	> 14 d	LD ₅₀	unknown	
Small mammal - ingestion	1017	mg a.i./kg bw	NR	LD ₅₀	rat	water exposure; no diet available
Terrestrial Plants						
Typical species - direct spray, drift, dust	0.08	lb a.i./ac	NR	EC ₂₅	tomato	based on seed emergence
RTE species - direct spray, drift, dust	0.001	lb a.i./ac	21 d	NOAEL		vigor
Typical species – runoff	12	lb a.i./ac	14 d	NOAEL	garden pea; soybean	based on seed emergence
RTE species - runoff	0.047	lb a.i./ac	NR	NOAEL	tomato	based on seed emergence
Aquatic Species						
Aquatic invertebrates	0.16	mg/L	96 h	EC ₅₀	scud (<i>Gammarus</i>)	95% a.i. product
Fish	0.71	mg/L	96 h	LC ₅₀	cutthroat trout	95% a.i. product
Aquatic plants and algae	0.0013	mg/L	NR	EC ₅₀	<i>Chlorella pyrenoidosa</i> (algae)	no % a.i. listed
Aquatic invertebrates	0.067	mg/L	28 d	NOAEL	daphnid	98% a.i. product; extrapolated from chronic LOAEL
Fish	0.033	mg/L	chronic	NOAEL	fathead minnow	98.6% a.i. product
Aquatic plants and algae	0.00044	mg/L	96 h	NOAEL	<i>Selenastrum</i> (algae)	98.6% a.i. product

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

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	12.7	mg/L	21 d	LC ₅₀	bullfrog	99.8% a.i. product
Amphibian	7.6	mg/L	21 d	NOAEL	bullfrog	99.8% a.i. product
Warmwater fish	2.8	mg/L	96 h	LC ₅₀	bluegill sunfish	95% a.i. product
Warmwater fish	0.03	mg/L	chronic	NOAEL	fathead minnow	98.6% a.i. product
Coldwater fish	0.71	mg/L	96 h	LC ₅₀	cutthroat trout	95% a.i. product
Coldwater fish	0.24	mg/L	96 h	NOAEL	cutthroat trout	95% a.i. product; extrapolated from LC50
Notes: Toxicity endpoints for terrestrial animals LD₅₀ - 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. EC₀₅ 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 LC₅₀ or EC₅₀ - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC₅₀). NOAEL - to address chronic exposure. Value for fish is the lower of the warmwater and coldwater values.						

Units represent those presented in the reviewed study.

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

TABLE 3-2
Physical-Chemical Properties of Diuron

Parameter	Value
Herbicide family	Phenylurea herbicide (Compendium of Pesticide Common Names 2003).
Mode of action	Disrupts plant photosynthesis (USEPA 2001a).
Chemical Abstract Service number	330-54-1 (USEPA 2001b).
Office of Pesticide Programs chemical code	035505 (DPR 2003).
Chemical class	Phenylurea herbicide (Compendium of Pesticide Common Names 2003).
Chemical name	3-(3,4-dichlorophenyl)-1,1-dimethylurea (International Union of Pure and Applied Chemistry [IUPAC]; Tomlin 1994).
Empirical formula	C ₉ H ₁₀ Cl ₂ N ₂ O (USEPA 2001b).
Molecular weight (MW)	233.1 (USEPA 2001b).
Appearance, ambient conditions	White crystal (USEPA 2001b).
Acid / Base properties	-1 to -2 (pKa) (Mackay et al. 1997).
Vapor pressure (millimeters of mercury [mmHg] at 25°C)	2 x 10 ⁻⁷ (30°C) (USEPA 2001b; Montgomery 1997); 6.9 x 10 ⁻⁷ (Mackay et al. 1997); 6.9 x 10 ⁻⁸ (HSDB 2003; Hornsby et al. 1996); 2.7 x 10 ⁻⁶ (Howard 1991); 8.2 x 10 ⁻⁹ (Tomlin 1994).
Water solubility (mg/L at 25°C)	42 (USEPA 2001b; Tomlin 1994; Hornsby et al. 1996); 40.0 (Mackay et al. 1997; Montgomery 1997); 36.4 (HSDB 2003); 37.3 (Howard 1991).
Log Octanol-water partition coefficient (log K _{OW} , unitless)	2.68 (USEPA 2001b); 2.78 (Mackay et al. 1997); 2.84 (Tomlin 1994); 2.58 (Montgomery 1997).
Henry's law constant (atm-m ³ /mole)	6.74 x 10 ⁻⁹ (Mackay et al. 1997).
Soil / Organic matter sorption coefficient (K _d / K _{oc}) ⁽¹⁾	Chino loam (1.4% organic matter): 14 (K _d -Freundlich) 1666 (K _{oc}), Barclay silty clay loam: 7.9 (K _d -Freundlich) 468 (K _{oc}), Keyport silt loam (7.7% organic matter): 28 (K _d -Freundlich) 626 (K _{oc}) (USEPA 2001a); All values log(K _{oc}) unless specified: 2.6, 2.59 (three soil average), 2.15-2.52, 1.97 (log(K _{om})), 2.58 (average 84 soils), 2.18, 2.83 (Webster soil), 2.49, 2.35, 2.57 (two OK subsurface soils), 2.94 (mucky peat), 2.68 (loam sand), 2.18, 2.48-2.49, 2.59 , 2.66, 2.68, 2.21-2.87 (Mackay et al. 1997); All K _{oc} values: 68-266 (range for aquifer sediments), 383 (average for 84 soils, standard deviation 38), 682 (Webster soil); 879 (mucky peat soil), 478 (loamy sand soil), 224 and 371 (two OK subsurface soils), 480 (HSDB 2003); 480 (K _{oc}) (Hornsby et al. 1996); 2.21-2.87 (log(K _{oc})) (Montgomery 1997); 93 K _{oc} values from various studies, K _{oc} range: 15 - 1377, average: 399 (log K _{oc} = 2.60), standard deviation: 278 (Montgomery 1997).
Bioconcentration factor (BCF)	2.16 (log(BCF), <i>Pimephales promelas</i>), 1.40 (log(BCF), species not specified) (Mackay et al. 1997); BCF values of 3.4 - 4.9 (0.5 mg diuron/L) and < 3 - 74 (0.05 mg diuron/L) were obtained from carp (<i>Cyprinus carpio</i>) after six week exposure (HSDB 2003).
Field dissipation half-life	Diuron (12 lb a.i./ac) applied once to bare ground plots in FL, MS, and CA with sand, silt loam, and silty clay loam soils, respectively. Half-lives were 73, 139, and 133 days respectively. (USEPA 2001a); 328 days, 90 days (Mackay et al. 1997; Hornsby et al. 1996). At higher application levels, diuron persisted in WY soils, under various irrigation methods, for over 15 months; mean half-life of approximately 330 days and will not leach below 5 to 10 centimeters (cm) from the surface; mean half-life 328 days with a standard deviation of 212 days (HSDB 2003).
Soil dissipation half-life ⁽²⁾	7.0 months (15°C), 5.5 months (30°C), Adkins loamy sand: 705 days (25°C), 414 days (30°C), 225 days (35°C); Seminahoo mucky peat: 3991 days (25°C), 2164 days (30°C), 1165 days (35°C). (Mackay et al. 1997).

TABLE 3-2 (Cont.)
Physical-Chemical Properties of Diuron

Parameter	Value
Aquatic dissipation half-life	Diuron applied (12 lb a.i./ac) once onto bare ground berm and slope of a channel plot of clay soil in CA and into a drainage ditch of silt loam soil in AK dissipated with half-lives of 177 days and 115 days, respectively. In CA study, calculated sediment half-life, 18.6 hours (USEPA 2001a; USEPA 2003b). In a fish pond, 90% of diuron in sediment was lost in 8 months (Howard 1991). Aerobic, organic rich pond sediment, degraded 90% of applied diuron (40 µg/ml) in 55 (25°C) and 17 (30°C) days (Montgomery 1997); 3-10 days (half-life, anaerobic pond sediment, 30°C), < 17 days (half-life, pond sediment, 30°C), ~5 days for 0.22 µg/ml to degrade (anaerobic, pond sediment) (Mackay et al. 1997).
Hydrolysis half-life	Stable to hydrolysis at pH 5, 7, and 9 (25°C). Estimated half-life, > 500 days for all pH values (USEPA 2001a); > 120 days (half-life, pH 5-9, 20°C) (Mackay et al. 1997).
Photodegradation half-life in water	Estimated half-life in sunlight, 43 days, based on observed 9 day half-life under continuous exposure to Xenon light. (USEPA 2001a); 2.25 hours (half-life, distilled water, 300 nm light) (Mackay et al. 1997). From a solution of 40 mg/L diuron, 42% loss in 1 hour under sunlamps and 45% loss in 25 days in natural sunlight, 84% lost from diuron solution in 135 minutes when exposed to 300 nm sunlamps at 50°C (HSDB 2003).
Photodegradation half-life in soil	Estimated half-life, 173 days, based on degradation observed in a silt loam soil irradiated for 12 hours per day for 30 days (USEPA 2001a).
Soil biodegradation half-life	372 days⁽³⁾ (aerobic), 1,000 days (anaerobic). Both experiments at 25°C in a silt loam soil. (USEPA 2001a). Biodegradation in soil increased with increasing temperature and decreasing initial concentration; less than 20% of diuron (60 mg/kg) added to soil was detoxified within eight weeks, and pH (4.3 to 7.5) had little effect on the degradation rate (HSDB 2003).
Aquatic biodegradation half-life	33 days (aerobic half-life), 5 days (anaerobic half-life). Both experiments at 25°C in a clay loam sediment (USEPA 2001a).
Other degradation rates / half-lives	Calculated volatilization half-lives from soil, 54 days and 1918 days (Mackay et al. 1997).
Foliar half-life	30 days (USDA 1999).
Foliar wash-off fraction	0.45 (USDA 1999).
Half-life in pond ⁽⁴⁾	33 days (estimated from herbicide's environmental behavior and values in this table).
Residue Rate for grass ⁽⁵⁾	197 ppm (maximum) and 36 ppm (typical) per lb a.i./ac
Residue Rate for vegetation ⁽⁶⁾	296 ppm (maximum) and 35 ppm (typical)
Residue Rate for insects ⁽⁷⁾	350 ppm (maximum) and 45 ppm (typical)
Residue Rate for berries ⁽⁸⁾	40.7 ppm (maximum) and 5.4 ppm (typical)
Notes: Values presented in bold were used in risk assessment calculations. (1) K _{oc} value used in risk assessment calculations was value selected by Mackay et al. (1997) for use in contaminant fate models. This K _{oc} value close to median K _{oc} value of 115 K _{oc} 's reported in Hornsby et al. (1996), Mackay et al. (1997), Montgomery (1997), and USEPA (2001a). (2) 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. (3) Value used for soil half-life in risk assessment calculations. (4) Used in risk assessments to calculate aqueous herbicide concentration in pond water that receives herbicide-laden runoff. (5) Residue rates selected are the high and mean values for long grass (Fletcher et al. 1994). (6) Residue rates selected are the high and mean values for leaves and leafy crops (Fletcher et al. 1994). (7) Residue rates selected are the high and mean values for forage such as legumes (Fletcher et al. 1994). (8) 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 diuron. The general approach and analytical methods for conducting the diuron ERA were based on 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 2005b) 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 diuron 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 the CM.

4.1.1 Definition of Risk Assessment Objectives

The primary objective of this ERA was to evaluate the potential ecological risks from diuron 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-managed 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, diuron is used by the BLM for vegetation management in their Energy & Mineral Sites, Rights-of-Way, and Recreation programs. The proposed BLM program involves the general use and application of herbicides on public lands 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, and prairie land. 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:

- 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 BLM management areas; 2) are likely to play key roles in site ecosystems; 3) have complex life cycles; 4) represent a range of trophic levels; and 5) are surrogates for other species likely to be found on BLM-managed 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-managed lands. Diuron is a terrestrial herbicide; therefore, as discussed in detail in the Methods Document (ENSR 2005b), 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 ac pond of 1 meter [m] depth, resulting in a volume of 1,011,715 liters [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 m 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, but others required more complex computer models (e.g., 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 (Groundwater Loading Effects of Agricultural Management Systems) computer model was used to estimate off-site transport of herbicide in surface runoff and root-zone groundwater. GLEAMS 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 (km) 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 diuron. The selection process is discussed in detail in Methods Document (ENSR 2005b), and the selected endpoints are presented below (impacts to RTE species are discussed in more detail in Section 6.0).

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

- **Measures of Effect** included median lethal dose and median lethal concentrations (e.g., LD₅₀ and LC₅₀) from acute toxicity tests on target organisms or suitable surrogates. To add conservatism to the RTE assessment, lowest available germination NOAELs were used to evaluate non-target RTE terrestrial plants, and LOC for RTE terrestrial animals were lower than for typical species (see Table 4-1).

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

- **Measures of Effect** included median lethal concentrations and median effective concentrations (e.g., LC₅₀ and EC₅₀) from acute toxicity tests on target organisms or suitable surrogates (e.g., data from other coldwater fish to represent threatened and endangered salmonids). As with terrestrial species, lowest available germination NOAELs were used to evaluate non-target RTE aquatic plants, and LOC for RTE fish and aquatic invertebrates were lower than for typical aquatic species (see Table 4-1).

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. Chronic risks to RTE fish and aquatic invertebrates were evaluated using lower LOCs than for typical species. Depending on data available for a given herbicide, chronic endpoints reflect either individual impacts (e.g., growth, physiological impairment, behavior) or population-level impacts (e.g., reproduction; Barnhouse 1993). For salmonids, careful attention was paid to smoltification (i.e., development of tolerance to seawater and other indications of change of parr [freshwater stage salmonids] to adulthood), thermoregulation (i.e., ability to maintain body temperature), and migratory behavior, if such data were available.

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 diuron on 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 (Available at: <http://www.epa.gov/oppfead1/endanger/effects>)

4.1.6 Development of the Conceptual Model

The diuron conceptual model (Figure 4-1) is presented as a series of working hypotheses about how diuron might pose hazards to the ecosystem and ecological receptors. The conceptual model indicates the possible exposure pathways for the herbicide, as well as the receptors 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 stream (i.e., aquatic plants, fish, 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 herbicide using standard models that predict concentrations in various environmental media (e.g., GLEAMS). All EECs predicted by the models are presented in Appendix B. The ecological effects characterization consisted of compiling exposure-response relationships from all available toxicity studies on 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., vehicle, ATV-mounted, backpack/horseback sprayer). In order to assess the potential ecological impacts of these herbicide uses, a variety of exposure scenarios were considered. These scenarios, which were selected based on actual BLM herbicide usage under a variety of conditions, are described in Section 4.1.3.

When considering the exposure scenarios and the associated predicted concentrations, it is important to recall 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 the 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 diuron: terrestrial animals, terrestrial plants, and aquatic species. A set of generic terrestrial animal receptors, listed below, were selected to cover a variety of species and feeding guilds that might be found on BLM-managed lands. Unless otherwise noted, receptor BWs were selected from the *Wildlife Exposure Factors Handbook* (USEPA 1993a). This list includes surrogate species, although not all of these surrogate species will be present within each 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 (*Odocoileus 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 1968²).

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. The tomato, garden pea (*Pisum sativum*), and soybean (*Glycine max*) were the surrogate species chosen to represent typical terrestrial plants, and the tomato was used as the surrogate for RTE terrestrial plants (toxicity data are only available for vegetable crop species). According to the herbicide label, diuron products are approved for the control of annual and perennial grasses and herbaceous weeds. However, it is possible that noncropland plants and grasses are not as sensitive to diuron as the selected broadleaf 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 (*Oncorhynchus mykiss*) and bluegill sunfish (*Lepomis*

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

macrochirus) were surrogates for fish, the water flea was a surrogate for aquatic invertebrates, and non-target aquatic plants and algae were represented by duckweed.

Section 3.0 of the Methods Document (ENSR 2005b) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for diuron.

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 a 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 and 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 diuron; diuron 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 height of the spray boom, the greater the off-site 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. 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. 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 by wind erosion of the surface soil was modeled using CALPUFF software. Five distinct watersheds were evaluated to determine herbicide concentrations in dust deposited on plants after a wind event, with dust deposition estimates calculated 1.5 to 100 km from the application area.

4.2.1.5 Accidental Spill to Pond

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

4.2.2 Effects Characterization

The ecological effects characterization phase entailed a compilation and analysis of the stressor-response relationships and any other evidence of adverse impacts from exposure to diuron. For the most part, available data consisted of toxicity studies conducted in support of USEPA pesticide registration described in Section 3.1. TRVs selected for use in the ERA are presented in Table 3-1. Appendix A presents the full set of toxicity information identified for diuron.

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 RQs were then compared to LOC 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 (i.e., rainfall, slope) and receptor assumptions (i.e., 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 and 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 EC₂₅ 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 is 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 (i.e., risk analysis), and provides comprehensive 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. 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 90th or 10th 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 above scenarios. Figures 4-3 to 4-7 present graphic representations of the range of RQs and associated LOCs.

4.3.1.1 Terrestrial Wildlife

In general, most acute RQs for terrestrial wildlife (Figure 4-3) were below the most conservative LOC of 0.1 (acute endangered species). However, direct spray of the pollinating insect resulted in elevated RQs at both the typical and maximum application rates. In addition, at the maximum application rate, risk was also predicted for the pollinating insect from indirect contact with foliage impacted by direct spray. These are highly conservative scenarios assuming that the insect absorbs 100% of the herbicide after application with no herbicide degradation or limitations to uptake by the insect. Therefore, these scenarios may overestimate risk to the insect.

RQs for acute ingestion scenarios were below the most conservative LOC (0.1; acute risk endangered species) when herbicide is applied at the typical application rate, but above the LOC in all cases at the maximum application rate. RQs for chronic ingestion scenarios were above the associated LOC of 1.0 for three receptors (the small and large mammalian herbivores and the large mammalian carnivore) when herbicide is applied at the typical application rate. At the maximum application rate, elevated RQs were predicted for all evaluated scenarios.

This evaluation indicates that direct spray impacts may pose a risk to insects, birds, and mammals, primarily when the maximum application rate is used.

4.3.1.2 Non-target Plants – Terrestrial and Aquatic

RQs for non-target terrestrial plants (Figure 4-4) ranged from 75 to 20,000, and RQs for non-target aquatic plants (Figure 4-5) ranged from 517 to 25,474 (Table 4-2). All of the RQs were above the plant LOC of 1.0, indicating that direct spray impacts may pose a risk to plants in both aquatic and terrestrial environments, which was expected because of the mode of action of herbicides. It may be noted that the 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.

4.3.1.3 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figure 4-6 and 4-7) in the pond and stream were above the most conservative LOC of 0.05 (acute endangered species), indicating that direct spray impacts may pose a risk to these aquatic species.

Chronic toxicity RQs were also above the LOC for chronic risk (1.0), indicating that direct spray impacts may pose a risk to these aquatic species. It may be noted that these accidental spray scenarios are conservative because they do not consider flow, adsorption to particles, or degradation that may occur over time. The herbicide concentration in the pond and stream are the instantaneous concentrations 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. There was no dilution due to degradation or stream flow. In addition, it is assumed that the pond and stream are adjacent to the herbicide application area.

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 diuron 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: off-site drift to soils, off-site drift to ponds, off-site drift to streams, 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

Many of the RQs for non-target terrestrial plants affected by off-site drift to off-site soils (Figure 4-8) were above the plant LOC of 1.0. For typical terrestrial plant species, elevated RQs were predicted at the typical application rate 25 ft from application with a high boom and at the maximum application rate within 100 ft from application with a low or high boom. Elevated RQs were predicted for RTE terrestrial plant species under all off-site drift scenarios. These results indicate that terrestrial plants, particularly RTE species, located near applications areas may be impacted by herbicide drift.

The majority of the RQs for non-target aquatic plants affected by off-site drift (Figure 4-9) were above the plant LOC of 1.0. The only scenario that did not consistently predict elevated RQs was off-site drift 900 ft from the application area. More elevated RQs were predicted with application using the high boom than using the low boom. These results indicate that off-site drift may impact aquatic plants in waterbodies adjacent to application areas. It may be noted that the aquatic scenarios are particularly conservative because they do not consider flow, adsorption to particles, or degradation of the herbicide over time.

4.3.2.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish (Figure 4-10) were below the most conservative LOC of 0.05 (acute endangered species) for all scenarios except one (off-site drift to the stream 25 ft from the maximum application with a high boom). Acute toxicity RQs for aquatic invertebrates (Figure 4-11) were generally also below the most conservative LOC of 0.05 (acute endangered species). However, off-site drift to the pond and stream within 25 ft of a low boom application or within 100 ft of a high boom application at the maximum application rate predicted elevated RQs for aquatic invertebrates. Off-site drift within 25 ft of a high boom application at the typical application rate also predicted a slightly elevated RQ (0.077) in the stream. These results indicate the potential for acute risk to fish and invertebrates due to off-site drift under selected application conditions.

Most chronic RQs were well below the LOC for chronic risk to endangered species (0.5). However, application at the maximum application rate resulted in elevated RQs for one aquatic invertebrate scenario (in the stream 25 ft from the high boom application) and three fish scenarios (in the pond 25 ft from the high boom application and in the stream 25 ft from the low and high boom applications). For fish, the only the scenario with an RQ above the chronic LOC of 1.0 was for the stream 25 ft from application at the maximum rate with a high boom. These results indicate minimal potential for chronic risk, except within 25 ft of the application area at the maximum application rate.

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 piscivorous birds (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 GLEAMS simulations were performed with different combinations of GLEAMS variables (i.e., soil type, soil erodability factor, annual precipitation, size of application area, hydraulic slope, surface roughness, and vegetation type) to account for a wide range of possible watersheds encountered on BLM-managed lands. In 24 simulations, soil type and precipitation values were altered, while the rest of the variables were held constant in a “base watershed” condition. In the remaining 18 simulations, precipitation was held constant, while the other six variables (each with three levels) were altered.

Table 4-4 presents the RQs for the following scenarios: surface runoff to off-site soils, overland flow (runoff) to off-site ponds, overland flow to off-site streams, and consumption of fish from contaminated ponds. 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, these conditions 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 (Table 4-4) were all below the plant LOC of 1.0 (Figure 4-13), 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 1.0. However,

several scenarios did result in elevated RQs. At the typical application rate, RQs for the base watershed with clay soils and between 100 and 250 inches of rain per year (250 inches per year was the maximum rainfall modeled) ranged from 1.0 to 2.85. At the maximum application rate, RQs were elevated above 1.0 for the base watershed with clay soils and at least 50 inches of rain per year, for the base watershed with loam soils and at least 200 inches of rain per year, and for the base watershed with clay loam soil and 50 inches of rain per year (no other rainfall amounts were modeled for this scenario). This indicates the potential for risk to RTE plant species in certain watersheds (with precipitation greater than 50 inches) at the typical or maximum application rates (these scenarios are unlikely on many BLM lands because of arid and semi-arid conditions).

Acute and chronic RQs for non-target aquatic plants impacted by overland flow of herbicide (Figure 4-14) exceeded the plant LOC for nearly all pond scenarios modeled at both the typical and maximum application rates.

Acute RQs for non-target aquatic plants in the stream were also generally above the plant LOC of 1.0, indicating that this transport mechanism may pose a risk to aquatic plant species in the stream. At the typical application rate, elevated RQs occurred in 35 of the 42 scenarios. At the maximum application rate, elevated RQs occurred in 37 of the 42 scenarios. These results indicate the high potential for acute impacts to aquatic plants in the stream.

Chronic RQs in the stream at the typical application rate were generally below the plant LOC, except in the base watershed with sandy soils and precipitation of more than 25 inches per year, in the base watershed with clay or loam soils and precipitation of more than 100 inches per year, and in the 100 and 1,000 ac application areas.

Most chronic stream RQs were above the plant LOC when the maximum application rate was considered. The only scenarios below this LOC were the base application watershed with sandy soils and less than 10 inches of rain per year, the base application watershed with clay or loam soil and less than 25 inches of rain per year, the 1 ac application area, and the base watershed with silt soil and 50 inches of rain per year. These results indicate the potential for chronic impacts to aquatic plants in the stream under most conditions at the maximum application rate.

4.3.3.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figure 4-15 and Figures 4-16) were above the most conservative LOC of 0.05 (acute endangered species) for nearly all pond scenarios. At the typical application rate, RQs were elevated above 0.05 for fish in 35 of 42 scenarios, and for aquatic invertebrates in 36 of 42 scenarios. At the maximum application rate, this increased to 36 and 38 of 42 scenarios for fish and aquatic invertebrates, respectively. Acute RQs for aquatic invertebrates in the stream were greater than the LOC of 0.05 for most scenarios at the maximum application rate (35 of 42 scenarios) and for high precipitation scenarios at the typical application rate (18 of 42 scenarios). Acute RQs for fish in the stream were greater than the LOC for high precipitation scenarios at the maximum application rate (16 of 42 scenarios) and for high precipitation scenarios in clay soils at the typical application rate (3 of 42 scenarios). This suggests that diuron poses substantial acute risks to aquatic animals in ponds and limited acute risks to aquatic stream animals (i.e., at the maximum application rate and in wet watersheds).

Chronic toxicity RQs in the stream 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 fish or aquatic invertebrates. However, chronic RQs for fish and aquatic invertebrates were elevated above this LOC in several pond scenarios. At the maximum application rate, RQs were elevated above 0.5 for fish in 36 of 42 scenarios, and for aquatic invertebrates in 33 of 42 scenarios. At the typical application rate, RQs were elevated above 0.5 for fish in 30 of 42 scenarios, and for aquatic invertebrates in 10 of 42 scenarios. At the typical application rate, only 10 of the fish RQs and 3 of the aquatic invertebrate RQs were above the chronic LOC of 1 for typical species, indicating significantly less risk to non-RTE species. These results indicate the potential for risk to fish and aquatic invertebrates in the pond, especially RTE species, as a result of surface runoff.

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 Tucson, 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 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 three 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 in which a truck spills an entire load (200 gal spill) of herbicide mixed for the maximum application rate into the 1/4 ac, 1 m deep pond. The herbicide concentration in the pond was the instantaneous concentration at the moment of the 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 101 for fish, 448 for aquatic invertebrates (Figure 4-6 and 4-7) and 55,180 for non-target aquatic plants (Figure 4-5). Therefore, there is the potential for risk to fish, aquatic invertebrates, and non-target aquatic plants under the scenario of a truck spill with diuron mixed for the maximum application rate. However, this scenario is highly conservative and represents unlikely and worst case conditions (limited waterbody volume, tank mixed for maximum application rate before transport to site).

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 diuron to salmonids via effects to their food and habitat; therefore, only qualitative estimates of indirect effects are possible. These estimates were accomplished by evaluating predicted impacts to prey items and vegetative cover in the stream scenarios discussed 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. Food 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. Salmonids were included in the derivation of the fish TRVs. The selected acute fish TRV was based on a study with the cutthroat trout (*Oncorhynchus clarki*). The chronic TRV was based on a warmwater fish. This indicates that chronic direct impacts to salmonids may be overestimated in the ERA. Aquatic invertebrates were also evaluated directly using acute and chronic TRVs based on the most sensitive aquatic invertebrate species. Direct impacts on prey items (i.e., mortality to fish and aquatic invertebrates due to herbicide exposure) may result in indirect impacts on the salmonid population.

RQs in excess of the acute and chronic LOCs for fish and aquatic invertebrates were observed for the accidental direct spray scenario. However, this is an extremely conservative scenario that is unlikely to occur as a result of BLM practices, and therefore, it represents a worst-case scenario. In addition, stream flow would be likely to dilute the herbicide concentration and reduce potential impacts, but possible reductions in herbicide concentration as a result of stream flow were not evaluated in this scenario.

The off-site drift scenarios predicted elevated RQs for fish and aquatic invertebrates (mostly RTE species) under selected conditions, primarily within 25 ft of the application area. Additional risk to aquatic invertebrates is predicted within 100 ft of a high boom application at the maximum rate. Most chronic RQs for fish and aquatic invertebrates in the stream impacted by surface runoff were below the associated LOCs. The exceptions were impacts to fish or aquatic invertebrates within 25 ft of an application at the maximum rate. Acute RQs for these surface runoff scenarios were elevated above the most conservative LOC for several scenarios; most significantly for aquatic invertebrates at the maximum application rate.

Because fish and aquatic invertebrates may be directly impacted by herbicide concentrations in the stream as a result of normal applications, their availability as prey item populations may be impacted, and there may be an indirect effect on salmonids. These impacts may be minimized through the use of increased buffer zones and reduced application rates near streams.

4.3.6.2 Qualitative Evaluation of Impacts to Vegetative Cover

A qualitative evaluation of indirect impacts to salmonids due to destruction of riparian vegetation and reduction of available cover was made by considering impacts to terrestrial and aquatic plants. 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 practices and represents a worst-case scenario. In addition, no reduction in herbicide concentration is calculated due to stream flow in this scenario. However, there is the potential for indirect impacts to salmonids due to a reduction in available cover if the stream is accidentally sprayed.

Elevated aquatic plant RQs were also observed in the stream scenarios as a result of off-site drift of the ground application of the herbicide more than 100 and less than 900 ft from the stream, indicating the potential for a reduction in cover, most significantly at the maximum application rate (chronic risk to aquatic plants are also predicted with greater than a 900-foot buffer at the maximum application rate). Elevated RQs were also predicted for many of the surface runoff scenarios. These results indicate there is the potential for indirect impacts to salmonids due to reduction in available cover due to off-site drift and surface runoff of the applied herbicide.

Terrestrial plants were evaluated for their potential to provide overhanging cover for salmonids. A reduction in the riparian cover has the potential to indirectly impact salmonids within the stream. RQs for typical and RTE 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.

RQs for typical terrestrial plants were also observed above the plant LOC (ranging from 1.11 to 5.19) as a result of off-site drift from the ground application of the herbicide. At the typical application rate, risk was predicted at least 25 ft and less than 100 ft from the application area, and at the maximum application rate, risk was predicted at least 100 ft and less than 900 ft from the application area. Elevated RQs for RTE species were also observed for all modeled application scenarios. These results indicate the potential for a reduction in riparian cover and indirect effects to salmonids due to off-site drift under selected conditions.

No RQs in excess of the LOC were observed for typical terrestrial plant species for any of the surface runoff scenarios. Elevated RQs were predicted for RTE terrestrial plant species under selected surface runoff conditions, primarily in clay or loam soils at high precipitation levels. These results indicate the limited potential for a reduction in riparian cover due to surface runoff, primarily when RTE plant species are present.

In August 2003, the OPP evaluated the potential for diuron to impact certain Pacific anadromous salmonids (specifically Pacific salmon and steelhead) and their critical habitats in California and southern Oregon. The OPP concluded that the non-crop use of diuron has the potential to affect selected habitats. In particular, the OPP indicated the potential for acute risks to RTE fish species and the potential for indirect effects on aquatic plant cover (Turner 2003b).

4.3.6.3 Conclusions

This qualitative evaluation indicates that salmonids may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). Indirect impacts to salmonids may also occur via a reduction in vegetative cover under some conditions. Accidental direct spray, off-site drift, and surface runoff may negatively impact terrestrial and aquatic plants, reducing the cover available to salmonids within the stream. However, increasing the buffer zones around streams, reducing the application rate, reducing the size of the application area, and avoidance of accidental application on non-target 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 diuron to threatened and endangered salmonids, USEPA OPP indicated that “for most pesticides applied to terrestrial environment, the effects in water, even lentic water, will be relatively transient” (Turner 2003a). 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 2003a). Therefore, it is expected that potential adverse impacts to food and cover would not occur beyond the season of application.

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	1.56E-02	5.21E-02
Pollinating insect - 100% absorption	6.10E-01	2.03E+00
Small mammal - 1st order dermal adsorption	2.26E-03	7.52E-03
Indirect Contact With Foliage After Direct Spray		
Small mammal - 100% absorption	1.56E-03	5.21E-03
Pollinating insect - 100% absorption	6.10E-02	2.03E-01
Small mammal - 1st order dermal adsorption	2.26E-04	7.52E-04
Ingestion of Food Items Contaminated by Direct Spray		
Small mammalian herbivore - acute exposure	1.14E-02	2.86E-01
Small mammalian herbivore - chronic exposure	1.99E+00	5.01E+01
Large mammalian herbivore - acute exposure	7.32E-02	1.33E+00
Large mammalian herbivore - chronic exposure	2.12E+01	3.87E+02
Small avian insectivore - acute exposure	2.34E-02	6.07E-01
Small avian insectivore - chronic exposure	1.48E-01	3.84E+00
Large avian herbivore - acute exposure	5.96E-02	1.68E+00
Large avian herbivore - chronic exposure	3.74E-01	1.05E+01
Large mammalian carnivore - acute exposure	3.66E-02	1.22E-01
Large mammalian carnivore - chronic exposure	2.89E+00	9.63E+00

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

Terrestrial Plants	Typical Species		RTE Species	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Direct Spray of Non-Target Terrestrial Plants				
Accidental direct spray	7.50E+01	2.50E+02	6.00E+03	2.00E+04

Aquatic Species	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Accidental Direct Spray Over Pond						
Acute	9.47E-01	3.16E+00	4.20E+00	1.40E+01	5.17E+02	1.72E+03
Chronic	2.04E+01	6.79E+01	1.00E+01	3.35E+01	1.53E+03	5.09E+03
Accidental Direct Spray Over Stream						
Acute	4.74E+00	1.58E+01	2.10E+01	7.01E+01	2.59E+03	8.62E+03
Chronic	1.02E+02	3.40E+02	5.02E+01	1.67E+02	7.64E+03	2.55E+04
Accidental spill						
Truck spill into pond	--	1.01E+02	--	4.48E+02	--	5.52E+04

Shading and boldface indicates terrestrial animal acute RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative).

Shading and boldface indicates terrestrial animal chronic RQs greater than 1 (LOC for chronic risk). 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).

RTE – Rare, threatened, and endangered.

-- indicates the scenario was not evaluated

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	9.43E-01	3.14E+00	7.54E+01	2.51E+02
Ground	Low Boom	100	3.33E-01	1.11E+00	2.66E+01	8.87E+01
Ground	Low Boom	900	5.13E-02	1.70E-01	4.10E+00	1.36E+01
Ground	High Boom	25	1.56E+00	5.19E+00	1.25E+02	4.15E+02
Ground	High Boom	100	5.24E-01	1.75E+00	4.19E+01	1.40E+02
Ground	High Boom	900	6.50E-02	2.19E-01	5.20E+00	1.75E+01

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 Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Pond								
Acute Toxicity								
Ground	Low Boom	25	5.76E-03	1.92E-02	2.56E-02	8.50E-02	3.15E+00	1.05E+01
Ground	Low Boom	100	3.15E-03	1.05E-02	1.40E-02	4.68E-02	1.72E+00	5.75E+00
Ground	Low Boom	900	6.10E-04	2.03E-03	2.71E-03	9.00E-03	3.33E-01	1.11E+00
Ground	High Boom	25	9.25E-03	3.08E-02	4.11E-02	1.37E-01	5.05E+00	1.68E+01
Ground	High Boom	100	4.87E-03	1.62E-02	2.16E-02	7.19E-02	2.66E+00	8.85E+00
Ground	High Boom	900	7.73E-04	2.58E-03	3.43E-03	1.14E-02	4.22E-01	1.41E+00

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 Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Pond								
Chronic Toxicity								
Ground	Low Boom	25	1.24E-01	4.12E-01	6.10E-02	2.03E-01	9.30E+00	3.09E+01
Ground	Low Boom	100	6.79E-02	2.27E-01	3.34E-02	1.12E-01	5.09E+00	1.70E+01
Ground	Low Boom	900	1.31E-02	4.36E-02	6.46E-03	2.15E-02	9.84E-01	3.27E+00
Ground	High Boom	25	1.99E-01	6.64E-01	9.81E-02	3.27E-01	1.49E+01	4.98E+01
Ground	High Boom	100	1.05E-01	3.48E-01	5.16E-02	1.72E-01	7.86E+00	2.61E+01
Ground	High Boom	900	1.66E-02	5.55E-02	8.19E-03	2.73E-02	1.25E+00	4.16E+00

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 Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Stream								
Acute Toxicity								
Ground	Low Boom	25	1.04E-02	3.46E-02	4.60E-02	1.53E-01	5.66E+00	1.89E+01
Ground	Low Boom	100	3.04E-03	1.01E-02	1.35E-02	4.49E-02	1.66E+00	5.53E+00
Ground	Low Boom	900	3.15E-04	1.05E-03	1.40E-03	4.65E-03	1.72E-01	5.72E-01
Ground	High Boom	25	1.73E-02	5.79E-02	7.69E-02	2.57E-01	9.47E+00	3.16E+01
Ground	High Boom	100	4.92E-03	1.64E-02	2.18E-02	7.27E-02	2.69E+00	8.95E+00
Ground	High Boom	900	4.16E-04	1.39E-03	1.84E-03	6.15E-03	2.27E-01	7.57E-01

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 Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Stream								
Chronic Toxicity								
Ground	Low Boom	25	2.23E-01	7.43E-01	1.10E-01	3.66E-01	1.67E+01	5.58E+01
Ground	Low Boom	100	6.53E-02	2.18E-01	3.22E-02	1.07E-01	4.90E+00	1.63E+01
Ground	Low Boom	900	6.77E-03	2.25E-02	3.34E-03	1.11E-02	5.08E-01	1.69E+00
Ground	High Boom	25	3.73E-01	1.25E+00	1.84E-01	6.13E-01	2.80E+01	9.34E+01
Ground	High Boom	100	1.06E-01	3.53E-01	5.21E-02	1.74E-01	7.93E+00	2.64E+01
Ground	High Boom	900	8.94E-03	2.98E-02	4.40E-03	1.47E-02	6.71E-01	2.24E+00

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)	Typical Application Rate	Maximum Application Rate
Ground	Low Boom	25	4.13E-04	1.37E-03
Ground	Low Boom	100	2.26E-04	7.54E-04
Ground	Low Boom	900	4.37E-05	1.45E-04
Ground	High Boom	25	6.63E-04	2.21E-03
Ground	High Boom	100	3.49E-04	1.16E-03
Ground	High Boom	900	5.54E-05	1.85E-04
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 RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative). Shading and boldface indicates terrestrial animal chronic RQs greater than 1 (LOC for chronic risk). RTE – Rare, threatened, and endangered.				

TABLE 4-4
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Non-Target Terrestrial Plants										
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Typical Species		RTE Species	
							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	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Clay	3.45E-04	1.15E-03	8.81E-02	2.94E-01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.31E-06	1.10E-05	8.44E-04	2.81E-03
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.89E-09	1.30E-08	9.92E-07	3.31E-06
25	10	0.05	0.015	0.401	Weeds (78)	Clay	6.63E-04	2.21E-03	1.69E-01	5.64E-01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	4.88E-05	1.63E-04	1.24E-02	4.15E-02
50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.15E-09	3.82E-09	2.93E-07	9.76E-07
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.54E-03	5.14E-03	3.94E-01	1.31E+00
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.29E-04	4.30E-04	3.29E-02	1.10E-01
100	10	0.05	0.015	0.401	Weeds (78)	Sand	3.78E-07	1.26E-06	9.66E-05	3.22E-04
100	10	0.05	0.015	0.401	Weeds (78)	Clay	3.93E-03	1.31E-02	1.00E+00	3.35E+00
100	10	0.05	0.015	0.401	Weeds (78)	Loam	3.88E-04	1.29E-03	9.91E-02	3.30E-01
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.28E-07	4.27E-07	3.27E-05	1.09E-04
150	10	0.05	0.015	0.401	Weeds (78)	Clay	5.13E-03	1.71E-02	1.31E+00	4.36E+00
150	10	0.05	0.015	0.401	Weeds (78)	Loam	8.16E-04	2.72E-03	2.08E-01	6.94E-01
200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.14E-06	1.38E-05	1.06E-03	3.52E-03
200	10	0.05	0.015	0.401	Weeds (78)	Clay	8.23E-03	2.74E-02	2.10E+00	7.01E+00
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.48E-03	4.95E-03	3.79E-01	1.26E+00

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

Potential Risk to Non-Target Terrestrial Plants										
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Typical Species		RTE Species	
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Soils (Cont.)										
250	10	0.05	0.015	0.401	Weeds (78)	Sand	4.63E-06	1.54E-05	1.18E-03	3.94E-03
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.11E-02	3.71E-02	2.85E+00	9.48E+00
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.12E-03	7.07E-03	5.41E-01	1.80E+00
50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-04	3.93E-04	3.01E-02	1.00E-01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-04	3.93E-04	3.01E-02	1.00E-01
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.17E-04	3.91E-04	3.00E-02	9.98E-02
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.16E-04	3.86E-04	2.96E-02	9.85E-02
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.19E-04	3.98E-04	3.05E-02	1.02E-01
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.27E-04	4.22E-04	3.23E-02	1.08E-01
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.18E-04	3.94E-04	3.02E-02	1.01E-01
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.18E-04	3.92E-04	3.00E-02	1.00E-01
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.15E-04	3.84E-04	2.94E-02	9.81E-02
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.15E-04	3.84E-04	2.94E-02	9.81E-02
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.16E-04	3.85E-04	2.95E-02	9.84E-02
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.23E-04	4.12E-04	3.15E-02	1.05E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	7.00E-04	2.33E-03	1.79E-01	5.96E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt	6.63E-04	2.21E-03	1.69E-01	5.64E-01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.29E-03	4.29E-03	3.29E-01	1.10E+00
50	10	0.05	0.015	0.401	Shrubs(79)	Loam	1.18E-04	3.94E-04	3.02E-02	1.01E-01
50	10	0.05	0.015	0.401	Rye Grass(54)	Loam	1.18E-04	3.94E-04	3.02E-02	1.01E-01
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.47E-04	4.89E-04	3.75E-02	1.25E-01

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
10	10	0.05	0.015	0.401	Weeds (78)	Sand	6.38E-03	2.13E-02	2.83E-02	9.44E-02	3.48E+00	1.16E+01	
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.75E-01	5.85E-01	7.78E-01	2.59E+00	9.58E+01	3.19E+02	
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.61E-03	5.38E-03	7.16E-03	2.39E-02	8.81E-01	2.94E+00	
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.47E-01	1.16E+00	1.54E+00	5.13E+00	1.89E+02	6.31E+02	
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.40E-01	4.65E-01	6.20E-01	2.07E+00	7.62E+01	2.54E+02	
25	10	0.05	0.015	0.401	Weeds (78)	Loam	7.09E-03	2.36E-02	3.15E-02	1.05E-01	3.87E+00	1.29E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.83E-01	9.43E-01	1.26E+00	4.18E+00	1.54E+02	5.15E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Clay	6.43E-01	2.14E+00	2.85E+00	9.51E+00	3.51E+02	1.17E+03	
50	10	0.05	0.015	0.401	Weeds (78)	Loam	7.42E-02	2.47E-01	3.29E-01	1.10E+00	4.05E+01	1.35E+02	
100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.06E-01	6.85E-01	9.12E-01	3.04E+00	1.12E+02	3.74E+02	
100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.30E-01	3.10E+00	4.13E+00	1.38E+01	5.08E+02	1.69E+03	
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.48E-01	4.92E-01	6.55E-01	2.18E+00	8.06E+01	2.69E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Sand	2.01E-01	6.69E-01	8.90E-01	2.97E+00	1.10E+02	3.65E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.04E+00	3.45E+00	4.60E+00	1.53E+01	5.66E+02	1.89E+03	
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.92E-01	6.41E-01	8.53E-01	2.84E+00	1.05E+02	3.50E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Sand	2.09E-01	6.96E-01	9.27E-01	3.09E+00	1.14E+02	3.80E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.02E+00	3.39E+00	4.52E+00	1.51E+01	5.56E+02	1.85E+03	
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.03E-01	6.77E-01	9.01E-01	3.00E+00	1.11E+02	3.70E+02	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Pond													
Acute Toxicity (Cont.)													
250	10	0.05	0.015	0.401	Weeds (78)	Sand	2.15E-01	7.16E-01	9.54E-01	3.18E+00	1.17E+02	3.91E+02	
250	10	0.05	0.015	0.401	Weeds (78)	Clay	9.92E-01	3.31E+00	4.40E+00	1.47E+01	5.42E+02	1.81E+03	
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.00E-01	6.68E-01	8.90E-01	2.97E+00	1.09E+02	3.65E+02	
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.08E-02	6.94E-02	9.24E-02	3.08E-01	1.14E+01	3.79E+01	
50	100	0.05	0.015	0.401	Weeds (78)	Loam	5.48E-02	1.83E-01	2.43E-01	8.10E-01	2.99E+01	9.97E+01	
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	5.47E-02	1.82E-01	2.43E-01	8.09E-01	2.99E+01	9.96E+01	
50	10	0.05	0.015	0.05	Weeds (78)	Loam	7.05E-02	2.35E-01	3.13E-01	1.04E+00	3.85E+01	1.28E+02	
50	10	0.05	0.015	0.2	Weeds (78)	Loam	7.15E-02	2.38E-01	3.17E-01	1.06E+00	3.91E+01	1.30E+02	
50	10	0.05	0.015	0.5	Weeds (78)	Loam	7.35E-02	2.45E-01	3.26E-01	1.09E+00	4.01E+01	1.34E+02	
50	10	0.05	0.023	0.401	Weeds (78)	Loam	7.12E-02	2.37E-01	3.16E-01	1.05E+00	3.89E+01	1.30E+02	
50	10	0.05	0.046	0.401	Weeds (78)	Loam	7.10E-02	2.37E-01	3.15E-01	1.05E+00	3.88E+01	1.29E+02	
50	10	0.05	0.15	0.401	Weeds (78)	Loam	7.04E-02	2.35E-01	3.12E-01	1.04E+00	3.85E+01	1.28E+02	
50	10	0.005	0.015	0.401	Weeds (78)	Loam	7.04E-02	2.35E-01	3.12E-01	1.04E+00	3.85E+01	1.28E+02	
50	10	0.01	0.015	0.401	Weeds (78)	Loam	7.05E-02	2.35E-01	3.13E-01	1.04E+00	3.85E+01	1.28E+02	
50	10	0.1	0.015	0.401	Weeds (78)	Loam	7.26E-02	2.42E-01	3.22E-01	1.07E+00	3.97E+01	1.32E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.97E-01	6.57E-01	8.75E-01	2.92E+00	1.08E+02	3.59E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.71E-01	5.71E-01	7.61E-01	2.54E+00	9.36E+01	3.12E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.13E-01	1.04E+00	1.39E+00	4.64E+00	1.71E+02	5.70E+02	
50	10	0.05	0.015	0.401	Shrubs(79)	Loam	7.13E-02	2.38E-01	3.16E-01	1.05E+00	3.89E+01	1.30E+02	
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	7.13E-02	2.38E-01	3.16E-01	1.05E+00	3.89E+01	1.30E+02	
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	8.06E-02	2.69E-01	3.57E-01	1.19E+00	4.40E+01	1.47E+02	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Pond													
Chronic Toxicity													
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.67E-02	8.89E-02	1.31E-02	4.38E-02	2.00E+00	6.67E+00	
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.81E-01	6.02E-01	8.90E-02	2.97E-01	1.36E+01	4.52E+01	
10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.16E-03	1.05E-02	1.56E-03	5.19E-03	2.37E-01	7.90E-01	
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.70E+00	1.23E+01	1.82E+00	6.07E+00	2.77E+02	9.25E+02	
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.85E-01	1.28E+00	1.90E-01	6.33E-01	2.89E+01	9.63E+01	
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.85E-02	6.16E-02	9.10E-03	3.03E-02	1.39E+00	4.62E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.12E+00	1.37E+01	2.03E+00	6.77E+00	2.77E+02	1.03E+03	
50	10	0.05	0.015	0.401	Weeds (78)	Clay	7.63E-01	2.54E+00	3.76E-01	1.25E+00	5.72E+01	1.91E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Loam	5.82E-01	1.94E+00	2.87E-01	9.56E-01	4.37E+01	1.46E+02	
100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.39E+00	7.95E+00	1.17E+00	3.92E+00	1.79E+02	5.96E+02	
100	10	0.05	0.015	0.401	Weeds (78)	Clay	8.60E-01	2.87E+00	4.24E-01	1.41E+00	6.45E+01	2.15E+02	
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.27E+00	4.23E+00	6.25E-01	2.08E+00	9.52E+01	3.17E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.73E+00	5.77E+00	8.53E-01	2.84E+00	1.30E+02	4.33E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Clay	6.54E-01	2.18E+00	3.22E-01	1.07E+00	4.91E+01	1.64E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.22E+00	4.08E+00	6.02E-01	2.01E+00	9.17E+01	3.06E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.73E+00	5.78E+00	8.54E-01	2.85E+00	1.30E+02	4.33E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Clay	5.22E-01	1.74E+00	2.57E-01	8.58E-01	3.92E+01	1.31E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.12E+00	3.72E+00	5.50E-01	1.83E+00	8.37E+01	2.79E+02	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Pond													
Chronic Toxicity (Cont.)													
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.75E+00	5.84E+00	8.62E-01	2.87E+00	1.31E+02	4.38E+02	
250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.46E-01	1.49E+00	2.20E-01	7.33E-01	3.35E+01	1.12E+02	
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.02E+00	3.40E+00	5.02E-01	1.67E+00	7.65E+01	2.55E+02	
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.42E-01	8.08E-01	1.19E-01	3.98E-01	1.82E+01	6.06E+01	
50	100	0.05	0.015	0.401	Weeds (78)	Loam	6.96E-01	2.32E+00	3.43E-01	1.14E+00	5.22E+01	1.74E+02	
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	7.06E-01	2.35E+00	3.48E-01	1.16E+00	5.29E+01	1.76E+02	
50	10	0.05	0.015	0.05	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.05	0.015	0.2	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.55E-01	4.36E+01	1.45E+02	
50	10	0.05	0.015	0.5	Weeds (78)	Loam	5.82E-01	1.94E+00	2.87E-01	9.56E-01	4.37E+01	1.46E+02	
50	10	0.05	0.023	0.401	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.05	0.046	0.401	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.05	0.15	0.401	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.005	0.015	0.401	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.01	0.015	0.401	Weeds (78)	Loam	5.81E-01	1.94E+00	2.86E-01	9.54E-01	4.36E+01	1.45E+02	
50	10	0.1	0.015	0.401	Weeds (78)	Loam	5.82E-01	1.94E+00	2.87E-01	9.55E-01	4.36E+01	1.45E+02	
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.64E-01	1.21E+00	1.79E-01	5.97E-01	2.73E+01	9.09E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.67E-01	8.90E-01	1.31E-01	4.38E-01	2.00E+01	6.67E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	8.42E-01	2.81E+00	4.15E-01	1.38E+00	6.32E+01	2.11E+02	
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	5.82E-01	1.94E+00	2.87E-01	9.56E-01	4.37E+01	1.46E+02	
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	5.82E-01	1.94E+00	2.87E-01	9.56E-01	4.37E+01	1.46E+02	
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	7.83E-01	2.61E+00	3.85E-01	1.28E+00	5.87E+01	1.96E+02	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Stream													
Acute Toxicity													
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.60E-04	8.65E-04	1.15E-03	3.84E-03	1.42E-01	4.72E-01	
10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.78E-03	1.93E-02	2.56E-02	8.54E-02	3.15E+00	1.05E+01	
10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.38E-05	1.79E-04	2.39E-04	7.96E-04	2.94E-02	9.80E-02	
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.33E-02	1.11E-01	1.48E-01	4.93E-01	1.82E+01	6.06E+01	
25	10	0.05	0.015	0.401	Weeds (78)	Clay	9.57E-03	3.19E-02	4.25E-02	1.42E-01	5.22E+00	1.74E+01	
25	10	0.05	0.015	0.401	Weeds (78)	Loam	7.03E-04	2.34E-03	3.12E-03	1.04E-02	3.84E-01	1.28E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Sand	3.95E-02	1.32E-01	1.75E-01	5.84E-01	2.16E+01	7.18E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.33E-02	7.76E-02	1.03E-01	3.44E-01	1.27E+01	4.24E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.23E+00	7.44E+00	
100	10	0.05	0.015	0.401	Weeds (78)	Sand	3.81E-02	1.27E-01	1.69E-01	5.63E-01	2.08E+01	6.93E+01	
100	10	0.05	0.015	0.401	Weeds (78)	Clay	4.67E-02	1.56E-01	2.07E-01	6.91E-01	2.55E+01	8.50E+01	
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-02	3.92E-02	5.22E-02	1.74E-01	6.42E+00	2.14E+01	
150	10	0.05	0.015	0.401	Weeds (78)	Sand	3.22E-02	1.07E-01	1.43E-01	4.76E-01	1.76E+01	5.86E+01	
150	10	0.05	0.015	0.401	Weeds (78)	Clay	5.86E-02	1.95E-01	2.60E-01	8.66E-01	3.20E+01	1.07E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.46E-02	4.88E-02	6.50E-02	2.17E-01	7.99E+00	2.66E+01	
200	10	0.05	0.015	0.401	Weeds (78)	Sand	3.45E-02	1.15E-01	1.53E-01	5.11E-01	1.89E+01	6.29E+01	
200	10	0.05	0.015	0.401	Weeds (78)	Clay	8.72E-02	2.91E-01	3.87E-01	1.29E+00	4.76E+01	1.59E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.17E-02	7.25E-02	9.65E-02	3.22E-01	1.19E+01	3.96E+01	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Stream													
Acute Toxicity (Cont.)													
250	10	0.05	0.015	0.401	Weeds (78)	Sand	3.44E-02	1.15E-01	1.53E-01	5.09E-01	1.88E+01	6.27E+01	
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.12E-01	3.72E-01	4.95E-01	1.65E+00	6.10E+01	2.03E+02	
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.73E-02	9.10E-02	1.21E-01	4.04E-01	1.49E+01	4.97E+01	
50	1	0.05	0.015	0.401	Weeds (78)	Loam	5.78E-04	1.93E-03	2.57E-03	8.55E-03	3.16E-01	1.05E+00	
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.88E-02	6.28E-02	8.36E-02	2.79E-01	1.03E+01	3.43E+01	
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	3.50E-02	1.17E-01	1.55E-01	5.18E-01	1.91E+01	6.37E+01	
50	10	0.05	0.015	0.05	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.42E+00	
50	10	0.05	0.015	0.2	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.04E-02	2.23E+00	7.43E+00	
50	10	0.05	0.015	0.5	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.04E-02	2.23E+00	7.44E+00	
50	10	0.05	0.023	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.42E+00	
50	10	0.05	0.046	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.43E+00	
50	10	0.05	0.15	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.42E+00	
50	10	0.005	0.015	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.42E+00	
50	10	0.01	0.015	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.23E+00	7.42E+00	
50	10	0.1	0.015	0.401	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.23E+00	7.44E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.07E-02	3.58E-02	4.76E-02	1.59E-01	5.86E+00	1.95E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.01E-02	3.36E-02	4.48E-02	1.49E-01	5.51E+00	1.84E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.84E-02	6.14E-02	8.17E-02	2.72E-01	1.01E+01	3.35E+01	
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.23E+00	7.44E+00	
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	4.09E-03	1.36E-02	1.81E-02	6.04E-02	2.23E+00	7.44E+00	
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	5.19E-03	1.73E-02	2.30E-02	7.67E-02	2.83E+00	9.44E+00	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
Surface Runoff to Off-Site Stream													
Chronic Toxicity													
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	8.21E-05	2.74E-04	4.05E-05	1.35E-04	6.16E-03	2.05E-02	
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.02E-03	3.41E-03	5.04E-04	1.68E-03	7.68E-02	2.56E-01	
10	10	0.05	0.015	0.401	Weeds (78)	Loam	9.49E-06	3.16E-05	4.68E-06	1.56E-05	7.12E-04	2.37E-03	
25	10	0.05	0.015	0.401	Weeds (78)	Sand	2.49E-02	8.30E-02	1.23E-02	4.09E-02	1.87E+00	6.23E+00	
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.44E-03	1.15E-02	1.69E-03	5.65E-03	2.58E-01	8.60E-01	
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.91E-04	6.36E-04	9.40E-05	3.13E-04	1.43E-02	4.77E-02	
50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.98E-02	1.66E-01	2.45E-02	8.18E-02	3.74E+00	1.25E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay	9.91E-03	3.30E-02	4.88E-03	1.63E-02	7.43E-01	2.48E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Loam	7.00E-03	2.33E-02	3.45E-03	1.15E-02	5.25E-01	1.75E+00	
100	10	0.05	0.015	0.401	Weeds (78)	Sand	5.88E-02	1.96E-01	2.89E-02	9.65E-02	4.41E+00	1.47E+01	
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.38E-02	7.93E-02	1.17E-02	3.90E-02	1.78E+00	5.95E+00	
100	10	0.05	0.015	0.401	Weeds (78)	Loam	2.66E-02	8.88E-02	1.31E-02	4.37E-02	2.00E+00	6.66E+00	
150	10	0.05	0.015	0.401	Weeds (78)	Sand	5.87E-02	1.96E-01	2.89E-02	9.64E-02	4.41E+00	1.47E+01	
150	10	0.05	0.015	0.401	Weeds (78)	Clay	3.05E-02	1.02E-01	1.50E-02	5.01E-02	2.29E+00	7.63E+00	
150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.53E-02	1.18E-01	1.74E-02	5.80E-02	2.65E+00	8.83E+00	
200	10	0.05	0.015	0.401	Weeds (78)	Sand	5.99E-02	2.00E-01	2.95E-02	9.84E-02	4.50E+00	1.50E+01	
200	10	0.05	0.015	0.401	Weeds (78)	Clay	3.35E-02	1.12E-01	1.65E-02	5.50E-02	2.51E+00	8.38E+00	
200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.97E-02	1.32E-01	1.95E-02	6.51E-02	2.98E+00	9.92E+00	

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

Potential Risk to Aquatic Receptors													
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	
							Surface Runoff to Off-Site Stream						
Chronic Toxicity (Cont.)													
250	10	0.05	0.015	0.401	Weeds (78)	Sand	6.08E-02	2.03E-01	3.00E-02	9.99E-02	4.56E+00	1.52E+01	
250	10	0.05	0.015	0.401	Weeds (78)	Clay	3.51E-02	1.17E-01	1.73E-02	5.76E-02	2.63E+00	8.77E+00	
250	10	0.05	0.015	0.401	Weeds (78)	Loam	4.19E-02	1.40E-01	2.06E-02	6.88E-02	3.14E+00	1.05E+01	
50	1	0.05	0.015	0.401	Weeds (78)	Loam	7.86E-04	2.62E-03	3.87E-04	1.29E-03	5.89E-02	1.96E-01	
50	100	0.05	0.015	0.401	Weeds (78)	Loam	4.01E-02	1.34E-01	1.98E-02	6.59E-02	3.01E+00	1.00E+01	
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.06E-01	3.53E-01	5.21E-02	1.74E-01	7.94E+00	2.65E+01	
50	10	0.05	0.015	0.05	Weeds (78)	Loam	6.96E-03	2.32E-02	3.43E-03	1.14E-02	5.22E-01	1.74E+00	
50	10	0.05	0.015	0.2	Weeds (78)	Loam	6.97E-03	2.32E-02	3.44E-03	1.15E-02	5.23E-01	1.74E+00	
50	10	0.05	0.015	0.5	Weeds (78)	Loam	7.00E-03	2.33E-02	3.45E-03	1.15E-02	5.25E-01	1.75E+00	
50	10	0.05	0.023	0.401	Weeds (78)	Loam	6.97E-03	2.32E-02	3.43E-03	1.14E-02	5.23E-01	1.74E+00	
50	10	0.05	0.046	0.401	Weeds (78)	Loam	6.97E-03	2.32E-02	3.43E-03	1.14E-02	5.23E-01	1.74E+00	
50	10	0.05	0.15	0.401	Weeds (78)	Loam	6.96E-03	2.32E-02	3.43E-03	1.14E-02	5.22E-01	1.74E+00	
50	10	0.005	0.015	0.401	Weeds (78)	Loam	6.96E-03	2.32E-02	3.43E-03	1.14E-02	5.22E-01	1.74E+00	
50	10	0.01	0.015	0.401	Weeds (78)	Loam	6.96E-03	2.32E-02	3.43E-03	1.14E-02	5.22E-01	1.74E+00	
50	10	0.1	0.015	0.401	Weeds (78)	Loam	6.99E-03	2.33E-02	3.44E-03	1.15E-02	5.24E-01	1.75E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.54E-03	1.51E-02	2.24E-03	7.46E-03	3.41E-01	1.14E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.88E-03	1.29E-02	1.91E-03	6.38E-03	2.91E-01	9.71E-01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	8.84E-03	2.95E-02	4.35E-03	1.45E-02	6.63E-01	2.21E+00	
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	6.98E-03	2.33E-02	3.44E-03	1.15E-02	5.24E-01	1.75E+00	
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	6.98E-03	2.33E-02	3.44E-03	1.15E-02	5.24E-01	1.75E+00	
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.00E-02	3.33E-02	4.93E-03	1.64E-02	7.50E-01	2.50E+00	

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

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond								
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	8.88E-05	2.96E-04
10	10	0.05	0.015	0.401	Weeds (78)	Clay	6.01E-04	2.00E-03
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-05	3.51E-05
25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.23E-02	4.10E-02
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.28E-03	4.27E-03
25	10	0.05	0.015	0.401	Weeds (78)	Loam	6.15E-05	2.05E-04
50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.37E-02	4.58E-02
50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.54E-03	8.47E-03
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.94E-03	6.46E-03
100	10	0.05	0.015	0.401	Weeds (78)	Sand	7.94E-03	2.65E-02
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.86E-03	9.54E-03
100	10	0.05	0.015	0.401	Weeds (78)	Loam	4.22E-03	1.41E-02
150	10	0.05	0.015	0.401	Weeds (78)	Sand	5.77E-03	1.92E-02
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.18E-03	7.26E-03
150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.07E-03	1.36E-02
200	10	0.05	0.015	0.401	Weeds (78)	Sand	5.77E-03	1.92E-02
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.74E-03	5.80E-03
200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.71E-03	1.24E-02
250	10	0.05	0.015	0.401	Weeds (78)	Sand	5.83E-03	1.94E-02
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.49E-03	4.95E-03
250	10	0.05	0.015	0.401	Weeds (78)	Loam	3.40E-03	1.13E-02
50	1	0.05	0.015	0.401	Weeds (78)	Loam	8.07E-04	2.69E-03
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.32E-03	7.72E-03
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	2.35E-03	7.83E-03
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.94E-03	6.45E-03

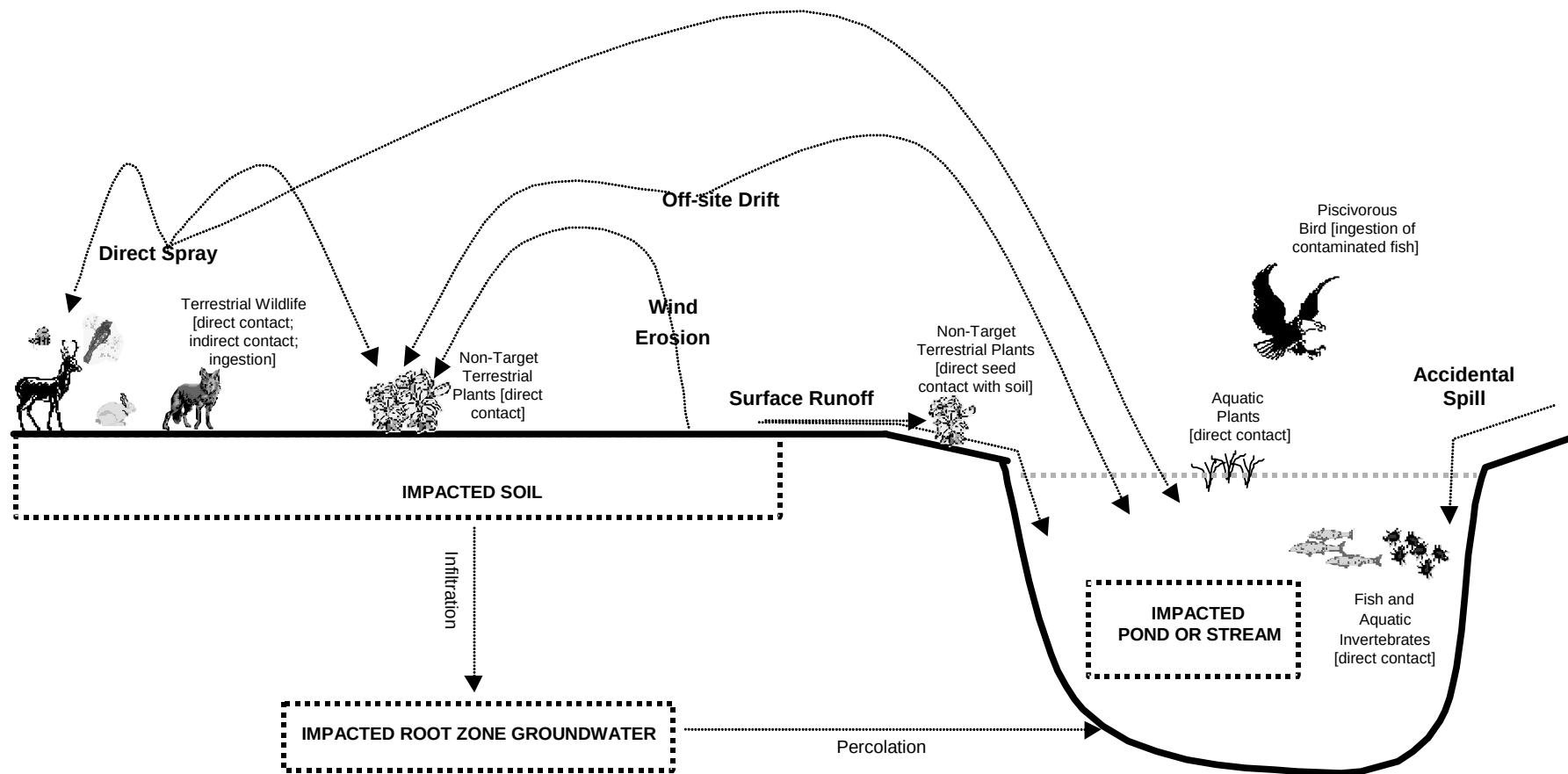
TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond (Cont.)								
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor¹	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.21E-03	4.03E-03
50	10	0.05	0.015	0.401	Weeds (78)	Silt	8.88E-04	2.96E-03
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	2.80E-03	9.35E-03
50	10	0.05	0.015	0.401	Shrubs(79)	Lam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Rye Grass(54)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	2.60E-03	8.68E-03
¹ Universal Soil Loss Equation. Shading and boldface indicates plant RQs greater than 1. Shading and boldface indicates terrestrial animal RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative). 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								

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					
Watershed Location	Distance from Receptor (km)	Typical Species		RTE Species	
		Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Montana	1.5	4.03E-04	1.34E-03	3.22E-02	1.07E-01
Montana	10	2.28E-04	7.61E-04	1.83E-02	6.09E-02
Montana	100	2.73E-08	1.03E-07	2.19E-06	8.21E-06
Oregon	1.5	2.31E-04	7.69E-04	1.85E-02	6.15E-02
Oregon	10	8.80E-05	2.93E-04	7.04E-03	2.35E-02
Oregon	100	3.10E-08	1.03E-07	2.48E-06	8.26E-06
Wyoming	1.5	4.56E-05	1.52E-04	3.65E-03	1.22E-02
Wyoming	10	3.15E-05	1.05E-04	2.52E-03	8.39E-03
Wyoming	100	7.74E-09	2.58E-08	6.19E-07	2.06E-06
Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).					

