Risks of Prometon Use to Federally Listed Endangered Barton Springs Salamander
(Eurycea sosorum)

Pesticide Effects Determination

Environmental Fate and Effects Division
Office of Pesticide Programs
Washington, D.C. 20460

September 18, 2007
(Final)

Primary Authors
Paige Doelling Brown, Ph.D., Fisheries Biologist
James A. Hetrick, Ph.D., Senior Science Advisor

Secondary Review
Edward Odenkirchen, Ph.D., Senior Science Advisor

Acting Branch Chief, Environmental Risk Assessment Branch 1
Thomas Bailey, Ph.D.

Table of Contents

1.0 Executive Summary 6

2.0 Problem Formulation 9
2.1 Purpose 9
2.2 Scope 10
2.3 Previous Assessments 11
2.3.1 Prometon 11
2.3.2 Barton Springs Salamander 11
2.4 Stressor Source and Distribution 12
2.4.1 Environmental Fate and Transport Assessment 13
2.4.2 Mechanism of Action 14
2.4.3 Use Characterization 14
2.5 Assessed Species 17
2.6 Action Area 19
2.7 Assessment Endpoints and Measures of Ecological Effect 21
2.8 Conceptual Model 22
2.8.1 Risk Hypotheses 22
2.8.2 Diagram 23
2.9 Analysis Plan 23

3.0 Exposure Assessment 24
3.1 Monitoring Data 24
3.2 Exposure Estimate Based on Modeling 29
3.2.1 Background 29
3.2.3 Modeling Approach 30
3.2.4 Equations to Estimate Prometon Concentrations 31
3.2.3 Label Application Rates and Intervals 34
3.2.7 Exposure Modeling Input and Output 34

4.0 Effects Assessment 36
4.1 Summary of Aquatic Ecotoxicity Studies 37
4.1.1 Toxicity to Freshwater Fish 37
4.1.2 Toxicity to Aquatic Phase Amphibians 37
4.1.3 Toxicity to Freshwater Invertebrates 38
4.1.4 Toxicity to Aquatic Plants 39
4.2 Use of Probit Slope Response Relationship 40
4.3 Incident Database Review 41

5.0 Risk Characterization 42
5.1 Risk Estimation 42
5.2 Risk Description 44
5.2.1 Direct Effects 44
5.2.2 Indirect Effects (Reduction in Prey Base) 44
5.2.3 Indirect Effects (Habitat Degradation) 44
5.3 Risk Conclusions 45

6.0 Uncertainties....................47
6.1 Exposure Assessment Uncertainties....................47
6.1.1 Modeling Assumptions....................47
6.2.2 Impact of Vegetative Setbacks on Runoff....................48
6.2.3 PRZM Modeling inputs and Predicted Aquatic Concentrations....................48
6.2 Effects Assessment Uncertainties....................49
6.2.1 Age Class and Sensitivity of Effects Thresholds....................49
6.2.2 Use of Surrogate Species Data....................49
6.2.3 Extrapolation of Effects....................50
6.2.4 Acute LOC Assumptions....................50

References....................51
ECOTOX References....................53

Appendix A – Barton Springs Salamander Life History
Appendix B – PRZM Scenario Development
Appendix C – Ecological Effects
Appendix D –ECOTOX Bibliography
Appendix E – RQ Methods and LOCs
Appendix F –RQ Calculations
Appendix G – Multi-AI Products

Table of Figures

Figure 1 Chemical structure of prometon....12
Figure 2 Right-of-Way Locations in Barton Springs Action Area....16
Figure 3 Location Map of Barton Springs....18
Figure 4 Aerial Photo of Barton Springs....18
Figure 5 Prometon Action Area....20
Figure 6 Conceptual Model for Barton Springs Salamander....23
Figure 7 Ground and Surface Water Sampling Sites For Monitoring Data....25

Table of Tables

Table 1 Effects Determination for Prometon....8
Table 2 Fate Profile for Prometon....13
Table 3 Products containing prometon....14
Table 4 Land Use in the Barton Springs Watershed Representing Potential Prometon Use Sites....16
Table 5 Summary of Assessment Endpoints and Measures of Ecological Effect....21
Table 6 Summary of USGS Monitoring Data for Barton Springs Complex....26
Table 7 Summary of USGS Monitoring Data for Surface Water in the BSSEA....27
Table 8 Summary of USGS Monitoring Data for Ground Water in the BSSEA....28
Table 9 Label Application Rates....34
Table 10 Input Parameters for PRZM Modeling....34
Table 11 Estimated Concentrations in the Standard Pond for Prometon Based on a Texas Rights-of-Way Scenario....35
Table 12 Spring EECs Based on 0.23/500ft^2 Ground Spray Application....35
Table 13 Aquatic Toxicity Profile for Prometon....36
Table 14 Probability of Individual Effects....40
Table 15 Risk Quotients for Prometon....42
Table 16 Correlation Between Percentage of ROW Treated and Amount of Prometon Applied....43
Table 17 Effects Determination for Prometon....46

1.0 Executive Summary

This ecological risk assessment evaluates the potential for the use of the herbicide prometon to affect the Barton Springs salamander *(Eurycea sosorum).* The Barton Springs salamander was Federally listed as an endangered species on May 30, 1997. No critical habitat was designated. The salamander has an extremely limited geographic range, inhabiting only four freshwater springs known as the Barton Springs complex in Austin, Texas. The salamanders are aquatic throughout their entire lifespan, and in addition to the springs, their habitat includes fractures in the karst system which supplies ground water to the springs (USFWS 2005). The distance they travel into the fractures, and the specific habitat use of this area is unknown. This assessment is one of a series of ecological risk assessments developed consistent with the settlement for the court case *Center for Biological Diversity and Save Our Springs Alliance v. Leavitt, No. 1:04CV00126-CKK (filed January 26, 2004).*

Prometon (PC 080804, CAS Registry #) is a nonselective "bare-ground" herbicide labeled for pre- and post-emergence applications to manage annual and perennial grasses and broadleaf weeds. It is a photosynthesis inhibitor and acts by disrupting CO_2 fixation and production of intermediary energy components - ATP and $NADPH_2$. Prometon is registered for weed control around buildings, storage areas, fences, pumps, machinery, fuel tanks, recreational areas, roadways, guard rails, airports, military installations, highway medians, pipelines, railroads, lumberyards, rights-of-way, and industrial sites.

Prometon is currently undergoing re-registration. The sole registrant, Makhteshim-Agan of North America, Inc. (MANA) is supporting a maximum single application rate of 0.23 lb ai/500 ft^2, applied once a year. Label analysis indicates this is the current maximum rate. Unlike many agricultural chemicals, prometon is generally only applied to small areas. This assessment considers the use pattern, and presents the risk associated with application of specific amounts of active ingredient in the action area.

Prometon is persistent and mobile in the environment. It is stable to abiotic hydrolysis, photodegradation, aerobic soil metabolism, and anaerobic soil metabolism. It is frequently detected in both ground and surface water. On an acute basis, it is slightly toxic to freshwater and saltwater fish and invertebrates. Aquatic plants are sensitive to prometon, with EC_{50}s ranging from 0.098 mg/L (green algae) to 0.624 mg/L (duckweed).

The salamander is neotenic (aquatic throughout its life history), thus the assessment focuses on the components of the aquatic system, including aquatic plants, invertebrates, and the salamander itself. Although terrestrial plants serve important functions in riparian systems, analysis of the Barton Springs action area indicated no terrestrial plants near the springs were likely to be exposed to prometon. No prometon is used in Zilker Park, where the springs are located, and as prometon can only be applied via ground spray or granular formulation, effects on terrestrial plants are not anticipated to occur further than 1,000 ft[1] away from the use site.

The Environmental Fate and Effects Division (EFED) evaluated direct effects (survival, reproduction, and growth) of prometon on the Barton Springs salamander, and indirect effects (reduction of prey base, habitat modification) on the ecosystem which supports the salamander. Effects determinations were made in accordance with procedures described in the Agency's Overview Document (U.S. EPA 2004), using the best available data. Effects determinations for prometon are made based on threshold yearly use rates in the BSSEA.

After completing the analysis of the effects of prometon on the Federally listed endangered Barton Springs salamander *(Eurycea sosorum)* in accordance with methods delineated in the Overview document (USEPA 2004), EFED concludes that the use of prometon (PC 080804) in the Barton Springs Segment of the Edwards Aquifer (BSSEA) is anticipated to have the following effects:

Total yearly use	
<1,650 lbs ai	No effect
≥1,650 lbs ai but <22,000 lb ai	May affect, not likely to adversely affect (Indirect)
≥22,000 lbs ai	May affect, likely to adversely affect (Direct)

Assessment endpoints and the basis of determination for each endpoint evaluated are shown in Table 1.

[1] Details for terrestrial plant analysis in the Ecological Risk Assessment for the Re-registration of Prometon, prepared concurrently with this document but not yet publically available. EFED anticipates this document will be publically available in the Nov-Dec 2007 timeframe. Further references to the Re-registration risk assessment in this document are designated as Prometon RED ERA 2007.

Table 1 Effects Determination for Prometon

Assessment Endpoint	Effects determination[1]	Basis for Determination
Direct Effects		
Survival, growth, and reproduction of Barton Springs salamander	<22,000 lbs yearly No effect ≥ 22,000 lbs yearly May affect LAA	No chronic risk LOCs are exceeded at any yearly application assessed. At applications of<22,000 lbs yearly, acute risk LOCs for the salamander are not exceeded. At applications of ≥ 22,000 lbs yearly, acute risk LOCs for the salamander are exceeded. Due to the uncertainties associated with actual usage, EFED has not attempted to discern an NLAA point for direct effects on the salamander.
Indirect Effects		
Reduction of prey (*i.e.,* freshwater invertebrates)	<55,000 lbs yearly No effect ≥ 55,000 lbs yearly May affect LAA	No chronic risk LOCs are exceeded at any yearly application assessed. At applications of<55,000 lbs yearly, acute risk LOCs for freshwater invertebrates are not exceeded. At applications of ≥55,000 lbs yearly, acute risk LOCs for aquatic invertebrates are exceeded. Due to the uncertainties associated with actual usage, EFED has not attempted to discern an NLAA point for indirect effects on the salamander.
Degradation of habitat and/or primary productivity (*i.e.,* aquatic plants)	<1,650 lbs yearly No effect ≥1,650 but <22,000 lbs yearly May affect NLAA (insignificant) ≥ 22,000 lbs yearly May affect LAA	No LOC exceedences at <1,650 lbs yearly. At 1,650 lbs yearly, acute risk LOCs exceeded for non-vascular aquatic plants, but not vascular aquatic plants. Recovery of plant community is expected. Reduction and/or modifications in plant community not anticipated to be severe enough to affect growth, survival, or reproduction of salamander. At applications of ≥22,000 lbs yearly, acute risk LOCs for both vascular and non-vascular aquatic plants are exceeded. Reduction and/or modifications in plant community may be severe enough to affect growth, survival, or reproduction of salamander.

[1] Determinations are based on total lbs of active ingredient used yearly in the BSSEA, assuming all applications are made simultaneously

2.0 Problem Formulation

2.1 Purpose

This ecological risk assessment has been conducted consistent with the settlement of the court case *Center for Biological Diversity and Save Our Springs Alliance v. Leavitt, No. 1:04CV00126-CKK (filed January 26, 2004).* The purpose of this ecological risk assessment is to determine if the registration of the herbicide prometon (PC 108801) could affect the Barton Springs salamander *(Eurycea sosorum),* implementing the Environmental Protection Agency's (the Agency) responsibility as directed in Section 7(a)(2) of the Endangered Species Act (ESA). The Barton Springs salamander was Federally listed as an endangered species on May 30, 1997 (62 FR 23377-23392) by the U.S. Fish and Wildlife Service (USFWS or the Service). No critical habitat has been designated for this species.

In this assessment, direct and indirect effects to the survival, growth, and reproduction of the Barton Springs salamander are evaluated in accordance with methodologies described in the Agency's Overview Document (U.S. EPA 2004).

As part of the "effects determination", the Agency reaches one of the following three conclusions regarding the potential for prometon to affect the Barton Springs salamander:

- "No effect";
- "May affect, but not likely to adversely affect"; or
- "May affect, likely to adversely affect".

If the results of the screening-level assessment show that pre-established levels of concern (LOCs) are not exceeded for direct effects on the Barton Springs salamander (U.S. EPA 2004), and no indirect effects are expected (*e.g.,* degradation of habitat or reduction of prey availability), a "no effect" determination is made. Exposure estimates are made based on both the potential and reported use of prometon within the action area. If, however, indirect effects are anticipated and/or estimated exposure exceeds the LOCs for direct effects, the Agency concludes a preliminary "may affect" determination for the Barton Springs salamander.

If a determination is made that use of prometon within the action area "may affect" the Barton Springs salamander, additional information is considered to refine the potential for exposure and evaluate the anticipated effects. The Agency uses the best available information to determine if the registered uses are "not likely to adversely affect (NLAA)" or "likely to adversely affect (LAA)" the Barton Springs salamander.

2.2 Scope

The end result of the Agency's pesticide registration process is an approved product label. The label is a legal document that stipulates how and on what use sites a given pesticide may be used. Product labels (also known as end-use labels) describe the formulation type, acceptable methods of application, approved use sites, and any restrictions on how applications may be conducted. Thus, the use or potential use of prometon in accordance with the approved product labels is the "action" being assessed. The majority of guideline toxicity data available pertains to the active ingredient ("ai"), and the effects of the active ingredient form the basis of the evaluation. When formulation-based toxicity data are available, they are considered in the assessment.

Prometon (PC 080804, CAS Registry #) is a nonselective "bare-ground" herbicide labeled for pre- and post-emergence applications to manage annual and perennial grasses and broadleaf weeds. Its primary purpose is complete control of all vegetation. It is a photosynthesis inhibitor and acts by disrupting CO_2 fixation and production of intermediary energy components - ATP and $NADPH_2$. Prometon is registered for weed control around buildings, storage areas, fences, pumps, machinery, fuel tanks, recreational areas, roadways, guard rails, airports, military installations, highway medians, pipelines, railroads, lumberyards, rights-of-way, and industrial sites (such as cross connects, pedestals, transformers, vaults, buried cable closures, telephone booths, fire plugs).

According to OPPIN, there are currently a total of 64 registered products as of January 2007, of which three are technical or manufacturing concentrate formulations. Prometon is currently in the re-registration process, and an ecological risk assessment for uses nationally is being developed concurrently with this effects determination. The sole registrant, Makhteshim-Agan of North America, Inc. (MANA) is supporting a maximum single application rate of 0.23 lb ai/500 ft^2 applied once a year. According to registrant provided data, typical use rates range from 0.175 to 0.23 lb ai/500 ft^2 (Prometon Use Closure Memorandum Case No. 2545, January 22, 2007). Unlike many agricultural chemicals, prometon is generally only applied to small areas.

The current registration for prometon allows for use nationwide, thus the action area for the entire registration would include areas throughout the United States and its territories. However, because this ecological risk assessment is species specific for the Barton Springs salamander (BSS), the BSS-prometon action area is defined as the locations where prometon, if used in accordance with label instructions, might reasonably be expected to be transported to a location where the salamander and/or key components of its supporting ecosystem might be exposed to it (*i.e.,* completed exposure pathways). Further discussion of the action area for the Barton Springs salamander is provided in Section 2.6.

2.3 Previous Assessments

2.3.1 Prometon

An ecological risk assessment for prometon has been conducted concurrently with the development of this effects determination (Prometon RED ERA 2007). This assessment concluded:

Use of prometon at the maximum supported rate poses an acute and chronic risk to terrestrial animals residing in or foraging at the treated site. Acute risks for both birds and mammals are expected to drop below levels of concern approximately 10 ft away from the treated site. Residue levels posing chronic risks extend further from the treatment site, potentially as far away as 70 ft for birds and 1,000 ft for mammals. Non-target terrestrial plants, both monocots and dicots, could be affected by spray drift or runoff from the treated site. Drift effects potentially extend up to 1,000 ft from the treated site for ground or truck-mounted sprayers. Granular treatments may cause non-target plant effects in locations receiving runoff.

At the maximum supported rate, no risk for aquatic animals is anticipated. Endangered species acute risk LOCs for aquatic animals were exceeded at EECs produced by some, but not all of the scenarios modeled. Based on modeling, effects on aquatic non-vascular plants, both freshwater and saltwater, are anticipated. Reduction of algal populations (primary productivity) could affect higher trophic levels but the specific impact is difficult to predict or quantify, and may differ from site to site. Effects to aquatic vascular plants are also anticipated based on model outputs.