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

FIGURE 4-2. Simplified Food Web.

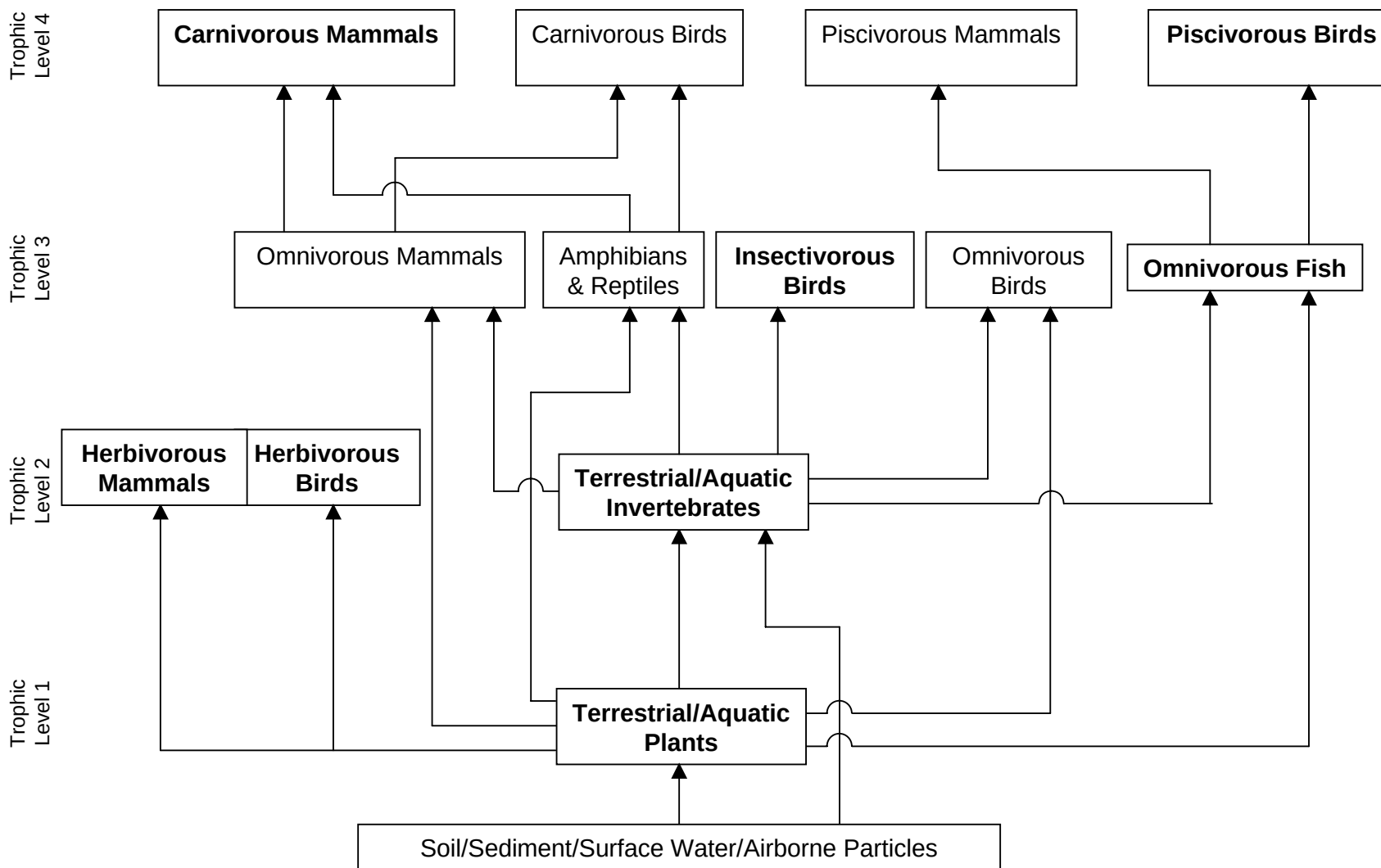


FIGURE 4-3. Direct Spray - Risk Quotients for Terrestrial Animals.

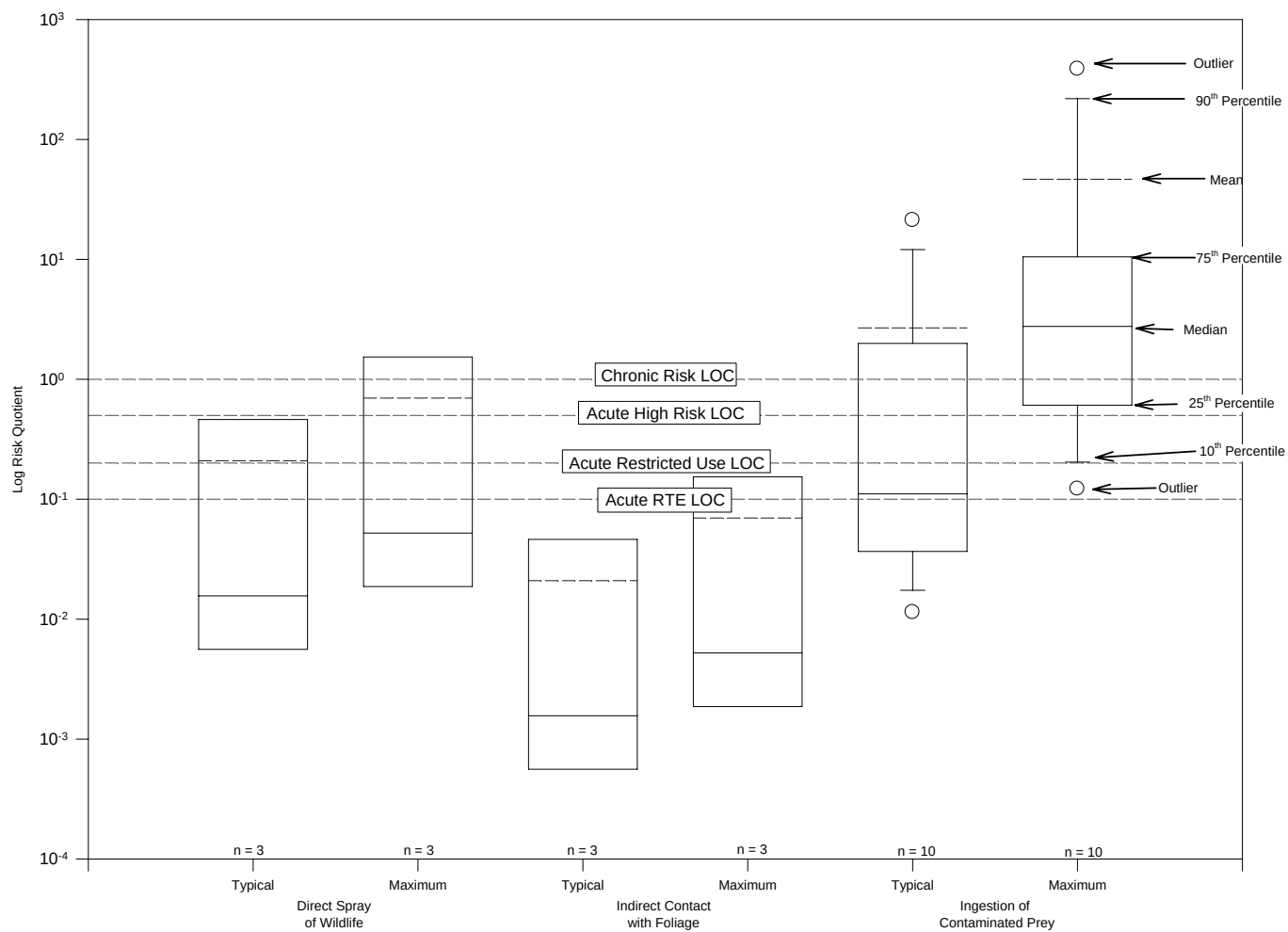


FIGURE 4-4. Direct Spray - Risk Quotients for Non-Target Terrestrial Plants.

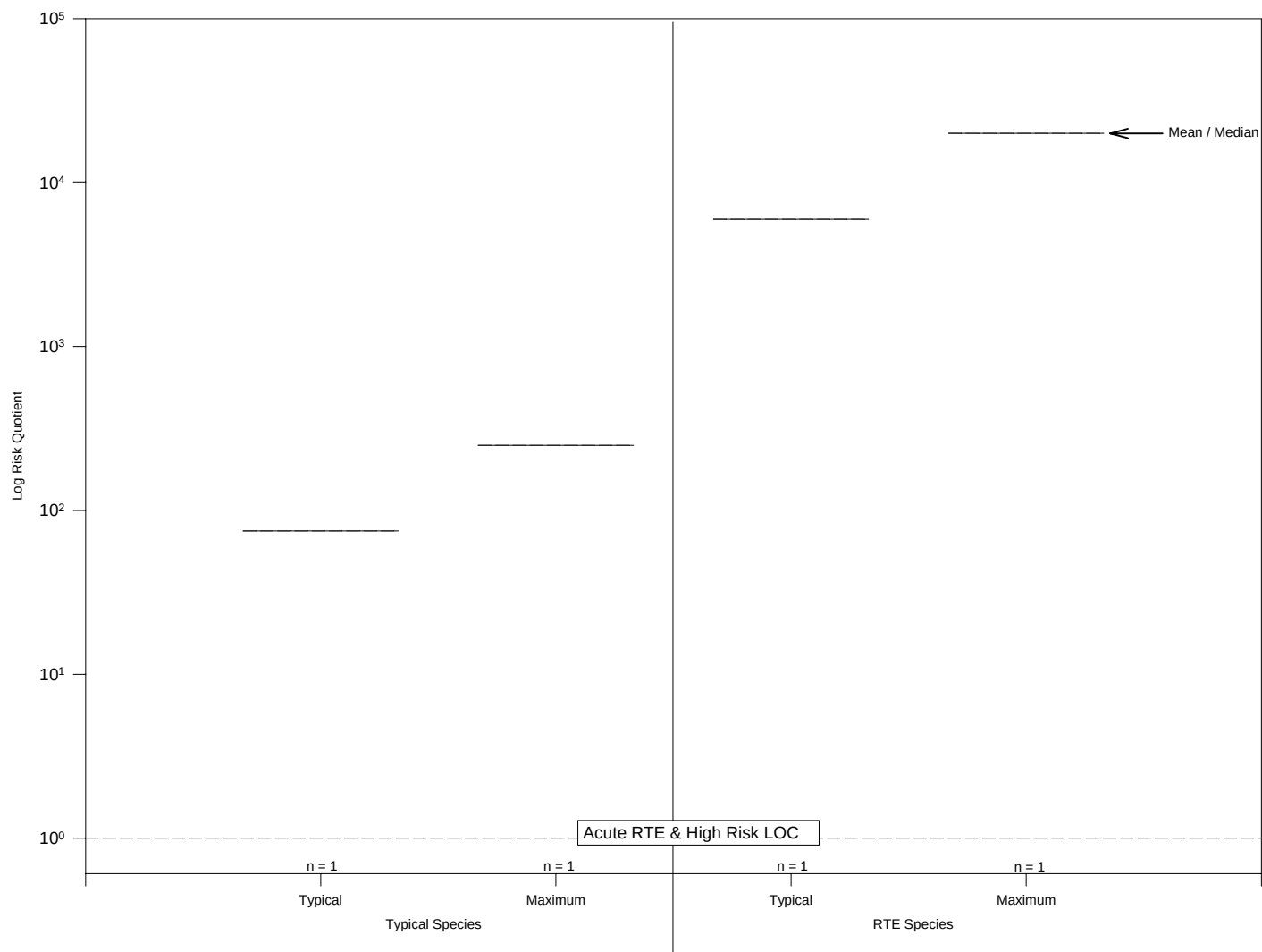


FIGURE 4-5. Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants.

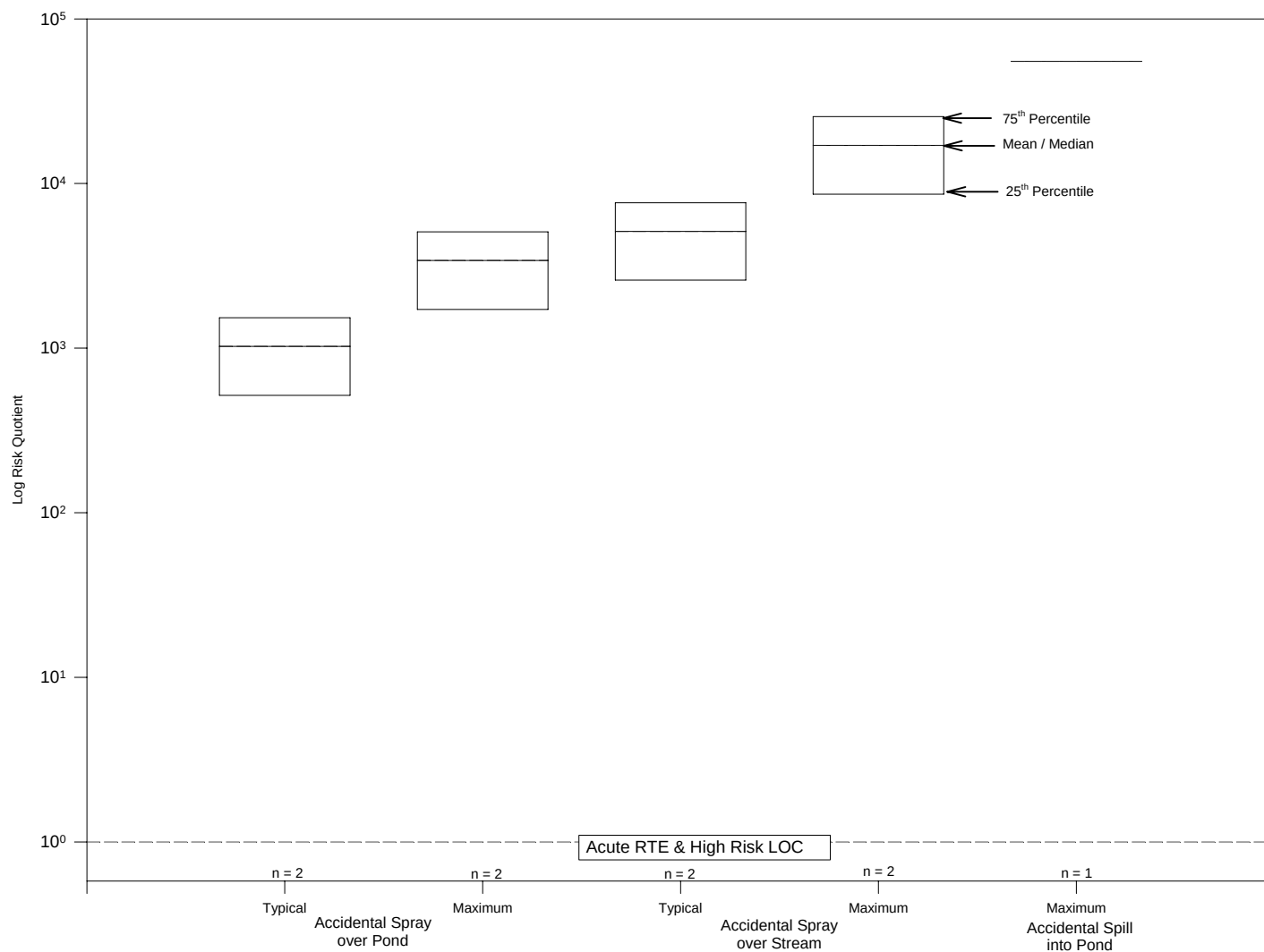


FIGURE 4-6. Accidental Direct Spray and Spills - Risk Quotients for Fish.

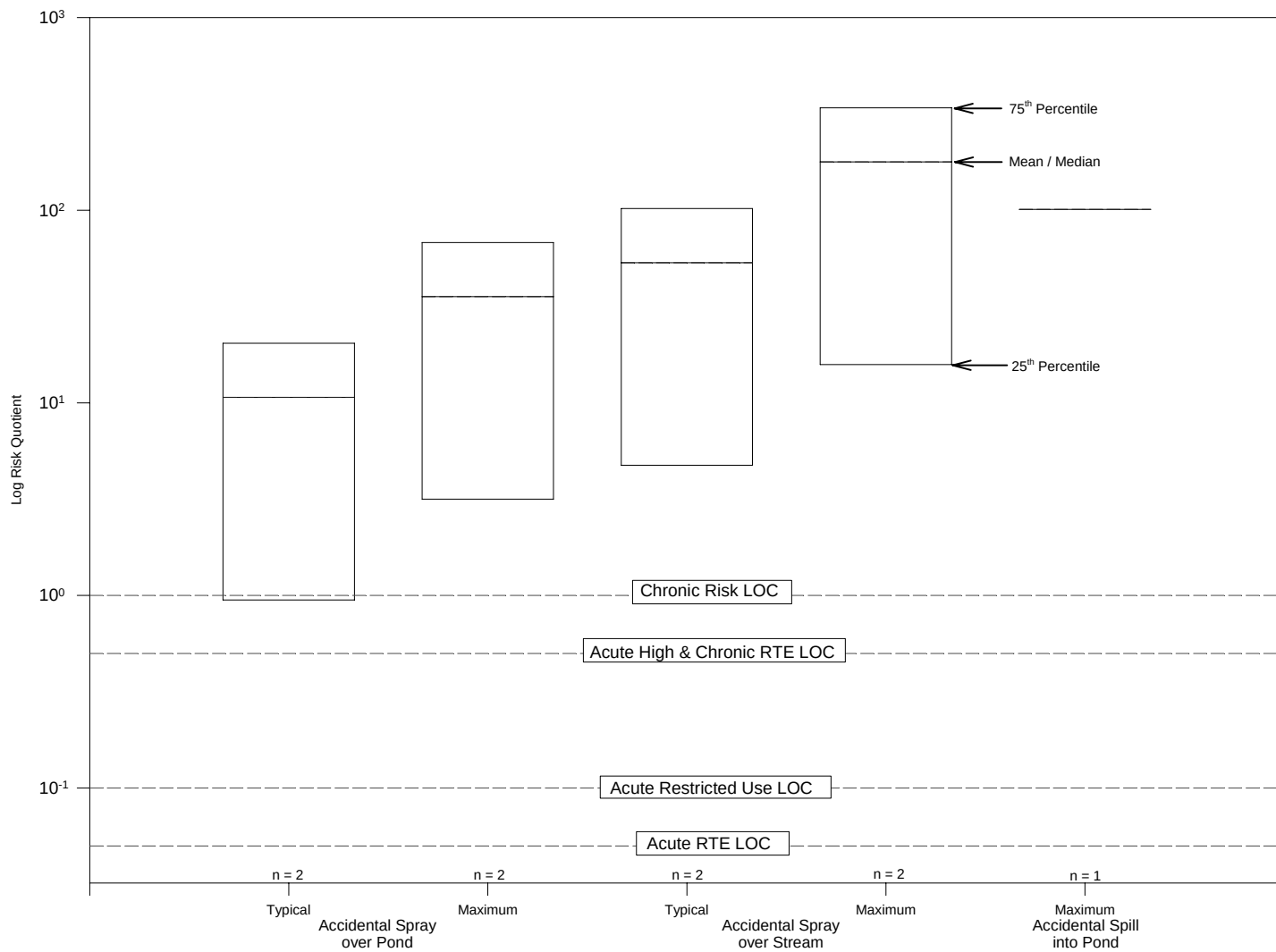


FIGURE 4-7. Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates.

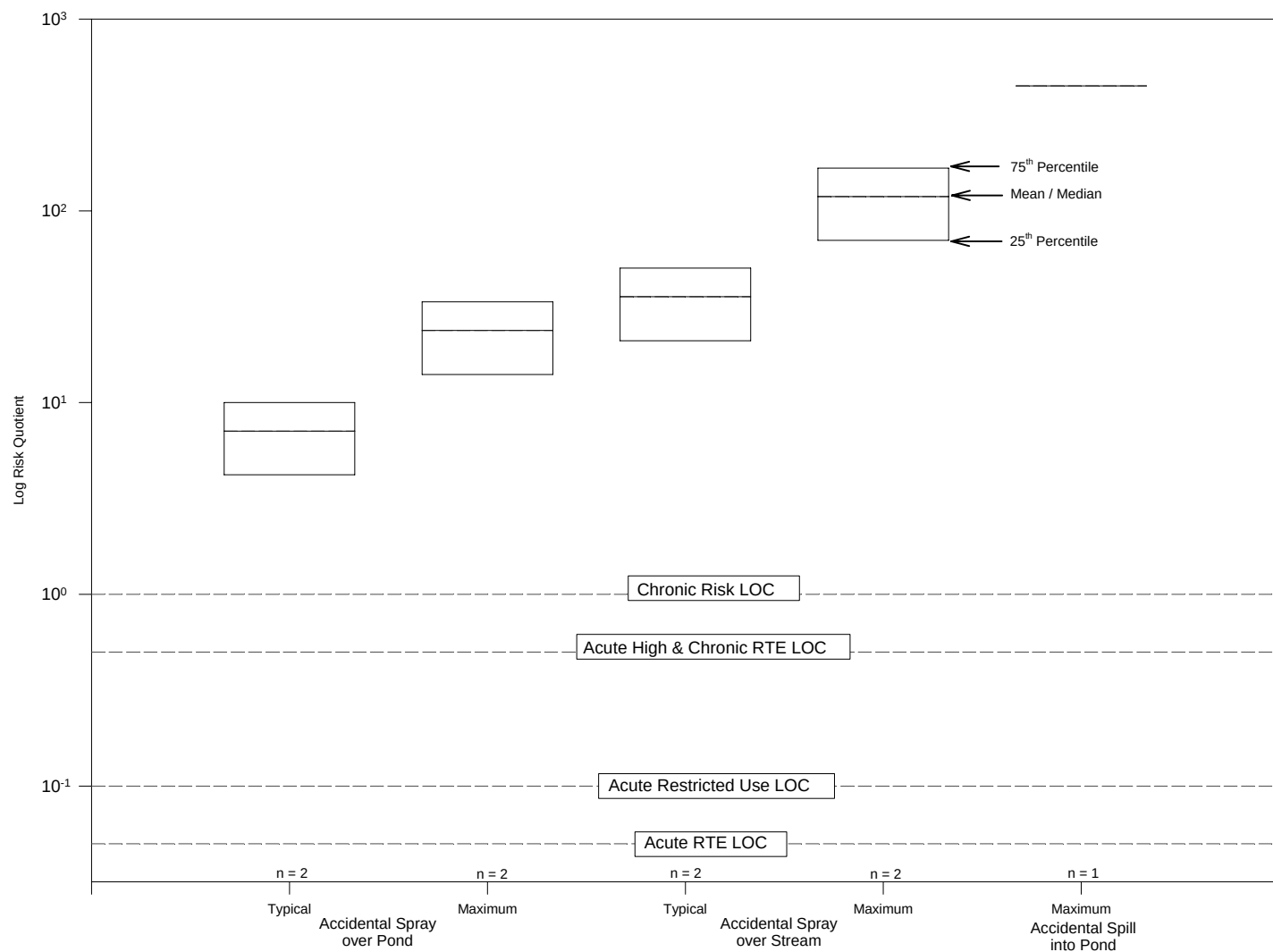


FIGURE 4-8. Off-Site Drift - Risk Quotients for Non-Target Terrestrial Plants.

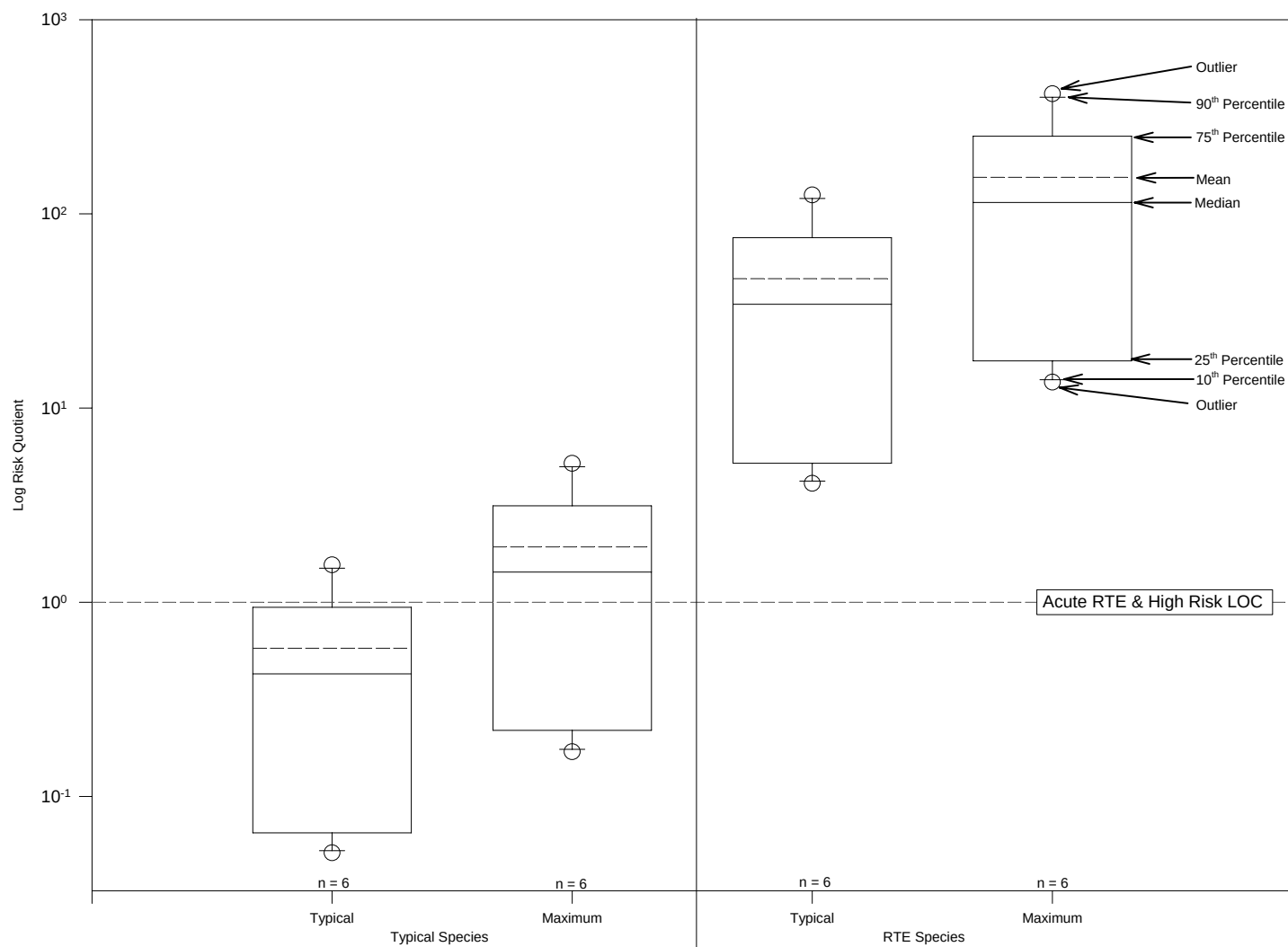


FIGURE 4-9. Off-Site Drift - Risk Quotients for Non-Target Aquatic Plants.

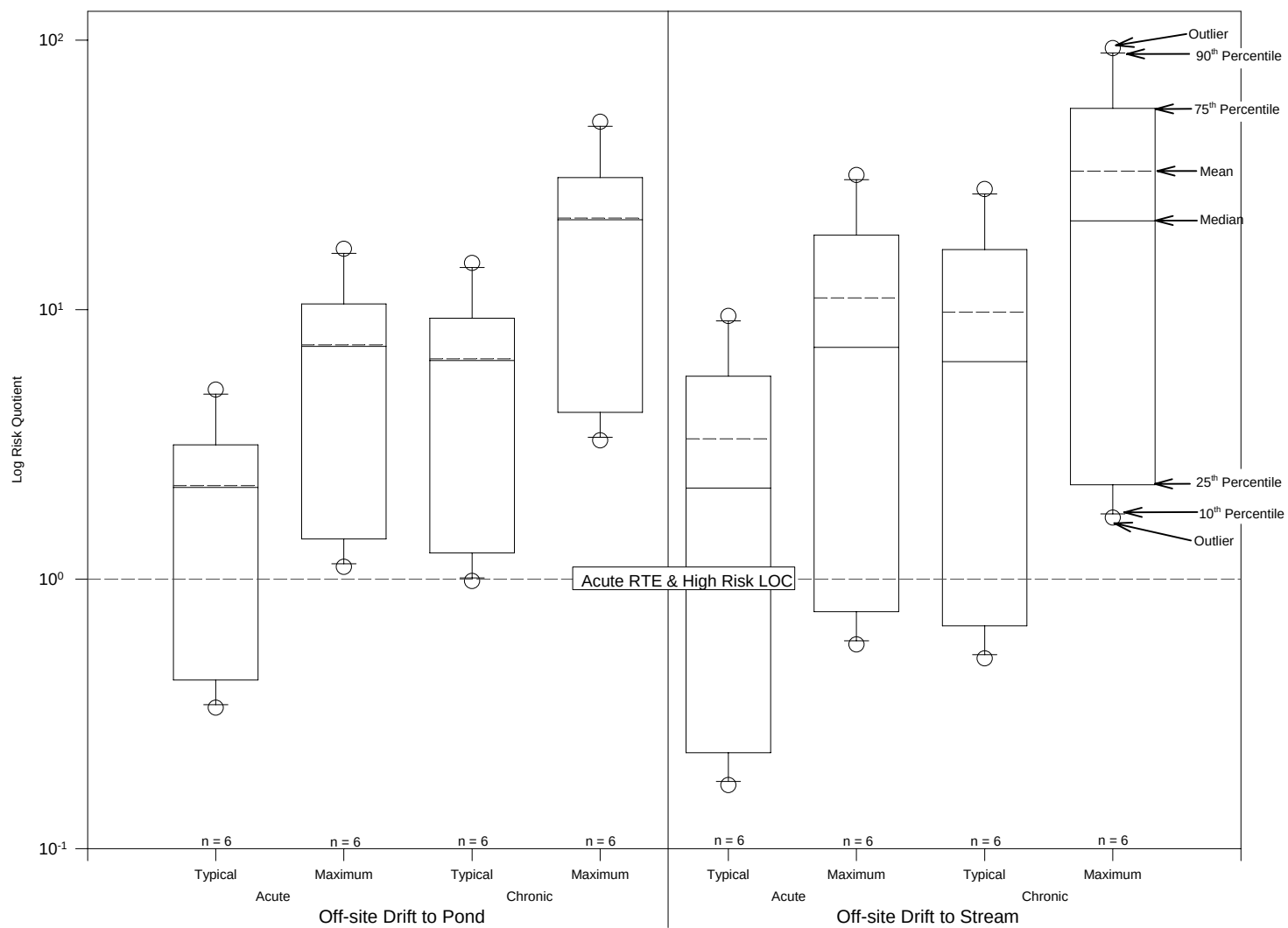


FIGURE 4-10. Off-Site Drift - Risk Quotients for Fish.

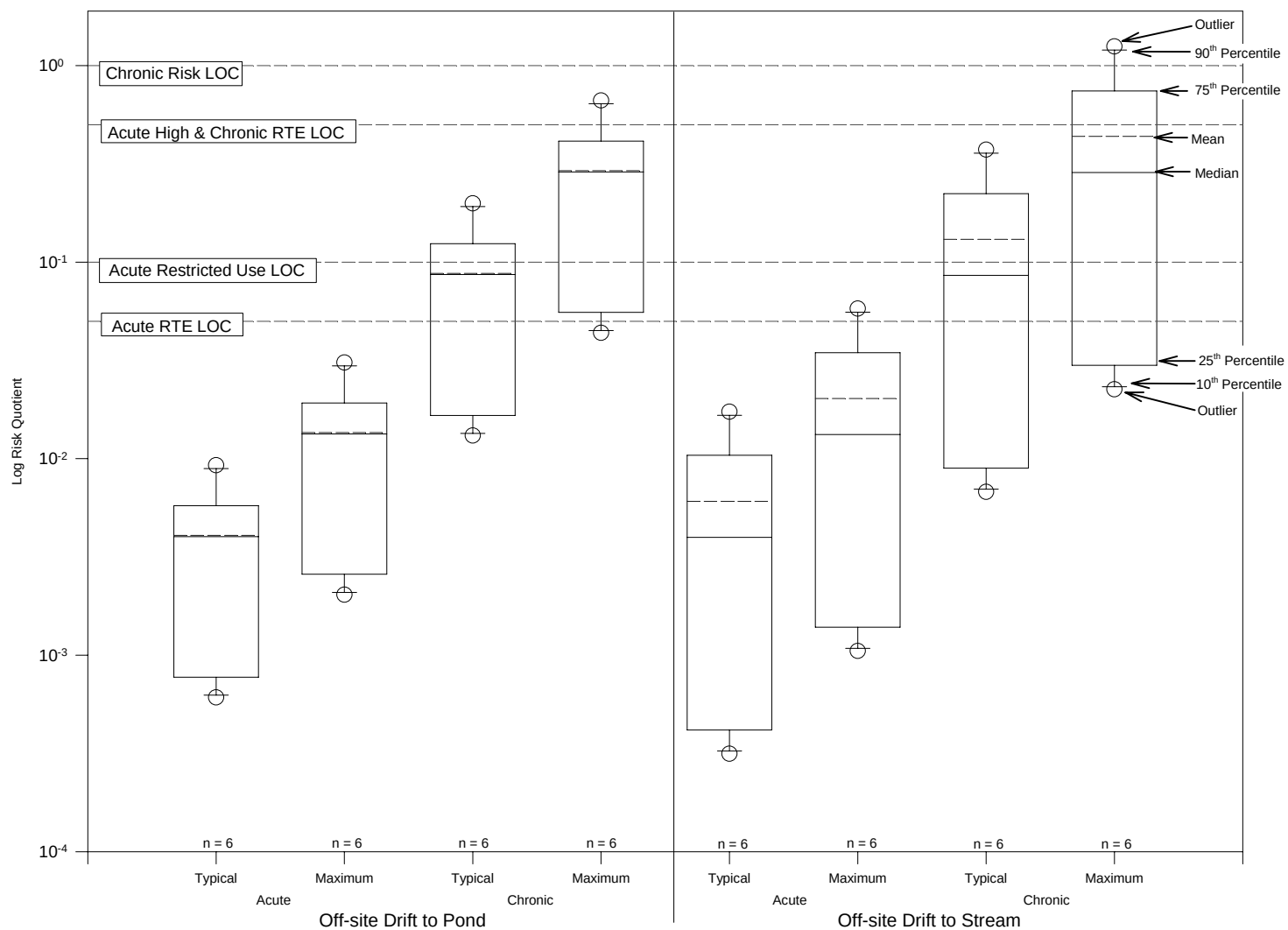


FIGURE 4-11. Off-Site Drift - Risk Quotients for Aquatic Invertebrates.

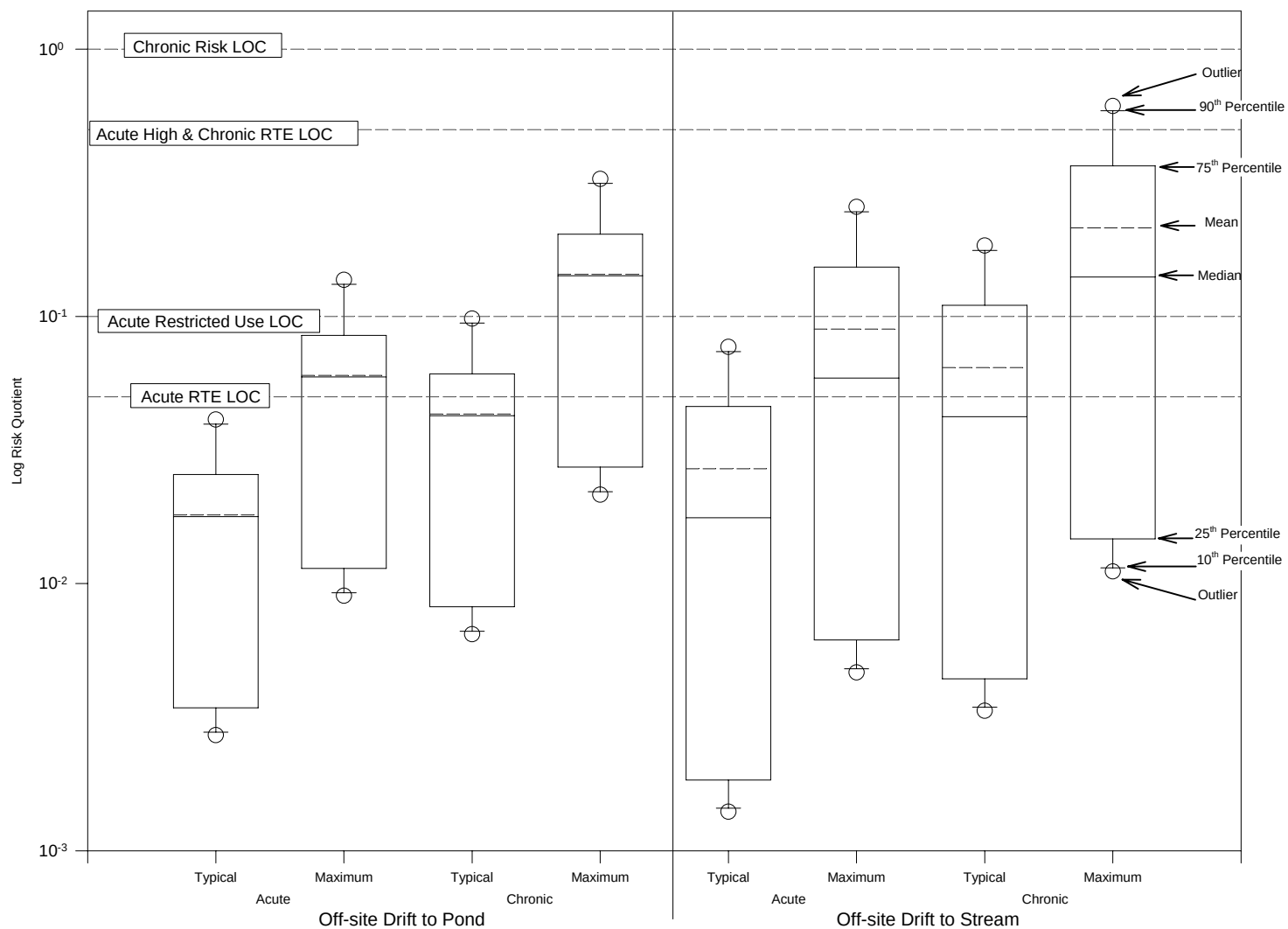


FIGURE 4-12. Off-Site Drift - Risk Quotients for Piscivorous Birds.

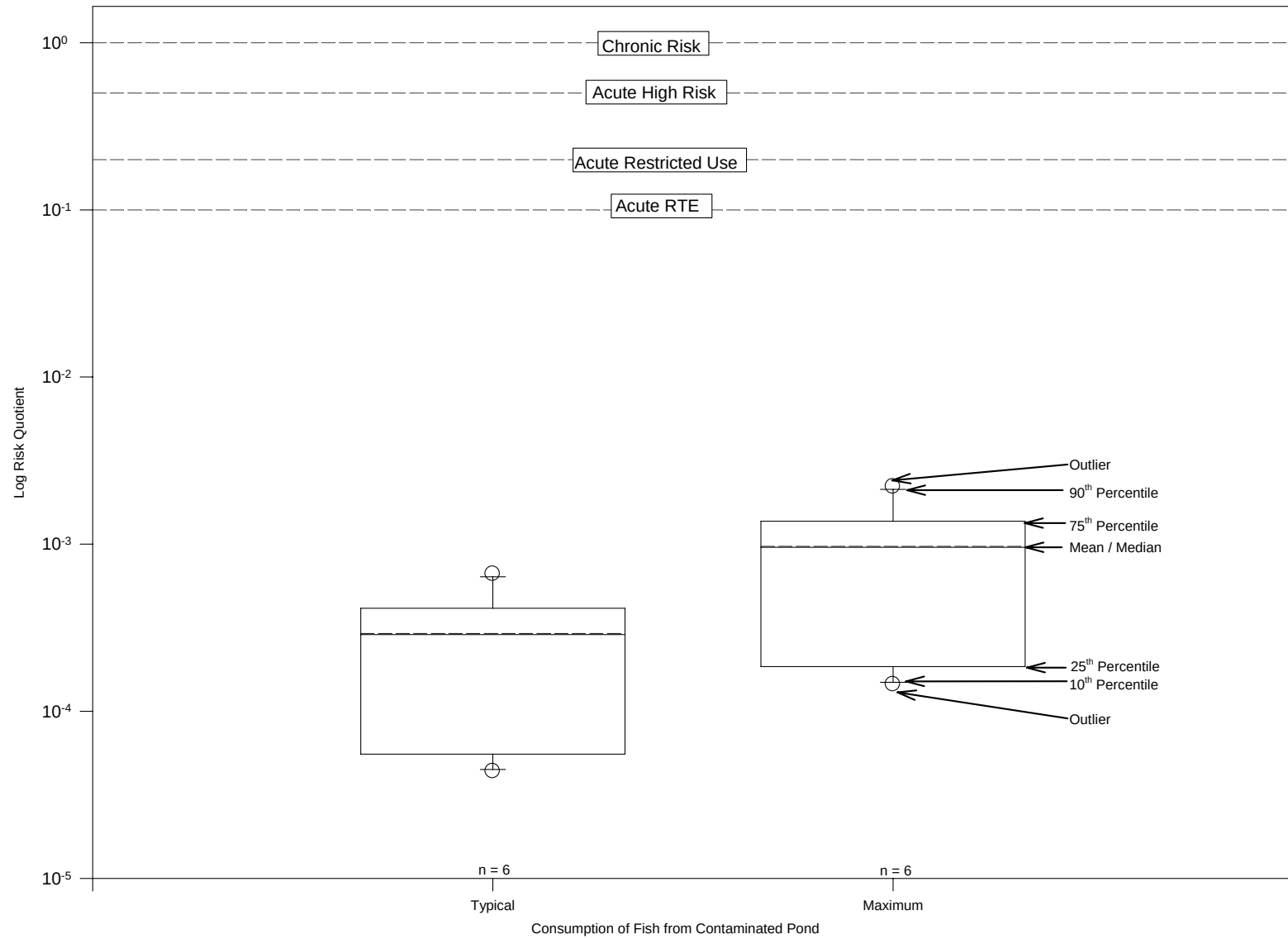


FIGURE 4-13. Surface Runoff - Risk Quotients for Non-Target Terrestrial Plants.

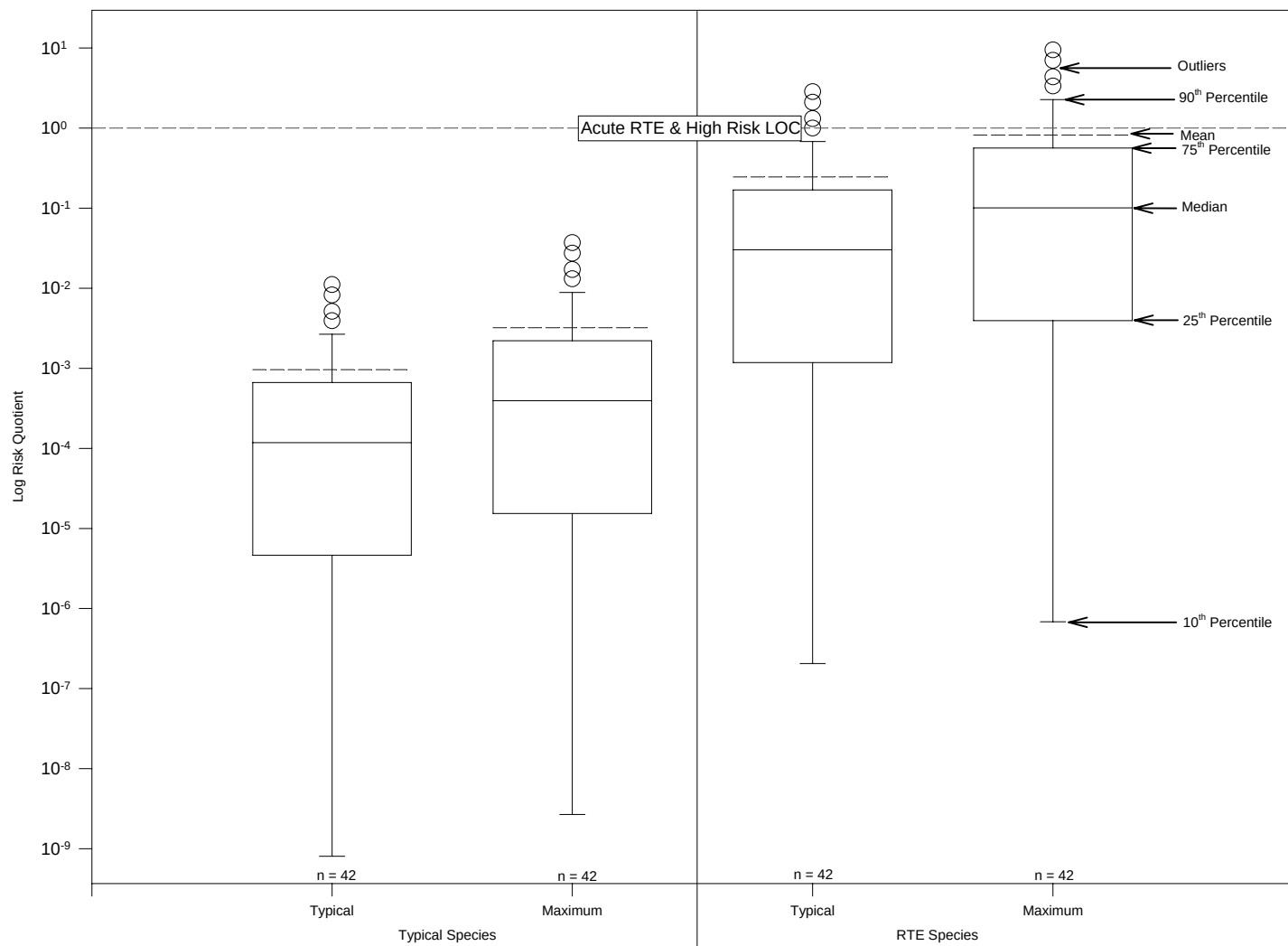


FIGURE 4-14 Surface Runoff - Risk Quotients for Non-Target Aquatic Plants.

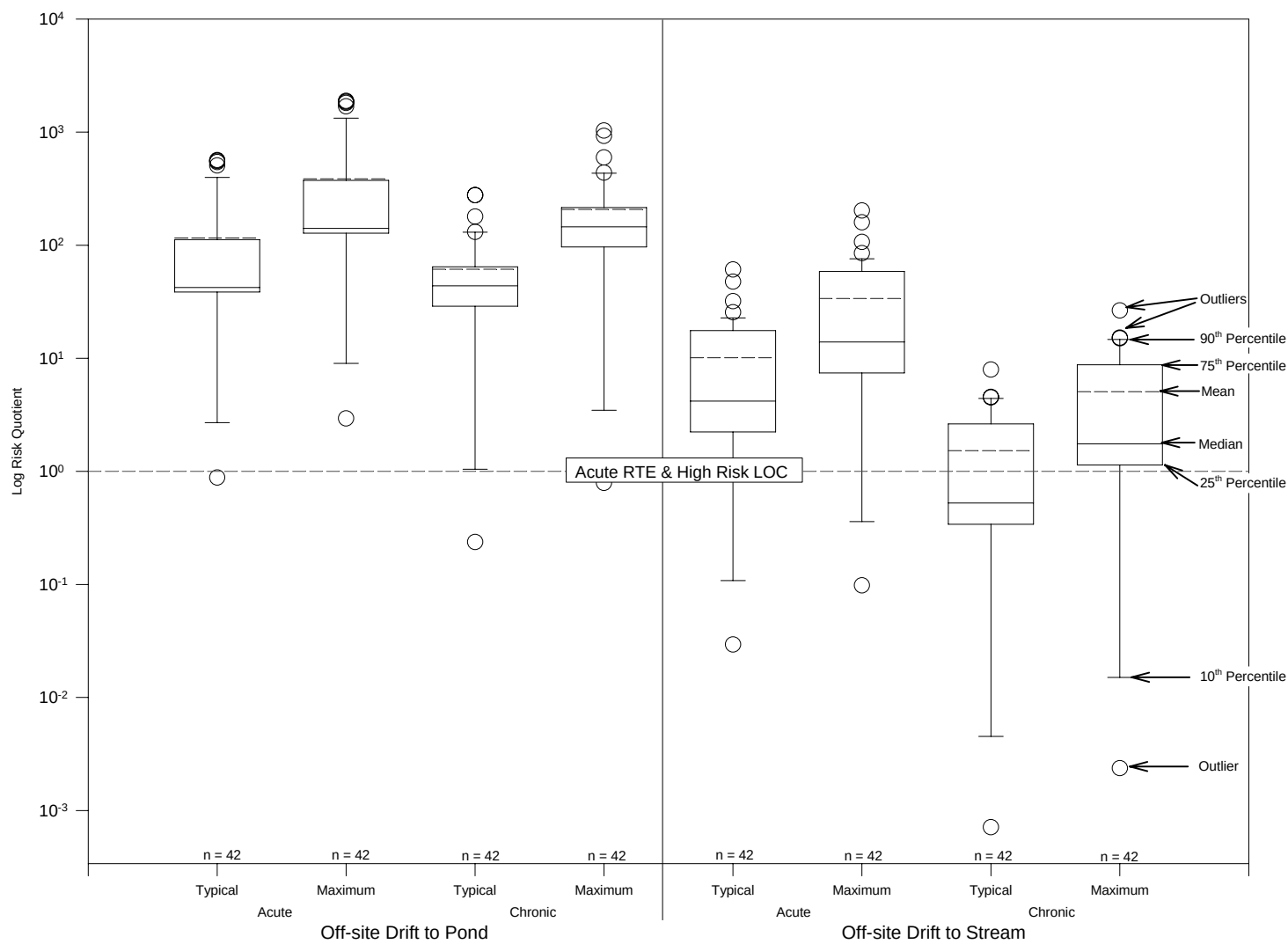


FIGURE 4-15. Surface Runoff - Risk Quotients for Fish.

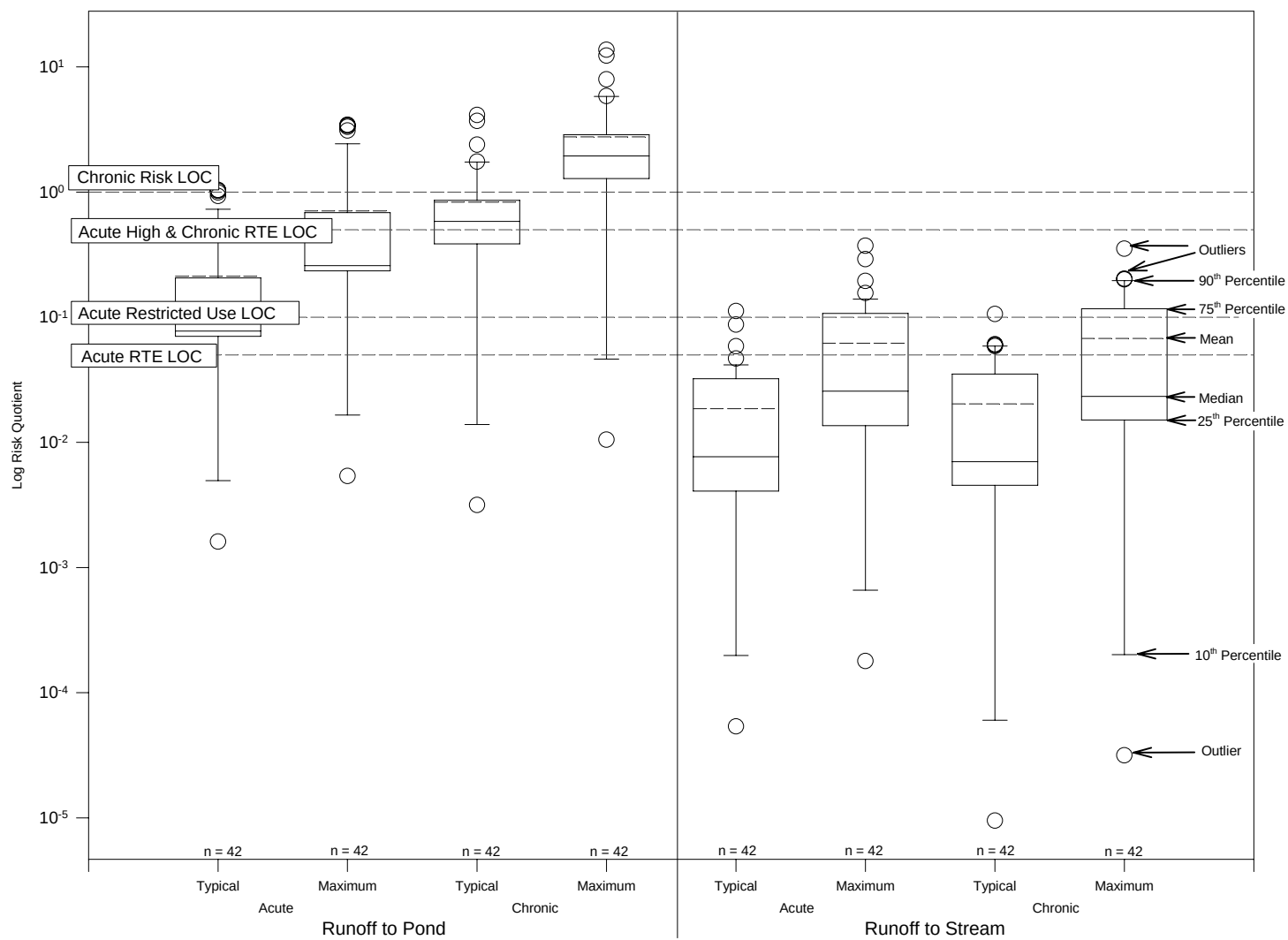


FIGURE 4-16. Surface Runoff - Risk Quotients for Aquatic Invertebrates.