2.3.2 Barton Springs Salamander

The Agency has also completed (U.S. EPA 2006b) ecological risk assessments evaluating the potential effects of atrazine, metolachlor, and diazanon on the Barton Springs Salamander. These assessments were conducted consistent with the settlement for the court case *Center for Biological Diversity and Save Our Springs Alliance v. Leavitt, No. 1:04CV00126-CKK (filed January 26, 2004)*.

Conclusions regarding atrazine use (U.S. EPA 2006) in the action area were that it:

- Would have no (direct) effect on the Barton Springs salamander (survival, growth or reproduction),
- Was not likely to adversely affect salamander prey, and
- Was not likely to adversely affect aquatic plants.

Conclusions regarding metolachlor (U.S. EPA 2006a) use in the action area were that it:

- Would have no (direct) effect on the Barton Springs salamander (survival, growth or reproduction)
- Was not likely to adversely affect salamander prey, and
- Was not likely to adversely affect aquatic plants.

Conclusions regarding diazinon use (U.S. EPA 2007b) in the action area were that it:

- Would have no (direct) effect on the Barton Springs salamander (survival, growth or reproduction)
- Was not likely to adversely affect salamander prey, and
- Was not likely to adversely affect aquatic plants.

2.4 Stressor Source and Distribution

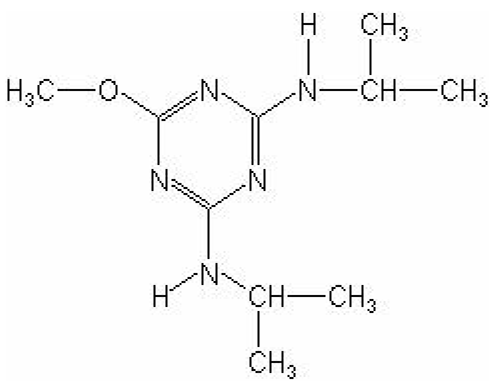

Figure 1 Chemical structure of prometon

Empirical formula:	$C_{10}H_{19}N_5O$
Molecular weight:	225 g/mol
CAS Registry Nos.:	1610-18-0
Chemical Class:	Triazine herbicides

2.4.1 Environmental Fate and Transport Assessment

Probable routes of prometon dissipation are through runoff into surface water and leaching into ground water. Prometon is stable to abiotic hydrolysis, photodegradation in water, aerobic soil metabolism, and anaerobic soil metabolism (Table 2). Half-lives of prometon range from 462 to 932 days in aerobic soil. In anaerobic soil the half-life is 557 days. Degradation products of prometon include 2 amino-4-(isopropylamino)-6-methyoxy-s-triazine (GS-14626), 2,4-diamino-6-methoxy-s-triazine (GS-12853), and 2-hydroxy-4,6 bis (isopropylamino)-s-triazine (GS-11526). Due to persistence of parent compound, formation of degradates is expected to be slow and in low quantities. Prometon is expected to be mobile in soil and aquatic environments. The average K_{oc} of prometon is 117 L/kg-OC. Based on its physical properties, prometon is anticipated to remain in surface water for extended periods and has a high potential to leach into groundwater.

Table 2 Fate Profile for Prometon

Physico-chemical Characteristic	Value	Source
Vapor Pressure (mbar)	3.1×10^{-6}	EFED files
Water Solubility (mg/L@20C)	620	EFED files
Log K_{ow}(@20C)	4.3	EFED files
Hydrolysis	Stable in pH 5, 7, and 9	MRID 41114801
Photodgradation in Water	Stable	MRID 40225801
Photodegradation on Soil	Stable	MRID 41114802
Aerobic Soil Metabolism	$t_{1/2}$ >365 days $t_{1/2}$ = 462 days Stable for 368 days, $t_{1/2}$ =932 days	MRID 4145501 MRID 42313501
Anerobic Soil Metabolism	Stable during 90 days, after 30 days aerobic $t_{1/2}$ = 462 days Stable during 60 days, after 32 days aerobic $t_{1/2}$ = 557 days	MRID 40145501 MRID 42313501
Adsorption/desorption	K_f=2.61 (1/n=0.893) K_{oc} 149.6 CA sandy loam K_f=2.90 (1/n=0.895) K_{oc} 172.0 Dubuque silt loam K_f=2.40 (1/n=0.868) K_{oc} 82.6 Kewaunee clay loam K_f=1.20 (1/n=0.911) K_{oc} 98.3 MS silt loam K_f=0.398 (1/n=0.738) K_{oc} 85.6 Plainfield sand	MRID 40225803
Terrestrial Field Dissipation	$t_{1/2}$ =200 to 400 days Fresno, CA	MRID 162534 MRID 162535 MRID 162536
Aerobic and Anaerobic Soil Metabolites	2-amino-4-(isopropylamino)-6-methoxy-s-triazine (GS-14626) 2,4-diamino-60methoxy-s-triazine (GS 12853) 2-hydroxy-4,6 bis(isolproylamino-s-triazine)	MRID 4145501 MRID 42313501

2.4.2 *Mechanism of Action*

Prometon is a photosynthesis inhibitor and acts by disrupting CO_2 fixation and production of intermediary energy components - ATP and $NADPH_2$. Prometon and other s-triazines affect photosystem II, competing with plastoquinone and disrupting the electron transport processes (Drost *et. al,* 2003).

2.4.3 *Use Characterization*

An analysis of available usage and land cover information (SRC 2006), including extensive discussions with local experts in the fields of agriculture and soil science, was completed to determine which prometon use sites are likely to be present in the area contributing surface or ground water to Barton Springs.

Prometon is a non-selective herbicide for use on rights-of way and perimeters around buildings, railroads, pipelines, airports, fuel tanks, etc**.** There is approximately 600,000 lbs of prometon annual use in the United States, according to the registrant. Prometon use can be categorized among farmsteads (60% of use), industrial sites (30% of use), and rights-of-way (10% of use). Table 3 lists examples of the products containing prometon.

Table 3 Products containing prometon

Product	Percent AI	Registration Number	Additional AIs
Pramitol MG 25E	26.3%	66222-24	No
Pramitol 4 MUP	45.3%	60222-43	No
Pramitol 25E	25%	66222-22	No
Pramitol 5PS	5%	66222-23	Boric acid, sodium chlorate, simazine
Pramitol 2.5	2.5%	66222-26	No
Pramitol 3.75	3.75%	66222-27	No
Pramitol 45C	45.3%	66222-38	No
Pramitol 1.8	1.8%	66222-44	No
Pramitol 2.2 L	2.2%	66222-45	No
Pramitol 1.8 RTU	1.8%	66222-52	No
Pramitol 2L/Diuron	21.62%	66222-55	Diuron
Prometon 5PS	5%	53883-97	Boric acid, sodium chlorate, simazine
Prometon 25E	25%	53883-98	No
Prometon 4SC	45.3%	53883-99	No

In Texas, prometon is classified as state-limited use herbicide[2]. When distributed in containers of "a capacity larger than 1 quart for liquid material or 2 lbs for dry or solid material" it is classified as a regulated herbicide. Container measurements are based on end-use products, and the actual volume of active ingredient in these containers may vary. As either a state-limited use or a regulated herbicide, it must be applied by a certified applicator. Applicators are required to keep records, but currently there is no requirement for reporting use to the state or county.

[2] http://www.agr.state.tx.us/agr/program_render/0,1987,1848_5539_0_0,00.html?channelId=5539, accessed 9/12/07 PDB

The Agency's Office of Pesticide Programs Biological and Economic Analysis Division (OPP/BEAD) provided an analysis of both national and local use information for the pesticides involved in this litigation (Kaul *et al*., 2005, Zinn and Jones, 2006, Kaul, *et al.,* 2006), but were unable to locate usage data for prometon. Unlike agricultural crops, where usage reporting is generally available, unless there is a state-mandated reporting requirement data for other types of uses is generally not available. Some sales data, provided by the registrant, indicates that prometon is sold in Texas, but not in large quantities. County-specific data were not available, thus EFED was unable to estimate how much prometon may be applied in the BSSEA on a yearly basis.

Prometon is often applied in discrete areas, or as bands. It is formulated as an emulsifiable concentrate, a ready-to-use, a water-based flowable concentrate, and as pelleted granules. Liquid applications may be made by handheld sprayer. Granular prometon may be applied using a whirly-bird spreader, or other similar hand-held spreader. Granular applications are typically not incorporated, but are often "wetted-in". Wetting-in consists of applying sufficient water to ensure the granules dissolve and the prometon is released. In some cases, granules are left until sufficient rainfall occurs to dissolve them. Aerial applications are not permitted.