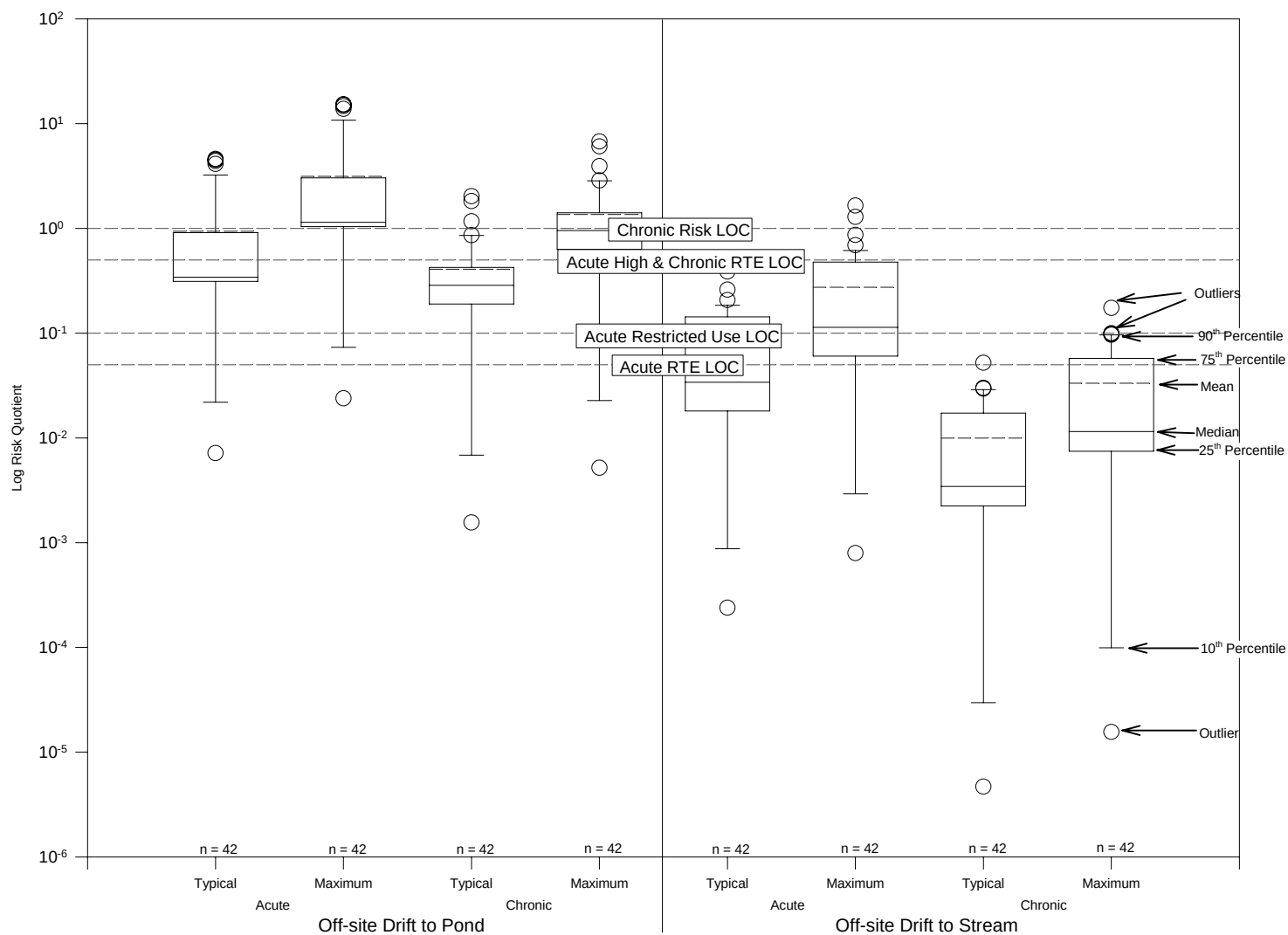


FIGURE 4-17. Surface Runoff - Risk Quotients for Piscivorous Birds.

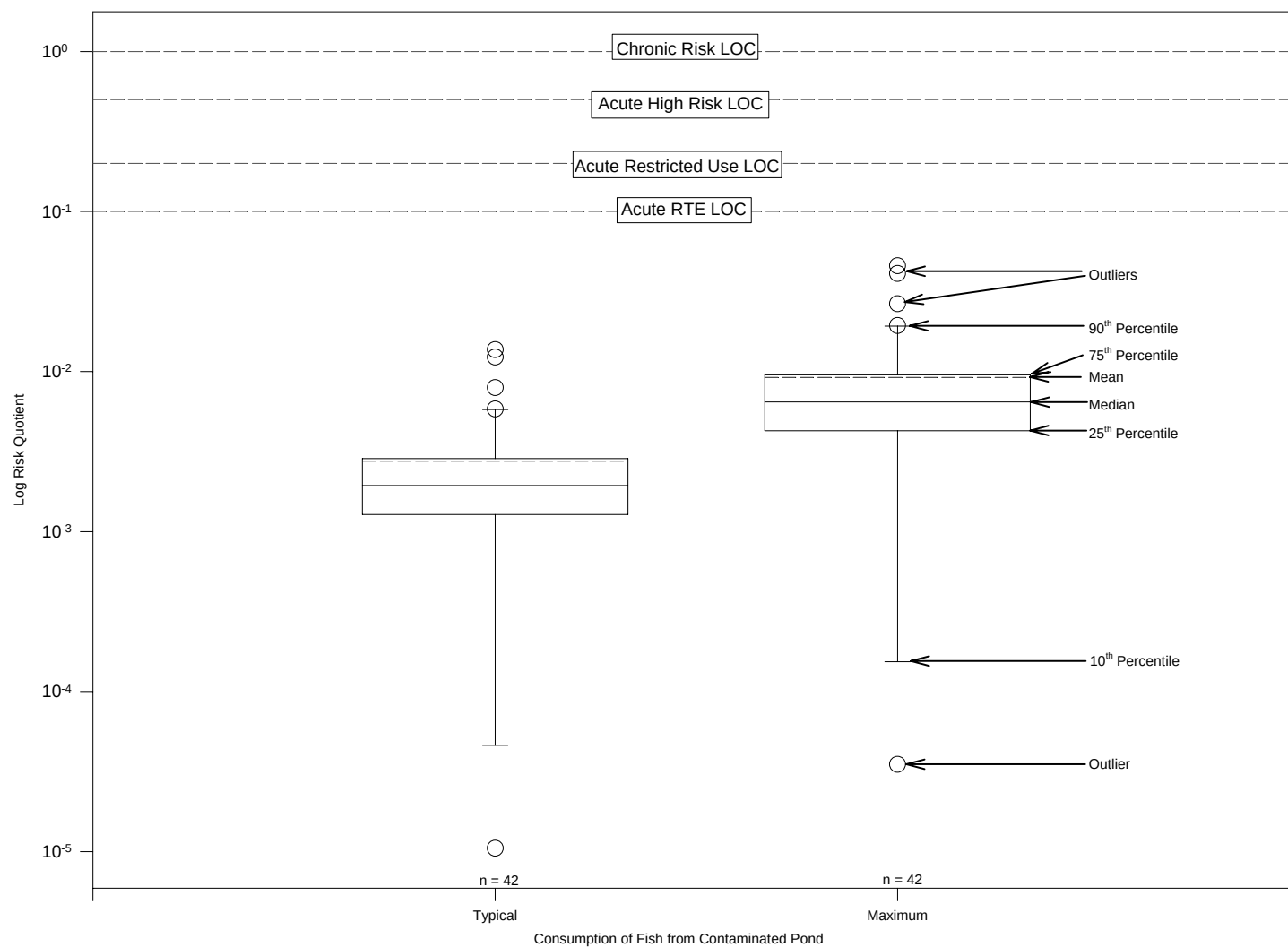
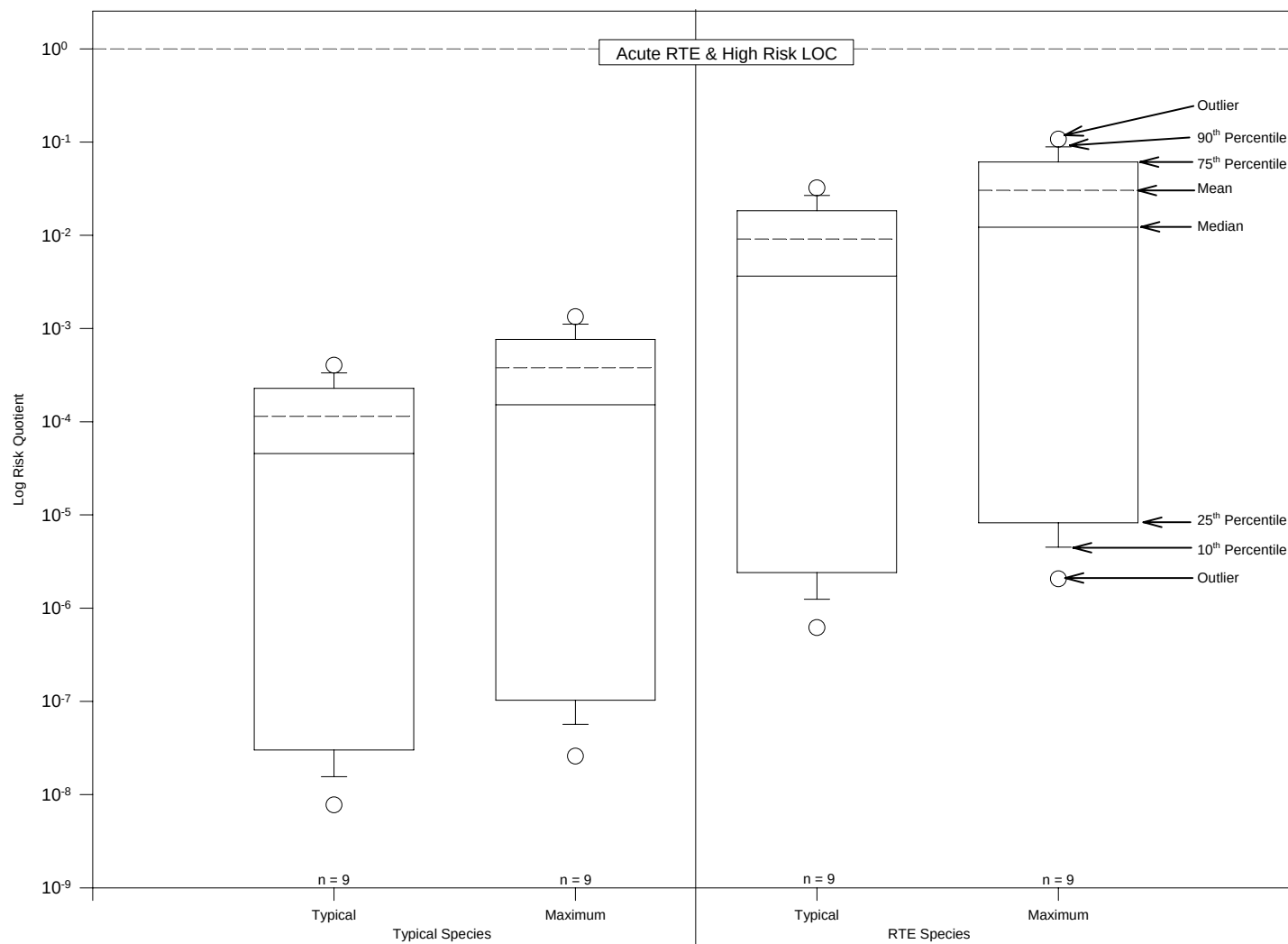


FIGURE 4-18. Wind Erosion and Transport Off-Site - Risk Quotients for Non-Target Terrestrial Plants.



5.0 SENSITIVITY ANALYSIS

The sensitivity analysis was designed to determine which factors, from 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 the 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 2005b). This section provides information specific to the sensitivity of each of these models to select input variables.

5.1 GLEAMS

GLEAMS is a model developed for field-size 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 ground water flow of herbicide resulting from edge-of-field and bottom-of-root-zone loadings of water, sediment, pesticides, and plant nutrients from the complex climate-soil-management interactions. Agricultural pesticides are simulated by the GLEAMS using three major components including hydrology, erosion, and pesticides. This section describes the sensitivity of model input to 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 ac, 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 erosive 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 ac 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 m³, 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 concentration was investigated by simulating different soil types within the application area. In this sensitivity analysis, clay, loam, and sand were evaluated.
8. Vegetation Type – Because vegetation type 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 evaluated 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 ac;
- slope of 0.05;
- roughness of 0.015;
- erodibility of 0.401 tons per ac 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 greater than 1.0 denote a positive relationship between herbicide concentration and the variable (increase in RQ) and values less than 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 related to herbicide exposure concentrations; as these factors increase, so do herbicide 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 herbicide concentrations and ecological risk. Changing from base case loam soils to sand, clay, clay loam, silt loam, or silt soils produced increased concentrations 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-target spray drift of herbicides. Predicted off-target 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 et al. 1998; Teske and Thistle 1999, as cited in SDTF 2002). 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 greater than 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 less than 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 decrease 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. Predicted concentrations were greater with high vs. low boom height (Table 5-3); therefore, ecological risk 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 application rates (Table 5-3). Maximum application rate concentrations were approximately three times greater than concentrations using the typical application rate. Mode of application scenarios were not tested in this sensitivity analysis since only ground applications are used by the BLM to disperse diuron. 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 2005b). 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.

ENSR
INTERNATIONAL

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	6.30E-06	5.01E-04	8.78E-04	8.36E-03	139.43	16.70	+	+
Area	acres	1	1000	2.60E-05	4.11E-04	3.50E-03	2.55E-02	134.39	61.96	+	+
Slope	unitless	0.005	0.1	2.30E-04	2.89E-03	2.33E-04	3.06E-03	1.016	1.058	+	+
Erodibility	tons/acre per English EI	0.05	0.5	2.30E-04	2.89E-03	2.31E-04	2.90E-03	1.005	1.002	+	+
Roughness	unitless	0.015	0.15	2.31E-04	2.90E-03	2.30E-04	2.89E-03	0.995	0.997	-	-
Flow Rate	m ³ /sec	0.05	100	4.85E-04	5.82E-03	3.18E-07	5.20E-06	0.001	0.001	-	-
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	6.09E-04	5.05E-03	4.19E-02	1.03E-01	68.73	20.48	+	+
Area	acres	1	1000	8.04E-03	1.49E-02	2.33E-02	3.95E-02	2.90	2.65	+	+
Slope	unitless	0.005	0.1	1.92E-02	5.00E-02	1.93E-02	5.69E-02	1.006	1.136	+	+
Erodibility	tons/acre per English EI	0.05	0.5	1.92E-02	5.01E-02	1.92E-02	5.22E-02	1.002	1.043	+	+
Roughness	unitless	0.015	0.15	1.92E-02	5.27E-02	1.92E-02	5.02E-02	0.998	0.953	-	-
Pond Volume	ac/ft	0.05	100	2.09E-02	4.79E-02	5.48E-05	1.08E-04	0.003	0.002	-	-
Concentrations were based on the average application 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

Soil Type	Predicted Concentration				Concentration $\times$ Soil Type / Concentration $_{Loam}$				Relative Change in Concentration			
	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
<i>Loam</i> ¹	2.31E-04	2.90E-03	1.92E-02	5.27E-02	NA	NA	NA	NA	NA	NA	NA	NA
Sand	1.64E-03	2.80E-02	1.36E-01	2.01E-01	7.1132	9.6547	7.0809	3.8108	+	+	+	+
Clay	3.28E-04	1.66E-02	2.52E-02	4.59E-01	1.4177	5.7246	1.3128	8.7009	+	+	+	+
Clay Loam	3.16E-04	1.44E-02	2.98E-02	2.44E-01	1.3671	4.9473	1.5517	4.6351	+	+	+	+
Silt Loam	1.59E-04	8.21E-03	1.27E-02	1.51E-01	0.6867	2.8303	0.6591	2.8623	-	+	-	+
Silt	1.37E-04	7.81E-03	9.34E-03	1.32E-01	0.5914	2.6897	0.4858	2.5139	-	+	-	+

Vegetation Type	Predicted Concentration				Concentration $\times$ Veg Type / Concentration $_{Weeds}$				Relative Change in Concentration			
	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
<i>Weeds</i> ¹	2.31E-04	2.90E-03	1.92E-02	5.27E-02	NA	NA	NA	NA	NA	NA	NA	NA
Conifer + Hardwood	3.31E-04	3.81E-03	2.58E-02	5.90E-02	1.4325	1.3114	1.3447	1.1202	+	+	+	+
Shrubs	2.32E-04	2.91E-03	1.93E-02	5.27E-02	1.0018	1.0023	1.0019	1.0009	+	+	+	+
Rye Grass	2.31E-04	2.91E-03	1.92E-02	5.27E-02	1.0016	1.0019	1.0016	1.0008	+	+	+	+

¹ Base Case

Concentrations were based on the average application rate.

+ = 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

				Minimum Downwind Distance Concentration			Maximum Downwind Distance Concentration		
Mode of Application	Application Height/Veg. Type	Minimum Downwind Distance (ft)	Maximum Downwind Distance (ft)	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	7.54E-02	3.75E-02	4.09E-03	4.10E-03	1.14E-03	4.33E-04
	High Boom	25	900	1.25E-01	6.28E-02	6.57E-03	5.20E-03	1.50E-03	5.49E-04
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	2.51E-01	1.25E-01	1.36E-02	1.36E-02	3.79E-03	1.44E-03
	High Boom	25	900	4.15E-01	2.10E-01	2.19E-02	1.75E-02	5.02E-03	1.83E-03

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

Effect of Downwind Distance

Mode of Application	Application Height or Vegetation Type	Minimum Buffer	Maximum Buffer	Concentration ₉₀₀ /Concentration ₂₅			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	0.0544	0.0304	0.1059	-	-	-
	High Boom	25	900	0.0417	0.0240	0.0836	-	-	-
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	0.0541	0.0303	0.1059	-	-	-
	High Boom	25	900	0.0421	0.0239	0.0836	-	-	-

Mode of Application	Application Height or Vegetation Type	Concentration Ratio 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	1.6525	1.6729	1.6064	+	+	+
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	1.6526	1.6749	1.6103	+	+	+

	Concentration Ratio ²			Relative Change in Concentration		
	Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Maximum vs. Typical	3.3331	3.3373	3.3333	+	+	+
(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 an herbicide by simulating scenarios where the organism lives year-round in the most affected area (i.e., area of highest concentration), or that the organism consumes only food items that have been impacted by the herbicide. The diuron screening level ERA incorporates additional conservatism in the assumptions used in the herbicide concentration models such as GLEAMS (Appendix B; ENSR 2005b). Even with highly conservative assumptions in the ERA, however, 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 evaluation³ 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

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.

concern, and the surrogates used to represent them (6.2.2), and the biological factors that affect the exposure to and 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 to RTE Species

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 diuron ERA by comparing calculated RQs to receptor-specific LOCs. As described in the methodology document for this ERA (ENSR 2005b), 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 0.1 provides the same result as dividing the TRV by 10. The LOC for avian and mammalian RTE species is 0.1 for acute and 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 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, the 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 (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 managed by the BLM. These species include 7 amphibians, 19 birds, 6 crustaceans, 65 fish, 30 mammals, 10 insects, 13 mollusks, 5 reptiles, and 151 plants⁴. Protection of these species is an integral goal of the BLM, 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

⁴ The number of RTE species may have changed slightly since the writing of this document.

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 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 2005b), 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 ERA. Many of these species are common laboratory species, or are described in USEPA (1993a, b) 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 in two ways in the ERA: (1) TRVs were derived using surrogate species toxicity data, and (2) 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 mammalian and avian 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.

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

The TRVs used in the ERA were selected after reviewing available ecotoxicological literature for diuron. 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 diuron TRVs are presented in Table 6-1.

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; that is, 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 food 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 LD₅₀ values from six organochlorine pesticides were compared to avian LD₅₀ values. Of the six pesticides, five lizard LD₅₀s 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-methylphenoxyacetic acid (MCPA) is relatively non-toxic to the African clawed frog (*Xenopus laevis*) with an LC₅₀ 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 diuron 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 cycles, making them vulnerable to developmental defects during the many stages of metamorphosis. However,

there is no evidence that the organisms evaluated in the ERA fail to provide reasonable protection as surrogates. Given the very low risks to animals in the modeled exposures, it is unlikely the concentrations of diuron predicted to occur as a result of regular herbicide usage would cause adverse effects to amphibians. Nonetheless, it should be noted that certain amphibians can be sensitive to pesticides, and site- and species-specific risk assessment should be carefully considered in the event that amphibian RTE species are present near a site of application.

Although the uncertainties associated with potential overestimates of risk to RTE mammals, birds, reptiles, and amphibians are valid, the vertebrate RQs generated in the ERA for diuron are generally low (Section 4.3). None of the piscivore (fish-eating) bird RQs exceed respective LOCs. However, there were several scenarios where RQs were elevated above LOCs. Of the four general scenarios in which vertebrate receptors were evaluated, the highest RQs were due to direct spray exposure. RQs for all of the receptors evaluated exceeded their respective LOCs for either the acute or chronic scenario at the maximum application rate. At the typical application rate, RQs for two acute exposures (large mammalian herbivore and large avian herbivore) and two chronic exposures (large mammalian herbivore and large mammalian carnivore) exceeded their respective LOCs. Fish RQ exceedances were most notable in the exposure from runoff to a pond and in the accidental direct spray or spill scenarios. (It is unknown how much of an effect the conditions creating uncertainties had on vertebrate RQs.)

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 2005b), and 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 in order to assess whether a site- and species-specific ERA should be considered to address potential risks to a given RTE. 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 (e.g., species and toxicity endpoint) to another (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 Kaputka 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 ERA 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 judgment, and (6) extrapolating laboratory data to field conditions. No extrapolation of toxicity data among Classes (i.e., between 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 discussed in this section.

Empirical data for each of the situations discussed in the Fairbrother and Kaputka paper (as applicable) are presented in Tables 6-8 through 6-12. In each of these tables, Fairbrother and Kaputka (1996) have presented the percentage of the available data that is included within a stated factor. For example, 90% of the observed LD₅₀ for bird species lie within a factor of ten (i.e., the highest LD₅₀ within the central 90% of the population is 10-fold higher than the lowest value). This can be compared to the approach used in this ERA. For example, for aquatic invertebrates, a LOC was defined of 0.05. This is analogous to application of an uncertainty factor 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 Kaputka (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 approach⁴, 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 Kaputka 1996).

⁶ Section 2, Fairbrother and Kaputka 1996. Page 7.

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 LD₅₀s varied from 1 to 1.55, with a mean of 1.148. The LD₅₀ for birds is now recommended to be 1 across all species.

6.3.3 Recommendations

Fairbrother and Kaputka (1996) provided a critical evaluation of the existing, proposed, and potential means for intra-species toxicity value extrapolation. The paper they published describes the shortcomings of many methods of intra-specific 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 food. 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 NOAA Fisheries (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 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 diuron on BLM-managed lands would not cause harm to these endangered fish.

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 habitat⁸ (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 diuron 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. Few diuron RQs for fish in a stream exceeded the respective RTE LOCs (Section 4.3). RQs from spray drift at 25 ft, accidental direct spray of a stream, and acute toxicity from runoff, particularly at the maximum application rate, were the exception. 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 consists of 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 at the population or community level, not the individual level. 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, aquatic invertebrate and fish, acute or chronic scenario RQs for exposure in a

⁸ Physical damage to habitat may also be covered under an evaluation of critical habitat. Since all reaches of streams and rivers on BLM 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.

stream exceeded respective LOCs primarily at the maximum application rate, suggesting potential direct impacts to the forage of salmonids in certain situations.

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, the potential for risk to aquatic vegetation may occur under all exposure scenarios evaluated in the ERA. The greatest potential for risk to aquatic vegetation would occur under accidental direct spray or spill of a terrestrial herbicide into an aquatic system. RQs exceeded LOCs by up to four orders of magnitude under the spill and accidental spray scenarios. RQs in the runoff and drift to the stream scenarios exceeded LOCs by up to two orders of magnitude. This suggests that there is potential for impacts to aquatic vegetation, and potential indirect effects on salmonids, from the use of diuron.

The actual food items of many aquatic invertebrates, however, are not leafy aquatic vegetation, but detritus or benthic algae. If aquatic vegetation is affected by an accidental herbicide exposure, the detritus in the stream should increase. Benthic algae are often the principal primary producers in streams. As such, disturbance of algal communities would cause an indirect effect (via a reduction in biomass at the base of the food chain) on all organisms living in the waterbody, including salmonids. Few data are available describing the herbicide's toxicity to benthic algae. Of the algae data available for diuron, the closest species to benthic algae (*Chlorella pyrenoidosa* and *Selenastrum capricornutum*) have an EC₅₀ of 0.0013 mg/L and a NOAEL of 0.00044 mg/L, respectively. It is unknown if benthic algae would be more or less sensitive than *Chlorella pyrenoidosa* or *Selenastrum capricornutum*, the species used to derive the acute and chronic aquatic plant TRVs.

As presented in Section 7.3.3.2, diuron may be used alone by BLM or in a tank mix with chlorsulfuron (Lee 2004, personal communication). However, none of the RQs for fish, aquatic invertebrates, aquatic plants, or vertebrate wildlife that were below their respective LOCs in the diuron-only calculations increased to above their respective LOCs in the tank mix calculations.

Based on an evaluation of the RQs calculated for this ERA, there is the potential that RTE fish, including salmonids, would be at indirect risk as a result of the effects of this herbicide (applied alone or in a mix with chlorsulfuron) on the aquatic food chain.

6.4.2 Physical Disturbance

The potential for indirect effects to salmonids due to physical disturbance is less easy to define than the potential for direct biological effects. Salmonids have distinct habitat requirements; any 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. Out of the potential effects of herbicide application, it is likely the killing of instream and riparian vegetation would cause the most important physical disturbances. The potential adverse effects could include, but would not necessarily be limited to: loss of primary producers (Section 6.4.1); 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.

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 burning⁹. 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 The following website provides a more detailed discussion of CWEs http://www.humboldt1.com/~heyenga/Herb.Drft.8_12_99.html.

Based on the results of the ERA, there is potential for non-target terrestrial and aquatic plant risk in certain circumstances, such as incidents of spills or accidental direct spray (Sections 4.3.1 and 4.3.5). In addition, potential risk to typical non-target plants is predicted in drift scenarios when the herbicide was applied 25 ft or 100 ft from the receptor. Potential risk to non-target RTE terrestrial plants may occur from drift 900 ft from the receptor, and in selected runoff scenarios. Having said this, land managers should consider the proximity of salmonid habitat to potential application areas. 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 diuron 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.

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; uncertainty factors were applied to toxicity data consistent with recommendation of Chapman et al. (1998).

Potential secondary effects of diuron 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 declines of populations and 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 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 diuron, especially when accidents occur, such as spills or accidental spraying. Typical and accidental application of diuron also pose some risks to fish (including RTE salmonids) and aquatic invertebrates, both directly and indirectly via impacts to aquatic plants and other food items for fish.

In August 2003, the OPP evaluated the potential for diuron to impact certain Pacific anadromous salmonids (specifically Pacific salmon and steelhead) and their critical habitats in California and southern Oregon. The OPP concluded that the non-crop use of diuron has the potential to affect selected habitats. In particular, the OPP indicated the potential for acute risks to RTE fish species and the potential for indirect effects on aquatic plant cover (Turner 2003b). In a separate evaluation, OPP also indicated that “for most pesticides applied to the terrestrial environment, the effects in water, even lentic water, will be relatively transient” (Turner 2003a). Only very persistent pesticides would be expected to have effects beyond the year of their application.

Based on the results of the ERA, there is potential RTE species may be harmed by inappropriate and irresponsible use of the herbicide diuron on BLM-managed lands. However, 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 would reduce this risk (see Section 8).

TABLE 6-1
Surrogate Species Used to Derive Diuron TRVs

Species in Diuron Laboratory/Toxicity Studies		Surrogate for
Honeybee	<i>Apis mellifera</i>	Pollinating insects
Rat	<i>Rattus norvegicus</i> spp.	Mammals
Dog	<i>Canis familiaris</i>	Mammals
Mallard	<i>Anas platyrhynchos</i>	Birds
Bobwhite Quail	<i>Colinus virginianus</i>	Birds
Tomato	<i>Lycopersicon esculentum</i>	Non-target terrestrial plants
Garden pea	<i>Pisum sativum</i>	Non-target terrestrial plants
Soybean	<i>Glycine max</i>	Non-target terrestrial plants
Scud	<i>Gammarus fasciatus</i>	Aquatic invertebrates
Daphnid	<i>Daphnia magna</i>	Aquatic invertebrates
Cutthroat trout	<i>Oncorhynchus clarki</i>	Fish/Salmonids
Algae	<i>Chlorella pyrenoidosa</i>	Non-target aquatic plants
Fathead minnow	<i>Pimephales promelas</i>	Fish
Green algae	<i>Selanastrum capricornutum</i>	Non-target aquatic plants

TABLE 6-2
Surrogate Species Used in Quantitative ERA Evaluation

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

TABLE 6-3
RTE Birds and Selected Surrogates

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

TABLE 6-4
RTE Mammals and Selected Surrogates

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

TABLE 6-5
RTE Reptiles and Selected Surrogates

RTE Reptilian Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
New Mexican ridge-nosed rattlesnake	<i>Crotalus willardi obscurus</i>	Carnivore/Insectivore	Coyote/Bald eagle American robin
Blunt-nosed leopard lizard	<i>Gambelia silus</i>	Carnivore/Insectivore	Coyote/Bald eagle American robin
Desert tortoise	<i>Gopherus agassizii</i>	Herbivore	Canada goose
Giant garter snake	<i>Thamnophis gigas</i>	Carnivore/Insectivore/Piscivore	Coyote American robin Bald eagle
Coachella Valley fringe-toed lizard	<i>Uma inornata</i>	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
RTE Amphibians and Selected Surrogates

RTE Amphibious Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
California tiger salamander	<i>Ambystoma californiense</i>	Invertivore ¹	Bluegill sunfish/Rainbow trout ³
		Vermivore ²	American robin ⁴
Sonoran tiger salamander	<i>Ambystoma tigrinum stebbinsi</i>	Invertivore/Insectivore ¹	Bluegill sunfish/Rainbow trout ³
		Carnivore/Ranivore ²	American robin ⁴
Desert slender salamander	<i>Batrachoseps aridus</i>	Invertivore	American robin ^{4,5}
Wyoming toad	<i>Bufo baxteri</i>	Insectivore	Bluegill sunfish/Rainbow trout ³
			American robin ⁴
Arroyo toad (=Arroyo southwestern toad)	<i>Bufo californicus</i>	Herbivore ¹	Bluegill sunfish/Rainbow trout ³
		Invertivore ²	American robin ⁴
California red-legged frog	<i>Rana aurora draytonii</i>	Herbivore ¹	Bluegill sunfish/Rainbow trout ³
		Invertivore ²	American robin ⁴
Chiricahua leopard frog	<i>Rana chiricahuensis</i>	Herbivore ¹	Bluegill sunfish/Rainbow trout ³
		Invertivore ²	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 <i>Bratrachoseps aridus</i> 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 Kaputka 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 Kaputka 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 Kaputka 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 Kaputka 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) the bias is 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 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 was 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 actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).

Thirty-five diuron 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/or hazards to ecological receptors. These reports, described in Section 2.3, indicated diuron as the “probable” cause in 13 incidents and the “possible” cause in 19 incidents. Three incident reports indicated that it was “highly probable” that the use of diuron resulted in the observed effects. One incident implicated the registered use of both diuron and bromacil in the plant damage of grasses due to drift and runoff in 1998. One incident implicated the misuse of both diuron and imazapic, which is believed to be responsible for mortality of birch and willow trees from drift and direct contact in 1997. The third incident where diuron was implicated as a “highly probable” cause, was the accidental use of diuron, which resulted in the mortality of 1000 fish due to runoff in 1975. As described in Table 2-2, effects included partial dieback of flora and mortality of multiple species of fish. These incident reports support the elevated RQs predicted by the ERA for impacts to aquatic species and terrestrial plants due to drift, runoff, or accidental exposures (i.e., spills or direct spray). However, since the incident reports generally provide limited information (e.g., no tissue or soil concentrations), and diuron may have been mixed with other products, it is impossible to fully correlate the impacts predicted in the ERA with the incident reports.

Species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide. These species have been selected as laboratory test organisms because they are generally sensitive to stressors, yet they can be maintained under laboratory conditions. However, the selected toxicity value for a receptor was based on a thorough review of the available data by qualified toxicologists and the selection of the most appropriate sensitive surrogate species. The surrogate species used in the registration testing are not an exact match to the wildlife receptors included in the ERA. For example, the only avian data available is 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. Species with alternative feeding habits or species from different taxonomic groups may be more or less sensitive to the herbicide than those species tested in the laboratory.

As discussed previously, plant toxicity data is generally only available for crop species which may have different sensitivities than the non-crop plants occurring on BLM managed lands. According to the herbicide label, diuron products are approved for the control of annual and perennial grasses and herbaceous weeds. However, it is possible that non-cropland plants and grasses are not as sensitive to diuron as the selected broadleaf surrogate plant species.

In general, the most sensitive available endpoint for the appropriate surrogate test species was used to derive TRVs. This approach is conservative since there may be a wide range of data and effects for different species. For example, EC₅₀s or LC₅₀s were available for six species of aquatic invertebrates. These values ranged from 0.16 mg/L for an amphipod (*Gammarus fasciatus*), to 19.4 mg/L for another amphipod (*Hyalella azteca*). Accordingly, 0.16 mg /L was selected as the aquatic invertebrate TRV, even though the majority of results were well above this value. This selection criterion for the TRVs has the potential to overestimate risk within the ERA.

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 LD₅₀ 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 LD₅₀ 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 LC₅₀ 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 2005b)¹⁰. Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD₅₀ value representing the full herbicide exposure over the course of the test.

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 active ingredients 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 active ingredients 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.

For diuron, the % active ingredients, listed in Appendix A when available from the reviewed study, ranged from 28% to 100%. The lowest % a.i. used in the actual TRV derivation was 95% in some studies used to derive TRVs for aquatic receptors. Adjusting these TRVs to 100% of the a.i. (by multiplying the TRV by the % a.i. in the study) would reduce these TRVs slightly, resulting in slightly more elevated RQs. However, this would not result in any additional

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

LOC exceedances. The remaining TRVs are based on studies with even higher percentages of a.i. so the RQ changes would be even more minimal.

7.2 Potential Indirect Effects on Salmonids

No actual field studies or ecological incident reports on the effects of diuron on salmonids were identified during the ERA. Therefore, any discussion of direct or indirect impacts to salmonids was limited to qualitative estimates of potential impacts on salmonid populations and communities. Salmonids were included in the derivation of the fish TRVs. The acute TRV was based on salmonid data, but the chronic TRV was based on toxicity testing with a warmwater species. Therefore, chronic risks to salmonids may be overestimated by the use of the warmwater chronic TRV. 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 may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates) or a reduction in vegetative cover under limited conditions.

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, Inert Ingredients, Adjuvants, and Mixtures

In a detailed herbicide risk assessment, it is preferable to estimate risks not just from the a.i. of an herbicide, but also from the cumulative risks of inert ingredients, adjuvants, surfactants, and degradates. Other herbicides may also factor into the risk estimates, as many herbicides can be tank mixed to expand the level of control and to accomplish multiple identified tasks. However, using currently available models (e.g., GLEAMS), it is only practical to calculate deterministic risk calculations (i.e., exposure modeling, effects assessment, and RQ calculations) for a single a.i..

In addition, information on inerts, adjuvants, 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 effects for risks due to degradates, inert ingredients, adjuvants, and tank mixtures.

7.3.1 Degradates

The potential toxicity of degradates, also called herbicide transformation products (TPs), should be considered when selecting an herbicide; however, it is beyond the scope of this risk assessment to evaluate all of the possible degradates of the various herbicide formulations containing diuron. 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 due to 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 with acute toxicity values below 1.0 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 diuron represents a source of uncertainty in the risk assessment.

7.3.2 Inerts

Pesticide products contain both active and inert ingredients. The terms “a.i.” and “inert ingredient” have been defined by Federal law—the FIFRA—since 1947. An a.i. is one that prevents, destroys, repels or mitigates the effects of 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, together 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 misled by the term “inert ingredient,” believing it to mean “harmless.” Since 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 the USEPA to review CBI on inert compounds in the following herbicides under consideration in ERAs: bromacil, chlorsulfuron, diflufenopyr, Overdrive® (a mix of dicamba and diflufenopyr), 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, and is therefore not disclosed in this document. However, a review of available data 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 in the following sources:

- TOMES (a proprietary toxicological database including EPA’s 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 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 Muller (1980), Lewis (1991), Dorn et al. (1997), and Wong et al. (1997) concerning aquatic toxicity of surfactants. These sources 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.

Appendix D presents the following general observation for diuron: higher application rates for diuron yielded higher exposure concentrations of surfactant inerts, exceeding 1.0 mg/L for the maximum pond scenario. This indicates that inerts associated with the application of diuron may increase acute toxicity to aquatic organisms if they reach the aquatic environment. Because of the lack of specific inert toxicity data, it is not possible to state that the inerts in diuron 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 and Tank Mixtures

Evaluating the potential additional/cumulative risks from mixtures and adjuvants of pesticides is substantially more difficult than evaluating the inerts in the herbicide composition. While many herbicides are present in the natural environment along with other pesticides and toxic chemicals, the composition of such mixtures is highly site-specific, and thus nearly impossible to address at the level of the programmatic EIS.

Herbicide label information indicates whether the herbicide can be tank mixed with other pesticides. Adjuvants (e.g., surfactants, crop oil concentrates, fertilizers) may also be added to the spray mixture to improve herbicide efficacy. 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 allowed a determination of whether the joint action of the mixture was additive, synergistic, or antagonistic. Such evidence is not likely to exist unless the mode of action is common among the chemicals and receptors.

7.3.3.1 Adjuvants

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 types of adjuvants are approved for use with that herbicide.

In reviewing the labels of several diuron formulations (for non-cropland applications), a nonionic surfactant was identified as the only adjuvant listed for use with the particular formulations. 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. 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 50 inches of precipitation 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 application rate recommended for nonionic surfactants, 0.5% v/v, and the maximum application rate for diuron, the maximum predicted concentration would be 6.9 mg/L. This value is within the range for acute toxicity to aquatic life for surfactants and anti-foam agents (1 to 10 mg/L) and above the level associated with chronic effects (0.1 mg/L). This indicates that surfactants associated with the use of diuron have the potential for negative impacts to aquatic life if they reach a downgradient waterbody.

This evaluation indicates that adjuvants may add some uncertainty to the level of risk predicted for the a.i.. 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.

7.3.3.2 Tank Mixtures

In reviewing the labels of several formulations of diuron, it is noted that this a.i. can be tank mixed with several other active ingredients, including: chlorsulfuron, imazapyr, and sulfometuron-methyl. However, it is not generally within BLM practice to tank mix diuron with these products. The use of tank mixtures of labeled herbicides, along with the addition of an adjuvant (when stated on the label) may be an efficient use of equipment and personnel. However, knowledge of both products and their interactions is necessary to avoid unintended negative effects. In general, herbicide interactions can be classified as additive, synergistic, or antagonistic:

- Additive effects occur when mixing two herbicides produces a response equal to the combined effects of each herbicide applied alone. The products neither hurt nor enhance each other.
- Synergistic responses occur when two herbicides provide a greater response than the added effects of each herbicide applied separately.
- Antagonistic responses occur when two herbicides applied together produce less control than if you applied each herbicide separately.

These types of interactions also describe the potential changes to the toxic effects of the individual herbicides and the tank mixture (i.e., the mixture may have more or less toxicity than either of the individual products). While a quantitative evaluation of all of these mixtures is beyond the scope of this ERA, a qualitative evaluation may be made if the assumption is made that the products in the tank mix will act in an additive manner. The predicted RQs for two a.i.s can be summed for each individual exposure scenario to see if the combined impacts result in additional RQs elevated over the corresponding LOCs.

In order to evaluate a common and representative tank mix scenario, the ERA evaluated a mixture with diuron and chlorsulfuron (a.i.s in the herbicide Telar DF). The RQs for these two chemicals were calculated for the ground applications described in Section 4.2.1 and combined to simulate a tank mix in Appendix E. A comparison of the RQs exceeding the LOCs for diuron applied alone and as a tank mix with chlorsulfuron is presented in Table 7-2. This comparison indicates that the tank mix does not generally predict more RQs above the associated LOCs than were predicted for diuron alone. The number of elevated RQs for typical terrestrial plant species does increase slightly with the use of the tank mix (from 6.0% to 10.3%). This indicates that the addition of chlorsulfuron in a tank mix does not

generally result in any additional risks than diuron alone; however, a slight increase in risks to typical terrestrial plant species may occur with the use of the tank mix. There is some uncertainty in this evaluation because these herbicides may not interact in an additive manner. This may overestimate risk if the interaction is antagonistic, or it may underestimate risk if the interaction is synergistic. In addition, other products may also be included in tank mixes and may contribute to the potential risk.

Selection of tank mixes, like adjuvants, is under the control of BLM land managers. To reduce uncertainties and potential negative impacts, it is required that land managers follow all label instructions and abide by any warnings. Labels for both tank mixed products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected. This is especially relevant when a mixture is applied in a manner that may already have the potential for risk for an individual herbicide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions increases the level of uncertainty in risk to the environment.

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 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. The results of this uncertainty analysis have 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 perspective.

7.4.1 AgDRIFT®

Off-target 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 about 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 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 US. 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 US. Furthermore, the study indicated that the runoff potential was a critical factor affecting herbicide transport. Table 7-3 is a statistical summary of the GLEAMS predicted total 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 an 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 model predicted that 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 study, the median total loss rates predicted using GLEAMS are substantially higher. This discrepancy 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 partially a result of 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 US, 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 water body. 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 over-estimate of likely impacts in most settings on BLM lands.

7.4.3 CALPUFF

The USEPA's CALPUFF air pollutant dispersion model was used to predict impacts of 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-managed 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 application. Thus, the model likely overpredicts 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) 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 since no relevant studies or incident reports were identified; it is likely that this qualitative evaluation overestimates the potential risk to salmonids due to 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, Adjuvants, and Tank Mixtures** - Only limited information is available regarding the toxicological effects of degradates, inerts, adjuvants, and tank mixtures; in general, it is unlikely that highly toxic degradates or inerts are present in approved herbicides; selection of tank mixes and 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 due to 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 (e.g., 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 terrestrial or aquatic area (home range = application area)	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 food receptors may result in sickness or mortality. Fewer prey items would be available for predators. Predators may stop foraging in areas with reduced prey populations, discriminate against, or conversely, select contaminated prey.
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.

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

Potential Source of Uncertainty	Direction of Effect	Justification
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 the full predicted EEC.
Over-simplification of dietary composition in the food web models	Unknown	Assumptions were made that contaminated food items (e.g., 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 (e.g., for amphibians), these exposure pathways may occur.
Amount of receptor's body exposed	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.
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 that 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 overestimate effects since 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.

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

Potential Source of Uncertainty	Direction of Effect	Justification
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 was 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.
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; this 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 a.i. has been investigated in the ERA. Inerts, adjuvants, and tank mixtures may increase or decrease the impacts of the a.i.. These uncertainties are discussed further in Section 7.3.

TABLE 7-2
Changes in RQs Exceeding LOCs for Tank Mixtures

Receptor	LOC	Number of RQs Exceeding LOC		% of Total RQs Exceeding LOC		
		Diuron RQs : Total RQs	Tank Mix RQs ¹ : Total RQs	Diuron	Tank Mix ¹	
Terrestrial Animals						
Birds and Wild Mammals						
Acute High	0.50	5:118	5:118	4.2	4.2	
Acute Restricted	0.20	7:118	7:118	5.9	5.9	
Acute RTE	0.10	8:118	8:118	6.8	6.8	
Chronic	1.00	8:10	8:10	80.0	80.0	
Terrestrial Plants						
Typical Species						
Acute High	1.00	7:116	12:116	6.0	10.3	
Acute RTE	1.00	7:116	12:116	6.0	10.3	
RTE Species						
Acute High	1.00	26:116	26:116	22.4	22.4	
Acute RTE	1.00	26:116	26:116	22.4	22.4	
Aquatic Receptors						
Fish and Invertebrates						
Acute High	0.50	97:394	97:394	24.6	24.6	
Acute Restricted	0.10	186:394	186:394	47.2	47.2	
Acute RTE	0.05	235:394	235:394	59.6	59.6	
Chronic	1.00	72:392	88:392	18.4	22.4	
Chronic RTE	0.50	121:392	127:392	30.9	32.4	
Plants						
Acute High	1.00	172:197	172:197	87.3	87.3	
Acute RTE	1.00	172:197	172:197	87.3	87.3	
RQ sums include RQs for both typical and maximum application rates.						
¹ Tank mix with chlorsulfuron.						

TABLE 7-3
Herbicide Loss Rates Predicted by the GLEAMS Model

Herbicide	Total Loss Rate			Runoff Loss Rate		
	Median	90 th	Maximum	Median	90 th	Maximum
Diflufenzopyr	0.27%	22%	54%	0.27%	6.0%	22%
Diuron	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 diuron, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed 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) and selected off-site transport scenarios. Risk was also predicted for fish and aquatic invertebrates under the accidental exposure scenarios.

The following bullets further summarize the risk assessment findings for diuron under evaluated exposure scenarios:

- Direct Spray – Risk to insects may occur when individuals or foliage are directly sprayed. Acute and chronic risks to terrestrial wildlife species may occur when contaminated food items are consumed. Risk to terrestrial and aquatic non-target plants, fish, and aquatic invertebrates is likely in accidental direct spray scenarios.
- Off-Site Drift – Risk to typical non-target terrestrial plant species was predicted within 100 ft of the application area (mostly at the maximum application rate), while risk to non-target RTE terrestrial plant species may occur for any of the modeled ground application scenarios. Risk to aquatic plants was predicted for all scenarios at the maximum application rate (except for acute risk in the stream with a buffer distance of 900 ft) and for distances less than or equal to 100 ft at the typical application rate (chronic risk in the pond also predicted at 900 ft for high boom application). Acute and chronic risks were predicted for fish within 25 ft of the application area (at maximum application rates). Risks were also predicted for aquatic invertebrates 25 ft from application with a low boom and 100 ft from application with a high boom. No risks were predicted to piscivorous birds.
- Surface Runoff – No risks to typical non-target terrestrial plants were predicted; risks to RTE terrestrial plants were predicted in watersheds with clay soils or clay loam soils and annual precipitation of at least 50 inches and in watersheds with loam soils and annual precipitation of at least 200 inches. Risks to aquatic species were not predicted for watersheds with very little precipitation (less than 5 inches per year). However, risks to aquatic plants and to pond-dwelling fish and aquatic invertebrates occur under most other modeled scenarios. In addition, acute risks to fish in the stream were predicted in several watersheds with at least 25 inches of rain per year (mostly at the maximum application rate), and acute risks to aquatic invertebrates were predicted at the typical and maximum application rates in watersheds with at least 10 inches of precipitation per year (effects were less likely in watersheds with loam soils). No chronic risk to fish or aquatic invertebrates were predicted in the stream, and no risks were predicted 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 fish, aquatic invertebrates, and non-target aquatic plants occurs when herbicides are spilled directly into the pond.

In addition, species that depend on non-target species for habitat, cover, and/or food (e.g., RTE salmonids) may be indirectly impacted by possible reductions in terrestrial or aquatic vegetation or effects on terrestrial and aquatic wildlife, particularly in accidental direct spray and spill scenarios.

Based on the results of the ERA, it is unlikely RTE species would be harmed by *appropriate* use (see following section) of the herbicide diuron on BLM-managed lands. Adherence to certain application guidelines (e.g., defined

application rates, equipment, herbicide mixture, downwind distance to potentially sensitive habitat, avoidance of critical habitat) can minimize the potential effects on non-target species from regular application.

8.1 Recommendations

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

- Select herbicide products carefully to minimize additional impacts from adjuvants and tank mixtures. This is especially important for application scenarios that already predict potential risk from the a.i..
- 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 to reduce risk for off-site drift and surface runoff exposures.
- Establish the following buffer zones during ground applications (using the typical application rates) to reduce impacts to aquatic areas due to off-site drift.
 - Application by low boom (spray boom height set at 20 inches above the ground) – more than 100 ft from pond or stream (no risk was predicted at 900 ft).
 - Application by high boom (spray boom height set at 50 inches above the ground) – more than 100 ft from stream (no risk was predicted at 900 ft).
 - Application by high boom – more than 1,000 ft from pond (chronic risk to aquatic plants is still predicted at 900 ft; simple regression analysis predicts an RQ of 1 for aquatic plants with a buffer zone of just over 1,000 ft at the maximum application rate).
- Limit the use of diuron in terrestrial habitats if potential impacts to RTE species are of concern.
- For all ground applications of diuron, a buffer zone of more than 1,000 ft from non-target terrestrial species is necessary to limit impacts to RTE terrestrial plants (risk to RTE plants is still predicted at 900 ft; simple regression analysis predicts an RQ of 1 for RTE plants with a buffer zone of just over 1,000 ft at the maximum application rate).
 - If no RTE species are present, terrestrial plants are protected by a buffer zone of 100 ft at the typical application rate and approximately 500 ft at the maximum rate (based on regression evaluation). Less risk is predicted from the use of a low boom for ground application at the typical application rate, and risk may be reduced if diuron is applied on foot or horseback with backpack sprayers.
- Application of diuron should be carefully limited to days without predicted winds.
- Limit the use of diuron in watersheds with downgradient ponds or streams (especially at the maximum application rate) if potential impacts to aquatic species are of concern (less risk predicted in streams than ponds). Carefully evaluate watershed characteristics when RTE salmonids are present in streams (low risk is only found with larger buffer zones in watersheds with low annual precipitation and in some watersheds with loam soils).

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute 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 diuron 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 Diuron 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	0	NA	NA	NA	NA	NA	NA
	[12: 16]	[6: 16]						
Terrestrial Plants (Typical Species)	M	H	0	L	0	0	0	0
	[1: 1]	[1: 1]	[5: 6]	[4: 6]	[42: 42]	[42: 42]	[9: 9]	[9: 9]
Terrestrial Plants (RTE Species)	H	H	M	H	0	0	0	0
	[1: 1]	[1: 1]	[3: 6]	[3: 6]	[38: 42]	[34: 42]	[9: 9]	[9: 9]
Fish In The Pond	M	H	0	0	L	L	NA	NA
	[2: 2]	[1: 2]	[12: 12]	[11: 12]	[60: 84]	[48: 84]		
Fish In The Stream	H	H	0	0	0	0	NA	NA
	[1: 1]	[1: 1]	[12: 12]	[9: 12]	[81: 84]	[68: 84]		
Aquatic Invertebrates In The Pond	M	H	0	0	0	L	NA	NA
	[2: 2]	[1: 2]	[12: 12]	[9: 12]	[38: 84]	[34: 84]		
Aquatic Invertebrates In The Stream	H	H	0	0	0	0	NA	NA
	[1: 1]	[1: 1]	[11: 12]	[8: 12]	[66: 84]	[49: 84]		
Aquatic Plants In The Pond	H	H	L	M	M	H	NA	NA
	[2: 2]	[2: 2]	[8: 12]	[6: 12]	[50: 84]	[64: 84]		
Aquatic Plants In The Stream	H	H	L	M	L	L	NA	NA
	[1: 1]	[1: 1]	[6: 12]	[6: 12]	[35: 84]	[39: 84]		
Piscivorous Bird	NA	NA	0	0	0	0	NA	NA
			[6: 6]	[6: 6]	[42: 42]	[42: 42]		

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.

9.0 REFERENCES

- Abt Assoc., Inc. 1995. Technical Basis for Recommended Ranges of Uncertainty Factors Used in Deriving Wildlife Criteria for the Great Lakes Water Quality Initiative. March 11, 1995. Draft Report Submitted to U.S. Environmental Protection Agency, Office of Water by Abt Associates, Inc. Bethesda, Maryland.
- Barnthouse, L. 1993. Population-level Effects. Pages 247-274 *In* G. W. Suter, II (ed.). Ecological Risk Assessment. Lewis Publishers. Boca Raton, Florida.
- Battaglin, A.W., E.M. Thurman, S.J. Kalkhoff, and S.D. Porter. 2003. Herbicides and Transformation Products in Surface Waters of the Midwestern United States. *Journal of the American Water Resources Association* (August) 2003:743-756.
- 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.
- Brown, L., and D. Amadon. 1968. Eagles, Hawks and Falcons of the World. Volume 1. Hamlyn Publishing Group Limited, New York.
- 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>.
- California Office of Environmental Health Hazard Assessment (CA OEHHA). 2003. California Wildlife Biology, Exposure Factor, and Toxicity Database (Cal/Ecotox). State of California Office of Environmental Health Hazard Assessment and University of California at Davis. Available at: http://www.oehha.ca.gov/cal_ecotox/default.htm
- Call, D.J., L.T. Brooke, R.J. Kent, M.L. Knuth, S.H. Poirier, J.M. Huot, and A.R. Lima. 1987. Bromacil and Diuron Herbicides: Toxicity, Uptake, and Elimination in Freshwater Fish. *Archives of Environmental Contamination and Toxicology* 16:607-613.
- Chapman, P.M., A. Fairbrother, and D. Brown. 1998. A Critical Evaluation of Safety (Uncertainty) Factors for Ecological Risk Assessment. *Environmental Toxicology and Chemistry* 17:99-108.
- Compendium of Pesticide Common Names. 2003. A Website Listing All ISO-approved Names of Chemical Pesticides. Available at: <http://www.hclrss.demon.co.uk>. Last updated April 2003.
- Dorn, P.B., J.H. Rodgers, Jr., W.B. Gillespie, Jr., R.E. Lizotte, Jr., and A.W. Dunn. 1997. The Effects of C12-13 Linear Alcohol Ethoxylate Surfactant on Periphyton, Macrophytes, Invertebrates and Fish in Stream Mesocosms. *Environmental Toxicology and Chemistry* 16(8):1634-1645.
- Dourson, M.L., and J.F. Starta. 1983. Regulatory History and Experimental Support of Uncertainty (Safety) Factors. *Regulatory Toxicology and Pharmacology* 3:224-238.
- Edge, W.D., R.L. Carey, J.O. Wolff, L.M. Ganio, and T. Manning. 1995. Effects of Guthion 2S on *Microtus canicaudus*: A Risk Assessment Validation. *Journal of Applied Ecology* 32.
- ENSR. 2005a. Vegetation Treatments Programmatic EIS Human Health Risk Assessment Draft Report. Prepared for the Bureau of Land Management. Westford, Massachusetts.
- _____. 2005b. Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology Final Report. Prepared for the Bureau of Land Management. Westford, Massachusetts.

- Fairbrother, A., and L.A. Kapustka. 1996. Toxicity Extrapolations in Terrestrial Systems. Ecological Planning and Toxicology, Inc. (ept). July 5, 1996.
- Fletcher, J.S., F.L. Johnson, and J.C. McFarlane. 1990. Influence of Greenhouse Versus Field Testing and Taxonomic Differences on Plant Sensitivity to Chemical Treatment. *Environmental Toxicology and Chemistry* 9:769-776.
- _____, J.E. Nellessen, and T.G. Pfleeger. 1994. Literature Review and Evaluation of the EPA Food-Chain (Kenaga) Nomogram: An Instrument for Estimating Pesticide Residue on Plants. *Environmental Toxicology and Chemistry* 13(9):1383-1391.
- Franke, C., G. Studinger, G. Berger, S. Bohling, U. Bruckmann, D. Cohors-Fresenborg, and U. Johncke. 1994. The Assessment of Bioaccumulation. *Chemosphere* 29(7):1501-1514.
- Freeman, K.E., and C. Boutin. 1994. Impacts of Agricultural Herbicide Use on Terrestrial Wildlife: A Review With Special Reference to Canada. Canada Minister of the Environment, Canadian Wildlife Service. Technical Report 196.
- Gaines, T.B., and R.E. Linder. 1986. Acute Toxicity of Pesticides in Adult and Weanling Rates. *Fundamental and Applied Toxicology* 7:299-308.
- Hazardous Substance Data Bank (HSDB). 2003. Database Prepared by the U.S. National Library of Medicine, Office of Health & Human Services, National Institute of Health. Available at website: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?hsdbb.htm>.
- Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. Lethal Dietary Toxicities of Environmental Pollutants to Birds. U.S. Fish and Wildlife Service, Special Scientific Report No. 191. Washington, DC.
- Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. P. Howard (ed.). Springer-Verlag. New York.
- Howard, P.H. (ed.). 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Pesticides. Lewis Publishers. Chelsea, Minnesota.
- Hurt, W.H., and R.P. Grossenheider. 1976. A Field Guide to the Mammals: North American north of Mexico. Third Edition. Houghton Mifflin Company. Boston Massachusetts.
- Lee, R. 2004. Personal Communication Concerning Use of Bromacil. Bureau of Land Management. Denver, Colorado.
- Leonard, R.A., W.G. Knisel, and D.A. Still. 1987. GLEAMS: Groundwater Loading Effects of Agricultural Management Systems. *Transactions of the American Society of Agricultural Engineers (ASAE)* 30(5):1403-1418.
- Lerch, R.N., and P.E. Blanchard. 2003. Watershed Vulnerability to Herbicide Transport in Northern Missouri and Southern Iowa Streams. *Environmental Science and Technology* 37(24):5518-5527.
- Lewis, M.A. 1991. Chronic and Sublethal Toxicities of Surfactants to Aquatic Animals: A Review and Risk Assessment. *Water Research* 25(1):101-113.
- Lyman, W., W. Reehl, and D. Rosenblatt. 1990. Handbook of Chemical Estimation Methods. American Chemical Society. Washington DC.
- Ma, J., W. Liang, L. Xu, S. Wang, Y. Wei, and J. Lu. 2001. Acute Toxicity of 33 Herbicides to the Green Alga *Chlorella pyrenoidosa*. *Bulletin of Environmental Contamination and Toxicology* 66:536-541.