Based on information provided by the registrants, typical use rates range from 0.175 to 0.23 lb ai/500ft^2 (Prometon Use Closure Memo, 1/22/07). There is currently no seasonal or annual maximum application rate, but the registrant is supporting a single maximum application rate of 0.23 lb ai/500ft^2 for re-registration. This is equivalent to a rate of 20.04 lb ai/A if the entire acre were to be treated. As a first approximation, EFED used the rate per acre and the assumption the entire acre was treated to estimate water concentrations.

Because of the type of use sites for prometon, and the fact no usage data were available, EFED opted to model rights-of-way as the primary use site for the chemical. A right-of-way specific scenario was developed for the Barton Springs area. Post-processing of the PRZM-generated water concentrations was done in an Excel spreadsheet.

Analysis of land-use/land-cover data (SRC 2006) identified three major types of land use that was classified as rights-of-way, accounting for 4.3% of the watershed (Table 3). Of the areas designated as rights-of-way, approximately 43% is in the recharge zone, and 57% is in the contributing zone. Specific land uses associated with the remainder of the watershed are presented in Appendix B, Table 3. For this assessment, rights-of-way include streets and roads, utilities, and railroad facilities. Because prometon may be applied around buildings and industrial sites, several of these categories are also included in the table, but were not modeled specifically. Exposure to prometon based on use around buildings is anticipated to be lower than the high end assumption (*i.e.,* all rights-of-way treated simultaneously) used in modeling. Buildings account for 1.4% of total land use in the watershed

Table 4 Land Use in the Barton Springs Watershed Representing Potential Prometon Use Sites

Land use	Area (sq.meters)	Area (acres)	Percent of Watershed
Rights-of-way	44,427,570	10,978	4.3
Streets and roads	43,237,121	10,684	4.2
Utilities	1,009,376	249	0.1
Railroad facilities	181,073	45	0.0
Buildings	14,741,828	3,643	1.4
Commercial	9,523,023	2,353	0.9
Warehousing	4,597,267	1,136	0.4
Miscellaneous Industrial	621,538	154	0.1
Entire Watershed	1,029,906,541	254,495	100

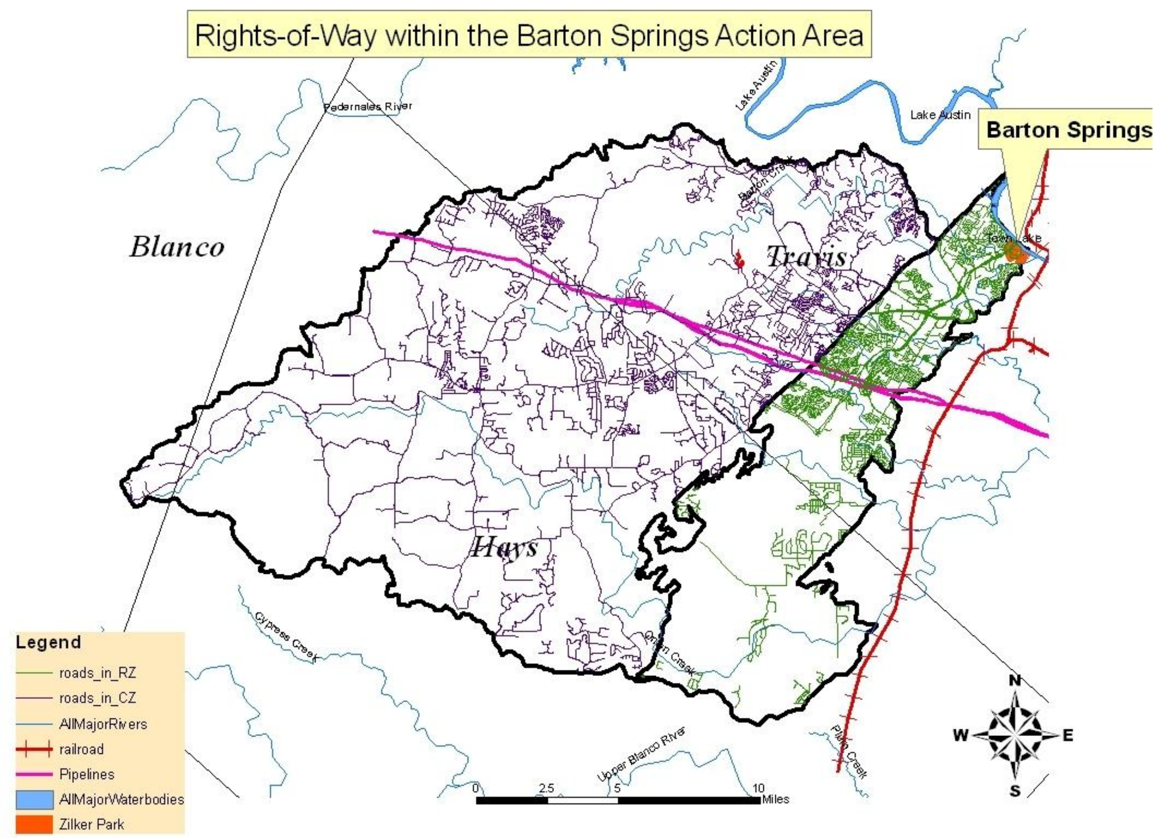

Figure 2 Right-of-Way Locations in Barton Springs Action Area

2.5 Assessed Species

The Barton Springs salamander is aquatic throughout its entire life cycle. Members of the Plethodontidae Family (lungless salamanders), they retain their gills, become sexually mature, and eventually reproduce in freshwater aquatic ecosystems. The best available information indicates the Barton Springs salamander is restricted to the four springs outlets that make up the Barton Springs complex (Figure 3 and Figure 4), located in Zilker Park near downtown Austin, Texas. As such, this species has one of the smallest ranges of any vertebrate species in North America (Chippindale 1993). The Barton Springs segment of the Edwards Aquifer and its contributing zone supply all of the water in the springs that make up the Barton Springs complex. Flows of clean spring water are essential to maintaining well-oxygenated water necessary for salamander respiration and survival.

The subterranean component of the Barton Spring salamander's habitat may provide a location for reproduction (USFWS, 2005); however, little is known about the reproductive biology of the Barton Springs salamander in the wild. It appears that salamanders can reproduce year-round, based on observations of gravid females, eggs, and larvae throughout the year in Barton Springs (USFWS 2005). Survey results indicate Barton Springs salamanders prefer areas near the spring outflows, with clean, loose substrate for cover, but they may also be associated with aquatic plants, especially moss. In addition to providing cover, moss and other aquatic plants harbor a variety and abundance of the salamander's prey, freshwater invertebrates. Based on available information, both adults and juveniles eat freshwater invertebrates (USFWS 2005).

Further information on the status and life history of the Barton Springs salamander is provided in Appendix A.

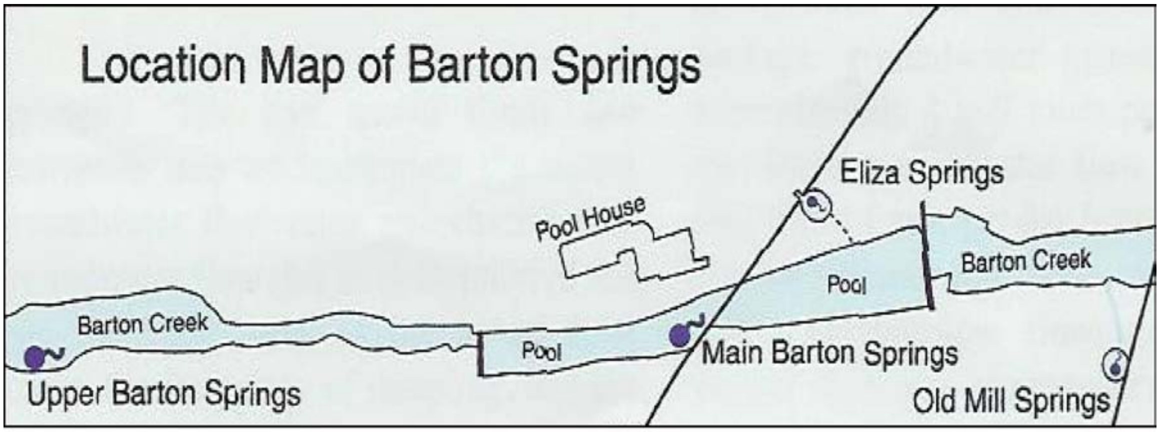

Diagram from Hauwert et al., Barton Springs Edwards Aquifer Conservation District Report

Figure 3 Location Map of Barton Springs

Figure 4 Aerial Photo of Barton Springs

2.6 Action Area

It is recognized by the Agency that the overall action area for the national registration of prometon includes any locations where registered uses might result in ecological effects. However, the scope of this assessment limits consideration of the overall action area to locations of those use sites applicable to the protection of the Barton Springs salamander. Thus, the BSS-prometon action area is defined largely by the hydrogeologic framework of Barton Springs. Deriving the geographical extent of this portion of the action area is the product of consideration of the types of effects prometon may be expected to have on the environment, the concentrations of prometon that are associated with those effects, and the best available information concerning the use of prometon and its fate and transport within the Barton Springs area.