- 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.
- Maguire, C.C., and B.A. Williams. 1987. Response of Thermal Stressed Juvenile Quail to Dietary Organophosphate Exposure. *Environmental Pollution* 47:25-39.
- Mineau, P., B.T. Collins, and A. Baril. 1996. On the Use of Scaling Factors to Improve Interspecies Extrapolation of Acute Toxicity in Birds. *Regulatory Toxicology and Pharmacology* 24:24-29.
- 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.
- Muller, R. 1980. Fish Toxicity and Surface Tension of Non-ionic Surfactants: Investigations of Anti-foam Agents. *Journal of Fish Biology* 16:585-589.
- National Oceanic and Atmospheric Administration (NOAA). 1999. Endangered and Threatened Wildlife and Plants; Definition of 'Harm.' National Marine Fisheries Services, National Oceanic and Atmospheric Administration, Commerce. Federal Register 64(215) Rules and Regulations: 60,727-60,731.
- _____. 2002. Pesticides and Pacific Salmon: Technical Guidance for NOAA Fisheries Section 7 Pesticide Consultations (Draft). Environmental Conservation Division. Seattle, Washington.
- Opresko, D.M., B.E. Sample, and G.W. Suter. 1994. Toxicological Benchmarks for Wildlife. ES/ER/TM-86/R1. Oak Ridge National Laboratory. Oak Ridge, Tennessee.
- Pesticide Information Project (PIP). 1993. Extension Toxicology Network (EXTOXNET): Diuron 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://pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/diuron-ext.html>.
- _____. 1996. Extension Toxicology Network (EXTOXNET): Diuron 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://ace.orst.edu/info/extoxnet/pips/diuron.htm>.
- Platte Chemical Co. 2000. Specimen Label for Diuron 80 WDG Weed Killer Platte Chemical Co., Greeley, Colorado. March 2000.
- Sample, B.E., D.M. Opresko, and G.W. Suter. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Risk Assessment Program. Document ES/ER/TM-86/R-3. <http://www.hsrdo.org/ecorisk/reports.html>. Oak Ridge National Laboratory. Oak Ridge, Tennessee.
- Sappington, L.C., F.L. Mayer, F.J. Dwyer, D.R. Buckler, J.R. Jones, and M.R. Ellersieck. 2001. Contaminant Sensitivity of Threatened and Endangered Fishes Compared to Standard Surrogate Species. *Environmental Toxicology and Chemistry* 20:2869-2876.
- Schafer, H., H. Hettler, U. Fritsche, G. Pitzen, G. Roderer, and A. Wenzel. 1994. Biotests Using Unicellular Algae and Ciliates for Predicting Long-term Effects of Toxicants. *Ecotoxicology and Environmental Safety* 27:64-81.
- Schuytema, G.S., and A.V. Nebeker. 1998. Comparative Toxicity of Diuron on Survival and Growth of Pacific Treefrog, Bullfrog, Red-legged Frog, and African Clawed Frog Embryos and Tadpoles. *Archives of Environmental Contamination and Toxicology* 34:370-376.

- Sheley, R., J. Petroff, M. Borman. 1999. Introduction to Biology and to Management of Noxious Rangeland Weeds. Corvallis, Oregon.
- Shirazi, M.A., R.S. Bennett, and R.K. Ringer. 1994. An Interpretation of Toxicity Response of Bobwhite Quail with Respect to Duration of Exposure. *Achieves of Environmental Contamination and Toxicology* 26:417-424.
- Sinclair, C.J. and A.B.A. Boxall. 2003. Assessing the Ecotoxicity of Pesticide Transformation Products. *Environmental Science and Technology* 37:4617-4625.
- Sparling, D.W., G. Linder, and C.A. Bishop (eds.). 2000. *Ecotoxicology of Amphibians and Reptiles*. Society of Environmental Toxicology and Chemistry (SETAC). Pensacola, Florida.
- Spray Drift Task Force (SDTF). 2002. A User's Guide for AgDRIFT 2.0.05: A Tiered Approach for the Assessment of Spray Drift of Pesticides. Regulatory Version.
- Swann, R., D. Laskowski, R. McCall, K. Vander Kuy, and J. Dishburger. 1983. A Rapid Method for the Estimation of the Environmental Parameters Octanol/Water Partition Coefficient, Soil Sorption Constant, Water-to-Air Ratio, and Water Solubility. *Residue Reviews* 85:17-28.
- Syracuse Environmental Research Associates, Inc. (SERA). 2001. Imazapic [Plateau and Plateau DG]-human Health and Ecological Risk Assessment Final Report. Prepared for USDA Forest Service, Forest Health Protection. SERA TR 00-21-28-01e, Dated January 28, 2001.
- Teske, M.E. and J.W. Barry. 1993. Parametric Sensitivity in Aerial Application. *Transactions of the ASAE* 36(1):27-33.
- _____ and H.W. Thistle. 1999. A Simulation of Release Hand Wind Speed Effects for Drift Minimization. *Transactions of the ASAE* 42(3):583-591.
- _____, _____, J.W. Barry and B. Eav. 1998. A Simulation of Boom Length Effects for Drift Minimization. *Transactions of the ASAE* 41(3):545-551.
- Tomlin, C. (ed.). 1994. *The Agrochemicals Desk Reference*. 2nd Edition. Lewis Publishers. Boca Raton, Florida.
- Turner, L. 2003a. Diuron Analysis of Risks to Endangered and Threatened Salmon and Steelhead. Environmental Field Branch. U.S. Environmental Protection Agency, Office of Pesticide Programs. July 30, 2003.
- _____. 2003b. 10 November 2003. Personal Communication (memorandum to A. Williams, Chief, Environmental Field, Branch, Field, and External Affairs Division from L. Turner, Ph.D., Environmental Field Branch, Field and External Affairs Division), Regarding Effects Determination for Bromacil for Certain Anadromous Pacific Salmonids. November 10. U.S. Environmental Protection Agency, Office of Pesticide Programs. Washington, D.C.
- U.S. Department of Agriculture (USDA) 1999. GLEAMS: Groundwater Loading Effects of Agricultural Management Systems, Version 3.0 User Manual. USDA, Agricultural Research Service.
- U.S. Department of the Interior Bureau of Land Management (USDI BLM). 1991. Final Environmental Impact Statement, Vegetation Treatment on BLM Lands in Thirteen Western States. Cheyenne, Wyoming. May 1991.
- _____. 2005. Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS. Reno, Nevada.

- U.S. Environmental Protection Agency (USEPA). No date. Environmental Risk Assessment for the Reregistration of Diuron. Memorandum from R. Lee, I. Abdel-Saheb, and J. Breithaupt of the Environmental Fate and Effects Division to M. Rice and R. Farrell of the Reregistration Branch, Special Review and Reregistration Division, Office of Prevention, Pesticide, and Toxic Substances, U.S. Environmental Protection Agency. Washington, D.C.
- _____. 1993a. Wildlife Exposure Factors Handbook. Vol. I. EPA/600-R/R-93/187a,187b. Office of Research and Development. Washington, D.C.
- _____. 1993b. Review Plant Data Submission. February 11, 1993. MRID 424911-01. Douglas Urban of the Ecological Effects Branch. U.S. Environmental Protection Agency. Washington D.C.
- _____. 1997. Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments (Interim Final). EPA 540/R-97/006. June, 1997. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response. Washington D.C.
- _____. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. U.S. Environmental Protection Agency. Washington, DC.
- _____. 2000. Ecological Soil Screening Level Guidance. Draft. July 10, 2000. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Washington D.C.
- _____. 2001a. Memorandum. To: Margaret Rice, PM #52/Roberta Farrell, CRM, Reregistration Branch, Special Review and Reregistration Division. From: Richard Lee, Ibrahim Abdel-Saheb, James Breithaupt, Environmental Fate and Effects Division. Subject: Environmental Risk Assessment for the Reregistration of Diuron. PC Code No. 035505. DP Barcode: D275045. August 27. FOIA Copy Courtesy of Edward Berg, USEPA.
- _____. 2001b. Memorandum: To: Diane Locke, Reregistration Branch 2, Health Effects Division. From: K. Dockter, Chemist, Reregistration Branch 2, Health Effects Division. Subject: Diuron. List A Reregistration Case 0046. PC Code 035505. Product Chemistry Chapter for the Reregistration Eligibility Decision [RED] Document. DP Barcode D274489. FOIA Copy Courtesy of Edward Berg, USEPA.
- _____. 2003a. USEPA Pesticide Ecotoxicity Database. Provided by Brian Montague, Office of Pesticide Programs. June 6, 2003.
- _____. 2003b. Diuron Analysis of Risks to Endangered and Threatened Salmon and Steelhead. Larry Turner, Ph.D., Environmental Field Branch, Office of Pesticide Programs. July 30. USEPA. 2003. USEPA Pesticide Ecotoxicity Database. Provided by Brian Montague, Office of Pesticide Programs. June 6, 2003.
- Westbrooks, R. 1998. Invasive Plants, Changing the Landscape of America: Fact Book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). Washington, DC.
- Wong, D, P.B. Dorn, and E.Y. Chai. 1997. Acute Toxicity and Structure-activity Relationships of Nine Alcohol Ethoxylate Surfactants to Fathead Minnow and *Daphnia magna*. Environmental Toxicology and Chemistry 16(9):1970-1976.

APPENDIX A

**Summary of Available and Relevant Toxicity Data
from Ecological Risk Assessment Literature
Review for Diuron**

Appendix A

Summary of Available and Relevant Toxicity Data from Ecological Risk Assessment Literature Review for Diuron

Introduction

A literature review and ecological data evaluation was conducted on nine herbicides that are currently being used or are proposed for use by the Bureau of Land Management (BLM) for vegetation management on 261 million acres of public lands in the Western U.S., including Alaska. The information gathered from this evaluation will be included along with other collected data to derive toxicity reference values for use in the ecological risk assessment (ERA; ENSR 2005). The ERA was conducted in conjunction with the Vegetation Treatments Programmatic Ecological Impact Statement (PEIS) for the BLM. Scientific papers were gathered during this process to provide data on acute and chronic toxicity of selected herbicides to the non-target species. The review process included consideration of U.S. Fish and Wildlife Service (USFWS) draft literature search guidance. The nine herbicides that were investigated during this evaluation were as follows:

- Diflufenzopyr
- Diquat
- Fluridone
- Imazapic
- Sulfometuron-methyl
- Bromacil
- Chlorsulfuron
- Diuron
- Tebuthiuron

This review process was carried out in three tiers: Tier I – Literature search and preliminary review to select individual manuscripts; Tier II – Screening to determine whether the manuscript is acceptable; and Tier III – Thorough review to obtain data for possible toxicity reference value (TRV) use. This report provides information for diuron; the other chemicals are discussed in separate reports.

Literature Search Methodology

The literature review process was initiated by conducting a keyword search pertaining to each of the nine chemicals in selected databases. The keyword search for all databases, except for one (Chemical Abstracts/Scifinder Scholar), included the herbicide name but not the commercial name (i.e., some commercial names are common words). The search parameters for Chemical Abstracts consisted of the herbicide name and chemical abstracts service (CAS) registry number. The open literature search was conducted at Colorado State University, Fort Collins, CO. The search period for diuron was from 1970 (the start of the database) to 2003. The following 12 databases were searched:

- AGRICOLA
- ASFA (Aquatic Sciences and Fisheries Abstracts)
- Biological Sciences
- BIOSIS / Biological Abstracts
- Chemical Abstracts / Scifinder Scholar
- Environmental Science and Pollution Management
- MedLine
- Safety Science and Risk

- Toxline
- Water Resources Abstracts
- Web of Science / Science Citation Index
- Zoological Records

All of the documents obtained in the open literature searches were then evaluated by a Senior Toxicologist to select manuscripts pertaining to the specific objectives of this project (Tier I). Relevant studies were those that were judged, to the extent possible while searching literature databases (i.e., relying on title and abstract, when available), to provide useful data for conducting the ERA. Relevant studies contained the following information at a minimum:

- Acute (mortality vs. survival) or chronic (largely growth or reproduction, although other sublethal data—if available—were also considered potentially relevant) toxicity data for the active ingredient.
- Verifiable numeric endpoint values (e.g., LC₅₀, NOEC) that could be used in the risk characterization process.
- Toxicity data for clinical test species (e.g., mice, rats) and species used for screening non-human impacts (all other mammals, birds, invertebrates, algae, plants).
- Field or mesocosm studies were also included, but only if effects from exposure to the single herbicide in question could be identified and separated from other stressors.

Literature that was excluded as part of this initial literature gathering process included:

- analytical chemistry studies;
- methods papers without specific toxicity data;
- modeling studies that contained no empirically-derived data; and
- reviews or reports that were not primary toxicity data sources (except as a source for obtaining primary literature).

These search criteria enhanced the ability to screen scientific papers for the type of toxicity information needed in the ERA. Hard copies of all manuscripts that met these criteria were then obtained for further evaluation. Once articles were obtained, they were incorporated into a comprehensive management database (EndNote®). There were 243 documents identified from this process and obtained for further consideration. The bibliography list of articles obtained for diuron is included in this report (Appendix A.1).

Literature Review Methodology

A cursory review (Tier II) was performed on each manuscript after a hard copy was obtained. Exclusion and inclusion criteria to determine acceptability for further review were developed prior to the process in conjunction with the BLM. Manuscripts were excluded that dealt only with the following subjects:

- Human health effects
- Effects on microorganisms: (e.g., fungi, bacteria)
- Genotoxic effects (mutagenic, carcinogenic)
- Bioassays on cells of a whole organism (e.g., rat hepatocytes, rat liver S9)
- Effects on target plants (efficacy testing)
- Non-toxic effects (e.g., fate, transport, leaching, analytical methods)
- Mixtures including herbicides other than the nine being reviewed

In addition, manuscripts that solely included data on marine receptors were originally excluded; however, these data were later included because marine ecosystems could be adjacent to application areas on BLM lands.

Inclusion criteria and rating (on a scale of 1 [weak] to 5 [strong]) of issues that were to be emphasized (requiring a subsequent review step) were as follows:

1. Effects on nontarget receptors related to ERA protocol
2. Chronic, sub-lethal, or reproductive effects that may have adverse effects on populations
3. Effects from inerts, degradates, and metabolites
4. Studies with mixtures that include diuron and any of the 8 other herbicides (i.e., not containing other herbicides)
5. Indirect effects to food supply or cover

Additional criteria that were used in reviewing papers (reviewers answered ‘Yes’ or ‘No’) are listed below:

- Were the corroborating studies described in sufficient detail (i.e., weight of evidence)?
- Did the study have a proper exposure dose, mechanism, and duration?
- Did the test include proper sample size, statistical analysis, and especially statistical endpoints (e.g., NOAEL, EC₅₀) or dose response curves?
- Were proper controls used and were they acceptable?
- Were the data published in a peer-reviewed journal?

Each of the 243 identified papers was scored on the selection criteria listed above, including documentation of the number of test organisms, statistical analysis, proper use, and performance of controls, and the study was classified as either “adequate” or “not adequate”.

In Tier III, papers that were found to be acceptable for use were evaluated more thoroughly based on criteria developed with the BLM, and the following information is included as a second review form page for each manuscript (Appendix A.2):

- Author(s).
- Date of publication.
- Title of publication.
- Name of publication.
- Herbicide(s) used in the study.
- Receptor category: 20 g mammal, honey bee, 70 kg herbivore, small bird, large bird, non-target plants (monocot and dicot), warmwater fish, coldwater fish, aquatic invertebrate, aquatic plant, aquatic macrophyte). The specific life history stage was also recorded when available.
- Exposure conditions specifying the formulation, concentration, or amount of active ingredient and medium.
- Effect: Acute or sublethal effect end points of product formulations and breakdown products, and/or their component chemicals, such as: larval and embryonic developmental effects, endocrine disruption, reproductive impairment, changes in behavioral traits such as predator avoidance, feeding/appetite, lethargy or excitement, homing ability, swimming speed, or attraction to or repulsion from the chemicals.
- Toxicity endpoints (e.g., NOAEL, EC₅₀, LC₅₀, or dose response curve).
- Degradates, inerts, if available.
- Ecological conditions of study (e.g., mesocosm, static/flow-through, water quality parameters).
- Comments (e.g., mixture effects: additive, synergistic, or antagonistic effect end points of multiple products, other observations).

The Tier II and III reviews for diuron were conducted by only one senior toxicologist (this is consistent with the scope of work outlined for the review process). In some cases, a second (or third) review of data adequacy took

place when a separate senior toxicologist compiled the Tier III reviews and entered the pertinent information into a master spreadsheet documenting review findings for possible use in TRV derivation. The documents used in this TRV derivation are designated in **bold** in the bibliography (Appendix A.1), and the derivation of TRVs from all available sources is reported in the ERA (ENSR 2005).

Results

There were 61 papers discovered in the open review of the literature for diuron, and of these, 32 were reviewed as part of the Tier III process. Data from 29 manuscripts were incorporated into the spreadsheet for TRV derivation for diuron (Table 1; Appendix A.3).

TABLE 1
Summary of the Results of the Open Literature Review for Diuron

Total number of papers obtained for diuron	61
Total number of papers accepted for Tier II review	32
Total number of papers used in TRV derivation	29

The data collected during this review resulted in toxicity information for aquatic invertebrates (cladocerans, spider mites, amphipods, midges, oligochaetes, polychaetes, snails), terrestrial invertebrates (earthworms, ladybugs), diatoms, algae (several species), fish (fathead minnow, catfish, bluegill, goldfish, carp), aquatic macrophytes (seagrass, duckweed), sea urchin, amphibians (frogs), birds (ducks, pheasants, quails), and small mammals (rats). There were multiple studies for some species. Data were available on the chronic toxicity of diuron to several species including fathead minnow (Call et al. 1987), diatom (Hentschel and Jumars 1994), marine periphyton (Molander et al. 1992), frog (Schuytema and Nebeker 1998), and rat (Khera et al. 1979). Two studies were found that examined the toxic effects of degradation products of diuron (Tixier et al. 2001; Fernandez-Alba et al. 2002). There were no studies that examined the toxicity of mixtures of diuron with any of the other eight herbicides evaluated. Several studies examined the indirect effects of diuron on food supply via changes in algal density (e.g., Ma et al. 2001; Ma 2002; Fernandez-Alba et al. 2002; Ma et al. 2002), diatom abundance (Hentschel and Jumars 1994) duckweed growth (Teisseire et al. 1999), and aquatic macrophyte biomass (Macinnis-Ng and Ralph 2003).

References

- Call, D.J., L.T. Brooke, R.J. Kent, M.L. Knuth, S.H. Poirier, J.M. Huot, and A.R. Lima. 1987. Bromacil and Diuron Herbicides: Toxicity, Uptake, and Elimination in Freshwater Fish. *Archives of Environmental Contamination and Toxicology* 16:607-613.
- ENSR. 2005. Diuron Ecological Risk Assessment Final Report. Prepared for the Bureau of Land Management. Westford, Massachusetts.
- Fernandez-Alba, A.R., M.D. Hernando, L. Piedra, and Y. Chisti. 2002. Toxicity Evaluation of Single and Mixed Antifouling Biocides Measured with Acute Toxicity Bioassays. *Analytica Chimica Acta* 456:303-312.
- Hentschel, B.T., and P.A. Jumars. 1994. In Situ Chemical Inhibition of Benthic Diatom Growth Affects Recruitment of Competing, Permanent and Temporary Meiofauna. *Limnology and Oceanography* 39(4):816-838.
- Khera, K.S., C. Whalen, G. Trivett, and G. Angers. 1979. Teratogenicity Studies on Pesticidal Formulations of Dimethoate, Diuron and Lindane in Rats. *Bulletin of Environmental Contamination and Toxicology* 22:522-529.

- Ma, J. 2002. Differential Sensitivity to 30 Herbicides among Populations of Two Green Algae *Scenedesmus obliquus* and *Chlorella pyrenoidosa*. *Bulletin of Environmental Contamination and Toxicology* 68:275-281.
- _____, W. Liang, L. Xu, S. Wang, Y. Wei, and J. Lu. 2001. Acute Toxicity of 33 Herbicides to the Green Alga *Chlorella pyrenoidosa*. *Bulletin of Environmental Contamination and Toxicology* 66:536-541.
- _____, L. Xu, S. Wang, R. Zheng, S. Jin, S. Huang, and Y. Huang. 2002. Toxicity of 40 Herbicides to the Green Alga *Chlorella vulgaris*. *Ecotoxicology and Environmental Safety* 51:128-132.
- Macinnis-Ng, C.M.O., and P.J. Ralph. 2003. Short-term Response and Recovery of *Zostera capricorni* Photosynthesis After Herbicide Exposure. *Aquatic Botany* 76:1-15.
- Molander, S., B. Dahl, H. Blanck, J. Jonsson, and M. Sjostrom. 1992. Combined Effects of Tri-*n*-butyl tin (TBT) and Diuron on Marine Periphyton Communities Detected as Pollution-induced Community Tolerance. *Archives of Environmental Contamination and Toxicology* 22:419-427.
- Schuytema, G.S., and A.V. Nebeker. 1998. Comparative Toxicity of Diuron on Survival and Growth of Pacific Treefrog, Bullfrog, Red-legged Frog, and African Clawed Frog Embryos and Tadpoles. *Archives of Environmental Contamination and Toxicology* 34:370-376.
- Teisseire, H., M. Couderchet, and G. Vernet. 1999. Phytotoxicity of Diuron Alone and in Combination With Copper or Folpet on Duckweed (*Lemna minor*). *Environmental Pollution* 106:39-45.
- Tixier, C., P. Bogaerts, M. Sancelme, F. Bonnemoy, L. Twagilimana, A. Cuer, J. Bohatier, and H. Veschambre. 2000. Fungal Biodegradation of a Phenylurea Herbicide, Diuron: Structure and Toxicity of Metabolites. *Pest Management Science* 56:455-462.

APPENDIX A.1

BIBLIOGRAPHY LIST

Appendix A.1. Bibliography List

- Agrawal, R.C., and S. Kumar. 1999. Hepato-toxic Effect of Diuron in Albino Rats. *Indian Journal of Experimental Biology* 37:503-504.
- Agrawal, R.C., and N.K. Mehrotra. 1997. Effect of Diuron on Germ Cells of Mice. *Indian Journal of Experimental Biology* 35:1256-1257.
- Anonymous. 1987. Diuron. *Dangerous Properties of Industrial Materials* 7(5):49-55.
- Bauer, C., and J. Rombke. 1997. Factors Influencing the Toxicity of Two Pesticides on Three Lumbricid Species in Laboratory Tests. *Soil Biology and Biochemistry* 29(3/4):705-708.
- Braginskii, L.P., V.D. Breskaravainaya, and E.P. Shcherban. 1979. Reaction of Freshwater Phyto- and Zooplankton to Pesticides. *Biology Bulletin of the Academy of Sciences of the USSR* 6(4):487-493.
- Bretau, S., J.P. Toutant, and P. Saglio. 2000. Effects of Carbofuran, Diuron, and Nicosulfuron on Acetylcholinesterase Activity in Goldfish (*Carassius auratus*). *Ecotoxicology and Environmental Safety* 47:117-124.
- Call, D.J., L.T. Brooke, R.J. Kent, M.L. Knuth, S.H. Poirier, J.M. Huot, and A.R. Lima. 1987. Bromacil and Diuron Herbicides: Toxicity, Uptake, and Elimination in Freshwater Fish. *Archives of Environmental Contamination and Toxicology* 16:607-613.
- Christian, F.A., and T.M. Tate. 1982. Toxicity of Fluometuron and Diuron on the Intermediate Snail Host (*Lymnaea* spp.) of *Fasciola hepatica*. *Bulletin of Environmental Contamination and Toxicology* 28(353):628-631.
- Davis, H.C., and H. Hidu. 1969. Effects of Pesticides on Embryonic Development of Clams and Oysters, and on Survival and Growth of the Larvae. *Fishery Bulletin* 67(2):393-404.
- deVlaming, V., V. Connor, C. DiGiorgio, H.C. Bailey, L.A. Deanovic, and D.E. Hinton. 2000. Application of Whole Effluent Toxicity Test Procedures to Ambient Water Quality Assessment. *Environmental Toxicology and Chemistry* 19(1):42-62.
- Dewez, D., M. Marchand, P. Eullaffroy, and R. Popovic. 2002. Evaluation of the Effects of Diuron and Its Derivatives on *Lemna gibba* Using a Fluorescence Toxicity Index. *Environmental Toxicology* 17(5):493-501.
- Eldred, D.V., C.L. Weikel, P.C. Jurs, and K.L.E. Kaiser. 1999. Prediction of Fathead Minnow Acute Toxicity of Organic Compounds from Molecular Structure. *Chemical Research in Toxicology* 12(7):670-678.
- Fernandez-Alba, A.R., M.D. Hernando, L. Piedra, and Y. Chisti. 2002. Toxicity Evaluation of Single and Mixed Antifouling Biocides Measured with Acute Toxicity Bioassays. *Analytica Chimica Acta* 456:303-312.
- Fiedler, H., G. Herrmann, K.W. Schramm, and O. Hutzinger. 1990. Application of QSARs to Predict Potential Aquatic Toxicities of Organochlorine Pesticides. *Toxicological and Environmental Chemistry* 26:157-160.
- Foster, S., M. Thomas, and W. Korth. 1998. Laboratory-derived Acute Toxicity of Selected Pesticides to *Ceriodaphnia dubia*. *Australasian Journal of Ecotoxicology* 4(1):53-59.
- Gaines, T.B., and R.E. Linder. 1986. Acute Toxicity of Pesticides in Adult and Weanling Rats. *Fundamental and Applied Toxicology* 7:299-308.

- Hartgers, E.M., G.H. Aalderink, P.J. Van den Brink, R. Gylstra, J.W.F. Wiegman, and T.C.M. Brock. 1998. Ecotoxicological Threshold Levels of a Mixture of Herbicides (Atrazine, Diuron, and Metlachlor) in Freshwater Microcosms. *Aquatic Ecology* 32:135-152.
- Haynes, D., P. Ralph, J. Prange, and B. Dennison. 2000. The Impact of the Herbicide Diuron on Photosynthesis in Three Species of Tropical Seagrass. *Marine Pollution Bulletin* 41(7-12):288-293.
- Heath, R.G., J.W. Spann, E.F. Hill, and J.F. Kreitzer. 1972. Comparative Dietary Toxicities of Pesticides to Birds. Wildlife No. 152. U.S. Fish and Wildlife Service. Washington D.C.
- Hentschel, B.T., and P.A. Jumars. 1994. In Situ Chemical Inhibition of Benthic Diatom Growth Affects Recruitment of Competing, Permanent and Temporary Meiofauna. *Limnology and Oceanography* 39(4):816-838.
- Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. Lethal Dietary Toxicities of Environmental Pollutants to Birds. U.S. Fish and Wildlife Service, Special Scientific Report Wildlife No. 191. Patuxent Wildlife Research Center. Laurel, Maryland.
- Hill, R.H., Jr., Z.J. Rollen, R.D. Kimbrough, D.F. Groce, and L.L. Needham. 1981. Tetrachloroazobenzene in 3,4-Dichloroaniline and Its Herbicidal Derivatives: Propanil, Diuron, Linuron, and Neburon. *Archives of Environmental Health* 36(1):11-14.
- Johnson, W.W., and A.M. Julin. 1974. Use of Diuron in Fisheries: Review. Bureau of Sport Fisheries and Wildlife. Columbia, Montana.
- Kersting, K. 1975. Effects of Diuron on the Energy Budget of a *Daphnia magna* Population. Sublethal Effects of Toxic Chemicals on Aquatic Animals. Proceedings of the Swedish-Netherlands Symposium. Elsevier Scientific Publishing Company. Wageningen, Netherlands.
- Khera, K.S., C. Whalen, G. Trivett, and G. Angers. 1979. Teratogenicity Studies on Pesticidal Formulations of Dimethoate, Diuron and Lindane in Rats. *Bulletin of Environmental Contamination and Toxicology* 22:522-529.
- Kobayashi, N., and H. Okamura. 2002. Effects of New Antifouling Compounds on the Development of Sea Urchin. *Marine Pollution Bulletin* 44:748-751.
- Korostylev, M.V. 1977. Effect of Diuron, Dilor, and Methylnitrophos on Chironomids. *Khozyaistva* 121:161-164.
- Ma, J. 2002. Differential Sensitivity to 30 Herbicides among Populations of Two Green Algae *Scenedesmus obliquus* and *Chlorella pyrenoidosa*. *Bulletin of Environmental Contamination and Toxicology* 68:275-281.
- _____, W. Liang, L. Xu, S. Wang, Y. Wei, and J. Lu. 2001. Acute Toxicity of 33 Herbicides to the Green Alga *Chlorella pyrenoidosa*. *Bulletin of Environmental Contamination and Toxicology* 66:536-541.
- _____, L. Xu, S. Wang, R. Zheng, S. Jin, S. Huang, and Y. Huang. 2002. Toxicity of 40 Herbicides to the Green Alga *Chlorella vulgaris*. *Ecotoxicology and Environmental Safety* 51:128-132.
- Macek, K.J., C. Hutchinson, and O.B. Cope. 1969. The Effects of Temperature on the Susceptibility of Bluegills and Rainbow Trout to Selected Pesticides. *Bulletin of Environmental Contamination and Toxicology* 4(3):174-183.
- Macinnis-Ng, C.M.O., and P.J. Ralph. 2003. Short-term Response and Recovery of *Zostera capricorni* Photosynthesis After Herbicide Exposure. *Aquatic Botany* 76:1-15.

- Mayer, F.L., and M.R. Ellersieck. 1986. Manual of Acute Toxicity: Interpretation and Database for 410 Chemicals. U.S. DOL, U.S. Fish and Wildlife Services/Research Publication 160.
- McCorkle, F.M., J.E. Chambers, and J.D. Yarbrough. 1977. Acute Toxicities of Selected Herbicides to Fingerling Channel Catfish, *Ictalurus punctatus*. Bulletin of Environmental Contamination and Toxicology 18(3):267-270.
- Metzger, J.A., and D.G. Pfeiffer. 2002. Topical Toxicity of Pesticides Used in Virginia Vineyards to the Predatory Mite, *Neoseiulus fallacis* (Garman). Journal of Entomological Science 37(4):329-337.
- Molander, S., B. Dahl, H. Blanck, J. Jonsson, and M. Sjostrom. 1992. Combined Effects of Tri-*n*-butyl tin (TBT) and Diuron on Marine Periphyton Communities Detected as Pollution-induced Community Tolerance. Archives of Environmental Contamination and Toxicology 22:419-427.
- Nebeker, A.V., and G.S. Schuytema. 1998. Chronic Effects of the Herbicide Diuron on Freshwater Cladocerans, Amphipods, Midges, Minnows, Worms, and Snails. Archives of Environmental Contamination and Toxicology 35:441-446.
- Nendza, M. 1991. Predictive QSAR Models Estimating Ecotoxic Hazard of Phenylureas: Mammalian Toxicity. Chemosphere 22(5-6):613-623.
- Owen, R., A. Knap, N. Ostrander, and K. Carbery. 2003. Comparative Acute Toxicity of Herbicides to Photosynthesis of Coral Zooxanthellae. Bulletin of Environmental Contamination and Toxicology 70:541-548.
- Reddy, D.C., P. Vijayakumari, V. Kalarani, and R.W. Davies. 1992. Changes in Erythropoietic Activity of *Sarotherodon mossambicus* Exposed to Sublethal Concentrations of the Herbicide Diuron. Bulletin of Environmental Contamination and Toxicology 49:730-737.
- Roberts, B.L., and H.W. Dorough. 1984. Relative Toxicities of Chemicals to the Earthworm *Eisenia foetida*. Environmental Toxicology and Chemistry 3:67-78.
- Robson, T.O. 1969. Developments in the Use of Herbicides for the Control of Aquatic Macrophytes. Water Treatment and Examination 18(4):327-337.
- Saglio, P., and S. Trijasse. 1998. Behavioral Responses to Atrazine and Diuron in Goldfish. Archives of Environmental Contamination and Toxicology 35:484-491.
- Sanders, H.O. 1970. Toxicities of Some Herbicides to Six Species of Freshwater Crustaceans. Journal of Water Pollution Control Federation 42:1544-1550.
- Schafer, H., H. Hettler, V. Fritsche, G. Pitzen, G. Roderer, and A. Wenzel. 1994. Biotests Using Unicellular Algae and Ciliates for Predicting Long-term Effects of Toxicants. Ecotoxicology and Environmental Safety 27:64-81.
- Schuytema, G.S., and A.V. Nebeker. 1998. Comparative Toxicity of Diuron on Survival and Growth of Pacific Treefrog, Bullfrog, Red-legged Frog, and African Clawed Frog Embryos and Tadpoles. Archives of Environmental Contamination and Toxicology 34:370-376.
- Sijm, D.T.H.M., C.K. Flenner, and A. Opperhuizen. 1991. The Influence of Biochemical Species Differences on Acute Fish Toxicity of Organic Chemicals. Comparative Biochemistry and Physiology Part C 100(1/2):33-35.

- Singh, S.P., and N.K. Yadav. 1978. Toxicity of Some Herbicides to Major Carp Fingerlings. *Indian Journal of Ecology* 5(2):141-147.
- Stam, P.A., D.F. Clower, J.B. Graves, and P.E. Schilling. 1978. Effects of Certain Herbicides on Some Insects and Spiders Found in Louisiana Cotton Fields. *Entomological Society of America* 71(3):477-480.
- Teisseire, H., M. Couderchet, and G. Vernet. 1999. Phytotoxicity of Diuron Alone and in Combination With Copper or Folpet on Duckweed (*Lemna minor*). *Environmental Pollution* 106:39-45.
- _____, and G. Vernet. 2000. Ascorbate and Glutathione Contents in Duckweed (*Lemna minor*), As Biomarkers of the Stress Generated by Copper, Folpet and Diuron. *Biomarkers* 5(4):263-273.
- Thomas, K.V., T.W. Fileman, J.W. Readman, and M.J. Waldock. 2001. Antifouling Paint Booster Biocides in the UK Coastal Environment and Potential Risks of Biological Effects. *Marine Pollution Bulletin* 42(8):677-688.
- Tixier, C., P. Bogaerts, M. Sancelme, F. Bonnemoy, L. Twagilimana, A. Cuer, J. Bohatier, and H. Veschambre. 2000. Fungal Biodegradation of a Phenylurea Herbicide, Diuron: Structure and Toxicity of Metabolites. *Pest Management Science* 56:455-462.
- _____, M. Sancelme, F. Bonnemoy, A. Cuer, and H. Veschambre. 2001. Degradation Products of a Phenylurea Herbicide, Diuron: Synthesis, Ecotoxicity, and Biotransformation. *Environmental Toxicology and Chemistry* 20(7):1381-1389.
- Tooby, T.E., J. Lucey, and B. Stott. 1980. The Tolerance of Grass Carp, *Ctenopharyngodon idella* Val., to Aquatic Herbicides. *Journal of Fish Biology* 16:591-597.
- Tucker, C.S., S.K. Kingsbury, and R.L. Ingram. 2003. Tissue Residues of Diuron in Channel Catfish *Ictalurus punctatus* Exposed to the Algicide in Consecutive Years. *Journal of the World Aquaculture Society* 34(2):203-209.
- Wang, S.W., C.Y. Chu, J.D. Hsu, and C.J. Wang. 1993. Haemotoxic Effect of Phenylurea Herbicides in Rats: Role of Haemoglobin-adduct Formation in Splenic Toxicity. *Food and Chemical Toxicology* 31(4):285-295.
- Yazar, O., J.M. Shively, and N.D. Camper. 1975. Effects of Selected Herbicides on Bacterial Populations in Nontreated and Treated Water. *Water Resources Bulletin* 11(2):294-299.
- Yoshida, T., T. Maruyama, H.I. Kojima, I. Allahpichay, and S. Mori. 1986. Evaluation of the Effect of Chemicals on Aquatic Ecosystem by Observing the Photosynthetic Activity of a Macrophyte, *Porphyra yezoensis*. *Aquatic Toxicology* 9:207-214.
- Zimba, P.V., C.S. Tucker, and C.C. Mischke. 2002. Short-term Effect of Diuron on Catfish Pond Ecology. *North American Journal of Aquaculture* 64:16-23.

APPENDIX A.2

TIER II AND III LITERATURE REVIEW FORMS

Reviewer/Date:	RZW 10/16/03
Title of Paper/Report:	Hepato-toxic effect of diuron in albino rats
Author(s)	Agrawal + Kumar
Journal/Year/Vol:Pages	Indian J Exp Biol 1999 / 37: 503-504

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	(yes) (tumor initiation promoting eff)
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	(yes)
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	very briefly
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	
- does compare liver wt w/ control (Ns @ 250mg/kg) - very little detail	

Reviewer/Date:	VZN
Title of Paper/Report:	Effect of diuron on germ cells of mice
Author(s)	Agrawal & Mehrotra
Journal/Year/Vol:Pages	Indian J. of Exp. Biol.

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	NO
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	NO
Effects to target plants (efficacy testing)	NO
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	NO
Mixtures including non-BLM herbicides	NO
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	1
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	1
Were proper controls used and was control performance acceptable?	1
Are the data presented in a peer-reviewed journal?	1

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: mutagenic test - excluded	

Reviewer/Date:	MD 10/7/03
Title of Paper/Report:	Diuron
Author(s)	Anonymous
Journal/Year/Vol:Pages	Dangerous Properties of industrial materials report Sept/02 1984 p49-55

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	NO
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	NO
Effects to target plants (efficacy testing)	NO
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	NO
Mixtures including non-BLM herbicides	NO
Marine receptors	Yes

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1 summary
Chronic effects (e.g., reproductive) that may affect populations	NA
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	NA
Indirect effects (food supply, cover)	NA

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NO
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NA
Were proper controls used and was control performance acceptable?	NA
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	

Summary of info on diuron

unable to validate refs

p50 table of fw tox
p51 tables of sw & animal tox

Reviewer/Date:	1305 10/7/03
Title of Paper/Report:	Bromacil and Diuron herbicides: toxicity, uptake, and elimination in freshwater fish
Author(s)	Call et al
Journal/Year/Vol:Pages	Arch Environ Contam Toxicol 1987 16: 607-613

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	4
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: med-high ranking	

Degradates/Inerts:	
Additional Comments and Observations:	- BCFs = < 3.2 (bromacil) & 2.0 (diuron) - elimination of both in rainbow trout - measured concs reported

Reviewer/Date:	RSN 10/7/03
Title of Paper/Report:	Toxicity of Fluometuron and diuron on the intermediate snail host (<i>Lymnaea</i> spp.) of <i>Fasciola hepatica</i>
Author(s)	Christian and Tate
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 1982:628-631 28(53)

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	W/S
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	NA acute effects
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: low ranking	

Task 2: Data Evaluation

Reviewer/Date:	RBN 10/7/03
Partial Title of Paper/Report:	

Herbicides tested:	Fluometuron Diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	Lymnaea snail
Test Species:	Lymnaea spp.		
Life Stage:	NP		
Duration:	96h		

Exposure Conditions	
Formulation:	N.R.
Concentration/amount of active ingredient:	N.R.
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	0-100 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	Static!

Test System Monitoring			
Dissolved Oxygen:	N.R.	Conductivity:	
Temperature:	↓	Organic Carbon (D or T):	
pH:	↓	Ammonia:	
Other ()::		Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	diuron 15.3 mg/L				
Growth	Fluo 34.7 ↓				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- Stats used - no report of analytical, likely nominal concs. - also have 24, 48 & 72 h data - not a very detailed report

Reviewer/Date:	RZN 10/7/03
Title of Paper/Report:	Effects of pesticides on embryonic development of clams and oysters and on survival and growth of the larvae
Author(s)	Davis & Hilde
Journal/Year/Vol:Pages	Fishery Bull 1969 67:303-404

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓ Yes

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	✓
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes NO
Additional comments regarding acceptance/rejection: Duron marine study	

Reviewer/Date:	RSN 10/7/03
Title of Paper/Report:	Application of whole effluent toxicity test procedures to ambient water quality assessment
Author(s)	de Vlaming et al
Journal/Year/Vol:Pages	Environ Toxicol Chem 2000 19:42-62

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NA
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	✓

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: duration evaluation of field collected waters + identifying sources of toxicity	

Reviewer/Date:	BSN 10/7/05
Title of Paper/Report:	Evaluation of the effects of diuron and its derivatives on Lemna gibba using a fluorescence
Author(s)	Dewez et al
Journal/Year/Vol:Pages	Environ Toxicol 2002 17:493-501

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	NA
Inerts, degradates, metabolite effects	4
Mixtures of any of the five herbicides	NA
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	Not evaluated
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	✓
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: expt uses fluorescence - not related to effect on biomass and production	

Reviewer/Date:	PJN 10/18/03
Title of Paper/Report:	Prediction of fathead minnow acute toxicity of organic compounds from molecular structure
Author(s)	Eldred et al
Journal/Year/Vol:Pages	Chem Res Toxicol 1999 12: 670-678

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	✓

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: diuron bromacil Structure activity relationships - No tox data	

Reviewer/Date:	RBN 10/8/05
Title of Paper/Report:	Toxicity evaluation of single and mixed antifouling biocides measured with acute
Author(s)	Fernández-Alba, Hermendo, Piedra, Christi
Journal/Year/Vol:Pages	Amb. Chim Acta 2002 456:303-312

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals <u>only</u> with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	algae
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	Yes
Mixtures of any of the five herbicides	No
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes - not stats N.R.
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2? yes

Additional comments regarding acceptance/rejection:

single & mixture studies
rank: med

Task 2: Data Evaluation

Reviewer/Date:	RZW 10/8/03
Partial Title of Paper/Report:	Toxicity evaluation of single and mixed anti-fouling...

Herbicides tested:	diuron degradation products (1-(3,4-dichlorophenyl) methylurea & 1-(3,4-dichlorophenyl) urea		
20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Selenastrum capricornutum Daphnia magna		
Life Stage:	<24h old - magna cells → algae		
Duration:	48h - magna 72h - algae		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	Highest purity available
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	D.M. 20±1°C at 56, 25°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other ()::		Other ()::	
Other ()::		Other ()::	

Duration		Biological and Statistical Endpoints				
Endpoint	mg/L	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	S.C.	0.045			0.015	
Growth	D.M.	8.6			3.5	
Reproduction			1-(3,4-DCP)methylurea		1-(3,4-DCP)urea	
Embryo/Larval Develop.	/S.C.	0.058			0.04	
	ALSO D.M.	0.074			14.9	

Degradates/Inerts:	
Additional Comments and Observations:	- also used Microtox (excluded) - Magna used OECD Guideline 202 - algae " " " " LOEC = initial toxicity threshold of a chemical not sure the if they were determined statist

* - used test kits for algae & magna

Reviewer/Date:	MZN 10/8/03
Title of Paper/Report:	Application of QSARs to predict potential aquatic toxicities of organochlorine pesticides
Author(s)	Fiedler et al
Journal/Year/Vol:Pages	Toxicol Environ Chem 1989 1990 26:157-160

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA yes
Was the test of proper exposure dose, mechanism, & duration?	not evaluated
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	↓
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?

NO

Additional comments regarding acceptance/rejection:

diuron

NO new tox data, modeling

(tox data present - from aquire(!))
(LC50s) for fish - not even mention what kind

Reviewer/Date:	R3N 10/8/03
Title of Paper/Report:	Laboratory-derived acute toxicity of selected pesticides to <i>G. dubia</i>
Author(s)	Foster, Thomas, Korth
Journal/Year/Vol:Pages	Australasian J. Ecotox 1998 4:53-59

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	5
Chronic effects (e.g., reproductive) that may affect populations	Na
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes - !

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: high ranking	

Task 2: Data Evaluation

Reviewer/Date:	PBN 10/8/03
Partial Title of Paper/Report:	Laboratory-derived acute toxicity...

Herbicides tested:	bromacil diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	~~Aquatic Invertebrate~~	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Ceriodaphnia dubia		
Life Stage:	< 24h		
Duration:	48h		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	2 water types culture / natural
Test Concentrations (if appropriate):	0.5 dil series
Test System (e.g., flow-thru, mesocosm, etc.):	Static

Test System Monitoring			
Dissolved Oxygen:	nmw mqs / supply	Conductivity:	nmw mqs / supply
Temperature:		Organic Carbon (D or T):	
pH:	7.3-8.2	Ammonia:	
Other (Ca mg/L):	12.7-18.7	Other (turbidity): NTU	0
Other (Mg mg/L):	0.3-0.48	Other (hardness) mg/L	32-41

Biological and Statistical Endpoints					
Endpoint	LC50 (EC50)	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	75 (63-88)	65 (56-75)	mg/L		
Growth	1.0 (0.9-1.1)	1.7 (1.5-2.0)			
Reproduction	Supply	2 DMW mqs			
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- methods based on EPA 41 - TSIC method for EC50 - measured concs used for calc of EC50

Reviewer/Date:	NSN 10/12/03
Title of Paper/Report:	Ecotoxicological thresholds levels of a mixture of herbicides (atrazine, diuron, and metolachlor) in freshwater microcosms
Author(s)	Hartgers et al
Journal/Year/Vol:Pages	Aquat Ecol. 1998 32: 135-152

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	YES
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	4
Chronic effects (e.g., reproductive) that may affect populations	4
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	yes

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluated
Was the test of proper exposure dose, mechanism, & duration?	↓
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	↓
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?

No

Additional comments regarding acceptance/rejection:

tox data present EC50s for algae (*Skeletonema costatum*) but from p.c. - no data to review

mixture of 3 pesticides (2 non-BLM)
 microcosm study
 Atrazine, metolachlor, diuron

Reviewer/Date:	N3N 10/11/03
Title of Paper/Report:	The impact of the herbicide durgan on photosynthesis in three species of tropical seagrasses
Author(s)	Haynes et al
Journal/Year/Vol:Pages	Marine Poll. Bull. 2000 41: 7-12

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	No
Inerts, degradates, metabolite effects	No
Mixtures of any of the five herbicides	4 ✓
Indirect effects (food supply, cover)	4 2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes (n=2)
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: mod ranking seawater	

Task 2: Data Evaluation

Reviewer/Date:	RZW 10/11/03
Partial Title of Paper/Report:	The impact of the herbicide diuron on photosyn...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	tropical seagrass (Australia)
Test Species:	Halophila ovalis	Cymodocea serrulata	Zostera capricorn
Life Stage:			
Duration:	5 d exposure period / 5 d recovery period		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	seawater
Test Concentrations (if appropriate):	0, 0.1, 1.0, 10 + 100 µg/L
Test System (e.g., flow-thru, mesocosm. etc.):	50 L glass aquaria

Test System Monitoring	
Dissolved Oxygen:	
Temperature:	20°C - 35°C
pH:	8.13 - 8.42
Other (Salinity):	32.6 - 39.4 ppt
Other ()::	
Conductivity:	
Organic Carbon (D or T):	
Ammoma:	
Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	chlorophyll		1.0	10.0	for all 7 sp @ DS
Growth			(~0.95)	(~2.3)	
Reproduction			measured	measured	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- acclimated 24 h prior to experimentation - measured conc see p1 (p289) - except chlorophyll fluorescence - stats

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	P3N 10/11/03
Title of Paper/Report:	Comparative dietary toxicities of pesticides to birds
Author(s)	~~Heath~~ Heath et al
Journal/Year/Vol:Pages	~~Book~~ 1972 No: 152 1-54

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	5
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	No - internal review

Should evaluation of this paper continue in Task 2? | yes

Additional comments regarding acceptance/rejection:

USPW pub

mod-high ranking

Task 2: Data Evaluation

Reviewer Date:	130 10/11/03
Partial Title of Paper/Report:	Comparative dietary toxicities of pesticides...

Herbicides tested:	diquat diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: pheasants (Phasianus colchicus)	
Test Species:	Bobwhites quail (Colinus virginianus) mallard (Anas platyrhynchos) quail (Coturnix)		
Life Stage:	2-3 wk old birds		
Duration:	5 d exposure to diet / 3 d extra for observation		

Exposure Conditions	
Formulation:	
Concentration amount of active ingredient:	
Medium (water, food, soil, etc.):	diet (ad libitum) mixed w/ corn oil or propylene glycol
Test Concentrations (if appropriate):	6 cones spaced geometrically
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature:	Organic Carbon (D or T):
pH:	Ammonia:
Other ()::	Other ()::
Other ()::	Other ()::

Endpoint	Biological and Statistical Endpoints				
	LC50/EC50	IC (LC50)	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival CV	715	1730			
Growth CL	333	> 5000 (14% mort)			
Reproduction PC	634	> 5000 (33% mort + 4200, repellent + 5000)			
Embryo Larval Develop. AP	510	> 5000 (30% mort)			

Degradates/Inerts:	
Additional Comments and Observations:	- acclimated to unspiced diet - stats mentioned

Reviewer/Date:	NBW 10/13/03
Title of Paper/Report:	In situ chemical inhibition of benthic diatom growth affects recruitment of competing, permanent and temporary mesofauna
Author(s)	Hentschel & Turner
Journal/Year/Vol:Pages	Limnol Oceanogr 1994 39: 816-838

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Intons
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	yes

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	4
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	4
Indirect effects (food supply, cover)	5

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: Marine - in situ effect on diatoms as food sources for oligo & poly characters	

Task 2: Data Evaluation

Reviewer/Date:	NRN 10/13/03
Partial Title of Paper/Report:	In situ chemical inhibition of benthic diatoms

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: diatom & ?	
Test Species:		indirect effect on + polythene	
Life Stage:		Hobsonia Florida	
Duration:	59 d		

Exposure Conditions	
Formulation:	NR
Concentration/amount of active ingredient:	NR
Medium (water, food, soil, etc.):	sediment porewater dsw w/ diffusion chamber
Test Concentrations (if appropriate):	2×10^{-4} M (High) & 2×10^{-6} M (low) + control
Test System (e.g., flow-thru, mesocosm, etc.):	in situ (intertidal sandflat)

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ()::		Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	diatoms abundance		low	high	days 17, 27, 41
Growth			low	high	days 11, 17, 27, 31, 45
Reproduction	juvenile + adults		high	high	
Embryo/Larval Develop.	adults H. Florida		low	high	days 4, 31 (4)

Degradates/Inerts:	NR
Additional Comments and Observations:	- state reported - did not discuss analytical - measured vs nominal? not rank (no analytical)

Reviewer/Date:	PJW 10/13/03
Title of Paper/Report:	Lethal dietary toxicities of environmental pollutants to birds
Author(s)	Hill et al
Journal/Year/Vol:Pages	USFWS Special Scientific Rpt 1975 #191: 1-61

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	✓
Are the data presented in a peer-reviewed journal?	Y

Should evaluation of this paper continue in Task 2?

No

Additional comments regarding acceptance/rejection:

Same data as in Heath 1972

Reviewer/Date:	R3N 10/14/03
Title of Paper/Report:	tetrachlorobenzene in 3,4-dichloroaniline and its herbicidal derivatives: propanil, diuron, linuron, and nebur
Author(s)	Hill et al
Journal/Year/Vol:Pages	Arch Environ Health 1981 36:11-14

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	yes
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	yes
Mixtures of any of the five herbicides	NA
Indirect effects (food supply, cover)	No

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	no evaluation
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes NO
Additional comments regarding acceptance/rejection:	
skin test diuron + tetrachlorobenzene (34 + 43 mg/ml) 28 mg/kg mod ranking	

Task 2: Data Evaluation

Reviewer/Date:	RZW 10/11/03
Partial Title of Paper/Report:	Tetrachlorazobenzene in 3,4-dichloroaniline

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	Rabbit
Test Species:	New Zealand rabbits		
Life Stage:	adult female		
Duration:	14-22 d after first treatment		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	soln
Test Concentrations (if appropriate):	applied daily for 5d
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ()::		Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	

Reviewer/Date:	LEN 10/12/03
Title of Paper/Report:	A review of the literature on the use of dieldrin in fisheries
Author(s)	Johnson & Julin
Journal/Year/Vol:Pages	Bureau of Sport Fisheries and Wildlife 1974

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	4
Chronic effects (e.g., reproductive) that may affect populations	NO
Inerts, degradates, metabolite effects	↓
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NO
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NO
Were proper controls used and was control performance acceptable?	NA
Are the data presented in a peer-reviewed journal?	NO internal review

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: See table 2 summary rpt presents data from literature - no new data Missing some of pag 95	

Reviewer/Date:	ABN 10/13/03
Title of Paper/Report:	Effects of diuron on the energy budget of a <i>Daphnia magna</i> population
Author(s)	Kersting K
Journal/Year/Vol:Pages	Proceedings of the Swedish-Netherlands Symposium, Wageningen, Netherlands, Elsevier Scientific Publishing Co 159-166 1975

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	1
Genotoxic effects (mutagenic, carcinogenic)	1
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	1
Effects to target plants (efficacy testing)	1
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	1
Mixtures including non-BLM herbicides	1
Marine receptors	1

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	3
Inerts, degradates, metabolite effects	No
Mixtures of any of the five herbicides	No
Indirect effects (food supply, cover)	yes

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	1 data presented as
Are the data presented in a peer-reviewed journal?	1

Should evaluation of this paper continue in Task 2?

yes NO

Additional comments regarding acceptance/rejection:

memorandum weak exp design, insufficient info
no stats, no analy

2 of
ctrl

Task 2: Data Evaluation

Reviewer/Date:	<i>RS 10/13/03</i>
Partial Title of Paper/Report:	<i>Effects of diuron on the energy budget of a...</i>

Herbicides tested:	<i>diuron</i>

20 g Mammal	<i>Honey Bee</i>	70 kg Herbivore	Large Bird
Small Bird	<i>Aquatic Invertebrate</i>	Warmwater Fish	Coldwater Fish
Non-Target Plants	<i>Aquatic Plant (Macrophyte)</i>	Other:	<i>algae</i>
Test Species:	<i>Daphnia magna</i>	<i>Chlorella vulgaris</i>	
Life Stage:			
Duration:	<i>~3 wks</i>		

Exposure Conditions	
Formulation:	<i>870 granulate (AA Karmex 870 granulate)</i>
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	<i>0, 0.5, 4.0 mg/L</i>
Test System (e.g., flow-thru, mesocosm, etc.):	<i>static microcosm (aquarium ~ 2L)</i>

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	<i>18°C</i>	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (<i>photoperiod</i>):	<i>14h light : 10h dark</i>	Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	<i>- endpoint caloric values</i> <i>- reps, exp design not described</i> <i>- no stats</i> <i>- final biomass (2 of each) ↓ @ 4 mg/L</i>

Reviewer/Date:	RZN 10/13/03
Title of Paper/Report:	The use of microsystems for the evaluation of the effect of toxicants
Author(s)	Kersting
Journal/Year/Vol:Pages	Hydrobiol Bull 1975 19:102-108

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	0
Chronic effects (e.g., reproductive) that may affect populations	0
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	0

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes (partly)
Was the test of proper exposure dose, mechanism, & duration?	NO
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NO
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	
diuron microcosm, improper design (1 lot), problems w/ controls, nominal conc, no stats measurements (counts) of algae & magna over time	

Reviewer/Date:	R3W 6/12/03 DSP 4-674
Title of Paper/Report:	Teratogenicity studies on pesticide formulations of dimethoate, duron, and lindane in rats
Author(s)	Khera et al
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 1979 22:522-529

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	YES
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	NO
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	↓

teratogenicity, other data well

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	NA
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluated
Was the test of proper exposure dose, mechanism, & duration?	↓
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	↓
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	NO / yes
Additional comments regarding acceptance/rejection: exclusion criteria - terat & but other tox data (fetal wt)	

Task 2: Data Evaluation

Reviewer/Date:	V3N
Partial Title of Paper/Report:	Teratogenicity study on pesticide formulation of...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Female Wistar rats 175-200g		
Life Stage:	adult		
Duration:	22d		

Exposure Conditions	
Formulation:	Karmex [®]
Concentration/amount of active ingredient:	80% diuron
Medium (water, food, soil, etc.):	corn oil - vehicle
Test Concentrations (if appropriate):	125, 250, 500 mg/kg formulated diuron
Test System (e.g., flow-thru, mesocosm, etc.):	corn oil - administered 1x daily

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ()::		Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
Growth			500 mg/kg - LOEC		for fetal wt
Reproduction			250 mg/kg - LOEC		"
Embryo/Larval Develop.			125 mg/kg		For Anomalous Fetuses & litters

Degradates/Inerts:	
Additional Comments and Observations:	- control group reported - treated same as rats. - stats performed w/ student t-test → <u>not appropriate</u> stat diff seen for fetal wt/above but not for # pregnant, # of corpora lutea per pregnancy, # of live fetuses, # dead or resorbed fetuses should use multiple comparisons test e.g. Dunnett

Reviewer/Date:	NBN 10/12/03
Title of Paper/Report:	Effects of new antifouling compounds on the development of sea urchin
Author(s)	Kobayashi & Okamura
Journal/Year/Vol:Pages	Marine Poll Bull

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	Yes
Marine receptors	Yes

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	2
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes, not very detailed
Was the test of proper exposure dose, mechanism, & duration?	N.R.
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	2 ? not N.R.
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: - Low rank data not very well described/present	

Task 2: Data Evaluation

Reviewer/Date:	AJW 10/12/03
Partial Title of Paper/Report:	Effects of new anti-fouling compounds on the development of...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Sea urchin	
Test Species:	Hemicentrotus pulcherrimus Anthocidaris crassispina		
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	stock 10,000 mg/L in DMSO
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature: 22°C Ac. 19°C	Organic Carbon (D or T):
pH:	Ammonia:
Other ():	Other ():
Other ():	Other ():

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival			Further		
Growth (development)			1 mg/L organism?		
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- no analytical discussed - no diuron data presented - others are - likely because little effect - low rank

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	RZN 10/12/03
Title of Paper/Report:	Effect of diuron, dieldrin, methyl nitrophenols on chironomids
Author(s)	Korostylev
Journal/Year/Vol:Pages	Khovrychya 121:161-164 1977

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	
Additional comments regarding acceptance/rejection:	
LC50s reported in abstract in Russian could not verify 1.8 mg/L (144h)	

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	Pillard / 5-17-03 HSN
Title of Paper/Report:	Acute toxicity of 12 herbicides to the green algae - - -
Author(s)	J. Ma & W. Liang
Journal/Year/Vol:Pages	Bull Environ. Contam Toxicol / 2001 / 67:347-351

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes (algae)
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	/
Chronic effects (e.g., reproductive) that may affect populations	3
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	/
Was the test of proper exposure dose, mechanism, & duration?	/
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	/
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	X No Yes NO
Additional comments regarding acceptance/rejection: Deals only w microorganisms - no apparent data on specific target herbicides //	

Reviewer/Date:	DJS 6/13/03
Title of Paper/Report:	Toxicity of 40 herbicides to the green alga <i>Chlorella vulgaris</i>
Author(s)	Ma et al 2002
Journal/Year/Vol:Pages	Ecotox Environ Safety 2002 51:128-132

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	alga
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2 growth
Inerts, degradates, metabolite effects	na
Mixtures of any of the five herbicides	✓
Indirect effects (food supply, cover)	2 growth

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes
Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	none

low mod rank

Task 2: Data Evaluation

Reviewer/Date:	12N 10/13/03
Partial Title of Paper/Report:	Toxicity of 40 herbicides to the ...

Herbicides tested:	duroon

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: algae	
Test Species:	Chlorella vulgaris		
Life Stage:			
Duration:	96h		

Exposure Conditions	
Formulation:	50% WP
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	liquid
Test Concentrations (if appropriate):	0 - 150 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	static 50 ml Erlenmeyer flask

Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature: 25°C	Organic Carbon (D or T):
pH:	Ammonia:
Other (alaker): 100 rpm	Other ():
Other (light): continuous 5000 lux/m	Other ():

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	4.3 mg/L				
Growth	1.84 x 10 ⁻⁶ mol/L				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- controls used - stats EC50 linear reg. - solvents used - below acceptable levels - no analytical discussed/presented

Reviewer/Date:	KZN 10/13/03
Title of Paper/Report:	Acute toxicity of 33 herbicides to the green alga <i>Chlorella pyrenoidosa</i>
Author(s)	Ma et al
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 2001 66:536-541

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	algae
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2 growth
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	1/2 growth
Indirect effects (food supply, cover)	2 growth

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?

yes

Additional comments regarding acceptance/rejection:

Low-mod rank

Task 2: Data Evaluation

Reviewer/Date:	ASN 10/13/03
Partial Title of Paper/Report:	Acute toxicity of 33 herbicides to the...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Algae - green	
Test Species:	Chlorella pyrenoidosa		
Life Stage:	cells		
Duration:	96 h		

Exposure Conditions	
Formulation:	50% WP
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	0-50 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	50 ml Erlenmeyer flasks static

n=3

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (shaker):	100 rpm	Other ():	
Other (light):	continuous 3000 lux	Other ():	

7cm²

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
Growth	growth	1.3 x 10 ⁻⁴ mg/L			
Reproduction	"	5.59 x 10 ⁻⁴ M			
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- controls mentioned - stats used to - solvent: acetone, methanol, d H₂O - nominal (no analytical discussed)

Reviewer/Date:	RIN 12/13/03
Title of Paper/Report:	Differential sensitivity to 30 herbicides among populations of two green algae <i>Scenedesmus obliquus</i> and <i>Chlorella pyrenoidosa</i>
Author(s)	Ma
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 2002 68:275-281

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	algae
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on non-target receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2 growth
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	2 growth

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
nominal conc. Low-mid rank <i>Chlorella pyrenoidosa</i> already presented in Ma et al 2001	

Task 2: Data Evaluation

Reviewer/Date:	RZN, 10/13/03
Partial Title of Paper/Report:	Differential sensitivity to 30 herbicides among...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Scenedesmus obliquus		
Life Stage:			
Duration:	96 h		

Exposure Conditions	
Formulation:	50% WP
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	0 - 150 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	static 50 ml Erlenmeyer flasks

N=3

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (shaker):	100 rpm	Other ():	
Other (light intensity):	5000 lux/cm ²	Other ():	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
Growth	4.09×10^{-3} mg/L				
Reproduction	1.75×10^{-4} M				
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- controls included - EC50 stats - linear regression - solvents used to dissolve herb. (acetone, MeOH + d. H ₂ O)

Reviewer/Date:	R3W 10/13/03
Title of Paper/Report:	Topical toxicity of pesticides used in Virginia vineyards to the predatory mite, <i>Neoseiulus fallacis</i> (Parma)
Author(s)	Metzger & Pfeiffer
Journal/Year/Vol:Pages	J Entomol. Sci 2002 37: 329-337

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	1 mite bait cnts for spider mite
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes?

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: low rank - nominal conc - endpts as mg/L?	

Task 2: Data Evaluation

Reviewer/Date:	12/30 to 1/13/03
Partial Title of Paper/Report:	Partial toxicity of pesticides used in Virginia vineyards...

Herbicides tested:	duroon

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	Note
Test Species:	Neoseiulus fallacis (Garman) (Acari: Phytoseiidae)		
Life Stage:	adult		
Duration:	48h		

Exposure Conditions	
Formulation:	Karmex DF
Concentration/amount of active ingredient:	240 g rate/100 L = 300 g
Medium (water, food, soil, etc.):	liquid
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

n = 100

Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature:	Organic Carbon (D or T):
pH:	Ammonia:
Other (): 21-24°C	Other ():
Other ():	Other ():

Biological and Statistical Endpoints				
Endpoint	LC50/EC50	IC ()	(NOEC/NOAEC) LOEC	Other ()
Mortality/Survival			13.1	@ 48h n.s. from control
Growth				
Reproduction				
Embrvo/Larval Develop.				

Degradates/Inerts:	
Additional Comments and Observations:	slide-dip assay 1 cont. concentration stats described ANOVA followed by Tukey's

Reviewer/Date:	NZW 10/14/03
Title of Paper/Report:	Combined effects of tri-n-butyl tin (TBT) and diuron on marine periphyton communities detected as pollution-induced community tolerance
Author(s)	Molander et al
Journal/Year/Vol:Pages	Aqua Environ Contam Toxicol 1992/22:419-427

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	periphyton
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	yes (TBT)
Mixtures including non-BLM herbicides	↓
Marine receptors	yes

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes ECR
Were proper controls used and was control performance acceptable?	yes ?
Are the data presented in a peer-reviewed journal?	yes
Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
marine microcosm	
low - mod risk	

Task 2: Data Evaluation

Reviewer/Date:	KZW 10/14/00
Partial Title of Paper/Report:	combined effects of tri-n-butyl tin (TBT) and...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	marine periphyton
Test Species:			
Life Stage:			
Duration:	4 wks		

Exposure Conditions	
Formulation:	99% purity Pestanal-quality Acedol-6H
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	5 conc 3.2 nM - 1 μM
Test System (e.g., flow-thru, mesocosm, etc.):	microcosm
n=4	26 discs

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ():		Other ():	
Other ():		Other ():	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	10 nM	carbon incorporation			
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- measure concs 6S-100% of nominal - water in microcosms from pond - periphyton biomass - CHA - copepod abundance - photosynthesis inhibition

Reviewer/Date:	M3N 10/14/03
Title of Paper/Report:	Acute toxicities of selected herbicides to fingerling channel catfish, <i>Ictalurus punctatus</i>
Author(s)	McCorkle et al
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 1977/18:267-270

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes - briefly
Was the test of proper exposure dose, mechanism, & duration?	No - screen study
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
low ranking	
- nominal cones - 2 tested exp cones. - insufficient methods	

Task 2: Data Evaluation

Reviewer/Date:	RZN 10/14/03
Partial Title of Paper/Report:	Acute toxicities of selected herbicides to ...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Lctalurus punctatus (channel catfish)		
Life Stage:	1 yr old 14g / 12 cm		
Duration:	96h 48h		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	2 concs + 10 mg/L static
Test System (e.g., flow-thru, mesocosm, etc.):	Static 76L glass aquaria 5 fish/aq

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	20-21°C	Organic Carbon (D or T):	
pH:	8.2	Ammonia:	
Other (alk):	80 mg/L	Other (hard):	22 mg/L
Other (TSS):	133 mg/L	Other (Fe):	0.1 mg/L

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	> 10 mg/L		10 mg/L > 10 mg/L		
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- concs based on a.i. - screening study (2 concs)

- RPNs N.R.
- analytical not N.R. - likely nominal conc.

Reviewer/Date:	R3N 10/14/03
Title of Paper/Report:	The effects of temperature on the susceptibility of bluegills and rainbow trout to selected pesticides
Author(s)	Macek et al
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 1969 4: 174-183

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	

mod rank

Task 2: Data Evaluation

Reviewer/Date:	RZNS 10/14/03
Partial Title of Paper/Report:	The effects of temperature on the susceptibility of bluegills and rainbow trout to selected pesticides

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	~~Warmwater Fish~~	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	bluegill (<i>Lepomis macrochirus</i> Rafinesque)		
Life Stage:	0.6-1.5 g		
Duration:	76 h		

Exposure Conditions	
Formulation:	(Farmex) Diuron
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	RZ
Test System (e.g., flow-thru, mesocosm, etc.):	static ~~static~~ 15 L glass jars

n=2, 10/jar

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	see below	Organic Carbon (D or T):	
pH:	7.1	Ammonia:	
Other (ALK):	35 mg/L	Other (30 mg/L):	CaSO ₄ + MgSO ₄
Other ()::		Other ()::	

Biological and Statistical Endpoints						
Endpoint	TL50 96h	(LC50/EC50)	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	8700 mg/L		12.7°C			
Growth	7600		18.3°C			
Reproduction	5900		23.8°C			
Embryo/Larval Develop.						

Degradates/Inerts:	
Additional Comments and Observations:	RST temps @ 1.6°, 7.2° & 12.7°C bluegill temps @ 12.7°, 18.3°, 23.8°C measured concs - didn't see these - acclimating to conditions 48h

also have 24h dat

Reviewer/Date:	NZN 10/13/03
Title of Paper/Report:	short-term response and recovery of <i>Zostera capricorni</i> photosynthesis after herbicide exposure
Author(s)	Macinnis-Ng & Ralph
Journal/Year/Vol:Pages	Aquat Botany 2003 76:1-15

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	

nominal conc
low-mid rank

Task 2: Data Evaluation

Reviewer/Date:	ASN 10/13/03
Partial Title of Paper/Report:	short-term response and recovery of Zostera...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Seagrass	
Test Species:	Zostera capricorni		
Life Stage:	sprouts		
Duration:	10h + 4d recovery		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	0, 10 + 100 µg/L
Test System (e.g., flow-thru, mesocosm, etc.):	1050 L aquaria

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (Salinity):	35 ppt	Other ():	
Other (Light):	150 µmol photons m ⁻² s ⁻¹	Other ():	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	Chl A ~~SP~~		10	100	@ 10h Table 2
Growth	lab / max quantum yield (Chl A fluorescence)		0	10	@ 2 + 10h Table 1
Reproduction	effective quant yield		0	10	
Embryo/Larval Develop.	field MRY		0	10	@ 2h but
	" "		10	100	@ 10h field

Degradates/Inerts:	
Additional Comments and Observations:	2 month acclimation location Australia measured fluorescence describe stats lab + in situ studies

Reviewer/Date:	123N 10/14/03
Title of Paper/Report:	Chronic effects of the herbicide diuron on freshwater, Cladocerans, amphipods, mussels, minnows, worms, and snails
Author(s)	Nebeker & Schuytema
Journal/Year/Vol:Pages	Arch Environ Contam Toxicol 1998 35:441-446

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NA
Effects to microorganisms	1
Genotoxic effects (mutagenic, carcinogenic)	1
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	1
Effects to target plants (efficacy testing)	1
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	1
Mixtures including non-BLM herbicides	1
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	4
Chronic effects (e.g., reproductive) that may affect populations	3
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
- measured conc: - static / semistatic sol'n's mod-high rank	

Task 2: Data Evaluation

Reviewer/Date:	R3N 6/14/03
Partial Title of Paper/Report:	Chronic effects of the herbicide diuron on freshwater r.

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: <i>Lunbriculus variegatus</i> <i>Physa gyrina</i>	
Test Species:	<i>Daphnia pulex</i> <i>Hyalella azteca</i> <i>Chironomus tentans</i> <i>Pimephales promelas</i>		
Life Stage:	D.p. 5 d old, H.a. 2-3 d old, Ct. 2 d old 1st instar	PP el eggs (2.5 d)	
Duration:	7/10 d	PP juvenile 1.5 months old Pg - 15 d old	

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	6-7 concs
Test System (e.g., flow-thru, mesocosm, etc.):	static static-renewal

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	~ 75 $\mu S/cm$
Temperature:	10/22/24	Organic Carbon (D or T):	
pH:	~ 6.8	Ammonia:	
Other (hard):	23-24 mg/L	Other ():	
Other (calc):	2.5-26 mg/L	Other ():	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival D.p.	17.9 mg/L 96h		4.0	7.7	
Growth D.p.	7.1 mg/L 7d		4.0	7.7	no report mort
Reproduction H.a.	19.4 mg/L 96h				
Embryo/Larval Development C.t.	18.4 mg/L 10d		7.9	15.7 mg/L	
	33 mg/L 10d		3.4	7.1	off growth
	27.1 mg/L 10d		1.9	3.4	off mortality
	27.1 mg/L 10d		23.4 mg/L	3.4	growth
Degradates/Inerts: embryonal P.P.	11.7 mg/L 7d		4.2	8.3	growth
Additional Comments LV. and Observations: Pg.		10d 1.8	13.4	3.5	growth
				22.8 mg/L wt	

See Table 8 P 444

concs measured at TO

Reviewer/Date:	R3N 10/15/03
Title of Paper/Report:	Changes in erythropoietic activity of <i>Sarotherodon mossambicus</i> exposed to sublethal concentrations of the herbicide diuron
Author(s)	Reddy et al
Journal/Year/Vol:Pages	Bull Environ Contam Toxicol 1992 49: 730-737

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	Na
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	✓
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: how diuron affects blood cells of S. m. endpts: RBCs, hemoglobin & packed cell vol.	

Reviewer/Date:	RZN 10/15/03
Title of Paper/Report:	Relative toxicities of chemicals to the earthworm <i>Eisenia foetida</i>
Author(s)	Roberts & Dorough
Journal/Year/Vol:Pages	Environ Toxicol Chem 1984 3: 67-78

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: no chemical analysis presented dermal exposure mod high risk	

Task 2: Data Evaluation

Reviewer/Date:	NBN 10/19/03
Partial Title of Paper/Report:	Relative toxicities of chemicals to the earthworm

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Earthworm	
Test Species:	Eisenia fetida		
Life Stage:	adult 370-450 mg	100 worms / conc	
Duration:	48h		

Exposure Conditions	
Formulation:	Technical or analytical grade - corrected to 100% a.i.
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	filter paper - loose filter paper
Test Concentrations (if appropriate):	5-7 geometric series 0.1-1000 µg/cm ²
Test System (e.g., flow-thru, mesocosm, etc.):	dermal

Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature:	Organic Carbon (D or T):
pH:	Ammonia:
Other (Photosynthesis):	Other (): 24h dark
Other ():	Other ():

Biological and Statistical Endpoints					
Endpoint	LCS0/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	>1000 µg/cm ³				
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	(careful)...
Additional Comments and Observations:	- solvent + chemical applied (1ml) to paper - allowed to dry - add 1ml water to paper before adding worms - stats conducted

- nominal Conc.?

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	RZW 10/15/03
Title of Paper/Report:	Developments in the use of herbicides for the control of aquatic macrophytes
Author(s)	Robson
Journal/Year/Vol:Pages	Water Treatment & Examination 1969 327-337 18(4)

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluate
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	✓

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: disput review no new data disput 	

Reviewer/Date:	RZN 10/16/03
Title of Paper/Report:	Behavioral responses to Atrazine and diuron in Gold fish
Author(s)	Staglio & Trijasse
Journal/Year/Vol:Pages	Arch Environ Contam Toxicol 1998 35:484-491

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	NK
Inerts, degradates, metabolite effects	NK
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: behavioral studies / no confirmatory analytical	

low-med rank

Task 2: Data Evaluation

Reviewer/Date:	MBJ 10/16/03
Partial Title of Paper/Report:	Behavioral responses to atrazine and diuron in ...

Herbicides tested:	diuron

20 g Mammal	HoneyBee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Goldfish	
Test Species:	Carassius auratus		
Life Stage:	6-8 cm (length) 6-9 g (wt)		
Duration:	24h / 10 min		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	99% purity
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	24h - 0.5, 5, 50 µg/L / 10 min - 0.1, 1 + 10 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	static

Test System Monitoring			
Dissolved Oxygen:	8.98 mg/L	Conductivity:	
Temperature:	16.7, 6°C	Organic Carbon (D or T):	
pH:	7-7.3	Ammonia:	
Other (): 14h light		Other ():	
Other ():		Other ():	

5 fish/time / x4

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	burst swimming		5 µg/L	50 µg/L	24h exposure static
Growth	sheltering		50 µg/L	250	
Reproduction	surface		50 µg/L	250	↓
Embryo/Larval Develop.	burst swimming		<0.1 mg/L	0.1	flowing sol'n
	attraction		1.0 mg/L	10	↓
	surface		10	>10	
	grouping		10	>10	
Degradates/Inerts:	swimming		10	>10	↓
Additional Comments and Observations:	- acclimated 1 mo prior to testing - solvent (acetone 20 µg/mL) - blind test (diuron)				

No analytical except for culture/holding water

Reviewer/Date:	PSN 10/16/03
Title of Paper/Report:	Biotefts using unicellular algae and ciliates for predicting long-term effects of toxicants
Author(s)	Schäfer et al
Journal/Year/Vol:Pages	Ecotox & Environ Safe 1994 27:64-81

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	alga
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
Nominal conc.	
low-mol rank	

Task 2: Data Evaluation

Reviewer/Date:	ESN 10/16/03		
Partial Title of Paper/Report:	Biotests using unicellular algae and ciliates for predicting		
Herbicides tested:	bromacil diuron		
20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other ~~Algae~~ green ciliates ~~parietum~~	
Test Species:	Scenedesmus subspicatus Chlamydomonas reinhardtii Tetrahymena		
Life Stage:			
Duration:	72h-static		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	2
Medium (water, food, soil, etc.):	alga media
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	static

N=3

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	20°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (light):	8000 lux	Other ():	
Other (shaker):	low speed	Other ():	

72h Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	SS 0.097		0.024 / 0.0485		Bromacil (ng/L)
Growth			24h 72h		
Reproduction	SS 0.036		0.007 / 0.010		Diuron
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- data presented as nominal concs

endpt
Growth
72h

Reviewer/Date:	LBN 10/16/03
Title of Paper/Report:	Comparative toxicity of diuron on survival and growth of Pacific treefrog, bullfrog, red-legged frog, and African Clawed
Author(s)	Frog embryos and tadpoles Schuytema & Nebelcer
Journal/Year/Vol:Pages	Arch Environ Contam Toxicol 1978 34: 370-376

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	Some deformity emb.
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: Various scripts: lethal & sublethal not high rank	

Task 2: Data Evaluation

Reviewer/Date:	R3N 10/16/03
Partial Title of Paper/Report:	Comparative toxicity of diuron on survival and growth.

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Frogs	
Test Species:	Pacific treefrog <i>Pseudacris regilla</i>	bullfrog <i>Rana catesbeiana</i>	red-legged frog <i>Rana aurora</i>
Life Stage:	1st P.R. - embryos & tadpoles	P.R. embryo-stage 12 tadpole - 17d post hatch	
Duration:	embryo - 10d 10-21d (see p2 p372)	tadpole Rn 14d, 60d post exposure	same stage

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	0.5, 1.9, 3.8, 7.6, 14.5, 29.1 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	Static-renewal

Test System Monitoring			
Dissolved Oxygen:	7.0	Conductivity:	194.6
Temperature:	E 20°C T 20/24	Organic Carbon (D or T):	
pH:	7.4	Ammonia:	
Other (hard):	72.4	Other ()::	
Other (alk):	63.5	Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	EC(21d)LC50	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	15.2 mg/L		14.5 mg/L	21.0	4th 14d, for dry wt 21d
Growth		12.7 mg/L	7.6	14.5	21d. dry wt
Reproduction	22.2 mg/L		7.6	14.5	data wet, wt
Embryo/Larval Develop. PR	29.1		14.5 mg/L	29.1	(10d) survival deform.
	29.1		29.1	29.1	" deformative survival

Degradates/Inerts:	
Additional Comments and Observations:	see table 1 for conditions of embryo test w/ <i>P. regilla</i> analytical data used very detailed methods

Some endpoints above are avg of 2 exp. (Table 3, p 373)

Reviewer/Date:	PJN 10/16/03
Title of Paper/Report:	The influence of biochemical species differences on acute fish toxicity of organic chemicals
Author(s)	Sijm, Flenner & Opperhuizen
Journal/Year/Vol:Pages	Comp Biochem Physiol C 1991/100C:33-35

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	NA
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	✓
Are the data presented in a peer-reviewed journal?	✓

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	
diuron NO new data presented LC50s not even present in document	

Reviewer/Date:	RZN 10/16/03
Title of Paper/Report:	Effects of certain herbicides on some insects and spiders found in Louisiana cotton fields
Author(s)	Stam et al
Journal/Year/Vol:Pages	J Econom Entom 1978 71:477-480

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes Not Reported
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
no analytical lab + field work	

Task 2: Data Evaluation

Reviewer/Date:	LRN 10/11/03
Partial Title of Paper/Report:	Effects of certain herbicides on some insects...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: insects	
Test Species:	lab bugs Culex quinquefasciatus maculata & Symptetrus louisianae parasite Eretmocerus		
Life Stage:	2 hemipteran predators prius insidiosus neocoris punctipes hardeman		
Duration:	lab 48h field 3 applications observations e + 1d 2 nd applicat & after 3 rd application		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	field 2.530.45 1.7 Kg/ha → applied to leaves of cotton plants or 2.25 lb/acre
Test System (e.g., flow-thru, mesocosm, etc.):	lab: coated inside of vial w/ 10 ml soln dry expose or dipping tech submerge for 10s in Cn. Got SI
lab 20-30 insects/cp	
Test System Monitoring	
Dissolved Oxygen:	Conductivity:
Temperature:	Organic Carbon (D or T):
pH:	Ammonia:
Other ()::	Other ()::
Other ()::	Other ()::

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival			2.53 Kg/ha	2.5	field
Growth	>10%		102%	710%	1al (GP, L.M.D.)
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	field & lab experiments no analytical

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	ESN 10/21/03
Title of Paper/Report:	Phytotoxicity of diuron alone and in combination with copper or folpet on duckweed (Chenon)
Author(s)	Teisseire, Couderchet & Uernet
Journal/Year/Vol:Pages	Environ Poll 1999 106 39-45

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	duckweed
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	alone but
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes H ₂ O ₂
Was the test of proper exposure dose, mechanism, & duration?	yes not 0.01
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes in 1"
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: - nominal concs	

Task 2: Data Evaluation

Reviewer/Date:	AZN 10/21/03
Partial Title of Paper/Report:	Phytotoxicity of diuron alone and in combination

Herbicides tested:	diuron

20 g Mammal	HoneyBee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	aquatic macrophyte - duckweed
Test Species:	Lemna minor		
Life Stage:			
Duration:	7 d		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	>98% purity
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	nominal 5-100 µg/L a.i.
Test System (e.g., flow-thru, mesocosm, etc.):	semi-static renewed on day 4
N=3, exp repeated 3x	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25 °C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (illumination):	2500 lux	Other ()::	
Other ()::		Other ()::	

Biological and Statistical Endpoints				
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC/Other ()
Mortality/Survival				
Growth		growth IC50 25 µg/L		5 µg/L
Reproduction		inhibition IC50 60		
Embryo/Larval Develop.				

Degradates/Inerts:	
Additional Comments and Observations:	end pts: growth, total chlorophyll - chlorophyll content increased with diuron conc. - concs as nominal (a.i.)

Reviewer/Date:	F3W 10/21/05
Title of Paper/Report:	Ascorbate and glutathione contents in duckweed <i>Lemna minor</i> as biomarkers of the stress generated by copper, folpet, and diuron
Author(s)	Teisseire & Vernet
Journal/Year/Vol:Pages	Biomarkers 2000 5: 263-273

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	alone but also w/ Cu, folpet, + biomarker induction
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	Na biomarkers
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	Na
Indirect effects (food supply, cover)	Na

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: - endpoints: biomarkers - no direct link w/ fox	

Reviewer/Date:	RBN 10/17/03
Title of Paper/Report:	Anti-fouling paint booster biocides in the UK coastal environment and potential risks of biological effects
Author(s)	Thomas et al
Journal/Year/Vol:Pages	Marine Poll Bull 2001 42:677-688

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	YES
Mixtures including non-BLM herbicides	no
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	↓
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluated
Was the test of proper exposure dose, mechanism, & duration?	↓
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: survey of diuron cones in harbors/bays in the UK	

Reviewer/Date:	123J 10/12/03
Title of Paper/Report:	Fungal biodegradation of a phenylurea herbicide, diuron: structure and toxicity of metabolites
Author(s)	Tixier et al
Journal/Year/Vol:Pages	Pest Management Sci 2000 56:455-462

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Soil 1 Fungus
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	3 Biodegradation of parent & tox of metabol
Mixtures of any of the five herbicides	Na
Indirect effects (food supply, cover)	4

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	N/A
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection: microtox test, metabolism by fungi; analytical confirm Add = high rank	

Task 2: Data Evaluation

Reviewer/Date:	RSN 10/17/03
Partial Title of Paper/Report:	Fungal biodegradation of a phnylurea herbicide...

Herbicides tested:	Diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	Fungus / protozoan
Test Species:	Beauveria bassiana	Cunninghamiella elegans	Montierella isabellina
Life Stage:		protozoan → Tetrahymena pyriformis	
Duration:	14h TP	24h-ST	→ Spirostomum teres

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	TP = 28°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (photoperiod):	TP-dark	Other ()::	
Other ()::		Other ()::	

n = 4 TP

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC (50)	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival TP		6.33			diuron mail
Growth	growth inhibitory	2.28			metabolite 2
Reproduction		10.23			1 " 3
Embryo/Larval Develop. ST		40.2			diuron
	LC50	6.12			2
		10.18			3

Degradates/Inerts:	
Additional Comments and Observations:	- analytical confirmation of parent & metabolites - present data (tox) for microtox - other test w/ decreased fluorescence of via esterases - Stats discussed - OK

Reference method for ST

Metabolite 2 N(3,4-dichlorophenyl)N-methylurea
 3 N-3,4-dichlorophenyl urea

Reviewer/Date:	RZN 10/21/03.
Title of Paper/Report:	Degradation products of a phenylurea herbicide, diuron: synthesis, ecotoxicity, and biotransformation
Author(s)	Tixier et al
Journal/Year/Vol:Pages	Environ Toxicol Chem 2001 20: 1381-1389

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	yes
Genotoxic effects (mutagenic, carcinogenic)	Na
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓ Microtox

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	5
Mixtures of any of the five herbicides	Na
Indirect effects (food supply, cover)	Na

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?

NO

Additional comments regarding acceptance/rejection:

- biotransformation via fungal cells
 - tox data for using Microtox EC50s of degradation products

Reviewer/Date:	MBN 10/17/03
Title of Paper/Report:	The tolerance of grass carp <i>Ctenopharyngodon</i> della Val. to aquatic herbicides
Author(s)	Tooby, Lucey & Stott
Journal/Year/Vol:Pages	J Fish Biol 1980 16:591-597

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on non-target receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes n=?
Were proper controls used and was control performance acceptable?	NR
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	

- Minimal logs
- not sure about replication
- acetone conc higher than present data

low-mid rank

Task 2: Data Evaluation

Reviewer/Date:	RZW 10/17/03
Partial Title of Paper/Report:	The tolerance of grass carp, <i>Ctenopharyngodon</i> ...

Herbicides tested:	diuron digual

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	~~Warmwater Fish~~	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Grass & carp	
Test Species:	<i>Ctenopharyngodon idella</i>		
Life Stage:	9.5 cm 15.8 g	1+ yr	
Duration:	5d		

Exposure Conditions	
Formulation:	diuron technical grade (97%) digual 13.5% ^{Aquicide}
Concentration/amount of active ingredient:	100% 13.5%
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	geometric series
Test System (e.g., flow-thru, mesocosm, etc.):	40L glass aquaria flow-thru (10/4/03) 10 fish/aq

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	13°C - diuron	Organic Carbon (D or T):	
pH:	8.1	Ammonia:	
Other (): dechlorinated tap H ₂ O		Other ():	
Other (hard): 220 mg/L		Other ():	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	1718 (56.0-5275)				
Growth	31 (28-34)				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- FWK acclimation - fed during study - diuron - solvent control (acetone) - 1000 mg/L - highest conc. - also present at 48h LC50 - reps?

Reviewer/Date:	ALN 10/21/03
Title of Paper/Report:	Tissue residues of duron in channel catfish, <i>Ictalurus punctatus</i> exposed to the algicide in consecutive years
Author(s)	Tucker & Kingsbury
Journal/Year/Vol:Pages	J World Aquaculture Soc 2003 34: 203-209

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	yes
Mixtures including non-BLM herbicides	No
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	

- tissue residues of duron
- no carry over from one field yr to the next

Reviewer/Date:	12/22/03
Title of Paper/Report:	Haemolytic effect of phenylurea herbicides in rats: role of haemoglobin- adduct formation in splenic toxicity
Author(s)	Wang et al
Journal/Year/Vol:Pages	Ed Chem Toxic. 1993 31 285-295

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rat hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	✓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	- stats No
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	
heavy wt. data - ignored haemotoxic effects	

Task 2: Data Evaluation

Reviewer/Date:	ABW 10/22/03
Partial Title of Paper/Report:	Haematotoxic effect of phylarea herbicides...

Herbicides tested:	diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Female Sprague-Dawley rats	
Test Species:			
Life Stage:	120-150g		
Duration:	14 months		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Food
Test Concentrations (if appropriate):	250-1000 mg/kg diet
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	23°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (rel. hum):	50%	Other ()::	
Other (light/dark):	12h/12h	Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival					
✓ Growth			1000	2000	mg/kg
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- no analytical presented

Reviewer/Date:	R-305 10/26/03
Title of Paper/Report:	Evaluation of the effect of chemicals on aquatic ecosystem by observing the photosynthetic activity of a macrophyte, <i>Periphyra yezoensis</i>
Author(s)	Yoshida et al
Journal/Year/Vol:Pages	Aquatic Toxicol 1986/9: 207-214

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	Maybe ✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	yes

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: testing of macrophyte that appears to be important species for aquaculture in Japan	

diuron

exclude - unlikely relevance to US

Reviewer/Date:	10/26/03 RSD
Title of Paper/Report:	Short-term effect of divon on catfish pond ecology
Author(s)	Zimbar et al
Journal/Year/Vol:Pages	North American J Aquaculture 2002/64/16-23

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluated
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	
- focus on reduction of cyanobacteria and off-flavor in catfish fillets resulting	

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	Millard / 5-10-02
Title of Paper/Report:	Acute toxicity of pesticides in adult and weanling rats
Author(s)	T. B. Gaines & R. E. Linden
Journal/Year/Vol:Pages	fund. & Appl. Toxicol. / 1986 / 7:299-308

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes (LD50)
Were proper controls used and was control performance acceptable?	could not determine
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-22-03
Partial Title of Paper/Report:	Acute toxicity of pesticides in adult...

Herbicides tested:	diquat bromacil diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	(Other) Sherman - strain rat	
Test Species:	Rat		
Life Stage:	90 days (adult tests); 4-6 wks (weanlings)		

Exposure Conditions	
Formulation:	9,10-Dihydro-8a,10a-diazonia phenanthrene
Concentration/amount of active ingredient:	dibromide monohydrate
Medium (water, food, soil, etc.):	Water/oil CAS 638562-2
Test Concentrations (if appropriate):	Multiple doses used, but not presented
Test System (e.g., flow-thru, mesocosm, etc.):	Oral dosing or dermal dosing

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ():		Other ():	
Other ():		Other ():	

Biological and Statistical Endpoints					
Endpoint	LD50 LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Adult ♂ Mortality/Survival Oral	27 (26-29) mg/kg		147 (138-155 mg/kg)		
Adult ♀ Growth Surv. Oral	121 (108-136 mg/kg)				
Adult ♂ Reproduction Surv. Dermal	433 (344-568)				
Embryo/Larval Develop.					
Adult ♂	1258	adult ♂	791		
Adult ♀	1182	♀	641		
		weanling ♂	1737		

Degradates/Inerts:	
Additional Comments and Observations:	Oral application as dissolved in water or peanut oil. Diquat in water was used for dermal application.

new 10/8/03
see Table 2 p 304 for data on bromacil & diuron dermal for both ♂ + ♀ > 2500 mg/kg

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	Pillard / 5-17-03 145N
Title of Paper/Report:	Acute toxicity of 12 herbicides to the green algae - - -
Author(s)	J. Ma & W. Liang
Journal/Year/Vol:Pages	Bull Environ. Contam Toxicol / 2001 / 67:347-351

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes (algae)
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on non-target receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	~~Yes~~ No
Additional comments regarding acceptance/rejection: Deals only w microorganisms - no apparent data on specific target herbicides !!	

Reviewer/Date:	Pillard / 5-17-03
Title of Paper/Report:	Manual of acute toxicity: interpretation and data base for 410 chemicals ...
Author(s)	F.L. Mayer, & M.R. Ellersieck
Journal/Year/Vol:Pages	US DOI, FWS / 1986 / Res. Publ. 160

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	NK. Followed ASTM guidelines
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection: Database pub - summarizes many studies	

Task 2: Data Evaluation

Reviewer/Date:	RAN 10/6/03
Partial Title of Paper/Report:	Manual of acute tox: interpretation and...

Herbicides tested:	diquat fluridone diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	<u>Aquatic Invertebrate</u>	<u>Warmwater Fish</u>	<u>Coldwater Fish</u>
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Various		
Life Stage:	Various		
Duration:	48 - 96h		

Exposure Conditions	
Formulation:	diquat 35.3%
Concentration/amount of active ingredient:	fluridone (98% tech + 41% liquid)
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	NR
Test System (e.g., flow-thru, mesocosm, etc.):	static / static renewal / flow through

Test System Monitoring	
Dissolved Oxygen:	
Temperature:	11.1°C in app
pH:	
Other ()::	
Other ()::	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	2800 - 7500 μ g/L Bluegill		Diuron		
Growth	115,000 - 498,000 μ g/L		Diquat		
Reproduction					
Embryo/Larval Develop.			Diquat	18 LC50s	P179
			fluridone	24 LC50s	P245
			diuron	48 LC50s	P182
				59	

Degradates/Inerts:	
Additional Comments and Observations:	also list 24 & 48h data for some studies

Reviewer/Date:	Pillard / 11-26-03
Title of Paper/Report:	Toxicities of some herbicides to Six species of freshwater crustaceans
Author(s)	H. O. Sanders
Journal/Year/Vol:Pages	J. W. PCF. / 1970 / 42:1544-1550

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Unknown
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	No yes
Additional comments regarding acceptance/rejection: No reps apparently used, duplicate data not presented - found it, bioassay methods presented elsewhere (Index & Cope 1968 & 1969)	

Task 2: Data Evaluation

Reviewer/Date:	RZW 9/21/03
Partial Title of Paper/Report:	Toxicities of some herbicides to six species of freshwater crustaceans

Herbicides tested:	diquat diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Gammarus fasciatus		
Life Stage:	early instar		
Duration:	≤ 96 h		

Exposure Conditions	
Formulation:	technical (Diuron) or emulsifiable concentrate (diquat)
Concentration/amount of active ingredient:	Diuron technical
Medium (water, food, soil, etc.):	dissolved in EtOH (< 1 ml/L of H ₂ O)
Test Concentrations (if appropriate):	4-5 not specified (with appropriate controls)
Test System (e.g., flow-thru, mesocosm, etc.):	static 4 L of exposure H ₂ O

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	15.5°C	Organic Carbon (D or T):	
pH:	7.4	Ammonia:	
Other (TDS):	361 mg/L	Other (hardness):	272 mg/L
Other (ALC):	260 mg/L	Other ():	176 mg/L 96 mg/L

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ()	NOEC/NOAEC	LOEC	Other ()
Mortality/Survival	1.8/0.80-5.2 (48h)	7 Diuron mg/L			
Growth	0.7/0.14-9.2 (96h)				
Reproduction					
Embrvo/Larval Develop.					
mortality	> 100 mg/L for diquat				

Degradates/Inerts:	
Additional Comments and Observations:	< 10% mortality 9d prior to testing - n = 1 (?) with 10 organisms/chamber - 2h acclimation period in chamber prior to intro of herbicide - prelim tests used to set test concs

Data on scout (diquat & diuron) from a # of bioassays → methods not clearly presented

BLM National Vegetation EIS

Literature Review Form

Page 1 of 2

Reviewer/Date:	Pillard / 6-3-03
Title of Paper/Report:	Toxicity of some herbicides to major carp fingerlings
Author(s)	S. P. Singh & M. K. Yadav.
Journal/Year/Vol:Pages	J. Ecol / 1978 / 5: 141-147

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Study did not apparently follow appropriate scientific procedures - methods mentioned elsewhere (over 1971) - presents results in figs as % mortality - don't calc endpts eg. LC50, NOEC, etc deficient duration	

Reviewer/Date:	Pillard / 6-22-03
Title of Paper/Report:	Effects of selected herbicides on bacterial populations. . .
Author(s)	O. Yazan et al.
Journal/Year/Vol:Pages	Wat. Res. Bull / 1975 / 11: 294 - 299

Task 1: Application of Selection Criteria**A. Indicate if the paper meets these exclusion criteria**

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	(
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No (No reps)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Bacteria only; true reps apparently not used; no stats	

APPENDIX A.3

SPREADSHEET OF TOXICITY DATA FOR DIURON TRV

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹		Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Survival	LC ₅₀	>	29.1	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Deformity	EC ₅₀		22.2	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Deformity	NOAEL		14.5	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Deformity	LOAEL		29.1	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Length	NOAEL		29.1	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
Technical grade	99.8%	amphibian	Frog	<i>Pseudacris regilla</i>	embryo 10 d, stage 12	Static renewal	Water	10 d (4 d post-hatch)	10 d	Length	LOAEL	>	29.1	NR	mg/L	Yes/Yes				Schuytena & Nebeker. 1998. Arch. Environ. Contam. Toxicol. 34: 370-376.			No
1-(3,4-dichlorophenyl) methylurea	highest purity available	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>	cells	Static	Water	72 hr	72 hr	Growth	EC ₅₀		0.058	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No
1-(3,4-dichlorophenyl) urea	highest purity available	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>	cells	Static	Water	72 hr	72 hr	Growth	EC ₅₀		0.07	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No
50% wettable powder		aquatic plant	Green algae	<i>Chlorella pyrenoidosa</i>	cells	Static	Water	96 hr	96 hr	Growth	EC ₅₀		0.0013	NR	mg/L	No/No				Ma et al. 2001. Bull. Environ. Contam. Toxicol. 66: 536-541.			No
50% wettable powder		aquatic plant	Green algae	<i>Chlorella pyrenoidosa</i>	cells	Static	Water	96 hr	96 hr	Growth	EC ₅₀		5.59E-08	NR	M	No/No				Ma et al. 2001. Bull. Environ. Contam. Toxicol. 66: 536-541.			No
50% wettable powder		aquatic plant	Green algae	<i>Scenedesmus obliquus</i>	cells	Static	Water	96 hr	96 hr	Growth	EC ₅₀		0.00409	NR	mg/L	No/No				Ma. 2002. Bull. Environ. Contam. Toxicol. 68: 275-281.			No
50% wettable powder		aquatic plant	Green algae	<i>Scenedesmus obliquus</i>	cells	Static	Water	96 hr	96 hr	Growth	EC ₅₀		1.75E-08	NR	M	No/No				Ma. 2002. Bull. Environ. Contam. Toxicol. 68: 275-281.			No
50% wettable powder		aquatic plant	Green algae	<i>Chlorella vulgaris</i>	cells	Static	Liquid	96 hr	96 hr	Growth	EC ₅₀		0.0043	NR	mg/L	No/No				Ma et al. 2002. Ecotox. Environ. Safety 51: 128-132.			No
50% wettable powder		aquatic plant	Green algae	<i>Chlorella vulgaris</i>	cells	Static	Liquid	96 hr	96 hr	Growth	EC ₅₀		1.84E-08	NR	mol/L	No/No				Ma et al. 2002. Ecotox. Environ. Safety 51: 128-132.			No
DCMU	99%	aquatic plant	Marine periphyton		0 d - 4 w	Microcosm	Water	4 w	4 w	Photosynthesis	EC ₅₀		10	NR	µm	Yes/No ⁹				Molander et al. 1992. Arch. Environ. Contam. Toxicol. 22: 419-427.			No
Diuron	highest purity available	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>	cells	Static	Water	72 hr	72 hr	Growth	EC ₅₀		0.045	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No
Diuron	highest purity available	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>	cells	Static	Water	72 hr	72 hr	Growth	LOEC		0.015	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No
Diuron	96.8%	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>		96-hr Acute	Water	96 hr	96 hr		EC ₅₀		0.0024	NR	mg/L		EPA	MRID 42218401	1991. In USEPA 2003.	C. Rodriguez	1994	Yes	
Diuron	96.8%	aquatic plant	Green algae	<i>Selenastrum capricornutum</i>		96-hr Acute	Water	96 hr	96 hr		NOEC		0.00044	NR	mg/L		EPA	MRID 42218401	1991. In USEPA 2003.	C. Rodriguez	1994	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Dunaliella tertiolecta</i>			Water	240 hr	240 hr		EC ₅₀		0.02	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Chlamydomonas sp.</i>			Water	72 hr	72 hr		EC ₅₀		0.037	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Chlorococcum sp.</i>			Water	72 hr	72 hr		EC ₅₀		0.010	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Chlorella sp.</i>			Water	72 hr	72 hr		EC ₅₀		0.019	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Neochloris sp.</i>			Water	72 hr	72 hr		EC ₅₀		0.028	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Green algae	<i>Platymonas sp.</i>			Water	72 hr	72 hr		EC ₅₀		0.017	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Freshwater diatom	<i>Thalassiosira fluviatilis</i>		Static	Water	72 hr	72 hr		EC ₅₀		0.095	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Algae	<i>Monochrysis lutheri</i>			Water	72 hr	72 hr		EC ₅₀		0.018	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Algae	<i>Isochrysis galbana</i>			Water	240 hr	240 hr		EC ₅₀		0.01	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	
Diuron	95%	aquatic plant	Algae	<i>Achnanthes brevipes</i>			Water	72 hr	72 hr		EC ₅₀		0.024	NR	mg/L		EPA	MRID 40228401	1986. In USEPA 2003.	F.L. Mayer	1986	Yes	

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron	95%	aquatic plant	Algae	<i>Navicula incerta</i>			Water	72 hr	72 hr		EC ₅₀	0.093	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diuron	95%	aquatic plant	Algae	<i>Stauroneis amphoroides</i>			Water	72 hr	72 hr		EC ₅₀	0.031	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diuron	95%	aquatic plant	Algae	<i>Amphora exigua</i>			Water	72 hr	72 hr		EC ₅₀	0.031	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diuron	95%	aquatic plant	Algae	<i>Nitzschia closterium</i>			Water	72 hr	72 hr		EC ₅₀	0.05	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diuron	95%	aquatic plant	Algae	<i>Porphyridium cruentum</i>			Water	72 hr	72 hr		EC ₅₀	0.024	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
diuron/DCMU		aquatic plant	Diatom		various	In situ	Sediment Pore Water	59 d	59 d (test on d 17, 27, 41)	Abundance	NOEC	0.000002	NR	M	No/No				Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
diuron/DCMU		aquatic plant	Diatom		various	In situ	Sediment Pore Water	59 d	59 d (test on d 17, 27, 41)	Abundance	LOEC	0.0002	NR	M	No/No				Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Halophila ovalis</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	NOEC ⁵	1.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Cymodocea serrulata</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	NOEC ⁵	1.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Zostera capricorni</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	NOEC ⁵	1.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Halophila ovalis</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	LOEC ⁵	10.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Cymodocea serrulata</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	LOEC ⁵	10.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Technical grade	98%	aquatic plant	Tropical seagrass	<i>Zostera capricorni</i>	unknown	Static	Seawater	5 d	5 d (+ 5 d recovery)	Photosynthesis	LOEC ⁵	10.0	NR	ug/L	Yes/Yes				Haynes et al. 2000. Marine Poll. Bull. 41: 7-12.			No ⁶
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	10 h	10 h	Chlorophyll a	NOEC	10	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	10 h	10 h	Chlorophyll a	LOEC ¹⁰	100	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	2 hr	10 hr	Max. or effective quantum yield	NOEC	0	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	2 hr	10 hr	Max. or effective quantum yield	LOEC ¹⁰	10	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	10 h	10 h	Max. or effective quantum yield	NOEC	0	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	2 months post-sprig	Static	Water	10 h	10 h	Max. or effective quantum yield	LOEC ¹⁰	10	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	unknown	Static mesocosm	Water	2 hr	10 hr	Maximum quantum yield	NOEC	0	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	unknown	Static mesocosm	Water	2 hr	10 hr	Maximum quantum yield	LOEC ¹⁰	10	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	unknown	Static mesocosm	Water	10 h	10 h	Maximum quantum yield	NOEC	10	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Seagrass	<i>Zostera capricorni</i>	unknown	Static mesocosm	Water	10 h	10 h	Maximum quantum yield	LOEC ¹⁰	100	NR	ug/L	No/No				Macinnis-Ng & Ralph. 2003. Aquatic Biology 76: 1-15.			No
Diuron		aquatic plant	Green algae	<i>Scenedesmus subspicatus</i>	cells	Static	Algae media	72 hr	72 hr	Growth	EC ₅₀	0.036	NR	mg/L	No/No				Schafer et al. 1994. Ecotox. Environ. Safety 27: 64-81.			No
Diuron		aquatic plant	Green algae	<i>Scenedesmus subspicatus</i>	cells	Static	Algae media	72 hr	72 hr	Growth	NOEC	0.010	NR	mg/L	No/No				Schafer et al. 1994. Ecotox. Environ. Safety 27: 64-81.			No
Diuron		aquatic plant	Green algae	<i>Scenedesmus subspicatus</i>	cells	Static	Algae media	24 hr	24 hr	Growth	NOEC	0.007	NR	mg/L	No/No				Schafer et al. 1994. Ecotox. Environ. Safety 27: 64-81.			No
Diuron		bird	Ring-necked pheasant	<i>Phasianus colchicus</i>	2-3 w	Diet	Food	5 d	5 d (+ 3 d recovery)	Survival	LC ₅₀ ⁷	> 5000	NR	ppm (in feed)	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.			Yes
Diuron		bird	Mallard duck	<i>Anas platyrhynchos</i>	2-3 w	Diet	Food	5 d	5 d (+ 3 d recovery)	Survival	LC ₅₀	1730	NR	ppm (in feed)	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1982	Yes
Diuron		bird	Bobwhite quail	<i>Colinus virginianus</i>	2-3 w	Diet	Food	5 d	5 d (+ 3 d recovery)	Survival	LC ₅₀	1730	NR	ppm (in feed)	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1982	Yes

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron		bird	Mallard duck	<i>Anas platyrhynchos</i>	10 d	Diet	Food	5 d	5 d (+ 3 d recovery)	Survival	LC ₃₀	> 5000	NR	ppm (in feed)	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1982	Yes
Diuron		bird	Japanese quail	<i>Coturnix coturnix</i>	2-3 w	Diet	Food	5 d	5 d (+ 3 d recovery)	Survival	LC ₅₀ ¹⁴	> 5000	NR	ppm (in feed)	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1982	Yes
Diuron	92.8%	bird	Bobwhite quail	<i>Colinus virginianus</i>	17 w	Acute	Avian Oral	21 d	21 d	Mortality	LD ₅₀	940	NR	mg/kg BW		Wildlife Interntl	MRID 50150170		1985. In USEPA 2003.	E. Zucker	1993	Yes
Diuron	95%	bird	Mallard duck	<i>Anas platyrhynchos</i>	3 monthrs	Acute	Avian Oral	14 d	14 d	Mortality	LD ₅₀	> 2000	NR	mg/kg BW		FWS	MRID 00160000		1970. In USEPA 2003.	Hudson, R.H. et al	1982	Yes
Diuron	>95%	bird	Bobwhite quail	<i>Colinus virginianus</i>		Acute	Avian Dietary				LC ₅₀	NR	> 5000	ai ppm			MRID 00022923		In USEPA 2003.		1975	Yes
Diuron	>95%	bird	Mallard duck	<i>Anas platyrhynchos</i>		Acute	Avian Dietary				LC ₅₀	NR	1730	ai ppm			MRID 00022923			Hill, E.R.	1975	Yes
Diuron	92.8%	bird	Bobwhite quail	<i>Colinus virginianus</i>	17 w	acute	Oral	21 d	21 d	Mortality	NOEL	< 292	NR	mg/kg BW		Wildlife Interntl	MRID 50150170		1985. In USEPA 2003.	E. Zucker	1993	Yes
Diuron		fish	Bluegill sunfish	<i>Lepomis macrochirus</i>	1.1-1.3 g	Static	Water	96 hr	96 hr	Survival	LC ₅₀ ¹¹	NR	NR		Unknown/ No			FWS Res. Pub 160	Mayer & Ellersieck. 1986.			No
Diuron	95%	fish	Rainbow trout	<i>Oncorhynchus mykiss</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	1.95	NR	mg/L		EPA	STODIU04		1976. In USEPA 2003.	A. Stavola	1982	Yes
Diuron	95%	fish	Bluegill sunfish	<i>Lepomis macrochirus</i>		96-br Acute	Water	96 hr	96 hr	Survival	LC ₅₀	2.8	NR	mg/L		FWS	MRID 40098001		1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diuron	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	early life	Chronic	Water	60 d	60 d		NOEC	0.0264	NR	mg/L		EPA	MRID 00141636		In USEPA 2003.	A. Stavola	1982	Yes
Diuron	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	early life	Chronic	Water	60 d	60 d		LOEC	0.0618	NR	mg/L		EPA	MRID 00141636		In USEPA 2003.	A. Stavola	1982	Yes
Diuron	95%	fish	Cutthroat trout	<i>Oncorhynchus clarki</i>		96-br Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	0.71	NR	mg/L		FWS	MRID 40098001		1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diuron	95%	fish	Striped mullet	<i>Mugil cephalus</i>		96-hr Acute	Water	96 hr			LC ₅₀	NR	6.3	mg ai/L			MRID 40228401			F.L. Mayer	1986	Yes
Diuron	80%	fish	Rainbow trout	<i>Oncorhynchus mykiss</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	16	NR	mg/L		FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1980	Yes
Diuron	28%	fish	Rainbow trout	<i>Oncorhynchus mykiss</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	23.8	NR	mg/L		EPA	STODIV02		1975. In USEPA 2003.	A. Stavola	1982	Yes
Diuron	80%	fish	Rainbow trout	<i>Oncorhynchus mykiss</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	19.6	NR	mg/L		Dupont	MRID 42046002		In USEPA 2003.	C. Rodriguez	192	Yes
Diuron	95%	fish	Cutthroat trout	<i>Oncorhynchus clarki</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	1.4	NR	mg/L		FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1982	Yes
Diuron	95%	fish	Lake trout	<i>Salvelinus namaycush</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	2.7	NR	mg/L		FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1982	Yes
Diuron	95%	fish	Lake trout	<i>Salvelinus namaycush</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	1.2	NR	mg/L		FWS	MRID 40098001		1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diuron	95%	fish	Coho salmon	<i>Oncorhynchus kisutch</i>		96-hr Acute	Water	96 hr	96 hr	Mortality	LC ₅₀	< 2.4	NR	mg/L		FWS	MRID 40098001		1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diuron		fish	Fathead minnow	<i>Pimephales promelas</i>		Chronic	Water				LC ₅₀	NR										
Diuron	28%	fish	Bluegill sunfish	<i>Lepomis macrochirus</i>	1.9 g	Static	Water	96 hr	96 hr	Survival	LC ₅₀	84	NR	mg/L		EPA	STODIV01		1975. In USEPA 2003.	A. Stavola	1982	Yes
Diuron	95%	fish	Bluegill sunfish	<i>Lepomis macrochirus</i>		Static	Water	96 hr	96 hr	Survival	LC ₅₀	3.2	NR	mg/L		EPA	STODIU03		1976. In USEPA 2003.	A. Stavola	1982	Yes
Diuron	80%	fish	Bluegill sunfish	<i>Lepomis macrochirus</i>		Static	Water	96 hr	96 hr	Survival	LC ₅₀	> 300	NR	mg/L		DUP	MRID 42046001		1991. In USEPA 2003.	C. Rodriques	1992	Yes
Kannex		fish	Bluegill sunfish	<i>Lepomis macrochirus</i>	0.6 - 1.5 g	Static	Water	96 hr	96 hr	Survival	LC ₅₀ (12.7°C)	NR	8.9	mg ai/L	No/No				Macek et al. 1969. Bull. Environ. Contam. Toxicol. 4: 174-183.			No
Kannex		fish	Bluegill sunfish	<i>Lepomis macrochirus</i>	0.6 - 1.5 g	Static	Water	96 hr	96 hr	Survival	LC ₅₀ (18.3°C)	NR	7.6	mg ai/L	No/No				Macek et al. 1969. Bull. Environ. Contam. Toxicol. 4: 174-183.			No
Kannex		fish	Bluegill sunfish	<i>Lepomis macrochirus</i>	0.6 - 1.5 g	Static	Water	96 hr	96 hr	Survival	LC ₅₀ (23.8°C)	NR	5.9	mg ai/L	No/No				Macek et al. 1969. Bull. Environ. Contam. Toxicol. 4: 174-183.			No
Technical grade	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	30 d	Flow-through	Water	96 hr	192 hr	Survival	LC ₅₀	NR	14.2	mg ai/L	Yes/Yes	EPA	MRID 00141636		Call et al. 1987. Arch. Environ. Contam. Toxicol. 16: 607-613. ³	A. Stavola	1982	Yes
Technical grade	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	30 d	Flow through	Water	192 hr	192 hr	Survival	LC ₅₀	NR	7.7	mg ai/L	Yes/Yes				Call et al. 1987. Arch. Environ. Contam. Toxicol. 16: 607-613.			No
Technical grade	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	< 24 hr	Flow through	Water	64 d	64 d	Survival	NOEC	NR	33.4	ug ai/L	Yes/Yes				Call et al. 1987. Arch. Environ. Contam. Toxicol. 16: 607-613.			No
Technical grade	98.6%	fish	Fathead minnow	<i>Pimephales promelas</i>	< 24 hr	Flow through	Water	64 d	64 d	Survival	LOEC	NR	78	ug ai/L	Yes/Yes				Call et al. 1987. Arch. Environ. Contam. Toxicol. 16: 607-613.			No
Technical grade	100%	fish	Carp	<i>Ctenopharyngodon idella</i>	1+ y	Flow through	Water	96 hr	5 d	Survival	LC ₅₀	NR	31	mg ai/L	No/No				Tooby et al. 1980. J. Fish Biol. 16: 591-597.			No

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron		fish	Channel catfish	<i>Ictalurus punctatus</i>	1 y, 14 g/12 cm	Static	Water	48 hr	48 hr	Survival	LC ₅₀ (<10% mort.)	> 10	NR	mg/L	No/No				McCorkle et al. 1977. Bull. Environ. Contam. Toxicol. 18: 267-270.			No
Diuron		fish	Channel catfish	<i>Ictalurus punctatus</i>	1 y, 14 g/12 cm	Static	Water	48 hr	48 hr	Survival	NOEC	10	NR	mg/L	No/No				McCorkle et al. 1977. Bull. Environ. Contam. Toxicol. 18: 267-270.			No
Diuron		fish	Channel catfish	<i>Ictalurus punctatus</i>	1 y, 14 g/12 cm	Static	Water	48 hr	48 hr	Survival	LOEC (<10% mort.)	> 10	NR	mg/L	No/No				McCorkle et al. 1977. Bull. Environ. Contam. Toxicol. 18: 267-270.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	eggs (2.5 d)	Static	Water	7 d	7 - 10 d	Survival	LC ₅₀	NR	11.7	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	juv. 1.5 m	Static	Water	10 d	7 - 10 d	Survival	LC ₅₀	NR	27.1	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	eggs (2.5 d)	Static	Water	7 d	7 - 10 d	Growth	NOAEC	NR	4.2	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	juv. 1.5 m	Static	Water	10 d	7 - 10 d	Growth	NOAEC	NR	< 3.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	eggs (2.5 d)	Static	Water	7 d	7 - 10 d	Growth	LOAEC	NR	8.3	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	fish	Fathead minnow	<i>Pimephales promelas</i>	juv. 1.5 m	Static	Water	10 d	7 - 10 d	Growth	LOAEC	NR	3.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - burst swimming	NOEC/ NOAEC	5	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - sheltering	NOEC/ NOAEC	50	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - surfacing	NOEC/ NOAEC	50	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - burst swimming	NOEC/ NOAEC	< 0.1	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - attraction	NOEC/ NOAEC	1	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - surfacing	NOEC/ NOAEC	10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - grouping	NOEC/ NOAEC	10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - sheltering	NOEC/ NOAEC	10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - burst swimming	LOEC	50	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - sheltering	LOEC	> 50	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Static	Water	24 hr	24 hr (10 min. observation)	Behavior - surfacing	LOEC	> 50	NR	ug/l	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - burst swimming	LOEC	0.1	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - attraction	LOEC	10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - surfacing	LOEC	> 10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - grouping	LOEC	> 10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Diuron	99%	fish	Goldfish	<i>Carassius auratus</i>	6-8 cm (length), 6-9 g (wt)	Flow through	Water	10 min	10 min	Behavior - sheltering	LOEC	> 10	NR	mg/L	No/No ¹²				Saglio & Trijasse. 1998. Arch. Environ. Contam. Toxicol. 35: 484-491.			No
Technical grade		insect	Honey bee	<i>Apis mellifera</i>	Adult	Acute	Direct Application	48 hr	48 hr	Mortality	LD ₅₀	145	NR	ug/bee		UCR	MRID 00036935		1975. In USEPA 2003.	A. Vaughan	1986	Yes
Diuron	95%	insect	Stonefly	<i>Pteronarcys sp.</i>		96-hr Acute	Water	96 hr	96 hr		LC ₅₀	1.2	NR	ppm	Yes/Yes	FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1980	Yes
Diuron	99.8%	aquatic invertebrate	Midge	<i>Chironomus tentans</i>	2 d, 1st instar	Static	Water	10 d	7 - 10 d	Survival	LC ₅₀	NR	3.3	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Midge	<i>Chironomus tentans</i>	2 d, 1st instar	Static	Water	10 d	7 - 10 d	Survival	NOAEC	NR	3.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation	
Diuron	99.8%	aquatic invertebrate	Midge	<i>Chiromus tentans</i>	2 d, 1st instar	Static	Water	10 d	7 - 10 d	Survival	LOAEC	NR	7.1	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No	
Diuron		insect	Ladybug	<i>Coleomegilla maculata</i>		Field application	Plant	3 applications	3 applications		NOEC/ NOAEC	2.53	NR	kg/ha	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect		<i>Geocoris punctipes</i>		Field application	Plant	3 applications	3 applications		NOEC/ NOAEC	2.53	NR	kg/ha	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect		<i>Orius insidiosus</i>		Field application	Plant	3 applications	3 applications		NOEC/ NOAEC	2.53	NR	kg/ha	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect	Ladybug	<i>Coleomegilla maculata</i>		Field application	Plant	3 applications	3 applications		LOEC	>	2.5	NR	?	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Geocoris punctipes</i>		Field application	Plant	3 applications	3 applications		LOEC	>	2.5	NR	?	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Orius insidiosus</i>		Field application	Plant	3 applications	3 applications		LOEC	>	2.5	NR	?	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect	Ladybug	<i>Coleomegilla maculata</i>		Lab	Vial or Dipping	48 hr	48 hr	Mortality	LC ₅₀	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Geocoris punctipes</i>		Lab	Vial or Dipping	48 hr	48 hr	Mortality	LC ₅₀	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Orius insidiosus</i>		Lab	Vial or Dipping	48 hr	48 hr	Mortality	LC ₅₀	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect	Ladybug	<i>Coleomegilla maculata</i>		Lab	Vial or Dipping	48 hr	48 hr		NOEC/ NOAEC	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect		<i>Geocoris punctipes</i>		Lab	Vial or Dipping	48 hr	48 hr		NOEC/ NOAEC	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect		<i>Orius insidiosus</i>		Lab	Vial or Dipping	48 hr	48 hr		NOEC/ NOAEC	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No	
Diuron		insect	Ladybug	<i>Coleomegilla maculata</i>		Lab	Vial or Dipping	48 hr	48 hr		LOEC	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Geocoris punctipes</i>		Lab	Vial or Dipping	48 hr	48 hr		LOEC	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
Diuron		insect		<i>Orius insidiosus</i>		Lab	Vial or Dipping	48 hr	48 hr		LOEC	>	10	NR	%	No/No				Stam et al. 1978. J. Econom. Entom. 71: 477-480.			No
1-(3,4-dichlorophenyl) methylurea	highest purity available	aquatic invertebrate	Water flea	<i>Daphnia magna</i>	< 24 hr	Static	Water	48 hr	48 hr	Immobilization	EC ₅₀	0.04	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No	
1-(3,4-dichlorophenyl) urea	highest purity available	aquatic invertebrate	Water flea	<i>Daphnia magna</i>	< 24 hr	Static	Water	48 hr	48 hr	Immobilization	EC ₅₀	14.9	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No	
3,(3,4-dichlorophenyl)-1,1-dimethylurea ⁸		aquatic invertebrate	Sea urchin	<i>Hemicentrotus pulcherrimus</i>	eggs and sperm	Static	Seawater	32 hr or 48 hr	32 hr or 48 hr	Development	NOEC	1	NR	mg/L	No/No				Kobayashi & Okamura. 2002. Marine Poll. Bull. 44: 748-751.			No ⁶	
3,(3,4-dichlorophenyl)-1,1-dimethylurea ⁸		aquatic invertebrate	Sea urchin	<i>Anthodiaris crassispina</i>	eggs and sperm	Static	Seawater	32 hr or 48 hr	32 hr or 48 hr	Development	NOEC	1	NR	mg/L	No/No				Kobayashi & Okamura. 2002. Marine Poll. Bull. 44: 748-751.			No ⁶	
Diuron		aquatic invertebrate	Snail	<i>Lymnea sp.</i>		Static	Water	96 hr	96 hr	Survival	LC ₅₀	NR	15.3	mg ai/L	No/No				Christian & Tate. 1983. Bull. Environ. Toxicol. Chem. 30: 628-631.			No	
Diuron		aquatic invertebrate	Water flea	<i>Ceriodaphnia dubia</i>	<24 hr	Static	Water	48 hr	48 hr	Immobilization	EC ₅₀ ⁴	1.0	NR	mg/L	Yes/No				Foster et al.1998. Australasian J. Ecotoxicol. 4:53-59.			No	
Diuron		aquatic invertebrate	Water flea	<i>Ceriodaphnia dubia</i>	<24 hr	Static	Water	48 hr	48 hr	Immobilization	EC ₅₀ ⁴	1.7	NR	mg/L	Yes/No				Foster et al. 1998. Australasian J. Ecotoxicol. 4:53-59.			No	
Diuron	highest purity available	aquatic invertebrate	Water flea	<i>Daphnia magna</i>	< 24 hr	Static	Water	48 hr	48 hr	Immobilization	EC ₅₀	8.6	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No	
Diuron	highest purity available	aquatic invertebrate	Water flea	<i>Daphnia magna</i>	< 24 hr	Static	Water	48 hr	48 hr	Immobilization	LOEC	3.5	NR	mg/L	No/No				Fernandez-Alba et al. 2002. Analytica Chimca Acta. 456: 303-312.			No	
Diuron	95%	aquatic invertebrate	Scud	<i>Gammarus fasciatus</i>		48-hr Acute	Water	48 hr			EC ₅₀	0.16	NR	mg/L	Yes/Yes	FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1980	Yes	
Diuron	95%	aquatic invertebrate	Water flea	<i>Daphnia pulex</i>	1st-l	48-hr Acute	Water	48 hr	48 hr		EC ₅₀	1.4	NR	mg/L	Yes/Yes	FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1980	Yes	
Diuron	80%	aquatic invertebrate	Water flea	<i>Daphnia magna</i>		48-hr Acute	Water	48 hr	48 hr		EC ₅₀	8.4	NR	mg/L	Yes/Yes	DUP	MRID 42046003		1991. In USEPA 2003.	C. Rodriquez	1992	Yes	