Unlike exposure pathways for most aquatic organisms, where stressors are transported via surface water to the receptor within a defined watershed, the habitat of the Barton Springs salamander is almost completely ground water driven. Runoff from treated fields, transported through the fractured limestone (karst) of the Edwards Aquifer is the principal route of exposure for the salamander (U.S. EPA 2006). Thus, the action area for this assessment is defined by those areas within the hydrogeologic "watershed," including the Barton Springs Segment of the Edwards Aquifer and the Contributing Zone (BSSEA), that supply water to the four springs (Main Barton Springs, Eliza Springs, Old Mill Springs, and Upper Barton Springs) occupied by the salamanders (USFWS 2005). During high flow conditions, surface water flow from Barton Creek may enter the pool if it overtops the dam at the upper end of the pool. Any pesticide used in the land areas contributing to the ground water in the Barton Springs segment of the aquifer or to the surface water in Barton Creek could potentially be transported to the springs.

Flow to the Barton Springs is controlled by the geology and hydrogeology of the BSSEA. Numerous geological and ground water studies (Slade *et al*., 1986, Hauwert *et al.,* 2004) have been conducted to define the extent of the area contributing to the Barton Springs and characterize the flow within the system. The BSSEA is a 354 square mile area, comprised of four hydrogeologic zones. These are, from west to east, the Contributing Zone, the Recharge Zone, the Transition Zone, and the Artesian Zone. Of these zones, the Contributing and Recharge Zones have the greatest and most direct influence on Barton Springs. There is evidence that the Transition Zone has some limited input into the Barton Springs, while the Artesian Zone contributes no subsurface flow to the springs (Slade *et al.,* 1985, Hauwert *et al.,* 2004). The BSSEA is characterized as a karst system permitting relatively rapid transit of ground water, with velocities along the dominant flow path of 1-5 miles/day, depending on ground water flow conditions (USFWS 2005) particularly within the fracture portions. Based on dye tracer studies, pesticides applied within the recharge and contributing zones could potentially be present in the water of the springs on a time scale of days to weeks (Hauwert *et al*., 2004)

Spray drift and/or long-range atmospheric transport of pesticides could potentially contribute to concentrations in the aquatic habitat used by the salamander. Given the physico-chemical profile for prometon and the fact that prometon has been detected in both air and rainfall samples, the potential for long range transport from outside the area defined by the BSSEA cannot be precluded, but is not expected to approach concentrations in runoff predicted by modeling. Prometon introduced to the ground water system via atmospheric deposition or other environmental processes not specifically accounted for in the assessment is addressed by evaluation of the monitoring data, and assessment of a background concentration.

Thus, the action area for prometon as it relates to the Barton Springs salamander (the "BSS-prometon action area") is defined by the Contributing Zone, Recharge Zone, and Transition Zone within the BSSEA (Figure 5).

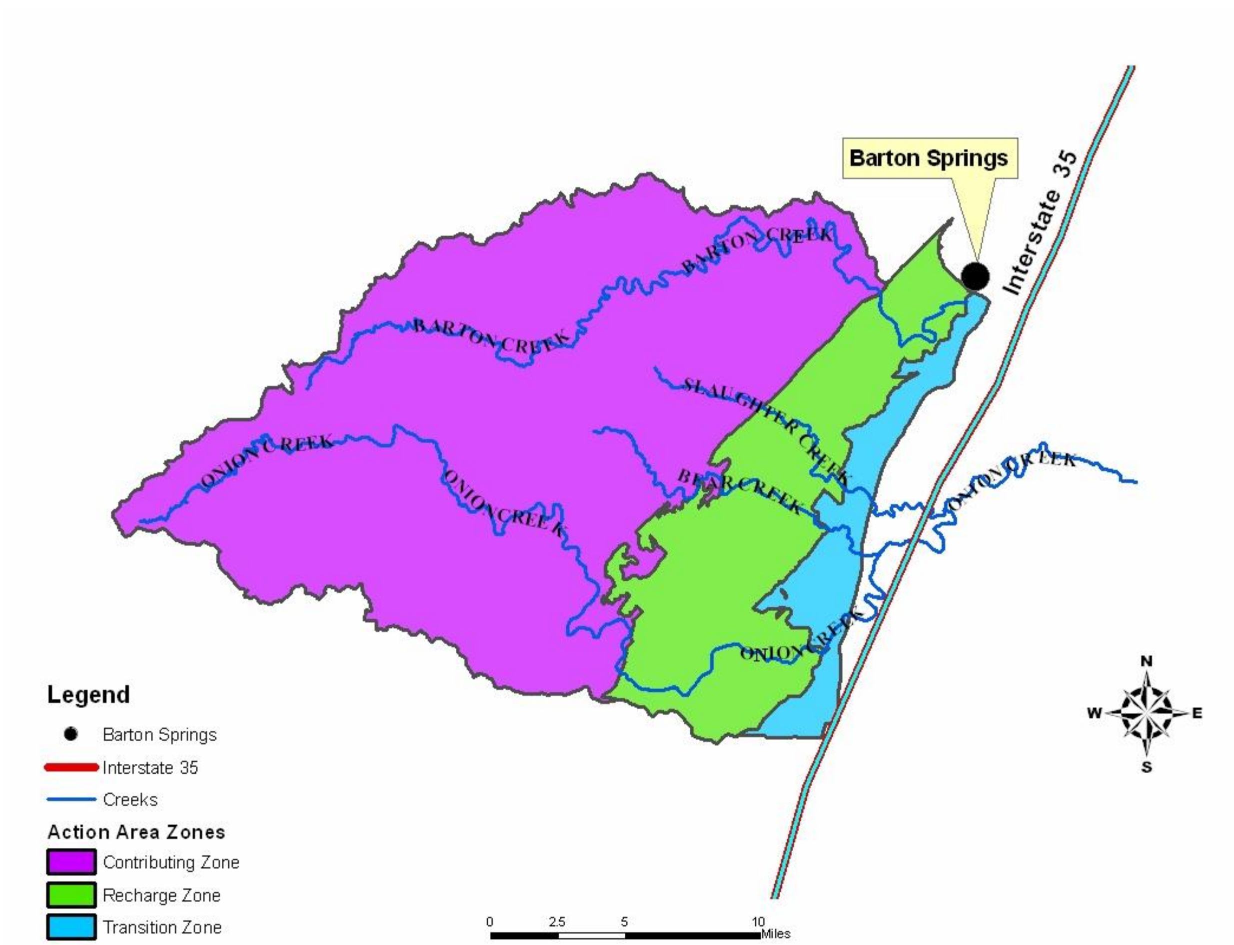

Figure 5 BSS-Prometon Action Area

2.7 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[3] Selection of the assessment endpoints is based on valued entities (*i.e.,* Barton Springs salamanders), the ecosystems potentially at risk (*i.e,* Barton Springs), the migration pathways of prometon (*i.e.,*ground water and surface water tranport), and the routes by which ecological receptors are exposed to prometon-related contamination (*i.e.,* direct contact in aqueous medium).

Assessment endpoints for the Barton Springs salamander include direct toxic effects on the survival, reproduction, and growth of the salamander itself, as well as indirect effects, such as reduction of the prey base and/or modification of its habitat. Each assessment endpoint requires one or more "measures of ecological effect," defined as changes in the attributes of an assessment endpoint itself or changes in a surrogate entity or attribute in response to exposure to a pesticide. Measures of ecological effect are evaluated based on acute and chronic toxicity information from registrant-submitted guideline tests, and data from open literature which meets specific acceptance criteria[4].