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron	98%	aquatic invertebrate	Water flea	<i>Daphnia magna</i>	early life	Chronic	Water	28 d	28 d		LOEC	0.2	NR	mg/L	Yes/Yes	EPA	STODIU05		1979. In USEPA 2003.	A. Stavola	1982	Yes
Diuron	95%	aquatic invertebrate	Water flea	<i>Simocephalus sp.</i>	1st-I	48-hr Acute	Water	48 hr	48 hr		EC ₅₀	2	NR	mg/L	Yes/Yes	FWS	MRID 40094602		1980. In USEPA 2003.	Johnson & Finley	1980	Yes
diuron/DCMU		aquatic invertebrate	Oligochaete	<i>Amphichaeta leydigii</i>	unknown	In situ	Sediment Pore Water	59 d	59 d (test on d 11, 17, 27, 31, 59)	Abundance	NOEC	0.00002	NR	M	No/No				Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
diuron/DCMU		aquatic invertebrate	Oligochaete	<i>Amphichaeta leydigii</i>	unknown	In situ	Sediment Pore Water	59 d	59 d (test on d 11, 17, 27, 31, 59)	Abundance	LOEC	0.0002	NR	M	No/No				Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
Karnex DF	240 g/100 L	aquatic invertebrate	Spider mite	<i>Neoseiulus fallacis (Garman)</i>	adult	Slide dip bioassay	Liquid	48 hr	48 hr	Survival	NOEC	NR	13.1	mg ai/L	No/No				Metzger & Pfeiffer. 2002. J. Entomol. Sci. 37: 329-337.			No
Technical grade	corrected to 100% a.i.	invertebrate	Earthworm	<i>Eisenia foetida</i>	adult 370-450 mg	Dermal	Filter paper	48 hr	48 hr	Survival	LC ₅₀	NR	> 1000	ug ai/cm3	No/No				Roberts & Dorough. 1984. Environ. Toxicol. Chem. 3: 67-78.			No
Technical grade		aquatic invertebrate	Scud	<i>Gammarus fasciatus</i>	early instar	Static	Water	96 hr	96 hr	Survival	TL ₅₀	0.7	NR	mg/L	No/No				Sanders. 1970. Water Pollut. Control Feder. 42: 1544-1550.			No
Diuron	99.8%	aquatic invertebrate	Water flea	<i>Daphnia pulex</i>	5 d	Static	Water	96 hr	7 - 10 d	Survival	LC ₅₀	NR	17.9	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Water flea	<i>Daphnia pulex</i>	5 d	Static	Water	7 d	7 - 10 d	Survival	LC ₅₀	NR	7.1	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Amphipod	<i>Hyalella azteca</i>	2 - 3 d	Static	Water	96 hr	7 - 10 d	Survival	LC ₅₀	NR	19.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Amphipod	<i>Hyalella azteca</i>	2 - 3 d	Static	Water	10 d	7 - 10 d	Survival	LC ₅₀	NR	18.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Annelid worm	<i>Lumbriculus variegatus</i>	adult	Static	Water	10 d	7 - 10 d	Growth	NOAEC	NR	1.8	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Snail	<i>Physa gyrina</i>	15 d	Static	Water	10 d	7 - 10 d	Growth	NOAEC	NR	13.4	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Water flea	<i>Daphnia pulex</i>	5 d	Static	Water	7 d	7 - 10 d	Survival & Reproduction	NOAEC	NR	4.0	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Amphipod	<i>Hyalella azteca</i>	2 - 3 d	Static	Water	10 d	7 - 10 d	Survival	NOAEC	NR	0.9	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Annelid worm	<i>Lumbriculus variegatus</i>	adult	Static	Water	10 d	7 - 10 d	Growth	LOAEC	NR	3.5	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Snail	<i>Physa gyrina</i>	15 d	Static	Water	10 d	7 - 10 d	Growth	LOAEC	NR	22.8	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Water flea	<i>Daphnia pulex</i>	5 d	Static	Water	7 d	7 - 10 d	Survival & Reproduction	LOAEC	NR	7.0	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	99.8%	aquatic invertebrate	Amphipod	<i>Hyalella azteca</i>	2 - 3 d	Static	Water	10 d	7 - 10 d	Survival	LOAEC	NR	15.0	mg ai/L	Yes/Yes				Nebeker & Schuytema. 1998. Arch. Environ. Contam. Toxicol. 35:L 441-446.			No
Diuron	>98%	aquatic plant	Duckweed	<i>Lemna minor</i>	unknown	Semi-static (renew day 4)	Water/Media	7 d	7 d	Growth	IC ₅₀	NR	25	ug ai/L	No/No ¹⁵				Teisseire et al. 1999. Environ. Poll. 106: 39-45.			No
Diuron	>98%	aquatic plant	Duckweed	<i>Lemna minor</i>	unknown	Semi-static (renew day 4)	Water/Media	7 d	7 d	Growth	IC ₉₀	NR	60	ug ai/L	No/No ¹⁵				Teisseire et al. 1999. Environ. Poll. 106: 39-45.			No
Diuron	>98%	aquatic plant	Duckweed	<i>Lemna minor</i>	unknown	Semi-static (renew day 4)	Water/Media	7 d	7 d	Growth	LOEC	NR	5	ug ai/L	No/No ¹⁵				Teisseire et al. 1999. Environ. Poll. 106: 39-45.			No
Diuron		manunal	Rat	<i>Lab strain</i>		Chronic	Rat Oral			offspring body weight	NOEC	NR	250	ai ppm								Yes
Diuron		manimal	Rat	<i>Lab strain</i>		Chronic	Rat Oral			offspring body weight	LOEC	NR	1750	ai ppm								Yes
Diuron		mammal	Rat			Acute	Water				LC ₅₀	NR	5000 (m), 10000 (f)	mg ai/kg BW				EPA Ecological Risk Assessment (no date)				Yes

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron		mammal	Rat			Teratogenesis	Oral	gestation days 6 to 15		birth defects	NOEL	NR	125	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Rat			Teratogenesis	Oral	gestation days 6 to 15		birth defects	LOEL	NR	250	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Mouse			Teratogenesis	Oral			birth defects	LOEL	NR	2000	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Rat			Acute	Oral			Mortality	LD ₅₀	NR	3750	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Rabbit			Acute dermal	Dermal			Mortality	LD ₅₀	NR	> 2000	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Rat			Acute	Oral			Mortality	LD ₅₀	NR	3400	mg ai/kg BW					PIP, 1996			No
Diuron		mammal	Rat			Chronic diet	Diet		2 y	Systemic	LOEL	NR	125 (6.25)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00080899		IRIS, 2003			No
Diuron		mammal	Rat			Chronic diet	Diet		2 y	Systemic	NOEL	NR	25 (1.25)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00080899		IRIS, 2003			No
Diuron		mammal	Rat			Chronic diet	Diet		3-gen	Systemic	LOEL	NR	125 (6.25)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00080899		IRIS, 2003			No
Diuron		mammal	Rat			Chronic diet	Diet		3-gen	Reproduction	NOEL	NR	25 (1.25)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00080899		IRIS, 2003			No
Diuron		mammal	Rat			Chronic diet	Diet			Fetal toxicity	LOEL	NR	125	mg ai/kg/d				Khera et al. 1979. Bull. Environ. Contam. Toxicol. 22: 522-529.			No	
Diuron		mammal	Rat			Chronic diet	Diet			Teratogenesis	NOEL	NR	> 500	mg ai/kg/d				Khera et al. 1979. Bull. Environ. Contam. Toxicol. 22: 522-529.			No	
Diuron		mammal	Rat			Chronic diet	Diet		3 m	Systemic	NOEL	NR	50 (2.5)	ppm (mg ai/kg/d)		DuPont	MRID 00068036		IRIS, 2003			No
Diuron		mammal	Rat			Chronic diet	Diet		3 m	Systemic	LOEL	NR	500 (25)	ppm (mg ai/kg/d)		DuPont	MRID 00068036		IRIS, 2003			No
Diuron		mammal	Dog			Chronic diet	Diet		2 y	Systemic	NOEL	NR	25 (0.625)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00091192		IRIS, 2003			No
Diuron		mammal	Dog			Chronic diet	Diet		2 y	Systemic	LOEL	NR	125 (3.125)	ppm (mg ai/kg/d)		DuPont	MRID 00017763 & 00091192		IRIS, 2003			No
Technical grade		mammal	Rat	Sherman strain rat	adult male	Oral	Organism	Single dose	at least 14 d	mortality	LD ₅₀	NR	1258	mg ai/kg	No/No			Gaines & Linder.1986. Fund. Appl. Toxicol. 7: 299-308.			Yes	
Technical grade		mammal	Rat	Sherman strain rat	adult female	Oral	Organism	Single dose	at least 14 d	mortality	LD ₅₀	NR	1182	mg ai/kg	No/No			Gaines & Linder.1986. Fund. Appl. Toxicol. 7: 299-308.			Yes	
Technical grade		mammal	Rat	Sherman strain rat	adult male	Dermal	Organism	Single dose	at least 14 d	mortality	LD ₅₀	NR	> 2500	mg ai/kg	No/No			Gaines & Linder.1986. Fund. Appl. Toxicol. 7: 299-308.			Yes	
Technical grade		mammal	Rat	Sherman strain rat	adult female	Dermal	Organism	Single dose	at least 14 d	mortality	LD ₅₀	NR	> 2500	mg ai/kg	No/No			Gaines & Linder.1986. Fund. Appl. Toxicol. 7: 299-308.			Yes	
diuron (Sigma Chemical)		mammal	Rat		120-150 g female	Oral	Food	14 m	14 m	Body Weight	NOEC	1000	NR	mg/kg diet	No/No			Wang et al. 1993. Food & Chem. Toxicol. 31: 285-295.			No	
Diuron		terrestrial plant	Onion	Allium cepa						Seed emergence	EC ₅₀	NR	0.099	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Onion	Allium cepa						Seed emergence	EC ₀₅	NR	0.089	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Tomato	Lycopersicon esculentum						Seed emergence	EC ₅₀	NR	0.080	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Tomato	Lycopersicon esculentum						Seed emergence	EC ₀₅	NR	0.047	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Wheat	Triticum aestivum						Vigor	EC ₅₀	NR	0.021	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Wheat	Triticum aestivum						Vigor	EC ₀₅	NR	0.002	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Tomato	Lycopersicon esculentum						Vigor	EC ₅₀	NR	0.002	lb ai/acre				USEPA, 1995			Yes	
Diuron		terrestrial plant	Tomato	Lycopersicon esculentum						Vigor	EC ₀₅	NR	0.001	lb ai/acre				USEPA, 1995			Yes	

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron		terrestrial plant	Corn	<i>Zea mays</i>						Shoot weight	EC ₅₀	NR	0.390	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Corn	<i>Zea mays</i>						Shoot weight	EC ₀₅	NR	0.190	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Onion	<i>Allium cepa</i>						Shoot weight	EC ₅₀	NR	0.148	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Onion	<i>Allium cepa</i>						Shoot weight	EC ₀₅	NR	0.094	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Sorghum	<i>Sorghum bicolor</i>						Shoot weight	EC ₅₀	NR	0.075	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Sorghum	<i>Sorghum bicolor</i>						Shoot weight	EC ₀₅	NR	0.012	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Wheat	<i>Triticum aestivum</i>						Shoot weight	EC ₅₀	NR	0.021	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Wheat	<i>Triticum aestivum</i>						Shoot weight	EC ₀₅	NR	0.002	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Pea	<i>Pisum sativum</i>						Shoot weight	EC ₅₀	NR	0.014	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Pea	<i>Pisum sativum</i>						Shoot weight	EC ₀₅	NR	0.003	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Soybean	<i>Glycine max</i>						Shoot weight	EC ₅₀	NR	0.012	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Soybean	<i>Glycine max</i>						Shoot weight	EC ₀₅	NR	0.002	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Rape	<i>Brassica sp.</i>						Shoot weight	EC ₅₀	NR	0.033	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Rape	<i>Brassica sp.</i>						Shoot weight	EC ₀₅	NR	0.012	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Cucumber	<i>Cucumis sativus</i>						Shoot weight	EC ₅₀	NR	0.005	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Cucumber	<i>Cucumis sativus</i>						Shoot weight	EC ₀₅	NR	0.005	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Sugar beet	<i>Beta vulgaris</i>						Shoot weight	EC ₅₀	NR	0.009	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Sugar beet	<i>Beta vulgaris</i>						Shoot weight	EC ₀₅	NR	0.005	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>						Shoot weight	EC ₅₀	NR	0.002	lb ai/acre					USEPA, 1995			Yes
Diuron		terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>						Shoot weight	EC ₀₅	NR	0.001	lb ai/acre					USEPA, 1995			Yes
Diuron	97.3%	terrestrial plant	Onion	<i>Allium cepa</i>				14 d		Seed emergence	EC ₂₅	NR	0.09	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>				14 d		Seed emergence	EC ₂₅	NR	0.08	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Rape	<i>Brassica sp.</i>				14 d		Seed emergence	EC ₂₅	NR	0.09	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sugar beet	<i>Beta vulgaris</i>				14 d		Seed emergence	EC ₂₅	NR	0.09	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Wheat	<i>Triticum aestivum</i>				14 d		Seed emergence	EC ₂₅	NR	1.05	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Cucumber	<i>Cucumis sativus</i>				14 d		Seed emergence	EC ₂₅	NR	0.34	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Garden pea	<i>Pisum sativum</i>				14 d		Seed emergence	EC ₂₅	NR	> 12	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Soybean	<i>Glycine max</i>				14 d		Seed emergence	EC ₂₅	NR	> 12	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Corn	<i>Zea mays</i>				14 d		Seed emergence	EC ₂₅	NR	5.7	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sorghum	<i>Sorghum bicolor</i>				14 d		Seed emergence	EC ₂₅	NR	0.81	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Wheat	<i>Triticum aestivum</i>				21 d		Vigor	EC ₂₅	NR	0.02	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>				21 d		Vigor	EC ₂₅	NR	0.00	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Garden pea	<i>Pisum sativum</i>				21 d		Vigor	EC ₂₅	NR	0.01	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diuron	97.3%	terrestrial plant	Rape	<i>Brassica sp.</i>				21 d		Vigor	EC ₂₅	NR	0.03	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Onion	<i>Allium cepa</i>				21 d		Vigor	EC ₂₅	NR	0.15	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sorghum	<i>Sorghum bicolor</i>				21 d		Vigor	EC ₂₅	NR	0.08	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Cucumber	<i>Cucumis sativus</i>				21 d		Vigor	EC ₂₅	NR	0.01	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Soybean	<i>Glycine max</i>				21 d		Vigor	EC ₂₅	NR	0.01	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sugar beet	<i>Beta vulgaris</i>				21 d		Vigor	EC ₂₅	NR	0.01	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Corn	<i>Zea mays</i>				21 d		Vigor	EC ₂₅	NR	0.39	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Onion	<i>Allium cepa</i>				14 d		Seed emergence	NOEL	NR	0.047	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>				14 d		Seed emergence	NOEL	NR	0.047	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Rape	<i>Brassica sp.</i>				14 d		Seed emergence	NOEL	NR	0.047	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sugar beet	<i>Beta vulgaris</i>				14 d		Seed emergence	NOEL	NR	0.047	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Wheat	<i>Triticum aestivum</i>				14 d		Seed emergence	NOEL	NR	0.38	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Cucumber	<i>Cucumis sativus</i>				14 d		Seed emergence	NOEL	NR	0.19	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Garden pea	<i>Pisum sativum</i>				14 d		Seed emergence	NOEL	NR	12	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Soybean	<i>Glycine max</i>				14 d		Seed emergence	NOEL	NR	12	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Corn	<i>Zea mays</i>				14 d		Seed emergence	NOEL	NR	0.75	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sorghum	<i>Sorghum bicolor</i>				14 d		Seed emergence	NOEL	NR	0.75	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Wheat	<i>Triticum aestivum</i>				21 d		Vigor	NOEL	NR	0.0017	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Tomato	<i>Lycopersicon esculentum</i>				21 d		Vigor	NOEL	NR	0.001	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Garden pea	<i>Pisum sativum</i>				21 d		Vigor	NOEL	NR	0.0029	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Rape	<i>Brassica sp.</i>				21 d		Vigor	NOEL	NR	0.0117	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Onion	<i>Allium cepa</i>				21 d		Vigor	NOEL	NR	0.094	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sorghum	<i>Sorghum bicolor</i>				21 d		Vigor	NOEL	NR	0.0117	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Cucumber	<i>Cucumis sativus</i>				21 d		Vigor	NOEL	NR	0.005	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Soybean	<i>Glycine max</i>				21 d		Vigor	NOEL	NR	0.002	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Sugar beet	<i>Beta vulgaris</i>				21 d		Vigor	NOEL	NR	0.005	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
Diuron	97.3%	terrestrial plant	Corn	<i>Zea mays</i>				21 d		Vigor	NOEL	NR	0.19	lb ai/acre		DuPont	MRID 44113401		1996. In USEPA 2003.	GAI	1997	Yes
diuron/DCMU		aquatic invertebrate	polychaete	<i>Hobsonia florida</i>	small juvenile (3-6 setigers)	In situ	Sediment Pore Water	59 d	59 d	Abundance	LOEC	>	0.0002	NR	M	No/No			Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
diuron/DCMU		aquatic invertebrate	polychaete	<i>Hobsonia florida</i>	large juvenile (7-28 setigers)	In situ	Sediment Pore Water	59 d	59 d (test d 4, 31, 41)	Abundance	NOEC		0.000002	NR	M	No/No			Hentschel & Jumars. 1994. Limnol. Oceanogr.			No
diuron/DCMU		aquatic invertebrate	polychaete	<i>Hobsonia florida</i>	large juvenile (7-28 setigers)	In situ	Sediment Pore Water	59 d	59 d (test d 4, 31, 41)	Abundance	LOEC		0.0002	NR	M	No/No			Hentschel & Jumars. 1994. Limnol. Oceanogr.			No

Formulation	% purity/a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) ¹	Toxicity Value (ai) ¹	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source ²	EPA Reviewer	Date Reviewed	Used for TRV derivation

Boldface indicates study selected for derivation of toxicity reference value (TRV) used in risk assessment.

¹Toxicity values relate the dose of a compound with a potentially adverse effect. Values are reported as they were presented in the reviewed source.

²See the bibliography of this ERA document, Appendix A of the associated Literature Review document, and source footnote for complete citations.

³As cited in USEPA 2003.

⁴Based on measured concentrations.

⁵Measured final concentrations (D5) were 0.9 and 1.0 ug/l in two replicates.

⁶Marine species, not used for TRV derivation.

⁷33% mortality at 4200, repellent at 5000.

⁸Stock prepared in DMSO (dimethyl sulfoxide).

⁹Analysis during earlier experiments found concentrations between 65 and 100% of nominal.

¹⁰At least 100 ug/L after 96 h post-exposure.

¹¹96-h LC₅₀s range from 2.8 to 9.5 mg/L for 7 to 29°C.

¹²No analytical except for culture/holding water (diuron undetected).

¹³Same developmental stage due to holding temperature of older tadpoles.

¹⁴Test included 60 days post exposure in clean water.

¹⁵Nominal concentrations between 5 and 100 ug/L of a.i.

Abbreviations

m - male
f- female
a.i. - active ingredient

Durations

hr - hours
d - days
w - weeks
m - months
y - years

Endpoints

EC₀₅ - 5% effect concentration
EC₂₅ - 25% effect concentration
EC₅₀ - 50% effect concentration
IC₅₀ - concentration causing 25% inhibition of a process
IC₉₀ - concentration causing 90% inhibition of a process
LC₅₀ - median lethal concentration, 50% mortality
LD₅₀ - median lethal dose, 50% mortality
TL₅₀ - median tolerance limit
LOAEC - lowest-observable-adverse-effect concentration
LOAEL - lowest-observable-adverse-effect level
LOEC - lowest-observable-effect concentration
LOEL - lowest-observable-effect level
NOAEC - no-observable-adverse-effect concentration
NOAEL - no-observable-adverse-effect level
NOEC - no-observable-effect concentration
NOEL - no-observable-effect level

APPENDIX B

Ecological Risk Assessment Worksheet - Diuron

DERIVATION OF EECS

Section 3.0 of the Methods Document (ENSR 2005) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for bromacil. Note that in many cases, units were converted during the calculations (e.g., lb/acre converted to mg/cm²). These conversions were not included in the equations presented below.

Direct Spray

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

Direct Spray of Terrestrial Wildlife

Small mammal or Insect 100% Dermal Absorption

$$\text{Surface Areas (A): cm}^2 = 12.3 \times \text{BW}^{0.65}$$

Where: BW = body weight in grams

$$\text{Amount deposited on } \frac{1}{2} \text{ receptor (Amnt): } 0.5 \times A \times R$$

Where: A = Surface area in cm²

R = Application rate in lb a.i./acre

Small mammal 1st order

$$\text{Proportion absorbed over period T (Prop): } 1 - \exp(-k T)$$

Where: k = First order dermal absorption rate (hour⁻¹)

T = Time (24 hours)

$$\text{Absorbed Dose: Amnt} \times \text{Prop} \div \text{BW}$$

Ingestion of Food Items Contaminated by Direct Spray

All herbivorous receptors ingestion acute

$$\text{Concentration on food (C): } R \times rr$$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomogram (mg/kg per lb/acre)

$$\text{Dose estimates (D): } C \times A \div \text{BW}$$

Where: C = Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

BW = Body Weight

All herbivorous receptors ingestion chronic

$$\text{Initial concentration on food (C0): } R \times rr \times \text{Drift}$$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomogram (mg/kg per lb/acre)

Drift = 1

$$\text{Concentration on food at time T: } C0 \times \exp(-k \times T)$$

Where: C0 = Concentration on food at time zero (mg/kg food)

k = Decay Coefficient: $\ln(2) \div t_{50}$ (days⁻¹)

T = Time (90 days)

$$\text{Time-weighted Average Concentration on vegetation (CTWA): } C0 \times (1 - \exp(-k \times T)) \div (k \times T)$$

$$\text{Dose estimates (D): CTWA} \times A \times \text{Prop} \div \text{BW}$$

Where: CTWA = Time Weighted Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

Prop = Proportion of food impacted by direct spray (100%)

BW = Body Weight

Large carnivorous mammal ingestion acute

Amount deposited on small mammal prey (Amnt_mouse): $0.5 \times \text{SurfaceArea} \times R$

Where: R = Application rate (lb a.i./acre)

Dose estimates: $\text{Drift} \times \text{Prop} \times \text{Amnt\_mouse} \div \text{BW\_mouse} \times A \div \text{BW}$

Where: $\text{Drift} = 1$

Prop = Proportion of food impacted by direct spray (100%)

A = Wet weight food ingestion rate (kg/day)

BW = Body Weight of carnivore

BW_mouse = Body weight of food (small mammal; mouse)

Large carnivorous mammal ingestion chronic

Initial concentration on mammal (C_0): $0.5 \times \text{SurfaceArea} \times R \div \text{BW\_smallmammal}$

Where: R = Application rate (lb a.i./acre)

SurfaceArea = Surface area of food (small mammal; mouse)

BW_smallmammal = Body weight of food (small mammal; mouse)

Concentration absorbed in small mammal at time T (C_{90}): $C_0 \times \exp(-k \times T)$

Where: C_0 = Concentration on food at time zero (mg/kg food)

k = Decay Coefficient: $\ln(2)/t_{50}$ (days⁻¹)

T = Time (90 days)

Dose estimates: $C_{90} \times \text{FIR\_coyote} \times \text{Prop} \div \text{BW}$

Where: C_{90} = Concentration of herbicide in food at 90 days

FIR = Wet weight food ingestion rate (mg/kg-day)

Prop = Proportion of food impacted by direct spray (100%)

BW = Body Weight

Accidental Direct Spray Over Pond

Mass in Pond (M_p): $A_p \times R$

Where: A_p = Area of pond

R = Application rate (lb a.i./acre)

Concentration in Pond: $M_p \div (V_p)$

Where: V_p = Volume of pond

Accidental Direct Spray Over Stream

Mass in Stream Reach (M_s): $A_s \times R$

Where: A_s = Area of stream affected by spray

R = Application rate (lb a.i./acre)

Concentration in Pond: $M_s \div (V_s)$

Where: V_s = Volume of stream reach affected by spray

Off-Site Drift and Surface and Ground Water Runoff

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. Precipitation may also result in the transport of herbicides bound to soils from the application area via surface runoff and root-zone groundwater flow. To simulate these off-site herbicide transport mechanisms, AgDRIFT[®] software was used to evaluate a number of possible drift scenarios and GLEAMS software was used to evaluate transport to off-site soils or waterbodies via surface runoff or root-zone ground water flow. These models provide concentrations in media. Details of the model and calculations used to obtain soil and water concentrations are presented in the Methods document (ENSR 2004). The surface water concentrations were used in the ERAs to estimate fish concentrations and consumption of these fish by an avian piscivore. The following presents those calculations:

Consumption of Fish From Contaminated Pond

Concentration in fish = $C_w \times \text{BCF} \times \text{FCM TL2} \times \text{FCM TL3}$

Where: C_w = Concentration in water (obtained from model) mg/L

BCF = Bioconcentration factor (L/kg fish)

FCM TL2 = Trophic Level 2 food chain multiplier (unitless)

FCM TL3 = Trophic Level 3 food chain multiplier (unitless)

Dose estimates (D): $C \times A \times \text{Prop} \div \text{BW}$

Where: C = Concentration in fish (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

Prop = Proportion of food impacted (100%)

BW = Body Weight

Accidental Spill to Pond

To represent worst-case potential impacts to ponds, a spill scenario was considered. A truck or helicopter spilling an entire load of herbicide mixed for the maximum application rate into a 1/4 acre, 1 meter deep pond.

Truck or Helicopter Spill into Pond

Concentrations in water (Cw): $C_m \times V_{\text{spill}} \div V_p$

Where: C_m = Herbicide concentration in the truck or helicopter mixture (mg a.i./L)

V_{spill} = Volume of the spill (L)

V_p = Volume of the pond (L)

LIST OF TABLES

B-1	Direct Spray of Terrestrial Receptors and Exposure from Indirect Contact with Foliage.	B-1
B-2	Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Acute Exposure Scenario).....	B-2
B-3	Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Chronic Exposure Scenario).....	B-3
B-4	Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Acute Exposure Scenario).....	B-4
B-5	Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario).	B-5
B-6	Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Acute Exposure Scenario).....	B-6
B-7	Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Chronic Exposure Scenario)	B-7
B-8	Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Acute Exposure Scenario)	B-8
B-9	Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Chronic Exposure Scenario).....	B-9
B-10	Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation (Acute Exposure Scenario).....	B-10
B-11	Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario)	B-11
B-12	Potential Risks to Aquatic Species from Accidental Spray Drift to Pond	B-12
B-13	Potential Risks to Aquatic Species from Accidental Spray Drift to Stream	B-13
B-14	Potential Risks to Non-target Terrestrial Plants from Direct Spray and Spray Drift.....	B-14
B-15	Potential Risk to Predatory Bird (Bald Eagle) From Consumption of Contaminated Fish from Pond (Pond Impacted by Spray Drift Modeled in AgDrift)	B-15
B-16	Potential Risks to Aquatic Species from Surface Runoff to Pond	B-16
B-17	Potential Risks to Aquatic Species From Surface Runoff to Stream	B-17
B-18	Potential Risks to Non-Target Terrestrial Plants from Surface Runoff	B-18
B-19	Potential Risk to Predatory Bird (Bald Eagle) From Long-term Consumption of Contaminated Fish from Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)	B-19
B-20	Potential Risks to Non-Target Terrestrial Plants From Herbicide in Dust Deposited From Wind Erosion.....	B-20
B-21	Potential Risks to Aquatic Species From Accidental Spill to Pond (Acute Exposure)	B-21
B-22	Potential Risks to Aquatic Species From Accidental Direct Spray of Pond and Stream (Acute Exposure)	B-22

General note: Exposure parameters and equations in the following tables are described in more detail in the *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (ENSR 2004) and Section 4 of the ecological risk assessment for this herbicide.

TABLE B-1

Direct Spray of Terrestrial Receptors and Exposure From Indirect Contact With Foliage

Parameter		Pollinating Insect	Small Mammal	Units
Duration of exposure (T)		24	24	hours
Body weight (BW)		0.000093	0.02	kg
Surface areas (A): $12.3 \times BW(g)^{0.65}$ ¹		2.63	86.21	cm ²
Application rates (R)	Typical	6	6	lb/acre
	Maximum	20	20	lb/acre
Amount deposited on ½ receptor	Typical	0.0884	2.8989	mg
(Amnt): $0.5 \times A \times R \times cf$ ²	Maximum	0.2948	9.6628	mg
Dose Estimate Assuming 100% Dermal Adsorption³				
Absorbed Dose: (Amnt × Prop) / BW	Typical	9.51E+02	1.45E+02	mg/kg bw
	Maximum	3.17E+03	4.83E+02	mg/kg bw
Dose Estimate Assuming First Order Dermal Adsorption⁴				
First-order dermal absorption coefficient (k)	Central estimate (ka)		0.0231	hour ⁻¹
Proportion absorbed over period T	Typical		0.1444	unitless
(Prop): $1 - \exp(-k \times T)$ ⁵	Maximum		0.1444	unitless
Absorbed dose: (Amnt × Prop) / BW	Typical		2.09E+01	mg/kg bw
	Maximum		6.98E+01	mg/kg bw

RISK QUOTIENTS ⁶ - Direct Spray	Toxicity Reference Value (mg/kg bw) ⁷	Typical Application	Maximum Application
Small mammal - 100% absorption	2,080	1.56E-02	5.21E-02
Pollinating insect - 100% absorption	1,559	6.10E-01	2.03E+00
Small mammal - 1st order dermal adsorption	2,080	2.26E-03	7.52E-03

RISK QUOTIENTS - Indirect Contact ⁸	Toxicity Reference Value (mg/kg bw) ⁷	Typical Application	Maximum Application
Small mammal - 100% absorption	2,080	1.56E-03	5.21E-03
Pollinating insect - 100% absorption	1,559	6.10E-02	2.03E-01
Small mammal - 1st order dermal adsorption	2,080	2.26E-04	7.52E-04

¹ Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993). No surface area calculation identified for insects. Mammalian equation used as a surrogate.

² A conversion factor (cf) of 0.011208493 was used to convert the application rate (R) from lb/acre to mg/cm².

³ 100% dermal absorption - all of the herbicide falling on the receptor was assumed to penetrate the skin within 24 hours.

⁴ 1st order dermal absorption - absorption occurs over 24 hours, taking into consideration the potential for some herbicide to not be absorbed.

⁵ $\exp(-k \times T) = e^{-(k \times T)}$, where e is a constant = 2.7828.

⁶ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁷ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

⁸ Exposure from indirect contact assumed to be 1/10 of direct spray exposure (Harris and Solomon 1992).

TABLE B-2
Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		0.02	kg
Food ingestion rate (dry weight [dw]) ¹		0.003364	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.01463	kg ww/day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate – berries (rr) ³	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Concentration on berries (C): R × rr	Typical	32.4	mg/kg fruit
	Maximum	814	mg/kg fruit
Dose estimates (D): (C × ir) / BW	Typical	2.37E+01	mg/kg bw
	Maximum	5.95E+02	mg/kg bw

RISK QUOTIENTS ⁴ – Ingestion	Toxicity Reference Value (mg/kg bw) ⁵	Typical Application	Maximum Application
Small mammalian herbivore/omnivore (acute exposure)	2,080	1.14E-02	2.86E-01

¹ Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621 × (BW g)^{0.564}; converted into kg dw/day.

² Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁵ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-3

Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	days
Body weight (BW)		0.02	kg
Food ingestion rate (dry weight [dw]) ¹		0.0034	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.0146	kg ww/day
Half life on vegetation (t ₅₀)	Herbicide specific	30	days
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - berries (rr) ³	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t ₅₀ ⁴	Typical	0.0231	days ⁻¹
	Maximum	0.0231	days ⁻¹
Initial concentration on berries (C ₀): R × rr × Drift	Typical	32.4	mg/kg fruit
	Maximum	814	mg/kg fruit
Concentration on berries at time T (C ₉₀): C ₀ × exp(-k×T) ⁵	Typical	4.05	mg/kg fruit
	Maximum	101.75	mg/kg fruit
Time-weighted average concentration on vegetation (CTWA): C ₀ × (1-exp(-k×T)) / (k×T) ⁵	Typical	13.6335	mg/kg fruit
	Maximum	342.5198	mg/kg fruit
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	9.9706	mg/kg bw/day
	Maximum	250.4958	mg/kg bw/day

RISK QUOTIENTS – Ingestion ⁶	Toxicity Reference Value (mg/kg bw/day) ⁷	Typical Application	Maximum Application
Small mammalian herbivore/omnivore (chronic exposure)	5	1.99E+00	5.01E+01

¹ Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621×(BW g)^{0.564}; converted into kg dw/day.

² Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ ln = Natural log function.

⁵ exp(-k×T) = e^{^(-k×T)}, where e is a constant = 2.7828.

⁶ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁷ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-4
**Potential Risks to Large Herbivorous Mammal (Mule Deer) from Consumption of Contaminated Vegetation
(Acute Exposure Scenario)**

Parameters/Assumptions		Value	Units
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) ¹		1.9212	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		6.4038	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - grass (rr) ³	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Concentration on grass (C): $R \times rr$	Typical	216	mg/kg grass
	Maximum	3940	mg/kg grass
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): $(\text{Drift} \times \text{PC} \times \text{C} \times \text{ir}) / \text{BW}$	Typical	1.98E+01	mg/kg bw/day
	Maximum	3.60E+02	mg/kg bw/day

RISK QUOTIENTS ⁴ – Ingestion	Toxicity Reference Value (mg/kg bw/day) ⁵	Typical Application	Maximum Application
Large mammalian herbivore/gramivore (acute exposure)	270	7.32E-02	1.33E+00

¹ Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = $0.577 \times (\text{BW g})^{0.727}$; converted into kg dw/day.

² Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁵ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-5

Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) ¹		1.9212	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		6.4038	kg ww/day
Half life on vegetation (t ₅₀)	Herbicide specific	30	days
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - grass (rr) ³	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t ₅₀ ⁴	Typical	0.0231	days ⁻¹
	Maximum	0.0231	days ⁻¹
Initial concentration on grass (C ₀): R × rr × Drift	Typical	216	mg/kg grass
	Maximum	3940	mg/kg grass
Concentration on grass at time T (C ₉₀): C ₀ × exp(-k×T) ⁵	Typical	27	mg/kg grass
	Maximum	492.5	mg/kg grass
Time-weighted average concentration on vegetation (CTWA): C ₀ × (1-exp(-k×T)) / (k×T) ⁵	Typical	90.8898	mg/kg vegetation
	Maximum	1657.8971	mg/kg vegetation
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (CTWA × ir × PC) / BW	Typical	8.31E+00	mg/kg bw/day
	Maximum	1.52E+02	mg/kg bw/day

RISK QUOTIENTS ⁶ – Ingestion	Toxicity Reference Value (mg/kg bw/day) ⁷	Typical Application	Maximum Application
Large mammalian herbivore/gramivore (chronic exposure)	0.392	2.12E+01	3.87E+02

¹ Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = 0.577×(BW g)^{0.727}; converted into kg dw/day.

² Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ ln = Natural log function.

⁵ exp(-k×T) = e^{ln(-k×T)}, where e is a constant = 2.7828.

⁶ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁷ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-6
**Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals
(Acute Exposure Scenario)**

Parameters/Assumptions		Value	Units
Body weight (BW)		12	kg
Body weight small mammal (BW_mouse)		0.02	kg
Surface area small mammal (A)		86.21	cm ²
Food ingestion rate (dry weight [dw]) ¹		0.5297	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		1.6554	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Amount deposited on small mammal prey	Typical	2.8989	mg
(Amnt_mouse): $0.5 \times A \times R$ ³	Maximum	9.6628	mg
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: $[(\text{Drift} \times \text{PC} \times \text{Amnt\_mouse}) / \text{BW\_mouse}] \times \text{ir} / \text{BW}$	Typical	2.00E+01	mg/kg bw
	Maximum	6.66E+01	mg/kg bw

RISK QUOTIENTS ⁴ - Ingestion	Toxicity Reference Value (mg/kg bw) ⁵	Typical Application	Maximum Application
Large carnivorous mammal (acute exposure)	546	3.66E-02	1.22E-01

¹ Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = $0.0687 \times (\text{BW g})^{0.822}$; converted into kg dw/day.

² Assumes mammals are 68% water (USEPA 1993).

³ Surface area (A) and body weight of mouse receptor presented in Table B-1. Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993).

⁴ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁵ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-7

Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals
(Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		12	kg
Body weight small mammal (BW_mouse)		0.02	kg
Surface area small mammal (A)		86.21	cm ²
Food ingestion rate (dry weight [dw]) ¹		0.5297	kg dw/day
Food ingestion rate (wet weight, [ww]) (ir) ²		1.6554	kg ww/day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): $\ln(2) / t_{50}$ ³	Typical	0.0231	days ⁻¹
	Maximum	0.0231	days ⁻¹
Initial concentration on mammal (C ₀): $(0.5 \times A \times R) / BW\_mouse$	Typical	144.9426	mg/kg mammal
	Maximum	483.1421	mg/kg mammal
Concentration absorbed in small mammal at time T (C ₉₀): $C_0 \times \exp(-k \times T)$ ⁴	Typical	20.9356	mg/kg mammal
	Maximum	69.7854	mg/kg mammal
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): $(C_{90} \times ir \times PC) / BW$	Typical	2.89E+00	mg/kg bw/day
	Maximum	9.63E+00	mg/kg bw/day

RISK QUOTIENTS ⁵ - Ingestion	Toxicity Reference Value (mg/kg bw/day) ⁶	Typical Application	Maximum Application
Large mammalian carnivore (chronic exposure)	1	2.89E+00	9.63E+00

¹ Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = $0.0687 \times (BW \text{ g})^{0.822}$; converted into kg dw/day.
² Assumes mammals are 68% water (USEPA 1993).
³ $\ln$ = Natural log function.
⁴ $\exp(-k \times T) = e^{(-k \times T)}$, where e is a constant = 2.7828.
⁵ Risk Quotient = Estimated Dose/Toxicity Reference Value.
⁶ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-8
Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		0.08	kg
Food ingestion rate (dry weight [dw]) ¹		0.01124177	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.03626376	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - insects (rr) ³	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Concentration on insects (C): R × rr	Typical	270	mg/kg insect
	Maximum	7000	mg/kg insect
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (Drift × PC × C × ir) / BW	Typical	1.22E+02	mg/kg bw
	Maximum	3.17E+03	mg/kg bw

RISK QUOTIENTS ⁴ – Ingestion	Toxicity Reference Value (mg/kg bw) ⁵	Typical Application	Maximum Application
Small insectivorous bird (acute exposure)	5225	2.34E-02	6.07E-01

¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^{0.651}.

² Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁵ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-9

Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects
(Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		0.08	kg
Food ingestion rate (dry weight [dw]) ¹		0.0112	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.0363	kg ww/day
Half life on insect (t ₅₀)	Herbicide specific	30	days
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - insects (rr) ³	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t ₅₀ ⁴	Typical	0.0231	days ⁻¹
	Maximum	0.0231	days ⁻¹
Initial concentration on insects (C ₀): R × rr × Drift	Typical	270	mg/kg insect
	Maximum	7000	mg/kg insect
Concentration on insects at time T	Typical	33.75	mg/kg insect
(C ₉₀): C ₀ × exp(-k×T) ⁴	Maximum	875	mg/kg insect
Time-weighted average concentration on insects	Typical	113.6122	mg/kg insect
(CTWA): C ₀ × (1-exp(-k×T)) / (k×T) ⁵	Maximum	2945.5024	mg/kg insect
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	5.15E+01	mg/kg bw
	Maximum	1.34E+03	mg/kg bw

RISK QUOTIENTS - Ingestion ⁶	Toxicity Reference Value (mg/kg bw) ⁷	Typical Application	Maximum Application
Small insectivorous bird (chronic exposure)	348	1.48E-01	3.84E+00

¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^{0.651}.
² Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).
³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
⁴ ln = Natural log function.
⁵ exp(-k×T) = e^{^(-k×T)}, where e is a constant = 2.7828.
⁶ Risk Quotient = Estimated Dose/Toxicity Reference Value.
⁷ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-10
**Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation
(Acute Exposure Scenario)**

Parameters/Assumptions		Value	Units
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [dw]) ¹		0.1368	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.9125	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - vegetation (rr) ³	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Concentration on vegetation (C): $R \times rr$	Typical	210	mg/kg veg
	Maximum	5920	mg/kg veg
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: $(\text{Drift} \times \text{PC} \times \text{C} \times \text{ir}) / \text{BW}$	Typical	5.15E+01	mg/kg bw
	Maximum	1.45E+03	mg/kg bw

RISK QUOTIENTS ⁴ – Ingestion	Toxicity Reference Value (mg/kg bw) ⁵	Typical Application	Maximum Application
Large herbivorous bird – (acute exposure)	865	5.96E-02	1.68E+00

¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = $0.0582 \times (\text{BW})^{0.651}$.

² Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).

³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.

⁴ Risk Quotient = Estimated Dose/Toxicity Reference Value.

⁵ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-11

Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation
(Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [dw]) ¹		0.1369	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²		0.9126	kg ww/day
Half life on vegetation (t ₅₀)	Herbicide specific	30	days
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Residue rate - vegetation (rr) ³	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): $\ln(2) / t_{50}$ ⁴	Typical	0.0231	days ⁻¹
	Maximum	0.0231	days ⁻¹
Initial concentration on vegetation (C ₀): $R \times rr \times \text{Drift}$	Typical	210	mg/kg veg
	Maximum	5920	mg/kg veg
Concentration on vegetation at time T (C ₉₀): $C_0 \times \exp(-k \times T)$ ⁵	Typical	26.25	mg/kg veg
	Maximum	740	mg/kg veg
Time-weighted Average Concentration on vegetation (CTWA): $C_0 \times (1 - \exp(-k \times T)) / (k \times T)$ ⁵	Typical	88.3651	mg/kg veg
	Maximum	2491.0534	mg/kg veg
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): $(CTWA \times ir \times PC) / BW$	Typical	2.17E+01	mg/kg bw/day
	Maximum	6.11E+02	mg/kg bw/day

RISK QUOTIENTS ⁶ - Ingestion	Toxicity Reference Value (mg/kg bw/day) ⁷	Typical Application	Maximum Application
Large herbivorous bird (chronic exposure)	58	3.74E-01	1.05E+01

¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = $0.0582 \times (BW)^{0.651}$.
² Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).
³ Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
⁴ $\ln$ = Natural log function.
⁵ $\exp(-k \times T) = e^{(-k \times T)}$, where e is a constant = 2.7828.
⁶ Risk Quotient = Estimated Dose/Toxicity Reference Value.
⁷ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-12
Potential Risks to Aquatic Species from Accidental Spray Drift to Pond

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE									
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration (mg/L)	Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic		
				Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	4.09E-03	5.76E-03	2.56E-02	3.15E+00	1.24E-01	6.10E-02	9.30E+00
Ground	Low Boom	100	2.24E-03	3.15E-03	1.40E-02	1.72E+00	6.79E-02	3.34E-02	5.09E+00
Ground	Low Boom	900	4.33E-04	6.10E-04	2.71E-03	3.33E-01	1.31E-02	6.46E-03	9.84E-01
Ground	High Boom	25	6.57E-03	9.25E-03	4.11E-02	5.05E+00	1.99E-01	9.81E-02	1.49E+01
Ground	High Boom	100	3.46E-03	4.87E-03	2.16E-02	2.66E+00	1.05E-01	5.16E-02	7.86E+00
Ground	High Boom	900	5.49E-04	7.73E-04	3.43E-03	4.22E-01	1.66E-02	8.19E-03	1.25E+00
OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE									
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration (mg/L)	Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic		
				Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	1.36E-02	1.92E-02	8.50E-02	1.05E+01	4.12E-01	2.03E-01	3.09E+01
Ground	Low Boom	100	7.48E-03	1.05E-02	4.68E-02	5.75E+00	2.27E-01	1.12E-01	1.70E+01
Ground	Low Boom	900	1.44E-03	2.03E-03	9.00E-03	1.11E+00	4.36E-02	2.15E-02	3.27E+00
Ground	High Boom	25	2.19E-02	3.08E-02	1.37E-01	1.68E+01	6.64E-01	3.27E-01	4.98E+01
Ground	High Boom	100	1.15E-02	1.62E-02	7.19E-02	8.85E+00	3.48E-01	1.72E-01	2.61E+01
Ground	High Boom	900	1.83E-03	2.58E-03	1.14E-02	1.41E+00	5.55E-02	2.73E-02	4.16E+00

¹ Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-13

Potential Risks to Aquatic Species from Accidental Spray Drift to Stream

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE									
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Stream Concentration (mg/L)	Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic		
				Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	7.36E-03	1.04E-02	4.60E-02	5.66E+00	2.23E-01	1.10E-01	1.67E+01
Ground	Low Boom	100	2.16E-03	3.04E-03	1.35E-02	1.66E+00	6.53E-02	3.22E-02	4.90E+00
Ground	Low Boom	900	2.23E-04	3.15E-04	1.40E-03	1.72E-01	6.77E-03	3.34E-03	5.08E-01
Ground	High Boom	25	1.23E-02	1.73E-02	7.69E-02	9.47E+00	3.73E-01	1.84E-01	2.80E+01
Ground	High Boom	100	3.49E-03	4.92E-03	2.18E-02	2.69E+00	1.06E-01	5.21E-02	7.93E+00
Ground	High Boom	900	2.95E-04	4.16E-04	1.84E-03	2.27E-01	8.94E-03	4.40E-03	6.71E-01
OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE									
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Stream Concentration (mg/L)	Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic		
				Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	2.45E-02	3.46E-02	1.53E-01	1.89E+01	7.43E-01	3.66E-01	5.58E+01
Ground	Low Boom	100	7.19E-03	1.01E-02	4.49E-02	5.53E+00	2.18E-01	1.07E-01	1.63E+01
Ground	Low Boom	900	7.44E-04	1.05E-03	4.65E-03	5.72E-01	2.25E-02	1.11E-02	1.69E+00
Ground	High Boom	25	4.11E-02	5.79E-02	2.57E-01	3.16E+01	1.25E+00	6.13E-01	9.34E+01
Ground	High Boom	100	1.16E-02	1.64E-02	7.27E-02	8.95E+00	3.53E-01	1.74E-01	2.64E+01
Ground	High Boom	900	9.84E-04	1.39E-03	6.15E-03	7.57E-01	2.98E-02	1.47E-02	2.24E+00

¹ Risk Quotient = Estimated Dose/Toxicity Reference Value

TABLE B-14
Potential Risks to Non-target Terrestrial Plants from Direct Spray and Spray Drift

DIRECT SPRAY	Terrestrial Concentration (lb/acre)¹	Typical Species RQ²	Rare, Threatened, and Endangered Species RQ²
Typical application rate	6	7.50E+01	6.00E+03
Maximum application rate	20	2.50E+02	2.00E+04

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE					
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Soil Concentration (lb/acre)¹	Typical Species RQ²	Rare, Threatened, and Endangered Species RQ²
Ground	Low Boom	25	7.54E-02	9.43E-01	7.54E+01
Ground	Low Boom	100	2.66E-02	3.33E-01	2.66E+01
Ground	Low Boom	900	4.10E-03	5.13E-02	4.10E+00
Ground	High Boom	25	1.25E-01	1.56E+00	1.25E+02
Ground	High Boom	100	4.19E-02	5.24E-01	4.19E+01
Ground	High Boom	900	5.20E-03	6.50E-02	5.20E+00

OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE					
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Soil Concentration (lb/acre)¹	Typical Species RQ²	Rare, Threatened, and Endangered Species RQ²
Ground	Low Boom	25	2.51E-01	3.14E+00	2.51E+02
Ground	Low Boom	100	8.87E-02	1.11E+00	8.87E+01
Ground	Low Boom	900	1.36E-02	1.70E-01	1.36E+01
Ground	High Boom	25	4.15E-01	5.19E+00	4.15E+02
Ground	High Boom	100	1.40E-01	1.75E+00	1.40E+02
Ground	High Boom	900	1.75E-02	2.19E-01	1.75E+01

¹ a.i. = active ingredient.

² RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value

TABLE B-15

Potential Risk to Predatory Bird from Consumption of Contaminated Fish From Pond (Pond Impacted by Spray Drift Modeled in AgDRIFT)

Parameters/Assumptions	Value	Units
Body weight (BW)	5.15	kg
Food ingestion rate (dry weight [dw]) ¹	0.1018	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²	0.4072	kg ww/day
Bioconcentration factor (BCF)	74	L/kg fish
Proportion of diet contaminated (PC)	1	unitless
Toxicity reference value (TRV) ³	58	mg/kg-bw/day

TYPICAL APPLICATION RATE						
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration ⁴ (C _{pond} mg/L)	Concentration in fish (C _{Fish}): C _{pond} × BCF	Dose estimate (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
Ground	Low Boom	25	4.09E-03	3.03E-01	2.39E-02	4.13E-04
Ground	Low Boom	100	2.24E-03	1.66E-01	1.31E-02	2.26E-04
Ground	Low Boom	900	4.33E-04	3.20E-02	2.53E-03	4.37E-05
Ground	High Boom	25	6.57E-03	4.86E-01	3.84E-02	6.63E-04
Ground	High Boom	100	3.46E-03	2.56E-01	2.02E-02	3.49E-04
Ground	High Boom	900	5.49E-04	4.06E-02	3.21E-03	5.54E-05
MAXIMUM APPLICATION RATE						
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration ⁴ (C _{pond} mg/L)	Concentration in fish (C _{Fish}): C _{pond} × BCF	Dose estimate (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
Ground	Low Boom	25	1.36E-02	1.01E+00	7.96E-02	1.37E-03
Ground	Low Boom	100	7.48E-03	5.54E-01	4.38E-02	7.54E-04
Ground	Low Boom	900	1.44E-03	1.07E-01	8.42E-03	1.45E-04
Ground	High Boom	25	2.19E-02	1.62E+00	1.28E-01	2.21E-03
Ground	High Boom	100	1.15E-02	8.51E-01	6.73E-02	1.16E-03
Ground	High Boom	900	1.83E-03	1.35E-01	1.07E-02	1.85E-04

¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^{0.651}.

² Assumes fish are 75% water (USEPA 1993; Table 4-1 - value for bony fishes).

³ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

⁴ Pond concentrations in spray drift scenarios were calculated by the AgDRIFT. See associated report methodology document for further details.

⁵ Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-16

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_BASE_SAND_0 05_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_0 05_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_0 05_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_0 10_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	4.53E-03	8.80E-04	6.38E-03	2.83E-02	3.48E+00	2.67E-02	1.31E-02	2.00E+00	
G_BASE_CLAY_0 10_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.25E-01	5.96E-03	1.75E-01	7.78E-01	9.58E+01	1.81E-01	8.90E-02	1.36E+01	
G_BASE_LOAM_0 10_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.15E-03	1.04E-04	1.61E-03	7.16E-03	8.81E-01	3.16E-03	1.56E-03	2.37E-01	
G_BASE_SAND_0 25_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	2.46E-01	1.22E-01	3.47E-01	1.54E+00	1.89E+02	3.70E+00	1.82E+00	2.77E+02	
G_BASE_CLAY_0 25_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	9.91E-02	1.27E-02	1.40E-01	6.20E-01	7.62E+01	3.85E-01	1.90E-01	2.89E+01	
G_BASE_LOAM_0 25_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	5.03E-03	6.10E-04	7.09E-03	3.15E-02	3.87E+00	1.85E-02	9.10E-03	1.39E+00	
G_BASE_SAND_0 50_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.01E-01	1.36E-01	2.83E-01	1.26E+00	1.54E+02	4.12E+00	2.03E+00	2.77E+02	
G_BASE_CLAY_0 50_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	4.56E-01	2.52E-02	6.43E-01	2.85E+00	3.51E+02	7.63E-01	3.76E-01	5.72E+01	
G_BASE_LOAM_0 50_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	5.27E-02	1.92E-02	7.42E-02	3.29E-01	4.05E+01	5.82E-01	2.87E-01	4.37E+01	
G_BASE_SAND_1 00_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.46E-01	7.87E-02	2.06E-01	9.12E-01	1.12E+02	2.39E+00	1.17E+00	1.79E+02	
G_BASE_CLAY_1 00_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	6.60E-01	2.84E-02	9.30E-01	4.13E+00	5.08E+02	8.60E-01	4.24E-01	6.45E+01	
G_BASE_LOAM_1 00_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-01	4.19E-02	1.48E-01	6.55E-01	8.06E+01	1.27E+00	6.25E-01	9.52E+01	
G_BASE_SAND_1 50_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.42E-01	5.72E-02	2.01E-01	8.90E-01	1.10E+02	1.73E+00	8.53E-01	1.30E+02	
G_BASE_CLAY_1 50_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.36E-01	2.16E-02	1.04E+00	4.60E+00	5.66E+02	6.54E-01	3.22E-01	4.91E+01	

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_BASE_LOAM_1 50_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.36E-01	4.04E-02	1.92E-01	8.53E-01	1.05E+02	1.22E+00	6.02E-01	9.17E+01	
G_BASE_SAND_2 00_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.48E-01	5.72E-02	2.09E-01	9.27E-01	1.14E+02	1.73E+00	8.54E-01	1.30E+02	
G_BASE_CLAY_2 00_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	7.23E-01	1.72E-02	1.02E+00	4.52E+00	5.56E+02	5.22E-01	2.57E-01	3.92E+01	
G_BASE_LOAM_2 00_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.44E-01	3.68E-02	2.03E-01	9.01E-01	1.11E+02	1.12E+00	5.50E-01	8.37E+01	
G_BASE_SAND_2 50_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.53E-01	5.78E-02	2.15E-01	9.54E-01	1.17E+02	1.75E+00	8.62E-01	1.31E+02	
G_BASE_CLAY_2 50_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	7.04E-01	1.47E-02	9.92E-01	4.40E+00	5.42E+02	4.46E-01	2.20E-01	3.35E+01	
G_BASE_LOAM_2 50_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.42E-01	3.37E-02	2.00E-01	8.90E-01	1.09E+02	1.02E+00	5.02E-01	7.65E+01	
G_ARV1_050_PO ND_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.48E-02	8.00E-03	2.08E-02	9.24E-02	1.14E+01	2.42E-01	1.19E-01	1.82E+01	
G_ARV2_050_PO ND_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	3.89E-02	2.30E-02	5.48E-02	2.43E-01	2.99E+01	6.96E-01	3.43E-01	5.22E+01	
G_ARV3_050_PO ND_TYP	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	3.88E-02	2.33E-02	5.47E-02	2.43E-01	2.99E+01	7.06E-01	3.48E-01	5.29E+01	
G_ERV1_050_PON D_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	5.01E-02	1.92E-02	7.05E-02	3.13E-01	3.85E+01	5.81E-01	2.86E-01	4.36E+01	
G_ERV2_050_PON D_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	5.08E-02	1.92E-02	7.15E-02	3.17E-01	3.91E+01	5.81E-01	2.86E-01	4.36E+01	
G_ERV3_050_PON D_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	5.22E-02	1.92E-02	7.35E-02	3.26E-01	4.01E+01	5.82E-01	2.87E-01	4.37E+01	
G_RGV1_050_PO ND_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	5.06E-02	1.92E-02	7.12E-02	3.16E-01	3.89E+01	5.81E-01	2.86E-01	4.36E+01	
G_RGV2_050_PO ND_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	5.04E-02	1.92E-02	7.10E-02	3.15E-01	3.88E+01	5.81E-01	2.86E-01	4.36E+01	
G_RGV3_050_PO ND_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	5.00E-02	1.92E-02	7.04E-02	3.12E-01	3.85E+01	5.81E-01	2.86E-01	4.36E+01	
G_SLV1_050_PON D_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	5.00E-02	1.92E-02	7.04E-02	3.12E-01	3.85E+01	5.81E-01	2.86E-01	4.36E+01	

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_SLV2_050_PON D_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	5.00E-02	1.92E-02	7.05E-02	3.13E-01	3.85E+01	5.81E-01	2.86E-01	4.36E+01	
G_SLV3_050_PON D_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	5.16E-02	1.92E-02	7.26E-02	3.22E-01	3.97E+01	5.82E-01	2.87E-01	4.36E+01	
G_STV1_050_PON D_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.40E-01	1.20E-02	1.97E-01	8.75E-01	1.08E+02	3.64E-01	1.79E-01	2.73E+01	
G_STV2_050_PON D_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.22E-01	8.81E-03	1.71E-01	7.61E-01	9.36E+01	2.67E-01	1.31E-01	2.00E+01	
G_STV3_050_PON D_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	2.22E-01	2.78E-02	3.13E-01	1.39E+00	1.71E+02	8.42E-01	4.15E-01	6.32E+01	
G_VGV1_050_PO ND_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	5.06E-02	1.92E-02	7.13E-02	3.16E-01	3.89E+01	5.82E-01	2.87E-01	4.37E+01	
G_VGV2_050_PO ND_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	5.06E-02	1.92E-02	7.13E-02	3.16E-01	3.89E+01	5.82E-01	2.87E-01	4.37E+01	
G_VGV3_050_PO ND_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	5.72E-02	2.58E-02	8.06E-02	3.57E-01	4.40E+01	7.83E-01	3.85E-01	5.87E+01	
MAXIMUM APPLICATION RATE																
G_BASE_SAND_0 05_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_CLAY_0 05_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_LOAM_0 05_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_SAND_0 10_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.51E-02	2.93E-03	2.13E-02	9.44E-02	1.16E+01	8.89E-02	4.38E-02	6.67E+00	
G_BASE_CLAY_0 10_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Clay	4.15E-01	1.99E-02	5.85E-01	2.59E+00	3.19E+02	6.02E-01	2.97E-01	4.52E+01	
G_BASE_LOAM_0 10_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.82E-03	3.48E-04	5.38E-03	2.39E-02	2.94E+00	1.05E-02	5.19E-03	7.90E-01	
G_BASE_SAND_0 25_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Sand	8.21E-01	4.07E-01	1.16E+00	5.13E+00	6.31E+02	1.23E+01	6.07E+00	9.25E+02	
G_BASE_CLAY_0 25_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.30E-01	4.24E-02	4.65E-01	2.07E+00	2.54E+02	1.28E+00	6.33E-01	9.63E+01	

TABLE B-16 (Cont.)
Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - MAXIMUM APPLICATION RATE															
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients ¹ - Acute			Risk Quotients ¹ - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants
G_BASE_LOAM_0 25_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.68E-02	2.03E-03	2.36E-02	1.05E-01	1.29E+01	6.16E-02	3.03E-02	4.62E+00
G_BASE_SAND_0 50_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Sand	6.69E-01	4.54E-01	9.43E-01	4.18E+00	5.15E+02	1.37E+01	6.77E+00	1.03E+03
G_BASE_CLAY_0 50_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.52E+00	8.40E-02	2.14E+00	9.51E+00	1.17E+03	2.54E+00	1.25E+00	1.91E+02
G_BASE_LOAM_0 50_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.76E-01	6.41E-02	2.47E-01	1.10E+00	1.35E+02	1.94E+00	9.56E-01	1.46E+02
G_BASE_SAND_1 00_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Sand	4.86E-01	2.62E-01	6.85E-01	3.04E+00	3.74E+02	7.95E+00	3.92E+00	5.96E+02
G_BASE_CLAY_1 00_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.20E+00	9.46E-02	3.10E+00	1.38E+01	1.69E+03	2.87E+00	1.41E+00	2.15E+02
G_BASE_LOAM_1 00_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Loam	3.49E-01	1.40E-01	4.92E-01	2.18E+00	2.69E+02	4.23E+00	2.08E+00	3.17E+02
G_BASE_SAND_1 50_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Sand	4.75E-01	1.91E-01	6.69E-01	2.97E+00	3.65E+02	5.77E+00	2.84E+00	4.33E+02
G_BASE_CLAY_1 50_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.45E+00	7.19E-02	3.45E+00	1.53E+01	1.89E+03	2.18E+00	1.07E+00	1.64E+02
G_BASE_LOAM_1 50_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.55E-01	1.35E-01	6.41E-01	2.84E+00	3.50E+02	4.08E+00	2.01E+00	3.06E+02
G_BASE_SAND_2 00_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.94E-01	1.91E-01	6.96E-01	3.09E+00	3.80E+02	5.78E+00	2.85E+00	4.33E+02
G_BASE_CLAY_2 00_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.41E+00	5.75E-02	3.39E+00	1.51E+01	1.85E+03	1.74E+00	8.58E-01	1.31E+02
G_BASE_LOAM_2 00_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Loam	4.80E-01	1.23E-01	6.77E-01	3.00E+00	3.70E+02	3.72E+00	1.83E+00	2.79E+02
G_BASE_SAND_2 50_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Sand	5.09E-01	1.93E-01	7.16E-01	3.18E+00	3.91E+02	5.84E+00	2.87E+00	4.38E+02
G_BASE_CLAY_2 50_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Clay	2.35E+00	4.91E-02	3.31E+00	1.47E+01	1.81E+03	1.49E+00	7.33E-01	1.12E+02
G_BASE_LOAM_2 50_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Loam	4.74E-01	1.12E-01	6.68E-01	2.97E+00	3.65E+02	3.40E+00	1.67E+00	2.55E+02
G_ARV1_050_PO ND_MAX	50	1	0.05	0.015	0.401	Weeds (78)	Loam	4.93E-02	2.67E-02	6.94E-02	3.08E-01	3.79E+01	8.08E-01	3.98E-01	6.06E+01

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - MAXIMUM APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients ¹ – Acute			Risk Quotients ¹ - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_ARV2_050_PO ND_MAX	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.30E-01	7.66E-02	1.83E-01	8.10E-01	9.97E+01	2.32E+00	1.14E+00	1.74E+02	
G_ARV3_050_PO ND_MAX	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.29E-01	7.76E-02	1.82E-01	8.09E-01	9.96E+01	2.35E+00	1.16E+00	1.76E+02	
G_ERV1_050_PON D_MAX	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.67E-01	6.39E-02	2.35E-01	1.04E+00	1.28E+02	1.94E+00	9.54E-01	1.45E+02	
G_ERV2_050_PON D_MAX	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.69E-01	6.40E-02	2.38E-01	1.06E+00	1.30E+02	1.94E+00	9.55E-01	1.45E+02	
G_ERV3_050_PON D_MAX	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.74E-01	6.40E-02	2.45E-01	1.09E+00	1.34E+02	1.94E+00	9.56E-01	1.46E+02	
G_RGV1_050_PO ND_MAX	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.69E-01	6.39E-02	2.37E-01	1.05E+00	1.30E+02	1.94E+00	9.54E-01	1.45E+02	
G_RGV2_050_PO ND_MAX	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.68E-01	6.39E-02	2.37E-01	1.05E+00	1.29E+02	1.94E+00	9.54E-01	1.45E+02	
G_RGV3_050_PO ND_MAX	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.67E-01	6.39E-02	2.35E-01	1.04E+00	1.28E+02	1.94E+00	9.54E-01	1.45E+02	
G_SLV1_050_PON D_MAX	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.67E-01	6.39E-02	2.35E-01	1.04E+00	1.28E+02	1.94E+00	9.54E-01	1.45E+02	
G_SLV2_050_PON D_MAX	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.67E-01	6.39E-02	2.35E-01	1.04E+00	1.28E+02	1.94E+00	9.54E-01	1.45E+02	
G_SLV3_050_PON D_MAX	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.72E-01	6.40E-02	2.42E-01	1.07E+00	1.32E+02	1.94E+00	9.55E-01	1.45E+02	
G_STV1_050_PON D_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.67E-01	4.00E-02	6.57E-01	2.92E+00	3.59E+02	1.21E+00	5.97E-01	9.09E+01	
G_STV2_050_PON D_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt	4.06E-01	2.94E-02	5.71E-01	2.54E+00	3.12E+02	8.90E-01	4.38E-01	6.67E+01	
G_STV3_050_PON D_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	7.42E-01	9.27E-02	1.04E+00	4.64E+00	5.70E+02	2.81E+00	1.38E+00	2.11E+02	
G_VGV1_050_PO ND_MAX	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.69E-01	6.41E-02	2.38E-01	1.05E+00	1.30E+02	1.94E+00	9.56E-01	1.46E+02	
G_VGV2_050_PO ND_MAX	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.69E-01	6.40E-02	2.38E-01	1.05E+00	1.30E+02	1.94E+00	9.56E-01	1.46E+02	
G_VGV3_050_PO ND_MAX	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.91E-01	8.61E-02	2.69E-01	1.19E+00	1.47E+02	2.61E+00	1.28E+00	1.96E+02	

¹ Risk Quotient = Estimated Dose/Toxicity Reference Value.
² USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

¹ Risk Quotient = Estimated Dose/Toxicity Reference Value.

² USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

TABLE B-17
Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - modeled in GLEAMS TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_BASE_SAND_005_STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.84E-04	2.71E-06	2.60E-04	1.15E-03	1.42E-01	8.21E-05	4.05E-05	6.16E-03	
G_BASE_CLAY_010_STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	4.10E-03	3.38E-05	5.78E-03	2.56E-02	3.15E+00	1.02E-03	5.04E-04	7.68E-02	
G_BASE_LOAM_010_STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.82E-05	3.13E-07	5.38E-05	2.39E-04	2.94E-02	9.49E-06	4.68E-06	7.12E-04	
G_BASE_SAND_025_STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	2.36E-02	8.22E-04	3.33E-02	1.48E-01	1.82E+01	2.49E-02	1.23E-02	1.87E+00	
G_BASE_CLAY_025_STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	6.79E-03	1.14E-04	9.57E-03	4.25E-02	5.22E+00	3.44E-03	1.69E-03	2.58E-01	
G_BASE_LOAM_025_STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	4.99E-04	6.30E-06	7.03E-04	3.12E-03	3.84E-01	1.91E-04	9.40E-05	1.43E-02	
G_BASE_SAND_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.80E-02	1.64E-03	3.95E-02	1.75E-01	2.16E+01	4.98E-02	2.45E-02	3.74E+00	
G_BASE_CLAY_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.65E-02	3.27E-04	2.33E-02	1.03E-01	1.27E+01	9.91E-03	4.88E-03	7.43E-01	
G_BASE_LOAM_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	2.90E-03	2.31E-04	4.09E-03	1.81E-02	2.23E+00	7.00E-03	3.45E-03	5.25E-01	
G_BASE_SAND_100_STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.70E-02	1.94E-03	3.81E-02	1.69E-01	2.08E+01	5.88E-02	2.89E-02	4.41E+00	
G_BASE_CLAY_100_STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	3.32E-02	7.85E-04	4.67E-02	2.07E-01	2.55E+01	2.38E-02	1.17E-02	1.78E+00	
G_BASE_LOAM_100_STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	8.35E-03	8.79E-04	1.18E-02	5.22E-02	6.42E+00	2.66E-02	1.31E-02	2.00E+00	
G_BASE_SAND_150_STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	2.28E-02	1.94E-03	3.22E-02	1.43E-01	1.76E+01	5.87E-02	2.89E-02	4.41E+00	
G_BASE_CLAY_150_STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	4.16E-02	1.01E-03	5.86E-02	2.60E-01	3.20E+01	3.05E-02	1.50E-02	2.29E+00	

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - modeled in GLEAMS TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_BASE_LOAM_150_STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.04E-02	1.17E-03	1.46E-02	6.50E-02	7.99E+00	3.53E-02	1.74E-02	2.65E+00	
G_BASE_SAND_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	2.45E-02	1.98E-03	3.45E-02	1.53E-01	1.89E+01	5.99E-02	2.95E-02	4.50E+00	
G_BASE_CLAY_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	6.19E-02	1.11E-03	8.72E-02	3.87E-01	4.76E+01	3.35E-02	1.65E-02	2.51E+00	
G_BASE_LOAM_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.54E-02	1.31E-03	2.17E-02	9.65E-02	1.19E+01	3.97E-02	1.95E-02	2.98E+00	
G_BASE_SAND_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	2.44E-02	2.01E-03	3.44E-02	1.53E-01	1.88E+01	6.08E-02	3.00E-02	4.56E+00	
G_BASE_CLAY_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	7.93E-02	1.16E-03	1.12E-01	4.95E-01	6.10E+01	3.51E-02	1.73E-02	2.63E+00	
G_BASE_LOAM_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.94E-02	1.38E-03	2.73E-02	1.21E-01	1.49E+01	4.19E-02	2.06E-02	3.14E+00	
G_ARV1_050_STRE AM_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	4.10E-04	2.59E-05	5.78E-04	2.57E-03	3.16E-01	7.86E-04	3.87E-04	5.89E-02	
G_ARV2_050_STRE AM_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.34E-02	1.32E-03	1.88E-02	8.36E-02	1.03E+01	4.01E-02	1.98E-02	3.01E+00	
G_ARV3_050_STRE AM_TYP	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	2.49E-02	3.49E-03	3.50E-02	1.55E-01	1.91E+01	1.06E-01	5.21E-02	7.94E+00	
G_ERV1_050_STRE AM_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	2.89E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.96E-03	3.43E-03	5.22E-01	
G_ERV2_050_STRE AM_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	2.90E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.97E-03	3.44E-03	5.23E-01	
G_ERV3_050_STRE AM_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	2.90E-03	2.31E-04	4.09E-03	1.81E-02	2.23E+00	7.00E-03	3.45E-03	5.25E-01	
G_RGV1_050_STRE AM_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	2.90E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.97E-03	3.43E-03	5.23E-01	
G_RGV2_050_STRE AM_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	2.90E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.97E-03	3.43E-03	5.23E-01	
G_RGV3_050_STRE AM_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	2.89E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.96E-03	3.43E-03	5.22E-01	
G_SLV1_050_STREA M_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	2.89E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.96E-03	3.43E-03	5.22E-01	

TABLE B-17 (Cont.)
Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - modeled in GLEAMS																
TYPICAL APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_SLV2_050_STREA M_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	2.89E-03	2.30E-04	4.08E-03	1.81E-02	2.23E+00	6.96E-03	3.43E-03	5.22E-01	
G_SLV3_050_STREA M_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	2.90E-03	2.31E-04	4.09E-03	1.81E-02	2.23E+00	6.99E-03	3.44E-03	5.24E-01	
G_STV1_050_STREA M_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	7.62E-03	1.50E-04	1.07E-02	4.76E-02	5.86E+00	4.54E-03	2.24E-03	3.41E-01	
G_STV2_050_STREA M_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	7.16E-03	1.28E-04	1.01E-02	4.48E-02	5.51E+00	3.88E-03	1.91E-03	2.91E-01	
G_STV3_050_STREA M_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.31E-02	2.92E-04	1.84E-02	8.17E-02	1.01E+01	8.84E-03	4.35E-03	6.63E-01	
G_VGV1_050_STRE AM_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	2.90E-03	2.30E-04	4.09E-03	1.81E-02	2.23E+00	6.98E-03	3.44E-03	5.24E-01	
G_VGV2_050_STRE AM_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	2.90E-03	2.30E-04	4.09E-03	1.81E-02	2.23E+00	6.98E-03	3.44E-03	5.24E-01	
G_VGV3_050_STRE AM_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	3.68E-03	3.30E-04	5.19E-03	2.30E-02	2.83E+00	1.00E-02	4.93E-03	7.50E-01	
MAXIMUM APPLICATION RATE																
G_BASE_SAND_005 _STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_CLAY_005 _STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_LOAM_005 _STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
G_BASE_SAND_010 _STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Sand	6.14E-04	9.03E-06	8.65E-04	3.84E-03	4.72E-01	2.74E-04	1.35E-04	2.05E-02	
G_BASE_CLAY_010 _STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.37E-02	1.13E-04	1.93E-02	8.54E-02	1.05E+01	3.41E-03	1.68E-03	2.56E-01	
G_BASE_LOAM_010 _STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.27E-04	1.04E-06	1.79E-04	7.96E-04	9.80E-02	3.16E-05	1.56E-05	2.37E-03	
G_BASE_SAND_025 _STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Sand	7.88E-02	2.74E-03	1.11E-01	4.93E-01	6.06E+01	8.30E-02	4.09E-02	6.23E+00	
G_BASE_CLAY_025 _STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Clay	2.26E-02	3.78E-04	3.19E-02	1.42E-01	1.74E+01	1.15E-02	5.65E-03	8.60E-01	

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - modeled in GLEAMS																
MAXIMUM APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_BASE_LOAM_02 5_STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.66E-03	2.10E-05	2.34E-03	1.04E-02	1.28E+00	6.36E-04	3.13E-04	4.77E-02	
G_BASE_SAND_050 _STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Sand	9.34E-02	5.48E-03	1.32E-01	5.84E-01	7.18E+01	1.66E-01	8.18E-02	1.25E+01	
G_BASE_CLAY_050 _STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay	5.51E-02	1.09E-03	7.76E-02	3.44E-01	4.24E+01	3.30E-02	1.63E-02	2.48E+00	
G_BASE_LOAM_05 0_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Loam	9.67E-03	7.70E-04	1.36E-02	6.05E-02	7.44E+00	2.33E-02	1.15E-02	1.75E+00	
G_BASE_SAND_100 _STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Sand	9.01E-02	6.46E-03	1.27E-01	5.63E-01	6.93E+01	1.96E-01	9.65E-02	1.47E+01	
G_BASE_CLAY_100 _STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.11E-01	2.62E-03	1.56E-01	6.91E-01	8.50E+01	7.93E-02	3.90E-02	5.95E+00	
G_BASE_LOAM_10 0_STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Loam	2.78E-02	2.93E-03	3.92E-02	1.74E-01	2.14E+01	8.88E-02	4.37E-02	6.66E+00	
G_BASE_SAND_150 _STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Sand	7.61E-02	6.46E-03	1.07E-01	4.76E-01	5.86E+01	1.96E-01	9.64E-02	1.47E+01	
G_BASE_CLAY_150 _STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.39E-01	3.36E-03	1.95E-01	8.66E-01	1.07E+02	1.02E-01	5.01E-02	7.63E+00	
G_BASE_LOAM_15 0_STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.46E-02	3.88E-03	4.88E-02	2.17E-01	2.66E+01	1.18E-01	5.80E-02	8.83E+00	
G_BASE_SAND_200 _STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Sand	8.18E-02	6.59E-03	1.15E-01	5.11E-01	6.29E+01	2.00E-01	9.84E-02	1.50E+01	
G_BASE_CLAY_200 _STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.06E-01	3.69E-03	2.91E-01	1.29E+00	1.59E+02	1.12E-01	5.50E-02	8.38E+00	
G_BASE_LOAM_20 0_STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Loam	5.14E-02	4.36E-03	7.25E-02	3.22E-01	3.96E+01	1.32E-01	6.51E-02	9.92E+00	
G_BASE_SAND_250 _STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Sand	8.15E-02	6.69E-03	1.15E-01	5.09E-01	6.27E+01	2.03E-01	9.99E-02	1.52E+01	
G_BASE_CLAY_250 _STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Clay	2.64E-01	3.86E-03	3.72E-01	1.65E+00	2.03E+02	1.17E-01	5.76E-02	8.77E+00	
G_BASE_LOAM_25 0_STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Loam	6.46E-02	4.61E-03	9.10E-02	4.04E-01	4.97E+01	1.40E-01	6.88E-02	1.05E+01	
G_ARV1_050_STRE AM_MAX	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.37E-03	8.64E-05	1.93E-03	8.55E-03	1.05E+00	2.62E-03	1.29E-03	1.96E-01	

TABLE B-17 (Cont.)
Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - modeled in GLEAMS MAXIMUM APPLICATION RATE																
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ² Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic			
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	Fish	Aquatic Inverte- brates	Non- Target Aquatic Plants	
G_ARV2_050_STRE AM_MAX	50	100	0.05	0.015	0.401	Weeds (78)	Loam	4.46E-02	4.41E-03	6.28E-02	2.79E-01	3.43E+01	1.34E-01	6.59E-02	1.00E+01	
G_ARV3_050_STRE AM_MAX	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	8.29E-02	1.16E-02	1.17E-01	5.18E-01	6.37E+01	3.53E-01	1.74E-01	2.65E+01	
G_ERV1_050_STRE AM_MAX	50	10	0.05	0.015	0.05	Weeds (78)	Loam	9.65E-03	7.66E-04	1.36E-02	6.03E-02	7.42E+00	2.32E-02	1.14E-02	1.74E+00	
G_ERV2_050_STRE AM_MAX	50	10	0.05	0.015	0.2	Weeds (78)	Loam	9.66E-03	7.67E-04	1.36E-02	6.04E-02	7.43E+00	2.32E-02	1.15E-02	1.74E+00	
G_ERV3_050_STRE AM_MAX	50	10	0.05	0.015	0.5	Weeds (78)	Loam	9.67E-03	7.70E-04	1.36E-02	6.04E-02	7.44E+00	2.33E-02	1.15E-02	1.75E+00	
G_RGV1_050_STRE AM_MAX	50	10	0.05	0.023	0.401	Weeds (78)	Loam	9.65E-03	7.67E-04	1.36E-02	6.03E-02	7.42E+00	2.32E-02	1.14E-02	1.74E+00	
G_RGV2_050_STRE AM_MAX	50	10	0.05	0.046	0.401	Weeds (78)	Loam	9.65E-03	7.67E-04	1.36E-02	6.03E-02	7.43E+00	2.32E-02	1.14E-02	1.74E+00	
G_RGV3_050_STRE AM_MAX	50	10	0.05	0.15	0.401	Weeds (78)	Loam	9.65E-03	7.66E-04	1.36E-02	6.03E-02	7.42E+00	2.32E-02	1.14E-02	1.74E+00	
G_SLV1_050_STRE AM_MAX	50	10	0.005	0.015	0.401	Weeds (78)	Loam	9.65E-03	7.66E-04	1.36E-02	6.03E-02	7.42E+00	2.32E-02	1.14E-02	1.74E+00	
G_SLV2_050_STRE AM_MAX	50	10	0.01	0.015	0.401	Weeds (78)	Loam	9.65E-03	7.66E-04	1.36E-02	6.03E-02	7.42E+00	2.32E-02	1.14E-02	1.74E+00	
G_SLV3_050_STRE AM_MAX	50	10	0.1	0.015	0.401	Weeds (78)	Loam	9.67E-03	7.69E-04	1.36E-02	6.05E-02	7.44E+00	2.33E-02	1.15E-02	1.75E+00	
G_STV1_050_STRE AM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.54E-02	5.00E-04	3.58E-02	1.59E-01	1.95E+01	1.51E-02	7.46E-03	1.14E+00	
G_STV2_050_STRE AM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.39E-02	4.27E-04	3.36E-02	1.49E-01	1.84E+01	1.29E-02	6.38E-03	9.71E-01	
G_STV3_050_STRE AM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	4.36E-02	9.72E-04	6.14E-02	2.72E-01	3.35E+01	2.95E-02	1.45E-02	2.21E+00	
G_VGV1_050_STRE AM_MAX	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	9.67E-03	7.68E-04	1.36E-02	6.05E-02	7.44E+00	2.33E-02	1.15E-02	1.75E+00	
G_VGV3_050_STRE AM_MAX	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.23E-02	1.10E-03	1.73E-02	7.67E-02	9.44E+00	2.33E-02	1.15E-02	2.50E+00	

¹ RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value.

² USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

TABLE B-18

Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - modeled in GLEAMS TYPICAL APPLICATION RATE										
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE¹ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Terrestrial Concentration (lb/acre)	Typical Species RQ²	Rare, Threatened, and Endangered Species RQ²
G_BASE_SAND_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	4.14E-03	3.45E-04	8.81E-02
G_BASE_LOAM_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.97E-05	3.31E-06	8.44E-04
G_BASE_SAND_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	4.66E-08	3.89E-09	9.92E-07
G_BASE_CLAY_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	7.95E-03	6.63E-04	1.69E-01
G_BASE_LOAM_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	5.85E-04	4.88E-05	1.24E-02
G_BASE_SAND_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.38E-08	1.15E-09	2.93E-07
G_BASE_CLAY_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.85E-02	1.54E-03	3.94E-01
G_BASE_LOAM_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.55E-03	1.29E-04	3.29E-02
G_BASE_SAND_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	4.54E-06	3.78E-07	9.66E-05
G_BASE_CLAY_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	4.72E-02	3.93E-03	1.00E+00
G_BASE_LOAM_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	4.66E-03	3.88E-04	9.91E-02
G_BASE_SAND_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.54E-06	1.28E-07	3.27E-05
G_BASE_CLAY_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	6.15E-02	5.13E-03	1.31E+00
G_BASE_LOAM_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	9.79E-03	8.16E-04	2.08E-01
G_BASE_SAND_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.97E-05	4.14E-06	1.06E-03
G_BASE_CLAY_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	9.88E-02	8.23E-03	2.10E+00
G_BASE_LOAM_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.78E-02	1.48E-03	3.79E-01
G_BASE_SAND_250_TERR_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	5.56E-05	4.63E-06	1.18E-03
G_BASE_CLAY_250_TERR_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.34E-01	1.11E-02	2.85E+00

TABLE B-18 (Cont.)
Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - modeled in GLEAMS TYPICAL APPLICATION RATE										
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ¹ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Terrestrial Concentration (lb/acre)	Typical Species RQ ²	Rare, Threatened, and Endangered Species RQ ²
G_BASE_LOAM_250_TERR_TY	250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.54E-02	2.12E-03	5.41E-01
G_ARV1_050_TERR_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.41E-03	1.18E-04	3.01E-02
G_ARV2_050_TERR_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.42E-03	1.18E-04	3.01E-02
G_ARV3_050_TERR_TYP	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.41E-03	1.17E-04	3.00E-02
G_ERV1_050_TERR_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.39E-03	1.16E-04	2.96E-02
G_ERV2_050_TERR_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.43E-03	1.19E-04	3.05E-02
G_ERV3_050_TERR_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.52E-03	1.27E-04	3.23E-02
G_RGV1_050_TERR_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.42E-03	1.18E-04	3.02E-02
G_RGV2_050_TERR_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.41E-03	1.18E-04	3.00E-02
G_RGV3_050_TERR_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.38E-03	1.15E-04	2.94E-02
G_SLV1_050_TERR_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.38E-03	1.15E-04	2.94E-02
G_SLV2_050_TERR_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.39E-03	1.16E-04	2.95E-02
G_SLV3_050_TERR_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.48E-03	1.23E-04	3.15E-02
G_STV1_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	8.40E-03	7.00E-04	1.79E-01
G_STV2_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	7.95E-03	6.63E-04	1.69E-01
G_STV3_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.54E-02	1.29E-03	3.29E-01
G_VGV1_050_TERR_TYP	50	10	0.05	0.015	0.401	Shrubs(79)	Loam	1.42E-03	1.18E-04	3.02E-02
G_VGV2_050_TERR_TYP	50	10	0.05	0.015	0.401	Rye Grass(54)	Loam	1.42E-03	1.18E-04	3.02E-02
G_VGV3_050_TERR_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood(71)	Loam	1.76E-03	1.47E-04	3.75E-02
MAXIMUM APPLICATION RATE										
G_BASE_SAND_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00

TABLE B-18 (Cont.)

Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - modeled in GLEAMS MAXIMUM APPLICATION RATE										
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ¹ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Terrestrial Concentration (lb/acre)	Typical Species RQ ²	Rare, Threatened, and Endangered Species RQ ²
G_BASE_CLAY_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.38E-02	1.15E-03	2.94E-01
G_BASE_LOAM_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.32E-04	1.10E-05	2.81E-03
G_BASE_SAND_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.55E-07	1.30E-08	3.31E-06
G_BASE_CLAY_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Clay	2.65E-02	2.21E-03	5.64E-01
G_BASE_LOAM_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.95E-03	1.63E-04	4.15E-02
G_BASE_SAND_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.59E-08	3.82E-09	9.76E-07
G_BASE_CLAY_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay	6.17E-02	5.14E-03	1.31E+00
G_BASE_LOAM_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Loam	5.16E-03	4.30E-04	1.10E-01
G_BASE_SAND_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.51E-05	1.26E-06	3.22E-04
G_BASE_CLAY_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.57E-01	1.31E-02	3.35E+00
G_BASE_LOAM_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.55E-02	1.29E-03	3.30E-01
G_BASE_SAND_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Sand	5.12E-06	4.27E-07	1.09E-04
G_BASE_CLAY_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.05E-01	1.71E-02	4.36E+00
G_BASE_LOAM_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.26E-02	2.72E-03	6.94E-01
G_BASE_SAND_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.66E-04	1.38E-05	3.52E-03
G_BASE_CLAY_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Clay	3.29E-01	2.74E-02	7.01E+00
G_BASE_LOAM_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Loam	5.93E-02	4.95E-03	1.26E+00
G_BASE_SAND_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.85E-04	1.54E-05	3.94E-03
G_BASE_CLAY_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.46E-01	3.71E-02	9.48E+00
G_BASE_LOAM_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Loam	8.48E-02	7.07E-03	1.80E+00
G_ARV1_050_TERR_max	50	1	0.05	0.015	0.401	Weeds (78)	Loam	4.71E-03	3.93E-04	1.00E-01

TABLE B-18 (Cont.)
Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - modeled in GLEAMS MAXIMUM APPLICATION RATE										
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE¹ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Terrestrial Concentration (lb/acre)	Typical Species RQ²	Rare, Threatened, and Endangered Species RQ²
G_ARV2_050_TERR_max	50	100	0.05	0.015	0.401	Weeds (78)	Loam	4.72E-03	3.93E-04	1.00E-01
G_ARV3_050_TERR_max	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	4.69E-03	3.91E-04	9.98E-02
G_ERV1_050_TERR_max	50	10	0.05	0.015	0.05	Weeds (78)	Loam	4.63E-03	3.86E-04	9.85E-02
G_ERV2_050_TERR_max	50	10	0.05	0.015	0.2	Weeds (78)	Loam	4.77E-03	3.98E-04	1.02E-01
G_ERV3_050_TERR_max	50	10	0.05	0.015	0.5	Weeds (78)	Loam	5.06E-03	4.22E-04	1.08E-01
G_RGV1_050_TERR_max	50	10	0.05	0.023	0.401	Weeds (78)	Loam	4.73E-03	3.94E-04	1.01E-01
G_RGV2_050_TERR_max	50	10	0.05	0.046	0.401	Weeds (78)	Loam	4.71E-03	3.92E-04	1.00E-01
G_RGV3_050_TERR_max	50	10	0.05	0.15	0.401	Weeds (78)	Loam	4.61E-03	3.84E-04	9.81E-02
G_SLV1_050_TERR_max	50	10	0.005	0.015	0.401	Weeds (78)	Loam	4.61E-03	3.84E-04	9.81E-02
G_SLV2_050_TERR_max	50	10	0.01	0.015	0.401	Weeds (78)	Loam	4.62E-03	3.85E-04	9.84E-02
G_SLV3_050_TERR_max	50	10	0.1	0.015	0.401	Weeds (78)	Loam	4.94E-03	4.12E-04	1.05E-01
G_STV1_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.80E-02	2.33E-03	5.96E-01
G_STV2_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.65E-02	2.21E-03	5.64E-01
G_STV3_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	5.15E-02	4.29E-03	1.10E+00
G_VGV1_050_TERR_max	50	10	0.05	0.015	0.401	Shrubs(79)	Loam	4.73E-03	3.94E-04	1.01E-01
G_VGV2_050_TERR_max	50	10	0.05	0.015	0.401	Rye Grass(54)	Loam	4.73E-03	3.94E-04	1.01E-01
G_VGV3_050_TERR_max	50	10	0.05	0.015	0.401	Conifer + Hardwood(71)	Loam	5.87E-03	4.89E-04	1.25E-01

¹ USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.
² RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-19

Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish From Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)

Parameters/ Assumptions	Value	Units
Body weight (BW)	5.15	kg
Food ingestion rate (dry weight [dw]) ¹	0.1018	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) ²	0.4071	kg ww/day
Bioconcentration factor (BCF)	74	L/kg fish
Proportion of diet contaminated (PC)	1	unitless
Toxicity reference value (TRV) ³	58	mg/kg-bw/day

TYPICAL APPLICATION RATE											
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
G_BASE_SAND_005_P OND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_P OND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_ POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_P OND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	8.80E-04	6.51E-02	5.15E-03	8.88E-05
G_BASE_CLAY_010_P OND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.96E-03	4.41E-01	3.49E-02	6.01E-04
G_BASE_LOAM_010_ POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.04E-04	7.72E-03	6.10E-04	1.05E-05
G_BASE_SAND_025_P OND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.22E-01	9.03E+00	7.14E-01	1.23E-02
G_BASE_CLAY_025_P OND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.27E-02	9.41E-01	7.44E-02	1.28E-03

TABLE B-19 (Cont.)

**Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish From Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)**

TYPICAL APPLICATION RATE											
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
G_BASE_LOAM_025_PO ND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	6.10E-04	4.51E-02	3.57E-03	6.15E-05
G_BASE_SAND_050_PO ND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.36E-01	1.01E+01	7.96E-01	1.37E-02
G_BASE_CLAY_050_PO ND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.52E-02	1.86E+00	1.47E-01	2.54E-03
G_BASE_LOAM_050_PO ND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03
G_BASE_SAND_100_PO ND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	7.87E-02	5.83E+00	4.61E-01	7.94E-03
G_BASE_CLAY_100_PO ND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.84E-02	2.10E+00	1.66E-01	2.86E-03
G_BASE_LOAM_100_PO ND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	4.19E-02	3.10E+00	2.45E-01	4.22E-03
G_BASE_SAND_150_PO ND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	5.72E-02	4.23E+00	3.34E-01	5.77E-03
G_BASE_CLAY_150_PO ND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.16E-02	1.60E+00	1.26E-01	2.18E-03
G_BASE_LOAM_150_PO ND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.04E-02	2.99E+00	2.36E-01	4.07E-03
G_BASE_SAND_200_PO ND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	5.72E-02	4.23E+00	3.35E-01	5.77E-03
G_BASE_CLAY_200_PO ND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.72E-02	1.28E+00	1.01E-01	1.74E-03
G_BASE_LOAM_200_PO ND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.68E-02	2.73E+00	2.15E-01	3.71E-03
G_BASE_SAND_250_PO ND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	5.78E-02	4.28E+00	3.38E-01	5.83E-03
G_BASE_CLAY_250_PO ND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.47E-02	1.09E+00	8.61E-02	1.49E-03
G_BASE_LOAM_250_PO ND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	3.37E-02	2.49E+00	1.97E-01	3.40E-03

TABLE B-19 (Cont.)

**Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish From Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)**

TYPICAL APPLICATION RATE											
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
G_ARV1_050_POND_ TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	8.00E-03	5.92E-01	4.68E-02	8.07E-04
G_ARV2_050_POND_ TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.30E-02	1.70E+00	1.34E-01	2.32E-03
G_ARV3_050_POND_ TYP	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	2.33E-02	1.72E+00	1.36E-01	2.35E-03
G_ERV1_050_POND_ TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_ERV2_050_POND_ TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03
G_ERV3_050_POND_ TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03
G_RGV1_050_POND_ TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_RGV2_050_POND_ TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_RGV3_050_POND_ TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_SLV1_050_POND_ TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_SLV2_050_POND_ TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.93E-03
G_SLV3_050_POND_ TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03
G_STV1_050_POND_ TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.20E-02	8.88E-01	7.02E-02	1.21E-03
G_STV2_050_POND_ TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	8.81E-03	6.52E-01	5.15E-02	8.88E-04
G_STV3_050_POND_ TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	2.78E-02	2.06E+00	1.63E-01	2.80E-03
G_VGV1_050_POND_ TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03

TABLE B-19 (Cont.)

**Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish From Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)**

TYPICAL APPLICATION RATE											
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
G_VGV2_050_POND_ TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.92E-02	1.42E+00	1.12E-01	1.94E-03
G_VGV3_050_POND_ TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	2.58E-02	1.91E+00	1.51E-01	2.60E-03
MAXIMUM APPLICATION RATE											
G_BASE_SAND_005_ POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_ POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_ POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_ POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.93E-03	2.17E-01	1.72E-02	2.96E-04
G_BASE_CLAY_010_ POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.99E-02	1.47E+00	1.16E-01	2.00E-03
G_BASE_LOAM_010_ POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.48E-04	2.57E-02	2.03E-03	3.51E-05
G_BASE_SAND_025_ POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Sand	4.07E-01	3.01E+01	2.38E+00	4.10E-02
G_BASE_CLAY_025_ POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Clay	4.24E-02	3.14E+00	2.48E-01	4.27E-03
G_BASE_LOAM_025_ POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.03E-03	1.50E-01	1.19E-02	2.05E-04
G_BASE_SAND_050_ POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.54E-01	3.36E+01	2.65E+00	4.58E-02
G_BASE_CLAY_050_ POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay	8.40E-02	6.21E+00	4.91E-01	8.47E-03
G_BASE_LOAM_050_ POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Loam	6.41E-02	4.74E+00	3.75E-01	6.46E-03
G_BASE_SAND_100_ POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.62E-01	1.94E+01	1.54E+00	2.65E-02

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish From Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	MAXIMUM APPLICATION RATE			Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
					USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type				
G_BASE_CLAY_100_ POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.46E-02	7.00E+00	5.53E-01	9.54E-03
G_BASE_LOAM_100_ POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.40E-01	1.03E+01	8.17E-01	1.41E-02
G_BASE_SAND_150_ POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.91E-01	1.41E+01	1.11E+00	1.92E-02
G_BASE_CLAY_150_ POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.19E-02	5.32E+00	4.21E-01	7.26E-03
G_BASE_LOAM_150_ POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.35E-01	9.96E+00	7.87E-01	1.36E-02
G_BASE_SAND_200_ POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.91E-01	1.41E+01	1.12E+00	1.92E-02
G_BASE_CLAY_200_ POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Clay	5.75E-02	4.25E+00	3.36E-01	5.80E-03
G_BASE_LOAM_200_ POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.23E-01	9.08E+00	7.18E-01	1.24E-02
G_BASE_SAND_250_ POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.93E-01	1.43E+01	1.13E+00	1.94E-02
G_BASE_CLAY_250_ POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.91E-02	3.63E+00	2.87E-01	4.95E-03
G_BASE_LOAM_250_ POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.12E-01	8.30E+00	6.56E-01	1.13E-02
G_ARV1_050_POND_ max	50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.67E-02	1.97E+00	1.56E-01	2.69E-03
G_ARV2_050_POND_ max	50	100	0.05	0.015	0.401	Weeds (78)	Loam	7.66E-02	5.67E+00	4.48E-01	7.72E-03
G_ARV3_050_POND_ max	50	1000	0.05	0.015	0.401	Weeds (78)	Loam	7.76E-02	5.75E+00	4.54E-01	7.83E-03
G_ERV1_050_POND_ max	50	10	0.05	0.015	0.05	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_ERV2_050_POND_ max	50	10	0.05	0.015	0.2	Weeds (78)	Loam	6.40E-02	4.73E+00	3.74E-01	6.45E-03

TABLE B-19 (Cont.)

**Potential Risk to Predatory Bird from Long-Term Consumption of Contaminated Fish from Pond
(Pond Impacted by Surface Runoff Modeled in GLEAMS)**

MAXIMUM APPLICATION RATE											
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE ⁴ Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C _{pond} mg/L)	Concentrations in fish (C _{Fish}): C _{pond} × BCF	Dose estimates (D): (C _{Fish} × ir × PC) / BW	Risk Quotient ⁵
G_ERV3_050_POND_ max	50	10	0.05	0.015	0.5	Weeds (78)	Loam	6.40E-02	4.74E+00	3.75E-01	6.46E-03
G_RGV1_050_POND_ max	50	10	0.05	0.023	0.401	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_RGV2_050_POND_ max	50	10	0.05	0.046	0.401	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_RGV3_050_POND_ max	50	10	0.05	0.15	0.401	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_SLV1_050_POND_ max	50	10	0.005	0.015	0.401	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_SLV2_050_POND_ max	50	10	0.01	0.015	0.401	Weeds (78)	Loam	6.39E-02	4.73E+00	3.74E-01	6.45E-03
G_SLV3_050_POND_ max	50	10	0.1	0.015	0.401	Weeds (78)	Loam	6.40E-02	4.74E+00	3.74E-01	6.46E-03
G_STV1_050_POND_ max	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.00E-02	2.96E+00	2.34E-01	4.03E-03
G_STV2_050_POND_ max	50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.94E-02	2.17E+00	1.72E-01	2.96E-03
G_STV3_050_POND_ max	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	9.27E-02	6.86E+00	5.42E-01	9.35E-03
G_VGV1_050_POND_ max	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	6.41E-02	4.74E+00	3.75E-01	6.46E-03
G_VGV2_050_POND_ max	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	6.40E-02	4.74E+00	3.75E-01	6.46E-03
G_VGV3_050_POND_ max	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	8.61E-02	6.37E+00	5.04E-01	8.68E-03
¹ Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW) ^{0.651} . ² Assumes fish are 75% water (USEPA 1993; Table 4-1 - value for bony fishes). ³ Toxicity Reference Value (TRV) - Relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature ⁴ USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors. ⁵ Risk Quotient = Estimated Dose/Toxicity Reference Value.											

TABLE B-20
Potential Risks to Non-Target Terrestrial Plants from Herbicide in Dust
Deposited from Wind Erosion

WIND EROSION - modeled in CALPUFF							
TYPICAL APPLICATION RATE							
CALPUFF Scenario ID	Watershed Location	Distance from Receptor (km)	Terrestrial Concentration (lb/acre)	Typical Species		Rare, Threatened, and Endangered Species	
				TRV¹	RQ²	TRV¹	RQ²
dust_MT_0.5_typ	MT	0.5	3.22E-05	0.08	4.03E-04	1.00E-03	3.22E-02
dust_MT_5_typ	MT	5	1.83E-05	0.08	2.28E-04	1.00E-03	1.83E-02
dust_MT_50_typ	MT	50	2.19E-09	0.08	2.73E-08	1.00E-03	2.19E-06
dust_OR_0.5_typ	OR	0.5	1.85E-05	0.08	2.31E-04	1.00E-03	1.85E-02
dust_OR_5_typ	OR	5	7.04E-06	0.08	8.80E-05	1.00E-03	7.04E-03
dust_OR_50_typ	OR	50	2.48E-09	0.08	3.10E-08	1.00E-03	2.48E-06
dust_WY_0.5_typ	WY	0.5	3.65E-06	0.08	4.56E-05	1.00E-03	3.65E-03
dust_WY_5_typ	WY	5	2.52E-06	0.08	3.15E-05	1.00E-03	2.52E-03
dust_WY_50_typ	WY	50	6.19E-10	0.08	7.74E-09	1.00E-03	6.19E-07
MAXIMUM APPLICATION RATE							
dust_MT_0.5_max	MT	0.5	1.07E-04	0.08	1.34E-03	1.00E-03	1.07E-01
dust_MT_5_max	MT	5	6.09E-05	0.08	7.61E-04	1.00E-03	6.09E-02
dust_MT_50_max	MT	50	8.21E-09	0.08	1.03E-07	1.00E-03	8.21E-06
dust_OR_0.5_max	OR	0.5	6.15E-05	0.08	7.69E-04	1.00E-03	6.15E-02
dust_OR_5_max	OR	5	2.35E-05	0.08	2.93E-04	1.00E-03	2.35E-02
dust_OR_50_max	OR	50	8.26E-09	0.08	1.03E-07	1.00E-03	8.26E-06
dust_WY_0.5_max	WY	0.5	1.22E-05	0.08	1.52E-04	1.00E-03	1.22E-02
dust_WY_5_max	WY	5	8.39E-06	0.08	1.05E-04	1.00E-03	8.39E-03
dust_WY_50_max	WY	50	2.06E-09	0.08	2.58E-08	1.00E-03	2.06E-06

¹ Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

² Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-21

Potential Risks to Aquatic Species from Accidental Spill to Pond (Acute Exposure)

Parameters/Assumptions	Value	Units
Volume of pond (Vp)	1,011,715	L
Volume of spill (Vspill)		
Truck (Vspill _t)	757	L
Herbicide concentration in mixture (Cm)¹		
Truck mixture (Cm _t)	95871.49	mg/L

Scenario	Concentrations in water (Cw): $Cm \times V_{spill} / Vp$	Units	Risk Quotients ²		
			Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Truck spill into pond	71.73	mg/L	101.0343	4.48E+02	5.52E+04

¹ Based on herbicide mixed for the maximum application rate, where truck spray rate is 25 gallons per acre. Cm = [application rate x (1/spray rate)] converted from lb/gallon to mg/L.

² Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-22

 Potential Risks to Aquatic Species from Accidental Direct Spray of Pond
 and Stream (Acute Exposure)

Parameters/Assumptions	Rate	Value	Units
Pond			
Application rates (R)	Typical	6	lb/acre
	Maximum	20	lb/acre
Area of pond (Area)		0.25	acre
Volume of pond (Vol)		1,011,715	L
Mass sprayed on pond (R x Area)	Typical	680,388	mg
	Maximum	2,267,960	mg
Concentration in pond water (Mass/Volume)	Typical	0.6725	mg/L
	Maximum	2.2417	mg/L
Stream			
Width of stream		2	m
Length of stream impacted by direct spray		636.15	m
Area of stream impacted by spray (Area)		1,272.3	m ²
Depth of stream		0.2	m
Instantaneous volume of stream impacted by direct spray (Vol)		254,460	L
Mass sprayed on stream (R x Area)	Typical	1.886	lb
	Maximum	6.288	lb
Mass sprayed on stream - converted to mg	Typical	855,642.359	mg
	Maximum	2,852,141.195	mg
Concentration in stream water (Mass/Vol)	Typical	3.3626	mg/L
	Maximum	11.2086	mg/L

Scenario	Application Rate	Concentration in water (mg/L)	Risk Quotients ¹		
			Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Acute					
Direct spray to pond	Typical application	6.73E-01	9.47E-01	4.20E+00	5.17E+02
	Maximum application	2.24E+00	3.16E+00	1.40E+01	1.72E+03
Direct spray to stream	Typical application	3.36E+00	4.74E+00	2.10E+01	2.59E+03
	Maximum application	1.12E+01	1.58E+01	7.01E+01	8.62E+03
Chronic					
Direct spray to pond	Typical application	6.73E-01	2.04E+01	1.00E+01	1.53E+03
	Maximum application	2.24E+00	6.79E+01	3.35E+01	5.09E+03
Direct spray to stream	Typical application	3.36E+00	1.02E+02	5.02E+01	7.64E+03
	Maximum application	1.12E+01	3.40E+02	1.67E+02	2.55E+04
¹ Risk Quotient = Estimated Dose/Toxicity Reference Value.					

¹Risk Quotient = Estimated Dose/Toxicity Reference Value.

REFERENCES

- ENSR. 2005. Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology Final Report. Prepared for the Bureau of Land Management. Westford, Massachusetts.
- Fletcher, J.S., J.E. Nellessen, and T.G. Pfleeger. 1994. Literature Review and Evaluation of the EPA Food-Chain (Kenaga) Nomogram: An Instrument for Estimating Pesticide Residue on Plants. *Environmental Toxicology and Chemistry* 13(9):1383-1391.
- Harris, S.A. and K.R. Solomon. 1992. Human Exposure to 2,4-D Following Controlled Activities on Recently Sprayed Turf. *Journal of Environmental Science and Health B27(1)*:9-22.
- Hoerger, F. and E.E. Kenaga. 1972. Pesticide Residues on Plants: Correlation of Representative Data as a Basis for Estimation of Their Magnitude in the Environment. *In Environmental Quality and Safety, Volume I: Global Aspects of Toxicology and Technology as Applied to the Environment*. F. Coulston and F. Kerte (eds.). Academic Press. New York, New York.
- Nagy, K.A. 1987. Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds. *Ecological Monographs* 57(2):111-128.
- Stahl, W.R. 1967. Scaling of Respiratory Variables in Mammals. *Journal of Applied Physiology* 22:453-460.
- U.S. Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Volume I. EPA/600-R/R-93/187a,187b. Office of Research and Development. Washington, D.C.

APPENDIX C

**List of Rare, Threatened, and Endangered Species
for 17 BLM States**

TABLE C-2
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Amphibians																			
<i>Ambystoma californiense</i>	salamander, California tiger	I ⁽¹⁾ ; V ⁽²⁾			E ^(a)														
<i>Ambystoma tigrinum stebbinsi</i>	salamander, Sonora tiger	I/Inv ⁽¹⁾ ; C/R ⁽²⁾		E															
<i>Batrachoseps aridus</i>	salamander, desert slender	Inv			E														
<i>Bufo baxteri</i>	toad, Wyoming	I																	E
<i>Bufo californicus</i>	toad, arroyo (=arroyo southwestern)	H ⁽¹⁾ ; Inv ⁽²⁾			E														
<i>Rana aurora draytonii</i>	frog, California red-legged	H ⁽¹⁾ ; Inv ⁽²⁾			T ^(b)														
<i>Rana chiricahuensis</i>	frog, Chiricahua leopard	H ⁽¹⁾ ; Inv ⁽²⁾		T							T								
Birds																			
<i>Brachyramphus marmoratus marmoratus</i>	murrelet, marbled	Ps			T									T				T	
<i>Charadrius alexandrinus nivosus</i>	plover, western snowy	G		T	T	T			T	T	T		T	T		T	T	T	
<i>Charadrius melodus</i>	plover, piping	H																	
<i>Empidonax traillii eximius</i>	flycatcher, southwestern willow	I		E	E	E				E	E					E	E		
<i>Falco femoralis septentrionalis</i>	falcon, northern aplomado	C														E			
<i>Glaucidium brasilianum cactorum</i>	pygmy-owl, cactus ferruginous	C		E															
<i>Grus americana</i>	crane, whooping	O [Ps,H]				E ^(c) ,XN	E ^(c) ,XN	E ^(c)	E ^(c)		E ^(c) ,XN	E ^(c)	E ^(c)		E ^(c)	E ^(c)	E ^(c) ,XN		E ^(c) ,XN ^(d)
<i>Gymnogyps californianus</i>	condor, California	C		XN	E												XN		
<i>Haliaeetus leucocephalus</i>	eagle, bald	Ps		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
<i>Pelecanus occidentalis</i>	pelican, brown	P			E									E		E		E	
<i>Pipilo crissalis eremophilus</i>	towhee, Inyo California	O [G, I]			T														
<i>Polioptila californica californica</i>	gnatcatcher, coastal California	I			T														
<i>Polysticta stelleri</i>	eider, Steller's	I	T ^(e)																
<i>Rallus longirostris yumanensis</i>	rail, Yuma clapper	C		E	E														
<i>Somateria fischeri</i>	eider, spectacled	O [H, Inv]	T																

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Sterna antillarum</i>	tern, least	Ps				E ^(f)		E ^(f)	E ^(f)		E ^(f)	E ^(f)	E ^(f)		E ^(f)	E ^(f)			
<i>Strix occidentalis caurina</i>	owl, northern spotted	C			T									T				T	
<i>Strix occidentalis lucida</i>	owl, Mexican spotted	C		T		T					T					T	T		
<i>Vireo bellii pusillus</i>	vireo, least Bell's	I			E														
Crustaceans																			
<i>Branchinecta conservatio</i>	fairy shrimp, Conservancy				E														
<i>Branchinecta longiantenna</i>	fairy shrimp, longhorn				E														
<i>Branchinecta lynchi</i>	fairy shrimp, vernal pool				T									T					
<i>Gammarus desperatus</i>	amphipod, Noel's tadpole shrimp, vernal pool										PE ^(g)								
<i>Lepidurus packardi</i>					E														
<i>Thermosphaeroma thermophilus</i>	isopod, Socorro										E								
Fish																			
<i>Acipenser transmontanus</i>	sturgeon, white						E ^(f)	E ^(f)											
<i>Catostomus microps</i>	sucker, Modoc				E														
<i>Catostomus warnerensis</i>	sucker, Warner													T					
<i>Chasmistes brevirostris</i>	sucker, shortnose				E									E					
<i>Chasmistes cujus</i>	cui-ui									E									
<i>Chasmistes liorus</i>	sucker, June																E		
<i>Crenichthys baileyi baileyi</i>	springfish, White River									E									
<i>Crenichthys baileyi grandis</i>	springfish, Hiko White River									E									
<i>Crenichthys nevadae</i>	springfish, Railroad Valley									T									
<i>Cyprinella formosa</i>	shiner, beautiful			T							T								
<i>Cyprinodon diabolis</i>	pupfish, Devils Hole									E									
<i>Cyprinodon macularius</i>	pupfish, desert			E	E														
<i>Cyprinodon nevadensis mionectes</i>	pupfish, Ash Meadows Amargosa									E									
<i>Cyprinodon nevadensis pectoralis</i>	pupfish, Warm Springs									E									
<i>Cyprinodon radiusus</i>	pupfish, Owens				E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Deltistes luxatus</i>	sucker, Lost River				E									E					
<i>Empetrichthys latos</i>	poolfish, Pahrump									E									
<i>Eremichthys acros</i>	dace, desert									T									
<i>Gambusia nobilis</i>	gambusia, Pecos										E					E			
<i>Gasterosteus aculeatus williamsoni</i>	stickleback, unarmored threespine				E														
<i>Gila bicolor mohavensis</i>	chub, Mohave tui				E														
<i>Gila bicolor snyderi</i>	chub, Owens tui				E														
<i>Gila bicolor ssp.</i>	chub, Hutton tui													T ^(l)					
<i>Gila bicolor vaccaceps</i>	chub, Cowhead Lake tui				PE ^(k)														
<i>Gila boraxobius</i>	chub, Borax Lake													E					
<i>Gila cypha</i>	chub, humpback			E		E											E		
<i>Gila ditaenia</i>	chub, Sonora			T															
<i>Gila elegans</i>	chub, bonytail			E	E	E				E							E		
<i>Gila intermedia</i>	chub, Gila			PE ^(l)							PE ^(l)								
<i>Gila purpurea</i>	chub, Yaqui			E															
<i>Gila robusta jordani</i>	chub, Pahrnagat roundtail									E									
<i>Gila seminuda</i>	chub, Virgin River			E						E							E		
<i>Hybognathus amarus</i>	minnow, Rio Grande silvery										E					E			
<i>Ictalurus pricei</i>	catfish, Yaqui			T															
<i>Lepidomeda albivallis</i>	spinedace, White River									E									
<i>Lepidomeda mollispinis pratensis</i>	spinedace, Big Spring									T									
<i>Lepidomeda vittata</i>	spinedace, Little Colorado			T															
<i>Meda fulgida</i>	spikedace			T							T								
<i>Moapa coriacea</i>	dace, Moapa									E									
<i>Notropis girardi</i>	shiner, Arkansas River										T ^(m)		T ^(m)			T ^(m)			
<i>Notropis simus pecosensis</i>	shiner, Pecos bluntnose										T								
<i>Oncorhynchus keta</i>	salmon, chum													T ⁽ⁿ⁾				T ^(n,o)	
<i>Oncorhynchus kisutch</i>	salmon, coho				T ^(p)									T					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic NameCommon NameGeneral Diet of Vertebrates			State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Oncorhynchus mykiss	steelhead				E ^(q) , T ^(p) _{r,s,t}		T ^(u)							T ^(u,v,w,x)				E ^(y) , T ^(w) _{,x}	
Oncorhynchus nerka	salmon, sockeye						E ^(z)							E ^(z)				E ^(z) , T ^(aa) ₎	
Oncorhynchus tshawytscha	salmon, chinook				E ^(ab) , T ^(a) _{c,ad}		T ^(ae)							T ^(v,x)				E ^(af) , T ^(v,ae,ag)	
Oncorhynchus clarki henshawi	trout, Lahontan cutthroat				T					T				T			T		
Oncorhynchus clarki stomias	trout, greenback cutthroat					T													
Oncorhynchus gilae	trout, Gila			E							E								
Oregonichthys crameri	chub, Oregon													E					
Plagopterus argentissimus	woundfin			E ^(ah) , XN						E ^(ah)	E ^(ah) , XN						E ^(ah)		
Poeciliopsis occidentalis occidentalis	topminnow, Gila (incl. Yaqui)			E							E								
Poeciliopsis occidentalis sonoriensis	topminnow, Gila (incl. Yaqui)			E															
Ptychocheilus lucius	pikeminnow (=squawfish), Colorado			E ^(ai) , XN	XN	XN											XN		XN
Rhinichthys osculus lethoporus	dace, Independence Valley speckled									E									
Rhinichthys osculus nevadensis	dace, Ash Meadows speckled									E									
Rhinichthys osculus oligoporus	dace, Clover Valley speckled									E									
Rhinichthys osculus ssp.	dace, Fosskett speckled													T ^(ai)					
Rhinichthys osculus thermalis	dace, Kendall Warm Springs																		E
Salvelinus confluentus	trout, bull						T	T		T				T				T	
Scaphirhynchus albus	sturgeon, pallid							E	E			E			E				
Tiaroga cobitis	minnow, loach			T							T								
Xyrauchen texanus	sucker, razorback			E	E	E				E	E						E		E

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name Common Name General Diet of Vertebrates			State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<u>Insect</u>																			
<i>Ambrysus amargosus</i>	naucorid, Ash Meadows									T									
<i>Boloria acrocne</i>	butterfly, Uncompahgre fritillary				E														
<i>Desmocerus californicus dimorphus</i>	beetle, valley elderberry longhorn			T															
<i>Euphydryas editha quino</i>	butterfly, Quino checkerspot			E															
<i>Euproserpinus euterpe</i>	moth, Kern primrose sphinx			T															
<i>Hesperia leonardus montana</i>	skipper, Pawnee montane				T														
<i>Icaricia icarioides fenderi</i>	butterfly, Fender’s blue												E						
<i>Nicrophorus americanus</i>	beetle, American burying							E				E		E					
<i>Pseudocopaeodes eunus obscurus</i>	skipper, Carson wandering				E					E									
<i>Speyeria zerene hippolyta</i>	butterfly, Oregon silverspot			T									T				T		
<u>Mammals</u>																			
<i>Antilocapra americana sonoriensis</i>	pronghorn, Sonoran	H		E															
<i>Brachylagus idahoensis</i>	rabbit, pygmy	H															E ^(ak)		
<i>Canis lupus</i>	wolf, gray	C		E ^(al) , X _{N^(am)}	T ^(an)	E ^(al) , T ^(a) _n	XN, T ^(a) _n	XN, T ^(a) _n	T ^(ao)	T ^(an)	XN ^(am)	T ^(ao)	E ^(al)	T ^(an)	T ^(ao)	XN ^(am)	E ^(al) , T ^(a) _n	T ^(an)	XN, T ^(a) _n
<i>Cynomys parvidens</i>	prairie dog, Utah	H															T		
<i>Dipodomys heermanni morroensis</i>	kangaroo rat, Morro Bay	H			E														
<i>Dipodomys ingens</i>	kangaroo rat, giant	G			E														
<i>Dipodomys nitratoide exilis</i>	kangaroo rat, Fresno	H			E														
<i>Dipodomys nitratoide nitratoide</i>	kangaroo rat, Tipton	G			E														
<i>Dipodomys stephensi</i>	kangaroo rat, Stephens’	G			E														
<i>Enhydra lutris nereis</i>	otter, southern sea	C			XN, T [®]														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	General Diet of Vertebrates	State Listed															
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA
<i>Eumetopias jubatus</i>	sea-lion, Steller	C	E ^(ap) , T ^(aq)		T ^(aq)									T ^(aq)				T ^(aq)
<i>Herpailurus (=Felis) yaguarundi tolteca</i>	jaguarundi, Sinaloa	C		E														
<i>Leopardus (=Felis) pardalis</i>	ocelot	C		E												E		
<i>Leptonycteris curasoae yerbabuenae</i>	bat, lesser long-nosed	N, F		E							E							
<i>Leptonycteris nivalis</i>	bat, Mexican long-nosed	H									E					E		
<i>Lynx canadensis</i>	lynx, Canada	C				T	T	T									T	T
<i>Microtus californicus scirpensis</i>	vole, Amargosa	H			E													
<i>Microtus mexicanus hualpaiensis</i>	vole, Hualapai Mexican	H		E														
<i>Mustela nigripes</i>	ferret, black-footed	C		XN,E ^(c)		XN,E ^(c)		XN,E ^(c)							XN,E ^(c)		XN,E ^(c)	XN,E ^(c)
<i>Neotoma fuscipes riparia</i>	woodrat, riparian (=San Joaquin Valley)	H			E													
<i>Odocoileus virginianus leucurus</i>	deer, Columbian white-tailed	H												E ^(ak)			E ^(ak)	
<i>Ovis canadensis</i>	sheep, bighorn	H			E ^(ar)													
<i>Ovis canadensis californiana</i>	sheep, bighorn	Gm			E ^(as)													
<i>Panthera onca</i>	jaguar	C		E							E					E		
<i>Rangifer tarandus caribou</i>	caribou, woodland	H					E										E	
<i>Spermophilus brunneus brunneus</i>	squirrel, northern Idaho ground	H					T											
<i>Ursus arctos horribilis</i>	bear, grizzly	O [H, I, Ps]					T ^(at)	T ^(at)									T ^(ag)	T ^(ag)
<i>Vulpes macrotis mutica</i>	fox, San Joaquin kit	C			E													
<i>Zapus hudsonius preblei</i>	mouse, Preble's meadow jumping	O [Inv, H]				T												T
Molluscs																		
<i>Assiminea pecos</i>	snail, Pecos assimineia										PE ^(g)					PE ^(g)		
<i>Fonticella idahoensis</i>	springsnail, Idaho						E											
<i>Helminthoglypta walkeriana</i>	snail, Morro shoulderband (=Banded dune)				E													
<i>Lanx sp.</i>	limpet, Banbury Springs						E											

TABLE C-2 (Cont.)**ENSR**
INTERNATIONAL

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Ps = Piscivore; fish-eating	(m) Arkansas River Basin	(ag) Puget Sound
R = Ranivore; frog-eating	(n) Columbia River	(ah) except Gila River drainage
V = Vermivore; earthworm-eating drainages	(o) summer-run Hood Canal	(ai) except Salt and Verde River
<u>Status</u>		
T = Threatened	(p) central coast	(aj) Foskett
E = Endangered	(q) southern coast	(ak) Columbia Basin DPS
Population Segment	(r) Central Valley	(al) Southwestern Distinct
XN = Experimental population	(s) south central coast	(am) Mexican gray wolf, experimental population
P = Proposed	(t) northern Segment	(an) Western Distinct Population
T(SA) = Similarity in appearance to a threatened taxon		
(u) Snake River Basin (ao) Eastern Distinct Population		