Guideline tests are performed on a limited number of organisms, which serve as surrogates for other types of organisms expected to have similar responses. Open literature data may expand the number of organisms for which toxicity data are available, but these tests may or may not have been conducted in accordance with standardized protocols and are often not directly comparable to the guideline tests. EFED guidance (U.S. EPA 2004) specifies that, in absence of data from more closely related species, fish data are used for aquatic-phase amphibians. Species-sensitivity distributions are not well understood, thus to provide a conservative estimate of risk EFED uses the most sensitive organism in the representative phylogenic class. Barton Springs salamanders are neotenic (retain gills throughout their lives) and are considered aquatic-phase amphibians. No species-specific toxicity data were available at the time of this risk assessment. Thus, fish data are used as surrogates for the Barton Springs salamander.

Table 5 Summary of Assessment Endpoints and Measures of Ecological Effect

Assessment Endpoint	Measures of Ecological Effect[5]
1. Survival, growth, and reproduction of Barton Springs salamander individuals via direct effects	1a. Rainbow trout acute LC_{50}[2] 1b. Fathead minnow chronic NOAEC[1]
2. Survival, growth, and reproduction of Barton Springs salamander individuals via indirect effects on prey (*i.e.,* freshwater invertebrates)	2a. Water flea acute EC_{50}[1] 2b. Water flea chronic NOAEC[1]
3. Survival, growth, and reproduction of Barton Springs salamander individuals via indirect effects on habitat and/or primary productivity (*i.e.,* aquatic plant community)	3a. Non-vascular plant (freshwater algae) EC_{50}[1] 3b. Vascular plant (duckweed) EC_{50}[2]

[1] Guideline study
[2] ECOTOX study

[3] From U.S. EPA (1992). *Framework for Ecological Risk Assessment.* EPA/630/R-92/001.
[4] For exact guidelines, see the "Overview Document, "(U.S EPA 2004)
[5] All toxicity data reviewed for this assessment are included in Appendix C.

2.8 Conceptual Model

2.8.1 Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.,* changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (U.S. EPA 1998). For this assessment, the risk is stressor-linked, where the stressor is intentional release of prometon to the environment by application on approved use sites. Based on the results of previous ecological risk assessments regarding prometon, the following risk hypotheses are evaluated in this endangered species assessment:

- Prometon in ground water, surface water, and/or runoff from treated areas may directly affect Barton Springs salamanders by causing mortality or adversely affecting growth or fecundity;
- Prometon in ground water, surface water, and/or runoff from treated areas may indirectly affect Barton Springs salamanders by reducing or changing the composition of prey populations; and
- Prometon in ground water, surface water, and/or runoff from treated areas may indirectly affect Barton Springs salamanders by reducing or changing the composition of the plant community in the springs, thus affecting primary productivity and/or cover.

2.8.2 Diagram

The conceptual model diagram is a graphic representation of the structure of the risk assessment. It specifies the stressor, release mechanisms, abiotic receiving media, biological receptor types, and effects endpoints of potential concern. The conceptual model for the potential effects of prometon on the Barton Springs salamander is shown in Figure 6. Exposure routes shown in dashed lines are not quantitatively considered because these exposures are expected to be sufficiently low as not to cause direct or indirect effects to the Barton Springs salamander.

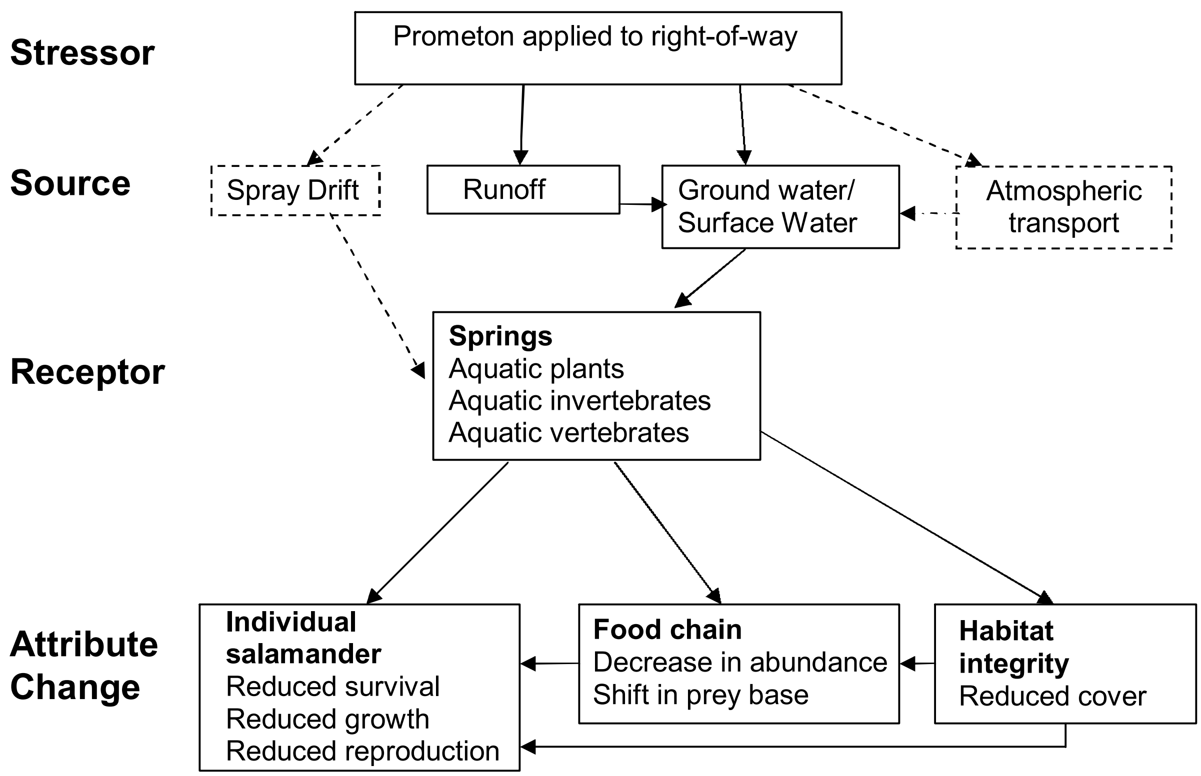

Figure 6 Conceptual Model for Barton Springs Salamander

2.9 Analysis Plan

This ecological risk assessment employs the standard methods as described in the Overview Document (U.S. EPA 2004), with the exception of the exposure assessment, which has been tailored specifically to the Barton Springs ecosystem.

3.0 *Exposure Assessment*

The exposure assessment includes evaluations based on monitoring data and modeled concentrations. Recent (2000-2004) USGS monitoring data for the surface streams, ground water wells, and the four springs making up the Barton Springs system (Mahler 2005) were available, and are summarized below. Exposure modeling is an application of the standard approach outlined in the Overview Document (U.S. EPA, 2004), modified to reflect the hydrogeologic conditions in the area surrounding Barton Springs. Both sets of exposure estimates are considered in the risk estimation.

3.1 *Monitoring Data*

Nationwide, prometon is frequently detected in surface water (between 10-60% detects in various monitoring programs) at a relatively low concentration (99th percentile of maximum concentration generally between 0.1-0.5 μg/L). The maximum reported peaks in the monitoring data examined were 40 μg/L in ground water and 25.1 μg/L in surface water[6]. Although it is not manufactured in large quantities (approximately 600,000 lb ai/year, according to the registrant), its frequent occurrence in surface water may be due to the fact that it is highly soluble, and essentially stable in water. Additionally, although it is typically only applied to small areas, equivalent per acre use rates are in the range of 20 lb ai, thus the overall mass of pesticide in the runoff may be equivalent to a larger area treated at a lower rate.

In the USGS provided monitoring data for surface streams, ground water wells, and the four springs making up the Barton Springs system prometon was one of the most frequently detected compounds (Mahler 2005a). Figure 7 shows sampling sites, with springs designated in yellow, surface wate sites in black, and ground water wells in red. In 2000-04, USGS conducted monitoring in the springs complex and in surface and ground water sources across the BSSEA for an extensive list of pesticides. This study included detection limits an order of magnitude lower than studies conducted earlier (0.01-0.02 μg/L, rather than 0.1-0.2 μg/L). In addition, the recent data from the USGS targeted single runoff events within the spring systems, with attempts to correlate composition of the sample with the storm hydrograph.

[6] Details for monitoring analysis in the Prometon RED ERA 2007.

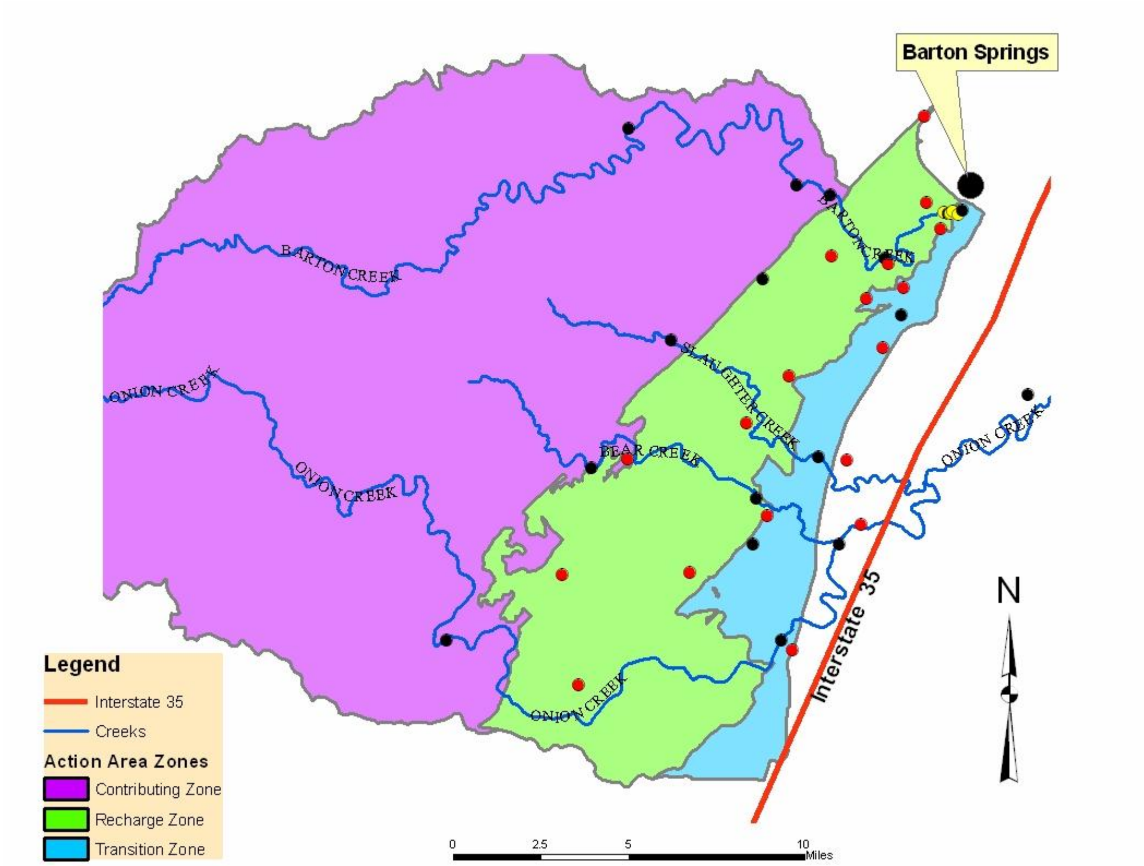

Figure 7 Ground and Surface Water Sampling Sites For Monitoring Data

In Figure 7, springs are designated in yellow, ground water wells in red, and surface water sites in black. While of high quality and targeted specifically to the Barton Springs system, the monitoring data may not capture the highest prometon concentrations, primarily due to the inherent difficulty of measuring contaminants in runoff events. However, the monitoring data provide a good cross-check to the modeled concentrations and can be used to establish a background concentration in the ground water.

Four springs were included in the USGS analysis: Main Spring, Eliza Spring, Upper Spring, and the Old Mill Spring. These four springs represent the main source of inflow into the Barton Springs pool system, with the Main Spring providing roughly 80% of overall flow.

Monitoring data (Table 6) showed prometon was regularly detected in one of the springs (Upper Spring) inhabited by the salamander. It was also detected once (3% detection rate) in Main Spring. It was not detected in either Old Mill Spring or Eliza Spring in any of the sampling. Based on the 2001-2004 data, prometon concentrations are at the detection limit of 0.01 μg/L. Out of 27 samples taken at Main Spring, prometon occurred in one. In Upper Springs, 9 out of 12 samples (75%) contained detectable concentrations of prometon, quantified as 0.01 μg/L in all cases.

Table 6 Summary of USGS Monitoring Data for Barton Springs Complex

Spring	Range of Sample Dates	# of Samples	# of Detects	Frequency of Detection (%)	Maximum Conc.[1] (μg/L)	Minimum Conc.[2] (μg/L)	Average Conc. (μg/L)
Main	1982-1987 1987-1993 2001-2004	3 10 27	0 0 1	0 0 3	<0.1 <0.2 0.01	<0.1 <0.1 <0.01	N/A N/A N/A
Upper	2001-2004	12	9	75	0.01	<0.01	0.01
Old Mill	2001-2003	7	0	0	<0.01	<0.01	N/A
Eliza	2000-2003	11	0	0	<0.02	<0.01	N/A

[1] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[2] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[3] Average includes quantified detections, values below detection limit not included.
NA Not applicable, not enough values to average

USGS also had monitoring data for several creeks (Barton Creek, Bear Creek, Onion Creek, Slaughter Creek, and Williamson Creek) in the BSSEA and for ground water wells

Monitoring data for surface water included 5 creeks and a total of 16 sites. Recent data (2000-2004) were available for 3 of the sites (Barton Creek, Onion Creek, and Williamson Creek). Overall, prometon was detected in 22 out of the 90 samples (25%) Of the creeks sampled, only one, Williamson Creek, consistently had detectable concentrations of prometon, ranging from 0.01 μg/L (2000-2004) to 5.6 μg/L (1982-1985). In the overall dataset, prometon detections appear more frequently in the samples taken in the 1980s than in samples from 1990 and later. Prometon was detected in Williamson Creek in the 2000-2004 sampling round, but at concentrations two orders of magnitude lower than the earlier samples. During the 2000-2004 sampling round no other creeks had detectable concentrations of prometon (LOD 0.02 μg/L).

Table 7 Summary of USGS Monitoring Data for Surface Water in the BSSEA

Water Source	Range of Sample Dates	# of Samples	# of Detects	Frequency of Detection (%)	Max Conc.[1] (μg/L)	Min Conc.[2] (μg/L)	Avg Conc.[3] (μg/L)
Barton Creek (6 sites)	1981-1982	3	0	0	<0.1	<0.1	N/A
	1993-1995	6	0	0	<0.2	<0.2	N/A
	2002-2004	7	0	0	<0.01	<0.01	N/A
	1993-1995	5	0	0	<0.2	<0.2	N/A
	1983-1985	7	0	0	<0.1	<0.1	N/A
	1981-1985	12	1	8	0.1	<0.1	N/A
	2000-2004	10	0	0	<0.02	<0.2	N/A
	1982	1	0	0	<0.1	<0.1	N/A
Bear Creek (2 sites)	1982-1983	3	2	67	0.2	0.1	0.15
	1982-1983	2	1	50	0.1	<0.1	N/A
Onion Creek (3 sites)	1982-1985	5	0	0	<0.1	<0.1	N/A
	2003-2004	2	0	0	<0.01	<0.01	
	1981-1983	4	0	0	<0.1	<0.1	N/A
	1982-1985	5	4	80	0.4	0.1	N/A
Slaughter Creek (2 sites)	1984	1	0	0	<0.1	<0.1	N/A
	1984	1	0	0	<0.1	<0.1	N/A
Williamson Creek (3 sites)	1982-1985	10	6	60	5.3	0.1	1.6
	2004	1	0	0	<0.01	<0.01	N/A
	2000-2004	7	4	57	0.04	0.01	0.02
	1982-1985	5	4	80	0.3	0.2	0.23

[1] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[2] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[3] Estimated

In 2001-2004 eleven ground water wells in the BSSEA were analyzed for pesticides, including prometon. The limit of detection for the analysis was 0.01 µg/L. Samples were taken once yearly, thus temporal variability of pesticide concentrations are not accounted for in this dataset. However, given the persistent nature of prometon in water EFED anticipates that it would be detectable up to a year following application, although it may appear distant from the source, and will be at lower concentrations due to dilution. In this dataset, prometon appeared to have a clear source affinity. It was detected in 3 of the 11 wells in every year of sampling, but never detected in any of the other wells. Generally, concentrations were close to the detection limit (0.01 µg/L). The maximum detected in ground water was 0.06 µg/L.