TABLE C-2
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Acanthomintha ilicifolia</i>	thornmint, San Diego			T														
<i>Agave arizonica</i>	agave, Arizona		E															
<i>Allium munzii</i>	onion, Munz's			E														
<i>Ambrosia pumila</i>	ambrosia, San Diego			E														
<i>Amsonia kearneyana</i>	blue-star, Kearney's		E															
<i>Arabis mcdonaldiana</i>	rock-cress, McDonald's			E									E					
<i>Arctomecon humilis</i>	bear-poppy, dwarf															E		
<i>Arctostaphylos morroensis</i>	manzanita, Morro			T														
<i>Arctostaphylos myrtifolia</i>	manzanita, Ione			T														
<i>Arenaria paludicola</i>	sandwort, Marsh			E									E				E	
<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>	poppy, Sacramento prickly									E								
<i>Asclepias welshii</i>	milkweed, Welsh's		T													T		
<i>Astragalus albens</i>	milk-vetch, Cushenbury			E														
<i>Astragalus ampullarioides</i>	milk-vetch, Shivwitz															E		
<i>Astragalus applegatei</i>	milk-vetch, Applegate's												E					
<i>Astragalus brauntonii</i>	milk-vetch, Braunton's			E														
<i>Astragalus desereticus</i>	milk-vetch, Deseret															T		
<i>Astragalus holmgreniorum</i>	milk-vetch, Holmgren		E													E		
<i>Astragalus humillimus</i>	milk-vetch, Mancos				E					E								
<i>Astragalus jaegerianus</i>	milk-vetch, Lane Mountain			E														
<i>Astragalus lentiginosus</i> var. <i>cochellae</i>	milk-vetch, Coachella Valley			E														
<i>Astragalus lentiginosus</i> var. <i>piscinensis</i>	milk-vetch, Fish Slough			T														
<i>Astragalus magdalenae</i> var. <i>peirsonii</i>	milk-vetch, Peirson's			T														
<i>Astragalus montii</i>	milk-vetch, heliotrope															T		
<i>Astragalus osterhoutii</i>	milk-vetch, Osterhout				E													
<i>Astragalus phoenix</i>	milk-vetch, Ash meadows								T									
<i>Astragalus tricarlinatus</i>	milk-vetch, triple-ribbed			E														
<i>Atriplex coronata</i> var. <i>notatior</i>	crownscale, San Jacinto Valley			E														
<i>Baccharis vanessae</i>	baccharis, Encinitas			T														
<i>Berberis nevinii</i>	barberry, Nevin's			E														
<i>Brodiaea filifolia</i>	brodiaea, thread-leaved			T														
<i>Calystegia stebbinsii</i>	morning-glory, Stebbins'			E														
<i>Camissonia benitensis</i>	evening-primrose, San Benito			T														
<i>Carex specuicola</i>	sedge, Navajo		T													T		
<i>Castilleja campestris</i> ssp. <i>succulenta</i>	owl's-clover, fleshy			T														
<i>Castilleja levisecta</i>	paintbrush, golden												T				T	

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Caulanthus californicus</i>	jewelflower, California			E														
<i>Ceanothus roderickii</i>	ceanothus, Pine Hill			E														
<i>Centaurium namophilum</i>	centaury, spring-loving			T					T									
<i>Chamaesyce hooveri</i>	spurge, Hoover's			T														
<i>Chlorogalum purpureum</i>	amole, purple			T														
<i>Chorizanthe howellii</i>	spineflower, Howell's			E														
<i>Chorizanthe orcuttiana</i>	spineflower, Orcutt's			E														
<i>Chorizanthe pungens</i> var. <i>pungens</i>	spineflower, Monterey			T														
<i>Cirsium fontinale</i> var. <i>obispoense</i>	thistle, Chorro Creek bog			E														
<i>Cirsium loncholepis</i>	thistle, La Graciosa			E														
<i>Clarkia springvillensis</i>	clarkia, Springville			T														
<i>Coryphantha robbinsorum</i>	cactus, Cochise pincushion		T															
<i>Coryphantha scheeri</i> var. <i>robustispina</i>	cactus, Pima pineapple		E															
<i>Coryphantha sneedii</i> var. <i>leei</i>	cactus, Lee pincushion									T								
<i>Coryphantha sneedii</i> var. <i>sneedii</i>	cactus, Sneed pincushion									E					E			
<i>Cycladenia jonesii</i> (= <i>humilis</i>)	Cycladenia, Jones		T													T		
<i>Deinandra</i> (= <i>Hemizonia</i>) <i>conjugens</i>	tarplant, Otay			T														
<i>Dodecahema leptoceras</i>	spineflower, slender-horned			E														
<i>Dudleya cymosa</i> ssp. <i>marcescens</i>	dudleya, marcescent			T														
<i>Echinocactus horizionthalonius</i> var. <i>nicholii</i>	cactus, Nichol's Turk's head		E															
<i>Echinocereus fendleri</i> var. <i>kuenzleri</i>	cactus, Kuenzler hedgehog									E								
<i>Echinocereus triglochidiatus</i> var. <i>arizonicus</i>	cactus, Arizona hedgehog		E															
<i>Enceliopsis nudicaulis</i> var. <i>corrugata</i>	sunray, Ash Meadows								T									
<i>Eremalche kernensis</i>	mallow, Kern			E														
<i>Eriastrum densifolium</i> ssp. <i>sanctorum</i>	woolly-star, Santa Ana River			E														
<i>Erigeron decumbens</i> var. <i>decumbens</i>	daisy, Willamette												E					
<i>Erigeron maguirei</i>	daisy, Maguire															T		
<i>Erigeron parishii</i>	daisy, Parish's			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Erigeron rhizomatus</i>	fleabane, Zuni		T							T								
<i>Eriodictyon altissimum</i>	mountain balm, Indian Knob			E														
<i>Eriodictyon capitatum</i>	yerba santa, Lompoc			E														
<i>Eriogonum apricum</i> (incl. var. <i>prostratum</i>)	buckwheat, Ione (incl. Irish Hill)			E														
<i>Eriogonum gypsophilum</i>	wild-buckwheat, gypsum									T								
<i>Eriogonum ovalifolium</i> var. <i>vineum</i>	buckwheat, cushenbury			E														
<i>Eriogonum ovalifolium</i> var. <i>williamsiae</i>	buckwheat, steamboat								E									
<i>Eriogonum pelinophilum</i>	wild-buckwheat, clay-loving				E													
<i>Erysimum menziesii</i>	wallflower, Menzies'			E														
<i>Eutrema penlandii</i>	mustard, Penland alpine fen				T													
<i>Fremontodendron californicum</i> ssp. <i>decumbens</i>	flannelbush, Pine Hill			E														
<i>Fremontodendron mexicanum</i>	flannelbush, Mexican			E														
<i>Fritillaria gentneri</i>	Fritillary, Gentner's												E					
<i>Galium californicum</i> ssp. <i>sierrae</i>	bedstraw, El Dorado			E														
<i>Gaura neomexicana</i> var. <i>coloradensis</i>	Butterfly plant, Colorado				T			T										T
<i>Gilia tenuiflora</i> ssp. <i>arenaria</i>	gilia, Monterey			E														
<i>Grindelia fraxino-pratensis</i>	gumplant, Ash Meadows			T					T									
<i>Hackelia venusta</i>	stickseed, showy																E	
<i>Hedeoma todsenii</i>	pennyroyal, Todsen's									E								
<i>Helianthus paradoxus</i>	sunflower, Pecos (=puzzle, =paradox)									T					T			
<i>Howellia aquatilis</i>	howellia, water			T		T	T						T				T	
<i>Ipomopsis sancti-spiritus</i>	ipomopsis, Holy Ghost									E								
<i>Ivesia kingii</i> var. <i>eremica</i>	ivesia, Ash Meadows								T									
<i>Lasthenia conjugens</i>	goldfields, Contra Costa			E														
<i>Layia carnosa</i>	layia, beach			E														
<i>Lepidium barnebyanum</i>	ridge-cress, Barneby															E		
<i>Lesquerella congesta</i>	bladderpod, Dudley Bluffs				T													
<i>Lesquerella tumulosa</i>	bladderpod, kodachrome															E		
<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>	water-umbel, Huachuca		E															
<i>Lilium occidentale</i>	lily, Western			E									E					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Limnanthes floccosa grandiflora</i>	Meadowfoam, large-flowered wooly												E					
<i>Limnanthes floccosa</i> ssp. <i>californica</i>	meadowfoam, Butte County			E														
<i>Lomatium bradshawii</i>	desert-parsley, Bradshaw's												E				E	
<i>Lomatium cookii</i>	lomatium, Cook's												E					
<i>Lupinus sulphureus</i> (= <i>oreganus</i>) ssp. <i>kincaidii</i> (= var. <i>kincaidii</i>)	Lupine, Kincaid's												T				T	
<i>Mentzelia leucophylla</i>	blazingstar, Ash Meadows								T									
<i>Mirabilis macfarlanei</i>	four-o'clock, MacFarlane's					T							T					
<i>Monolopia</i> (= <i>Lembertia</i>) <i>congdonii</i>	wooly-threads, San Joaquin			E														
<i>Nitrophila mohavensis</i>	niterwort, Amargosa			E					E									
<i>Opuntia treleasei</i>	cactus, Bakersfield			E														
<i>Orcuttia californica</i>	Orcutt grass, California			E														
<i>Orcuttia inaequalis</i>	Orcutt grass, San Joaquin			T														
<i>Orcuttia pilosa</i>	Orcutt grass, hairy			E														
<i>Orcuttia tenuis</i>	Orcutt grass, slender			T														
<i>Oxytheca parishii</i> var. <i>goodmaniana</i>	oxytheca, cushenbury			E														
<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>	cactus, Siler pincushion		T													T		
<i>Pediocactus bradyi</i>	cactus, Brady pincushion		E															
<i>Pediocactus despainii</i>	cactus, San Rafael															E		
<i>Pediocactus knowltonii</i>	cactus, Knowlton				E					E								
<i>Pediocactus peeblesianus</i>	cactus, Peebles Navajo		E															
<i>Pediocactus winkleri</i>	cactus, Winkler															T		
<i>Penstemon haydenii</i>	penstemon, blowout							E										E
<i>Penstemon penlandii</i>	beardtongue, Penland				E													
<i>Phacelia argillacea</i>	phacelia, clay															E		
<i>Phacelia formosula</i>	phacelia, North Park				E													
<i>Phlox hirsuta</i>	phlox, Yreka			E														
<i>Physaria obcordata</i>	twinpod, Dudley Bluffs				T													
<i>Plagiobothrys hirtus</i>	popcornflower, rough												E					
<i>Platanthera praeclara</i>	orchid, western prairie fringed							T			T	T						
<i>Pogogyne nudiuscula</i>	mesa-mint, Otay			E														
<i>Primula maguirei</i>	primrose, Maguire															T		
<i>Pseudobahia bahiifolia</i>	sunburst, Hartweg's golden			E														
<i>Pseudobahia peirsonii</i>	sunburst, San Joaquin adobe			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Purshia</i> (=Cowania) <i>subintegra</i>	Cliff-rose, Arizona		E															
<i>Ranunculus aestivalis</i> (=acriformis)	Buttercup, autumn															E		
<i>Schoenocrambe argillacea</i>	reed-mustard, clay															T		
<i>Schoenocrambe barnebyi</i>	reed-mustard, Barneby															E		
<i>Schoenocrambe</i> <i>suffrutescens</i>	reed-mustard, shrubby															E		
<i>Sclerocactus glaucus</i>	Cactus, Uinta Basin hookless				T											T		
<i>Sclerocactus mesae-verdae</i>	cactus, Mesa Verde				T					T								
<i>Sclerocactus wrightiae</i>	cactus, Wright fishhook															E		
<i>Senecio layneae</i>	butterweed, Layne's			T														
<i>Sidalcea keckii</i>	Checker-mallow, Keck's			E														
<i>Sidalcea nelsoniana</i>	checker-mallow, Nelson's												T				T	
<i>Sidalcea oregana</i> var. <i>calva</i>	checkermallow, Wenatchee Mountains																E	
<i>Silene spaldingii</i>	Catchfly, Spalding's					T	T						T				T	
<i>Spiranthes delitescens</i>	ladies'-tresses, Canelo Hills		E															
<i>Spiranthes diluvialis</i>	ladies'-tresses, Ute				T	T	T	T								T	T	T
<i>Spiranthes parksii</i>	ladies'-tresses, Navasota														E			
<i>Stephanomeria</i> <i>malheurensis</i>	wire-lettuce, Malheur												E					
<i>Streptanthus albidus</i> ssp. <i>albidus</i>	jewelflower, Metcalf Canyon			E														
<i>Streptanthus niger</i>	jewelflower, Tiburon			E														
<i>Styrax texanus</i>	snowbells, Texas														E			
<i>Suaeda californica</i>	seablite, California			E														
<i>Swallenia alexandrae</i>	grass, Eureka Dune			E														
<i>Taraxacum californicum</i>	taraxacum, California			E														
<i>Thelypodium howellii</i> <i>spectabilis</i>	thelypody, Howell's spectacular												T					
<i>Thelypodium stenopetalum</i>	mustard, slender-petaled			E														
<i>Thlaspi californicum</i>	penny-cress, Kneeland Prairie			E														
<i>Thymophylla tephroleuca</i>	dogweed, ashy														E			
<i>Thysanocarpus</i> <i>conchuliferus</i>	fringepod, Santa Cruz Island			E														
<i>Townsendia aprica</i>	townsendia, Last Chance															T		
<i>Trichostema</i> <i>austromontanum</i> ssp. <i>compactum</i>	bluecurls, Hidden Lake			T														
<i>Trifolium amoenum</i>	clover, showy Indian			E														
<i>Trifolium trichocalyx</i>	clover, Monterey			E														
<i>Tuctoria greenei</i>	tuctoria, Greene's			E														
<i>Tuctoria mucronata</i>	grass, Solano			E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxonomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
<i>Verbena californica</i>	vervain, Red Hills			T														
<i>Verbesina dissita</i>	crownbeard, big-leaved			T														
<i>Yermo xanthocephalus</i>	yellowhead, desert																	T
<i>Zizania texana</i>	wild-rice, Texas														E			
Status T = Threatened E = Endangered																		

APPENDIX D

**Review of Confidential Business Information
Memo**

MEMORANDUM

To: Mark Gerath, ENSR **Date:** November 2, 2004

From: Karl Ford, BLM

RE: Review of Confidential Business Information on Inert Ingredients Herbicides Proposed for Use on BLM Lands

Pesticide products contain both “active” and “inert” ingredients. The terms “active ingredient” (a.i.) and “inert ingredient” have been defined by Federal law, the Federal Insecticide, Fungicide, and Rodenticide Act (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 together 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 U.S. Environmental Protection Agency (USEPA) issued **Pesticide Regulation Notice 97-6** which encourages 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 comments from the public and the consumer interviews prompted USEPA to discontinue the use of the term “inert.” Many consumers are misled by the term “inert ingredient,” believing it to mean “harmless.” Since 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.

The Bureau of Land Management (BLM) scientists received clearance from USEPA to review Confidential Business Information (CBI) on inert compounds identified in products containing the following ten a.i.:

- Sulfometuron methyl
- Fluridone
- Dicamba (as an a.i. in the herbicide Overdrive)
- Diquat
- Diflufenzopyr
- Imazapic
- Diuron
- Bromacil
- Chlorsulfuron
- 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. Because this information is confidential, this information, including the name of the ingredients may not be disclosed.

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 categories. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- Inert Ingredients of Toxicological Concern. None.
- Potentially Toxic Inert Ingredients. None.
- Inerts of Unknown Toxicity. 12.
- Inerts of Minimal Toxicity. Over 50.
- Nine inerts were not found on USEPA's lists.

Toxicity information was also searched via the following sources:

- TOMES (a proprietary toxicological database including USEPA's Integrated Risk Information System [IRIS], the Hazardous Substance Data Bank [HSDB], the Registry of Toxic Effects of Chemical Substances (RTECS)
- USEPA's ECOTOX database which includes AQUIRE
- 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. Little chronic data, no cumulative effects data, and almost no indirect effects data (food chain species) were found.

A number of the List 4 compounds 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 ecological risk assessment, the exposure concentration of the inert compound was calculated and compared to toxicity information. 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 to as low as 0.1 mg/L.

Exposure concentrations were computed using Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). Inert compounds incorporated into the herbicide mixture are generally considered to be very stable compounds and tend to be highly mobile in the environment, primarily because of their inability to react with other materials or compounds. However, while these inert compounds are very mobile and relatively inactive they can potentially be toxic to aquatic organisms. To quantify the potential toxicity of inert compounds to aquatic organisms, the concentration of an inert compound in a river or pond adjacent to an herbicide application area was predicted using the GLEAMS model. 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. The chemical characteristics of the generalized inert compound were set at extremely high/low environmental fate values to describe it as a very mobile and stable compound; the application rate of the inert compound was fixed at 1 pound (lb) a.i./acre. The watershed characteristics were that of a typical sand watershed with atmospheric conditions representative of Medford, Oregon. The annual precipitation rate used in the inert compound simulation was 50 in/year, distributed in the same fashion as during a representative precipitation year in Medford, Oregon. The simulation was run to quasi-steady state conditions and the daily-predicted inert compound export rates from a single steady-state year of the simulation were used to calculate the annual average (chronic) and annual maximum 3-day average river and pond inert compound concentrations. The following table indicates the predicted river and pond concentrations for the inert compound resulting from an application rate of 1 lb a.i./acre. The concentrations per 1 lb a.i./acre application rate for each of eight herbicides simulated by GLEAMS, using the same watershed type, atmospheric conditions, and precipitation rate, is also listed for comparison.

Ratio of Concentration to Herbicide Application Rate (mg/L per lb a.i./acre)				
Herbicide	Average Annual River	Maximum 3 Day Average River	Average Annual Pond	Maximum 3 Day Average Pond
Diflufenzopyr	5.39E-06	3.33E-04	8.38E-04	7.52E-03
Imazapic	3.64E-04	8.19E-03	2.64E-02	5.45E-02
Sulfometuron	1.87E-04	5.81E-03	1.19E-02	3.77E-02
Tebuthiuron	4.68E-04	1.68E-02	4.33E-02	2.04E-01
Diuron	2.74E-04	4.67E-03	2.27E-02	3.35E-02
Bromacil	5.73E-04	1.72E-02	4.18E-02	1.27E-01
Chlorsulfuron	1.27E-04	2.31E-03	1.79E-02	5.31E-02
Dicamba	3.25E-04	1.30E-02	2.03E-02	1.72E-01
Inert Compound	1.20E-03	3.80E-02	3.20E-01	6.90E-01

The results of the GLEAMS simulations from the table above indicate that the ratio of river or pond concentration to application rate is highest for the inert compound. This was expected because of the extent that the chemical parameters were adjusted to represent a highly mobile and stable compound. In the case of the river, the concentrations were largely the result of characteristics related to the inert compound’s mobility but in the pond the stability of the compound was also important. The inert compound concentrations were predicted to be higher than the concentrations of each herbicide in all cases, albeit to varying degrees, and the extent of these higher concentrations was similar between each of the four statistical measures.

The exposure concentration was estimated by multiplying the percentage of the inert in the formulation times the application rate in pounds/acre times the dilution rates shown in the above table. Due to the constraints of the CBI process, the inerts of potential interest can not be disclosed but the following observations were made. Low application rates for sulfometuron methyl, fluridone, diquat, dicamba, diflufenzopyr, and imazapic resulted in low exposure concentrations of inerts of much less than 1 mg/L in all cases including the worst case (maximum 3-day pond) scenario. Higher application rates for diuron and bromacil yielded higher exposure concentrations of surfactant inerts, exceeding 1 mg/L for the maximum pond scenario. These results suggest that the inert compounds of diuron and bromacil may contribute acute toxicity to aquatic organisms if they reach the aquatic environment. Inerts did not seem to be an issue with chlorsulfuron and tebuthiuron.

This approach to estimating the exposure concentration will have relatively little uncertainty for several exposure scenarios such as spills where subsequent fate processes are relatively unimportant. Considerably more uncertainty will occur in scenarios that account for the physical-chemical properties of the constituent (e.g., the GLEAMS-dependent scenarios). The exposure concentration models are very conservative, e.g. if there is uncertainty, the exposure concentrations are likely to be overestimated, not underestimated. Considerable uncertainty also exists with the toxicity information as many of these substances had no specific toxicity information and toxicity information for surfactants was used as a surrogate.

References

- Dorn, P.B., J.H. Rodgers, Jr., W.B. Gillespie, Jr., R.E. Lizotte, Jr., and A.W. Dunn. 1997. The Effects of C12-13 Linear Alcohol Ethoxylate Surfactant on Periphyton, Macrophytes, Invertebrates and Fish in Stream Mesocosms. *Environmental Toxicology and Chemistry* 16(8):1634-1645.
- Lewis, M.A. 1991. Chronic and Sublethal Toxicities of Surfactants to Aquatic Animals: A Review and Risk Assessment. *Water Research* 25(1):101-113.
- Muller, R. 1980. Fish Toxicity and Surface Tension of Non-ionic Surfactants: Investigations of Anti-foam Agents. *Journal of Fish Biology* 16:585-589.
- Wong, D., P.B. Dorn, and E.Y. Chai. 1997. Acute Toxicity and Structure-activity Relationships of Nine Alcohol Ethoxylate Surfactants to Fathead Minnow and *Daphnia magna*. *Environmental Toxicology and Chemistry* 16(9):1970-1976.

APPENDIX E

Summary of Tank Mix Risk Quotients - Diuron

TABLE E-1

Summary of Risk Quotients for Direct Spray and Accidental Spill Scenarios (Terrestrial Animals)

	Typical Application Rate ¹	Maximum Application Rate ¹
Direct Spray of Terrestrial Wildlife		
Small mammal - 100% absorption	1.57E-02	5.23E-02
Pollinating insect - 100% absorption	6.38E-01	2.12E+00
Small mammal - 1st order dermal adsorption	2.26E-03	7.52E-03
Indirect Contact With Foliage After Direct Spray		
Small mammal - 100% absorption	1.57E-03	5.23E-03
Pollinating insect - 100% absorption	6.38E-02	2.12E-01
Small mammal - 1st order dermal adsorption	2.26E-04	7.52E-04
Ingestion of Prey Items Contaminated by Direct Spray		
Small mammalian herbivore - acute exposure	1.14E-02	2.87E-01
Small mammalian herbivore - chronic exposure	2.00E+00	5.03E+01
Large mammalian herbivore - acute exposure	7.35E-02	1.34E+00
Large mammalian herbivore - chronic exposure	2.12E+01	3.87E+02
Small avian insectivore - acute exposure	2.35E-02	6.09E-01
Small avian insectivore - chronic exposure	1.52E-01	3.93E+00
Large avian herbivore - acute exposure	5.98E-02	1.69E+00
Large avian herbivore - chronic exposure	3.75E-01	1.06E+01
Large mammalian carnivore - acute exposure	3.68E-02	1.23E-01
Large mammalian carnivore - chronic exposure	2.89E+00	9.63E+00
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. Shading and boldface indicates terrestrial animal acute scenario risk quotients (RQs) greater than 0.1 (level of concern (LOC) for acute risk to endangered species - most conservative). Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1.		

TABLE E-2

Summary of Risk Quotients for Direct Spray and Accidental Spill Scenarios (Terrestrial Plants)

	Typical Species		Rare, Threatened, and Endangered Species	
	Typical Application Rate ¹	Maximum Application Rate ¹	Typical Application Rate	Maximum Application Rate
Direct Spray of Non-Target Terrestrial Plants				
Accidental direct spray	8.21E+02	2.49E+03	8.24E+03	2.67E+04
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. Shading and boldface indicates plant RQs greater than the plant LOC of 1.0.				

TABLE E-3

Summary of Risk Quotients for Direct Spray and Accidental Spill Scenarios (Aquatic Species)

		Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
		Typical Application ¹	Maximum Application ¹	Typical Application	Maximum Application	Typical Application	Maximum Application
Accidental Direct Spray Over Pond							
	Acute	9.47E-01	3.16E+00	4.20E+00	1.40E+01	5.25E+02	1.75E+03
	Chronic	2.24E+01	7.47E+01	1.35E+01	4.48E+01	1.54E+03	5.13E+03
Accidental Direct Spray Over Stream							
	Acute	4.74E+00	1.58E+01	2.10E+01	7.01E+01	2.62E+03	8.73E+03
	Chronic	1.12E+02	3.74E+02	6.73E+01	2.24E+02	7.71E+03	2.57E+04
Accidental spill							
	Truck spill into pond	--	1.01E+02	--	4.48E+02	--	5.72E+04
	Helicopter spill into pond	--	1.95E-02	--	2.11E-03	--	1.11E+03
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. Shading and boldface indicates plant RQs greater than the plant LOC of 1.0. Shading and boldface indicates RQs greater than LOC of 0.05 for fish and invertebrates acute scenarios. Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.							

TABLE E-4
Summary of Risk Quotients for Spray Drift to Off-Site Soil Scenario (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 ¹	Maximum Application Rate ¹	Typical Application Rate	Maximum Application Rate
Ground	Low Boom	25	1.05E+01	3.19E+01	1.04E+02	3.38E+02
Ground	Low Boom	100	3.51E+00	1.07E+01	3.61E+01	1.17E+02
Ground	Low Boom	900	5.59E-01	1.70E+00	5.62E+00	1.82E+01
Ground	High Boom	25	1.74E+01	5.16E+01	1.72E+02	5.54E+02
Ground	High Boom	100	5.29E+00	1.77E+01	5.62E+01	1.88E+02
Ground	High Boom	900	7.16E-01	1.82E+00	7.15E+00	2.23E+01

¹The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre.

All concentrations modeled using AgDRIFT.

Shading and boldface indicates plant RQs greater than the plant LOC of 1.0. (All terrestrial RTE plants are potentially adversely affected by spray drift of diuron/chlorsulfuron tank mix)

TABLE E-5
Summary of Risk Quotients for Off-Site Drift to Pond Scenario (Aquatic Species)

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
			Typical Application ¹	Maximum Application ¹	Typical Application	Maximum Application	Typical Application	Maximum Application
Acute Toxicity								
Ground	Low Boom	25	5.76E-03	1.92E-02	2.56E-02	8.50E-02	3.19E+00	1.06E+01
Ground	Low Boom	100	3.16E-03	1.05E-02	1.40E-02	4.68E-02	1.75E+00	5.83E+00
Ground	Low Boom	900	6.10E-04	2.03E-03	2.71E-03	9.00E-03	3.38E-01	1.12E+00
Ground	High Boom	25	9.25E-03	3.08E-02	4.11E-02	1.37E-01	5.13E+00	1.71E+01
Ground	High Boom	100	4.87E-03	1.62E-02	2.16E-02	7.19E-02	2.70E+00	8.96E+00
Ground	High Boom	900	7.73E-04	2.58E-03	3.43E-03	1.14E-02	4.28E-01	1.43E+00
Chronic Toxicity								
Ground	Low Boom	25	1.36E-01	4.53E-01	8.18E-02	2.72E-01	9.38E+00	3.11E+01
Ground	Low Boom	100	7.47E-02	2.49E-01	4.48E-02	1.50E-01	5.13E+00	1.71E+01
Ground	Low Boom	900	1.44E-02	4.80E-02	8.66E-03	2.88E-02	9.93E-01	3.30E+00
Ground	High Boom	25	2.19E-01	7.30E-01	1.31E-01	4.38E-01	1.51E+01	5.02E+01
Ground	High Boom	100	1.15E-01	3.83E-01	6.92E-02	2.30E-01	7.93E+00	2.63E+01
Ground	High Boom	900	1.83E-02	6.10E-02	1.10E-02	3.66E-02	1.26E+00	4.19E+00
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. All concentrations modeled using AgDRIFT. Shading and boldface indicates plant RQs greater than the plant LOC of 1.0. Shading and boldface indicates RQs greater than LOC of 0.05 for fish and invertebrates acute scenarios. Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.								

Summary of Risk Quotients for Off-Site Drift to Stream Scenario (Aquatic Species)

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
			Typical Application ¹	Maximum Application ¹	Typical Application	Maximum Application	Typical Application	Maximum Application
Acute Toxicity								
Ground	Low Boom	25	1.04E-02	3.46E-02	4.60E-02	1.53E-01	5.74E+00	1.91E+01
Ground	Low Boom	100	3.04E-03	1.01E-02	1.35E-02	4.49E-02	1.68E+00	5.60E+00
Ground	Low Boom	900	3.15E-04	1.05E-03	1.40E-03	4.65E-03	1.74E-01	5.80E-01
Ground	High Boom	25	1.73E-02	5.79E-02	7.69E-02	2.57E-01	9.61E+00	3.20E+01
Ground	High Boom	100	4.92E-03	1.64E-02	2.18E-02	7.27E-02	2.72E+00	9.07E+00
Ground	High Boom	900	4.16E-04	1.39E-03	1.84E-03	6.15E-03	2.30E-01	7.67E-01
Chronic Toxicity								
Ground	Low Boom	25	2.45E-01	8.18E-01	1.47E-01	4.91E-01	1.69E+01	5.62E+01
Ground	Low Boom	100	7.19E-02	2.40E-01	4.31E-02	1.44E-01	4.94E+00	1.65E+01
Ground	Low Boom	900	7.45E-03	2.48E-02	4.47E-03	1.49E-02	5.12E-01	1.70E+00
Ground	High Boom	25	4.10E-01	1.37E+00	2.46E-01	8.22E-01	2.82E+01	9.41E+01
Ground	High Boom	100	1.16E-01	3.88E-01	6.98E-02	2.33E-01	8.00E+00	2.67E+01
Ground	High Boom	900	9.84E-03	3.28E-02	5.90E-03	1.97E-02	6.76E-01	2.25E+00
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. All concentrations modeled using AgDRIFT. Shading and boldface indicates plant RQs greater than the plant LOC of 1.0. Shading and boldface indicates RQs greater than LOC of 0.05 for fish and invertebrates acute scenarios. Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.								

Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.

TABLE E-7
Summary of Risk Quotients for Off-Site Drift Scenarios (Piscivorous Birds)

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond				
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Application Rate¹	
			Typical	Maximum
Ground	Low Boom	25	4.13E-04	1.37E-03
Ground	Low Boom	100	2.26E-04	7.55E-04
Ground	Low Boom	900	4.37E-05	1.45E-04
Ground	High Boom	25	6.63E-04	2.21E-03
Ground	High Boom	100	3.49E-04	1.16E-03
Ground	High Boom	900	5.54E-05	1.85E-04
¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. All concentrations modeled using AgDRIFT. Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1 (all RQs were below the LOC).				

TABLE E-8

Summary of Risk Quotients for Surface Runoff to Off-Site Soils Scenario (Non-Target Terrestrial Plants)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Typical Species		Rare, Threatened, and Endangered Species	
							Typical Application Rate ²	Maximum Application Rate ²	Typical Application Rate	Maximum Application Rate
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Clay	3.79E-04	1.25E-03	8.82E-02	2.94E-01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.43E-06	1.14E-05	8.45E-04	2.82E-03
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.89E-09	1.30E-08	9.92E-07	3.31E-06
25	10	0.05	0.015	0.401	Weeds (78)	Clay	4.15E-03	1.27E-02	1.80E-01	5.96E-01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	4.89E-05	1.63E-04	1.24E-02	4.15E-02
50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.15E-09	3.82E-09	2.93E-07	9.76E-07
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.70E-02	5.16E-02	4.41E-01	1.45E+00
50	10	0.05	0.015	0.401	Weeds (78)	Loam	2.52E-04	8.00E-04	3.33E-02	1.11E-01
100	10	0.05	0.015	0.401	Weeds (78)	Sand	3.78E-07	1.26E-06	9.66E-05	3.22E-04
100	10	0.05	0.015	0.401	Weeds (78)	Clay	3.76E-02	1.14E-01	1.11E+00	3.65E+00
100	10	0.05	0.015	0.401	Weeds (78)	Loam	4.48E-04	1.47E-03	9.93E-02	3.31E-01
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.28E-07	4.27E-07	3.27E-05	1.09E-04
150	10	0.05	0.015	0.401	Weeds (78)	Clay	4.21E-02	1.28E-01	1.42E+00	4.70E+00
150	10	0.05	0.015	0.401	Weeds (78)	Loam	8.68E-04	2.87E-03	2.08E-01	6.95E-01
200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.14E-06	1.38E-05	1.06E-03	3.52E-03
200	10	0.05	0.015	0.401	Weeds (78)	Clay	4.26E-02	1.30E-01	2.21E+00	7.32E+00
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.52E-03	5.07E-03	3.79E-01	1.26E+00
250	10	0.05	0.015	0.401	Weeds (78)	Sand	4.63E-06	1.54E-05	1.18E-03	3.94E-03
250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.14E-02	1.28E-01	2.94E+00	9.76E+00
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.15E-03	7.16E-03	5.41E-01	1.80E+00
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.40E-04	7.59E-04	3.04E-02	1.01E-01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.40E-04	7.60E-04	3.05E-02	1.02E-01
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	2.40E-04	7.58E-04	3.03E-02	1.01E-01
50	10	0.05	0.015	0.05	Weeds (78)	Loam	2.38E-04	7.52E-04	2.99E-02	9.96E-02
50	10	0.05	0.015	0.2	Weeds (78)	Loam	2.42E-04	7.65E-04	3.08E-02	1.03E-01
50	10	0.05	0.015	0.5	Weeds (78)	Loam	2.50E-04	7.91E-04	3.27E-02	1.09E-01

TABLE E-8 (Cont.)

Summary of Risk Quotients for Surface Runoff Scenarios (Non-Target Terrestrial Plants)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Typical Species		Rare, Threatened, and Endangered Species	
							Typical Application Rate ²	Maximum Application Rate ²	Typical Application Rate	Maximum Application Rate
50	10	0.05	0.023	0.401	Weeds (78)	Loam	2.41E-04	7.61E-04	3.06E-02	1.02E-01
50	10	0.05	0.046	0.401	Weeds (78)	Loam	2.40E-04	7.59E-04	3.04E-02	1.01E-01
50	10	0.05	0.15	0.401	Weeds (78)	Loam	2.37E-04	7.50E-04	2.98E-02	9.92E-02
50	10	0.005	0.015	0.401	Weeds (78)	Loam	2.37E-04	7.50E-04	2.98E-02	9.92E-02
50	10	0.01	0.015	0.401	Weeds (78)	Loam	2.38E-04	7.51E-04	2.99E-02	9.95E-02
50	10	0.1	0.015	0.401	Weeds (78)	Loam	2.46E-04	7.80E-04	3.19E-02	1.06E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.61E-03	1.11E-02	1.88E-01	6.22E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.89E-03	1.19E-02	1.79E-01	5.93E-01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.28E-02	3.87E-02	3.63E-01	1.20E+00
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	2.41E-04	7.61E-04	3.06E-02	1.02E-01
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	2.41E-04	7.61E-04	3.06E-02	1.02E-01
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	3.09E-04	9.75E-04	3.80E-02	1.26E-01

¹USLE = Universal Soil Loss Equation—predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

²The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre.

All concentrations modeled using GLEAMS.

Shading and boldface indicates plant RQs greater than the plant LOC of 1.

TABLE E-9

Summary of Risk Quotients for Surface Runoff to Off-Site Pond Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application
Acute Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	6.38E-03	2.13E-02	2.83E-02	9.44E-02	3.53E+00	1.17E+01
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.75E-01	5.85E-01	7.78E-01	2.59E+00	9.58E+01	3.19E+02
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.61E-03	5.38E-03	7.16E-03	2.39E-02	8.81E-01	2.94E+00
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.47E-01	1.16E+00	1.54E+00	5.13E+00	1.90E+02	6.34E+02
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.40E-01	4.65E-01	6.20E-01	2.07E+00	7.87E+01	2.61E+02
25	10	0.05	0.015	0.401	Weeds (78)	Loam	7.09E-03	2.36E-02	3.15E-02	1.05E-01	3.90E+00	1.30E+01
50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.83E-01	9.43E-01	1.26E+00	4.18E+00	1.58E+02	5.26E+02
50	10	0.05	0.015	0.401	Weeds (78)	Clay	6.43E-01	2.14E+00	2.85E+00	9.51E+00	3.60E+02	1.20E+03
50	10	0.05	0.015	0.401	Weeds (78)	Loam	7.42E-02	2.47E-01	3.29E-01	1.10E+00	4.08E+01	1.36E+02
100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.06E-01	6.86E-01	9.12E-01	3.04E+00	1.24E+02	4.10E+02
100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.30E-01	3.10E+00	4.13E+00	1.38E+01	5.12E+02	1.70E+03
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.48E-01	4.92E-01	6.55E-01	2.18E+00	8.11E+01	2.70E+02
150	10	0.05	0.015	0.401	Weeds (78)	Sand	2.01E-01	6.69E-01	8.90E-01	2.97E+00	1.20E+02	3.98E+02
150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.04E+00	3.45E+00	4.60E+00	1.53E+01	5.68E+02	1.89E+03
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.92E-01	6.41E-01	8.53E-01	2.84E+00	1.06E+02	3.53E+02
200	10	0.05	0.015	0.401	Weeds (78)	Sand	2.09E-01	6.97E-01	9.27E-01	3.09E+00	1.24E+02	4.11E+02
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.02E+00	3.39E+00	4.52E+00	1.51E+01	5.58E+02	1.86E+03
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.03E-01	6.77E-01	9.01E-01	3.00E+00	1.12E+02	3.74E+02
250	10	0.05	0.015	0.401	Weeds (78)	Sand	2.15E-01	7.17E-01	9.54E-01	3.18E+00	1.27E+02	4.21E+02
250	10	0.05	0.015	0.401	Weeds (78)	Clay	9.92E-01	3.31E+00	4.40E+00	1.47E+01	5.45E+02	1.82E+03
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.00E-01	6.68E-01	8.90E-01	2.97E+00	1.12E+02	3.71E+02
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.08E-02	6.94E-02	9.24E-02	3.08E-01	1.15E+01	3.84E+01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	5.48E-02	1.83E-01	2.43E-01	8.10E-01	3.02E+01	1.01E+02
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	5.47E-02	1.82E-01	2.43E-01	8.09E-01	3.02E+01	1.00E+02
50	10	0.05	0.015	0.05	Weeds (78)	Loam	7.05E-02	2.35E-01	3.13E-01	1.04E+00	3.88E+01	1.29E+02
50	10	0.05	0.015	0.2	Weeds (78)	Loam	7.15E-02	2.38E-01	3.17E-01	1.06E+00	3.93E+01	1.31E+02
50	10	0.05	0.015	0.5	Weeds (78)	Loam	7.35E-02	2.45E-01	3.26E-01	1.09E+00	4.04E+01	1.35E+02

TABLE E-9 (Cont.)

Summary of Risk Quotients for Surface Runoff to Off-Site Pond Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application
50	10	0.05	0.023	0.401	Weeds (78)	Loam	7.12E-02	2.37E-01	3.16E-01	1.05E+00	3.92E+01	1.30E+02
50	10	0.05	0.046	0.401	Weeds (78)	Loam	7.10E-02	2.37E-01	3.15E-01	1.05E+00	3.91E+01	1.30E+02
50	10	0.05	0.15	0.401	Weeds (78)	Loam	7.04E-02	2.35E-01	3.12E-01	1.04E+00	3.87E+01	1.29E+02
50	10	0.005	0.015	0.401	Weeds (78)	Loam	7.04E-02	2.35E-01	3.12E-01	1.04E+00	3.87E+01	1.29E+02
50	10	0.01	0.015	0.401	Weeds (78)	Loam	7.05E-02	2.35E-01	3.13E-01	1.04E+00	3.88E+01	1.29E+02
50	10	0.1	0.015	0.401	Weeds (78)	Loam	7.26E-02	2.42E-01	3.22E-01	1.07E+00	3.99E+01	1.33E+02
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.97E-01	6.57E-01	8.75E-01	2.92E+00	1.09E+02	3.62E+02
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.71E-01	5.71E-01	7.61E-01	2.54E+00	9.47E+01	3.15E+02
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.13E-01	1.04E+00	1.39E+00	4.64E+00	1.75E+02	5.82E+02
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	7.13E-02	2.38E-01	3.16E-01	1.05E+00	3.92E+01	1.31E+02
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	7.13E-02	2.38E-01	3.16E-01	1.05E+00	3.92E+01	1.31E+02
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	8.06E-02	2.69E-01	3.57E-01	1.19E+00	4.43E+01	1.48E+02
Chronic Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.93E-02	9.78E-02	1.76E-02	5.87E-02	2.03E+00	6.74E+00
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.99E-01	6.62E-01	1.19E-01	3.97E-01	1.36E+01	4.52E+01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.48E-03	1.16E-02	2.09E-03	6.96E-03	2.37E-01	7.91E-01
25	10	0.05	0.015	0.401	Weeds (78)	Sand	4.07E+00	1.36E+01	2.44E+00	8.14E+00	2.78E+02	9.26E+02
25	10	0.05	0.015	0.401	Weeds (78)	Clay	4.24E-01	1.41E+00	2.54E-01	8.48E-01	2.93E+01	9.77E+01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.03E-02	6.77E-02	1.22E-02	4.06E-02	1.41E+00	4.68E+00
50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.54E+00	1.51E+01	2.72E+00	9.07E+00	2.78E+02	1.04E+03
50	10	0.05	0.015	0.401	Weeds (78)	Clay	8.40E-01	2.80E+00	5.04E-01	1.68E+00	5.77E+01	1.92E+02
50	10	0.05	0.015	0.401	Weeds (78)	Loam	6.41E-01	2.14E+00	3.84E-01	1.28E+00	4.39E+01	1.46E+02
100	10	0.05	0.015	0.401	Weeds (78)	Sand	2.62E+00	8.75E+00	1.57E+00	5.25E+00	1.83E+02	6.10E+02
100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.46E-01	3.15E+00	5.68E-01	1.89E+00	6.46E+01	2.15E+02
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.40E+00	4.65E+00	8.38E-01	2.79E+00	9.56E+01	3.19E+02
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.91E+00	6.35E+00	1.14E+00	3.81E+00	1.33E+02	4.42E+02
150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.19E-01	2.40E+00	4.32E-01	1.44E+00	4.92E+01	1.64E+02
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.35E+00	4.48E+00	8.07E-01	2.69E+00	9.24E+01	3.08E+02
200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.91E+00	6.36E+00	1.14E+00	3.81E+00	1.32E+02	4.38E+02

TABLE E-9 (Cont.)

Summary of Risk Quotients for Surface Runoff to Off-Site Pond Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application
200	10	0.05	0.015	0.401	Weeds (78)	Clay	5.75E-01	1.92E+00	3.45E-01	1.15E+00	3.94E+01	1.31E+02
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.23E+00	4.09E+00	7.37E-01	2.46E+00	8.46E+01	2.82E+02
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.93E+00	6.42E+00	1.16E+00	3.85E+00	1.32E+02	4.41E+02
250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.91E-01	1.64E+00	2.94E-01	9.82E-01	3.37E+01	1.12E+02
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.12E+00	3.74E+00	6.73E-01	2.24E+00	7.76E+01	2.58E+02
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.67E-01	8.89E-01	1.60E-01	5.33E-01	1.83E+01	6.10E+01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	7.66E-01	2.55E+00	4.59E-01	1.53E+00	5.25E+01	1.75E+02
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	7.76E-01	2.59E+00	4.66E-01	1.55E+00	5.32E+01	1.77E+02
50	10	0.05	0.015	0.05	Weeds (78)	Loam	6.39E-01	2.13E+00	3.84E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.05	0.015	0.2	Weeds (78)	Loam	6.40E-01	2.13E+00	3.84E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.05	0.015	0.5	Weeds (78)	Loam	6.40E-01	2.13E+00	3.84E-01	1.28E+00	4.39E+01	1.46E+02
50	10	0.05	0.023	0.401	Weeds (78)	Loam	6.39E-01	2.13E+00	3.84E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.05	0.046	0.401	Weeds (78)	Loam	6.39E-01	2.13E+00	3.84E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.05	0.15	0.401	Weeds (78)	Loam	6.39E-01	2.13E+00	3.83E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.005	0.015	0.401	Weeds (78)	Loam	6.39E-01	2.13E+00	3.83E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.01	0.015	0.401	Weeds (78)	Loam	6.39E-01	2.13E+00	3.84E-01	1.28E+00	4.38E+01	1.46E+02
50	10	0.1	0.015	0.401	Weeds (78)	Loam	6.40E-01	2.13E+00	3.84E-01	1.28E+00	4.39E+01	1.46E+02
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.00E-01	1.33E+00	2.40E-01	8.00E-01	2.74E+01	9.13E+01
50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.94E-01	9.79E-01	1.76E-01	5.87E-01	2.01E+01	6.71E+01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	9.27E-01	3.09E+00	5.56E-01	1.85E+00	6.34E+01	2.11E+02
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	6.41E-01	2.14E+00	3.84E-01	1.28E+00	4.39E+01	1.46E+02
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	6.40E-01	2.13E+00	3.84E-01	1.28E+00	4.39E+01	1.46E+02
50	10	0.05	0.015	0.401	Conifer + Hardwood(71)	Loam	8.61E-01	2.87E+00	5.16E-01	1.72E+00	5.90E+01	1.96E+02

¹USLE = Universal Soil Loss Equation—predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

²The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre.

All concentrations modeled using GLEAMS.

Shading and boldface indicates plant RQs greater than the plant LOC of 1.0.

Shading and boldface indicates RQs greater than LOC of 0.05 for fish and invertebrates acute scenarios.

Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.

TABLE E-10

Summary of Risk Quotients for Surface Runoff to Off-Site Stream Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants		
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application	
Acute Toxicity													
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.60E-04	8.65E-04	1.15E-03	3.84E-03	1.43E-01	4.78E-01	
10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.78E-03	1.93E-02	2.56E-02	8.54E-02	3.15E+00	1.05E+01	
10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.38E-05	1.79E-04	2.39E-04	7.96E-04	2.94E-02	9.80E-02	
25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.33E-02	1.11E-01	1.48E-01	4.93E-01	1.83E+01	6.09E+01	
25	10	0.05	0.015	0.401	Weeds (78)	Clay	9.57E-03	3.19E-02	4.25E-02	1.42E-01	5.30E+00	1.77E+01	
25	10	0.05	0.015	0.401	Weeds (78)	Loam	7.03E-04	2.34E-03	3.12E-03	1.04E-02	3.85E-01	1.28E+00	
50	10	0.05	0.015	0.401	Weeds (78)	Sand	3.95E-02	1.32E-01	1.75E-01	5.84E-01	2.17E+01	7.23E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.33E-02	7.76E-02	1.03E-01	3.44E-01	1.30E+01	4.33E+01	
50	10	0.05	0.015	0.401	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.25E+00	7.50E+00	
100	10	0.05	0.015	0.401	Weeds (78)	Sand	3.81E-02	1.27E-01	1.69E-01	5.63E-01	2.19E+01	7.25E+01	
100	10	0.05	0.015	0.401	Weeds (78)	Clay	4.67E-02	1.56E-01	2.07E-01	6.91E-01	2.60E+01	8.66E+01	
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-02	3.92E-02	5.22E-02	1.74E-01	6.48E+00	2.16E+01	
150	10	0.05	0.015	0.401	Weeds (78)	Sand	3.22E-02	1.07E-01	1.43E-01	4.76E-01	1.89E+01	6.26E+01	
150	10	0.05	0.015	0.401	Weeds (78)	Clay	5.86E-02	1.95E-01	2.60E-01	8.66E-01	3.25E+01	1.08E+02	
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.46E-02	4.88E-02	6.50E-02	2.17E-01	8.09E+00	2.69E+01	
200	10	0.05	0.015	0.401	Weeds (78)	Sand	3.46E-02	1.15E-01	1.53E-01	5.11E-01	2.02E+01	6.70E+01	
200	10	0.05	0.015	0.401	Weeds (78)	Clay	8.72E-02	2.91E-01	3.87E-01	1.29E+00	4.80E+01	1.60E+02	
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.17E-02	7.25E-02	9.65E-02	3.22E-01	1.20E+01	4.00E+01	
250	10	0.05	0.015	0.401	Weeds (78)	Sand	3.45E-02	1.15E-01	1.53E-01	5.09E-01	2.04E+01	6.74E+01	
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.12E-01	3.72E-01	4.95E-01	1.65E+00	6.13E+01	2.04E+02	
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.73E-02	9.10E-02	1.21E-01	4.04E-01	1.51E+01	5.04E+01	
50	1	0.05	0.015	0.401	Weeds (78)	Loam	5.78E-04	1.93E-03	2.57E-03	8.55E-03	3.19E-01	1.06E+00	
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.88E-02	6.28E-02	8.36E-02	2.79E-01	1.04E+01	3.45E+01	
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	3.50E-02	1.17E-01	1.55E-01	5.18E-01	1.93E+01	6.43E+01	
50	10	0.05	0.015	0.05	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.48E+00	
50	10	0.05	0.015	0.2	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.04E-02	2.25E+00	7.49E+00	
50	10	0.05	0.015	0.5	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.04E-02	2.25E+00	7.50E+00	

TABLE E-10 (Cont.)

Summary of Risk Quotients for Surface Runoff to Off-Site Stream Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application
50	10	0.05	0.023	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.48E+00
50	10	0.05	0.046	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.49E+00
50	10	0.05	0.15	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.48E+00
50	10	0.005	0.015	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.48E+00
50	10	0.01	0.015	0.401	Weeds (78)	Loam	4.08E-03	1.36E-02	1.81E-02	6.03E-02	2.25E+00	7.48E+00
50	10	0.1	0.015	0.401	Weeds (78)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.25E+00	7.50E+00
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.07E-02	3.58E-02	4.76E-02	1.59E-01	5.92E+00	1.97E+01
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.01E-02	3.36E-02	4.48E-02	1.49E-01	5.58E+00	1.86E+01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.84E-02	6.14E-02	8.17E-02	2.72E-01	1.03E+01	3.42E+01
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	4.09E-03	1.36E-02	1.81E-02	6.05E-02	2.25E+00	7.50E+00
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	4.09E-03	1.36E-02	1.81E-02	6.04E-02	2.25E+00	7.50E+00
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	5.19E-03	1.73E-02	2.30E-02	7.67E-02	2.86E+00	9.52E+00
Chronic Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	9.03E-05	3.01E-04	5.42E-05	1.81E-04	6.20E-03	2.07E-02
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.13E-03	3.75E-03	6.76E-04	2.25E-03	7.68E-02	2.56E-01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.04E-05	3.48E-05	6.27E-06	2.09E-05	7.12E-04	2.37E-03
25	10	0.05	0.015	0.401	Weeds (78)	Sand	2.74E-02	9.13E-02	1.64E-02	5.48E-02	1.87E+00	6.24E+00
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.78E-03	1.26E-02	2.27E-03	7.57E-03	2.59E-01	8.64E-01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.10E-04	7.00E-04	1.26E-04	4.20E-04	1.44E-02	4.80E-02
50	10	0.05	0.015	0.401	Weeds (78)	Sand	5.48E-02	1.83E-01	3.29E-02	1.10E-01	3.75E+00	1.25E+01
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.09E-02	3.63E-02	6.54E-03	2.18E-02	7.48E-01	2.49E+00
50	10	0.05	0.015	0.401	Weeds (78)	Loam	7.70E-03	2.57E-02	4.62E-03	1.54E-02	5.28E-01	1.76E+00
100	10	0.05	0.015	0.401	Weeds (78)	Sand	6.46E-02	2.15E-01	3.88E-02	1.29E-01	4.46E+00	1.48E+01
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.62E-02	8.72E-02	1.57E-02	5.23E-02	1.79E+00	5.97E+00
100	10	0.05	0.015	0.401	Weeds (78)	Loam	2.93E-02	9.77E-02	1.76E-02	5.86E-02	2.01E+00	6.68E+00
150	10	0.05	0.015	0.401	Weeds (78)	Sand	6.46E-02	2.15E-01	3.88E-02	1.29E-01	4.47E+00	1.49E+01
150	10	0.05	0.015	0.401	Weeds (78)	Clay	3.36E-02	1.12E-01	2.01E-02	6.72E-02	2.30E+00	7.67E+00
150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.88E-02	1.29E-01	2.33E-02	7.77E-02	2.66E+00	8.87E+00

TABLE E-10 (Cont.)

Summary of Risk Quotients for Surface Runoff to Off-Site Stream Scenario (Aquatic Species)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
							Typical Application ²	Maximum Application ²	Typical Application	Maximum Application	Typical Application	Maximum Application
200	10	0.05	0.015	0.401	Weeds (78)	Sand	6.59E-02	2.20E-01	3.96E-02	1.32E-01	4.56E+00	1.52E+01
200	10	0.05	0.015	0.401	Weeds (78)	Clay	3.69E-02	1.23E-01	2.21E-02	7.37E-02	2.52E+00	8.41E+00
200	10	0.05	0.015	0.401	Weeds (78)	Loam	4.36E-02	1.45E-01	2.62E-02	8.73E-02	2.99E+00	9.97E+00
250	10	0.05	0.015	0.401	Weeds (78)	Sand	6.69E-02	2.23E-01	4.02E-02	1.34E-01	4.63E+00	1.54E+01
250	10	0.05	0.015	0.401	Weeds (78)	Clay	3.86E-02	1.29E-01	2.31E-02	7.72E-02	2.64E+00	8.80E+00
250	10	0.05	0.015	0.401	Weeds (78)	Loam	4.61E-02	1.54E-01	2.77E-02	9.22E-02	3.17E+00	1.05E+01
50	1	0.05	0.015	0.401	Weeds (78)	Loam	8.64E-04	2.88E-03	5.19E-04	1.73E-03	5.92E-02	1.97E-01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	4.41E-02	1.47E-01	2.65E-02	8.83E-02	3.02E+00	1.01E+01
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.16E-01	3.88E-01	6.99E-02	2.33E-01	7.98E+00	2.66E+01
50	10	0.05	0.015	0.05	Weeds (78)	Loam	7.66E-03	2.55E-02	4.60E-03	1.53E-02	5.25E-01	1.75E+00
50	10	0.05	0.015	0.2	Weeds (78)	Loam	7.67E-03	2.56E-02	4.60E-03	1.53E-02	5.25E-01	1.75E+00
50	10	0.05	0.015	0.5	Weeds (78)	Loam	7.70E-03	2.57E-02	4.62E-03	1.54E-02	5.27E-01	1.76E+00
50	10	0.05	0.023	0.401	Weeds (78)	Loam	7.67E-03	2.56E-02	4.60E-03	1.53E-02	5.25E-01	1.75E+00
50	10	0.05	0.046	0.401	Weeds (78)	Loam	7.67E-03	2.56E-02	4.60E-03	1.53E-02	5.25E-01	1.75E+00
50	10	0.05	0.15	0.401	Weeds (78)	Loam	7.66E-03	2.55E-02	4.59E-03	1.53E-02	5.24E-01	1.75E+00
50	10	0.005	0.015	0.401	Weeds (78)	Loam	7.66E-03	2.55E-02	4.59E-03	1.53E-02	5.24E-01	1.75E+00
50	10	0.01	0.015	0.401	Weeds (78)	Loam	7.66E-03	2.55E-02	4.60E-03	1.53E-02	5.25E-01	1.75E+00
50	10	0.1	0.015	0.401	Weeds (78)	Loam	7.69E-03	2.56E-02	4.61E-03	1.54E-02	5.27E-01	1.75E+00
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	5.00E-03	1.67E-02	3.00E-03	9.99E-03	3.42E-01	1.14E+00
50	10	0.05	0.015	0.401	Weeds (78)	Silt	4.27E-03	1.42E-02	2.56E-03	8.54E-03	2.93E-01	9.75E-01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	9.72E-03	3.24E-02	5.83E-03	1.94E-02	6.67E-01	2.22E+00
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	7.68E-03	2.56E-02	4.61E-03	1.54E-02	5.26E-01	1.75E+00
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	7.68E-03	2.56E-02	4.61E-03	1.54E-02	5.26E-01	1.75E+00
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.10E-02	3.67E-02	6.60E-03	2.20E-02	7.53E-01	2.51E+00

¹ USLE = Universal Soil Loss Equation—predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

² The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre.

All concentrations modeled using GLEAMS.

Shading and boldface indicates plant RQs greater than the plant LOC of 1.0.

Shading and boldface indicates RQs greater than LOC of 0.05 for fish and invertebrates acute scenarios.

Shading and boldface indicates RQs greater than LOC of 0.5 for fish and invertebrates chronic scenarios.

TABLE E-11
Summary of Risk Quotients for Surface Runoff Scenarios (Consumption of Fish from Contaminated Pond by Piscivorous Bird)

Annual Precipitation Rate (in/yr)	Application Area	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor ¹	Vegetation Type	Soil Type	Application Rate ²	
							Typical	Maximum
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	8.88E-05	2.96E-04
10	10	0.05	0.015	0.401	Weeds (78)	Clay	6.01E-04	2.00E-03
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-05	3.51E-05
25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.23E-02	4.10E-02
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.28E-03	4.28E-03
25	10	0.05	0.015	0.401	Weeds (78)	Loam	6.15E-05	2.05E-04
50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.37E-02	4.58E-02
50	10	0.05	0.015	0.401	Weeds (78)	Clay	2.54E-03	8.47E-03
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.94E-03	6.46E-03
100	10	0.05	0.015	0.401	Weeds (78)	Sand	7.94E-03	2.65E-02
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.86E-03	9.54E-03
100	10	0.05	0.015	0.401	Weeds (78)	Loam	4.23E-03	1.41E-02
150	10	0.05	0.015	0.401	Weeds (78)	Sand	5.77E-03	1.92E-02
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.18E-03	7.26E-03
150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.07E-03	1.36E-02
200	10	0.05	0.015	0.401	Weeds (78)	Sand	5.77E-03	1.92E-02
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.74E-03	5.80E-03
200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.71E-03	1.24E-02
250	10	0.05	0.015	0.401	Weeds (78)	Sand	5.83E-03	1.94E-02
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.49E-03	4.95E-03
250	10	0.05	0.015	0.401	Weeds (78)	Loam	3.40E-03	1.13E-02
50	1	0.05	0.015	0.401	Weeds (78)	Loam	8.07E-04	2.69E-03
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.32E-03	7.72E-03
50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	2.35E-03	7.83E-03
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.94E-03	6.45E-03
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.93E-03	6.45E-03
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.21E-03	4.03E-03
50	10	0.05	0.015	0.401	Weeds (78)	Silt	8.88E-04	2.96E-03
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	2.80E-03	9.35E-03
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.94E-03	6.46E-03
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	2.60E-03	8.68E-03

¹ USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

² The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre.

Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre.

All concentrations modeled using GLEAMS.

Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1 (all RQs were below the LOC).

TABLE E-12

Summary of Risk Quotients for Transport of Wind-Blown Dust to Off-Site Soil Scenario
(Non-Target Terrestrial Plants)

Watershed Location	Distance from Receptor (km)	Typical Species		Rare, Threatened, and Endangered Species	
		Typical Application Rate ¹	Maximum Application Rate ¹	Typical Application Rate	Maximum Application Rate
Montana	1.5	4.41E-03	1.34E-02	4.43E-02	1.44E-01
Montana	10	2.50E-03	7.58E-03	2.51E-02	8.13E-02
Montana	100	2.99E-07	1.02E-06	3.00E-06	1.10E-05
Oregon	1.5	2.53E-03	7.66E-03	2.54E-02	8.22E-02
Oregon	10	9.63E-04	2.92E-03	9.67E-03	3.13E-02
Oregon	100	3.39E-07	1.03E-06	3.40E-06	1.10E-05
Wyoming	1.5	4.99E-04	1.51E-03	5.01E-03	1.63E-02
Wyoming	10	3.44E-04	1.04E-03	3.46E-03	1.12E-02
Wyoming	100	8.47E-08	2.57E-07	8.50E-07	2.76E-06

¹ The typical application rate for diuron is 6.0 lb active ingredient/acre; the maximum application rate is 20.0 lb a.i./acre. Chlorsulfuron is tank mixed with diuron at a typical rate of 0.047 lb a.i./acre and at a maximum rate of 0.141 lb a.i./acre. All concentrations modeled using CALPUFF. Shading and boldface indicates plant RQs greater than the plant LOC of 1.0 (all RQs were below the LOC).