Table 8 Summary of USGS Monitoring Data for Ground Water in the BSSEA

Water Source	Range of Sample Dates	# of Samples	# of Detects	Frequency of Detection (%)	Max Conc.[1] (µg/L)	Min Conc.[2] (µg/L)	Avg Conc.[3] (µg/L)
Buda	2001-2004	4	0	0	<0.01	<0.01	N/A
Buda West	2001-2004	4	0	0	<0.01	<0.01	N/A
Ford Oaks	2001-2004	4	4	100	0.06	0.05	0.053
Ford Oaks North	2001-2004	4	0	0	<0.01	<0.01	N/A
Mancheca	2001-2004	4	0	0	<0.01	<0.01	N/A
Pleasant Hill	2001-2004	4	0	0	<0.01	<0.01	N/A
South Lamar	2001-2004	4	0	0	<0.01	<0.01	N/A
Sunset Valley North	2001-2004	4	0	0	<0.01	<0.01	N/A
Sunset Valley South	2001-2004	4	4	100	0.02	0.01	0.013
Sunset Valley East	2001-2004	3	0	0	<0.01	<0.01	N/A
Sunset Valley West	2001-2004	3	3	100	0.01	0.01	0.01

[1] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[2] If there were no quantifiable measurements, this is given as the highest LOD/LOQ in the series
[3] Estimated

3.2 Exposure Estimate Based on Modeling

The exposure assessment is an application of the standard approach outlined in the Overview Document (U.S. EPA 2004), modified to reflect the hydrogeologic conditions in the area surrounding Barton Springs. New regionally-specific PRZM scenarios, representing both agricultural and non-agricultural use sites were developed for the Barton Springs assessments (Appendix B), following the standard methodology for scenario development (U.S. EPA 2005). Using standard methods, runoff estimates predicted by the PRZM model are linked to the Exposure Analysis Modeling System (EXAMS), simulating the runoff entering a natural water body. For most ecological risk assessments, EFED uses a standard water body of fixed volume and geometry in EXAMS. EXAMS incorporates the processes of degradation and sorption expected to occur in ponds, canals, and first and second order streams. The standard water body is static (no outflow). Concentrations in larger water bodies are expected to be lower, thus the standard water body generally provides a conservative estimate of concentrations to which aquatic organisms may be exposed.

Because of the potentially rapid transit of the applied pesticide to Barton Springs via a ground water pathway, EFED opted to modify the standard methods, and calculate an estimated spring concentration rather than using the standard pond. A short explanation of the modeling is provided below, and more extensive descriptions can be found in U.S. EPA 2006 and U.S. EPA 2007b.

3.2.1 Background

The Barton Springs salamander resides in a geographically limited area defined by a set of spring-fed pools in the outskirts of the city of Austin. All of the springs are fed via subsurface flow originating in fractured limestone (karst) of the Edwards Aquifer, which extends to the south-southwest away from the pool system. This area is known as the Barton Springs Segment of the Edwards Aquifer (BSSEA). The BSSEA includes four distinct hydrogeologic zones. From west to east, these are the Contributing Zone, the Recharge Zone, the Transition Zone, and the Artesian Zone.

Based on existing studies, surface water from the Contributing Zone and the Recharge Zone are most likely to contribute directly to the Barton Springs system (Slade *et al.,* 1985, Hauwert *et al.,* 2004). Ground water supplying the springs is derived from a combination of perennial ground water flow and recharge that originates from both infiltration of rainfall and downwelling from surface streams. Therefore, the exposure assessment focuses on the subsurface pathway delivering ground water to the springs.

An extensive summary of how ground water in the BSSEA system travels is provided in the ecological risk assessment for atrazine (EPA 2006b). This information is derived from a number of studies conducted by the U.S. FWS, the U.S.GS, and the City of

Austin, and is considered best available data (Slade et al., 1986, Hauwert et al., 2004, USFWS 2005).

This assessment assumes that the estimated environmental concentration (EEC) is derived from both ground water and surface runoff; thus, spray drift is not a factor in the exposure assessment.

3.2.3 Modeling Approach

The Barton Springs are supplied predominantly with water discharging from fractures and conduits formed in the Barton Springs Segment of the Edwards Aquifer (BSSEA) as a result of dissolution of the fractured limestone aquifer over time. Approximately 85% of the water that recharges this aquifer infiltrates through the beds of six creeks that cross the recharge zone (Slade *et al*. 1986, Barrett and Charbeneau 1996), with the remaining approximately 15% of the recharge derived from precipitation and recharge in interbed areas in the recharge zone. In the BSSEA, natural ground water discharge occurs primarily at Barton Springs complex (Lindgren *et al*., 2004). Recharge features in creek bottoms overlying the recharge zone allow only a limited flow of water during a storm event; therefore, water that is in excess of the flow capacities of recharge features leaves the recharge zone as creek flow. The Contributing Zone encompasses the watersheds of the upstream portions of the six major creeks that cross the Recharge Zone, and therefore provides the source for most of the water that will enter the BSSEA as recharge. These streams gain water, as they flow across the land surface in the Contributing Zone, from the lower-permeability Glen Rose limestone of the Trinity aquifer (Lindgren *et al*., 2004). Kuniansky (1989) estimated baseflow discharge from the Trinity aquifer to streams and creeks in this area ranging from 25% to 90% of total flow. In the portion of the Trinity aquifer nearest the contributing zone this was loosely estimated at 30%. The remainder of water in creeks in the Contributing Zone is derived from precipitation and runoff.

The exposure modeling attempts to capture the most important aspects of the hydrology unique to the Barton Springs area. Thus, the contributing zone and the recharge zone are distinguished and treated separately. Runoff from the recharge zone is assumed to enter the karst environment directly, whereas runoff from the contributing zone is assumed to mix with stream water prior to entering the karst environment of the recharge zone. The long-term average flow volume in the streams in the contributing zone was assumed to be due 30% to aquifer discharge (base flow) and 70 % to runoff, consistent with Kuniansky (1989).

Masses and volumes of runoff were determined for this assessment from the right-of-way scenario developed for this assessment. As with the Agency's standard exposure modeling, 30 years of meteorological data for the Austin area were used to estimate 1-in-10-year exposure in the Barton Springs.

3.2.4 Equations to Estimate Prometon Concentrations

Contributing Zone.

Using the 70:30 contribution ratio established by Kuniansky (1989) the long-term average stream flow was used to calculate an approximate average daily stream flow in the contributing zone. The long-term (30 years simulated) runoff volume was calculated for the right-of-way scenario using PRZM and the respective areas determined by the landuse analysis.

$$V_{CZ} = \sum_{t=1}^{n} \left(V_{CZright-of-way,t} + V_{CZnon-use,t} \right) \tag{3.1}$$

where V_{CZ} = 30 year simulated cumulative runoff volume [volume]
$V_{CZright\text{-}of\text{-}way,t}$ = right-of-way runoff volume on day t in the contributing zone [volume]
$V_{CZnon\text{-}use,t}$ = non-use runoff volume on day t in the contributing zone [volume]
n = number of days in simulation

The estimated daily aquifer-driven base flow in the streams within the contributing zone was calculated from the 70:30 ratio as given by Kuniansky (1989):

$$V_{base} = \frac{V_{CZ}}{n} \left(\frac{0.30}{0.70} \right) \tag{3.2}$$

where V_{base} = the long-term average daily aquifer-driven stream volume

Daily runoff volume was calculated by adding the daily runoff flows as follows:

$$V_{CZ,t} = V_{CZright-of-way,t} + V_{CZnon-use,t} \tag{3.3}$$

where $V_{CZ,t}$ = the total runoff volume on day t in the contributing zone
$V_{CZi,t}$ = the volume for scenario i on any day t in the contributing zone

Daily stream volume was calculated by adding the base stream flow to the daily runoff volume as follows:

$$V_{stream,t} = V_{CZ,t} + V_{base} \tag{3.4}$$

where $V_{stream,t}$ = the total stream volume on day t in the contributing zone

The concentration in runoff in the contributing zone was calculated directly from the PRZM output and the area of the scenarios as follows:

$$C_{CZ,t} = \frac{\left(M_{CZright-of-way,t}\right)}{\left(V_{CZ,t}\right)} \qquad \textbf{(3.5)}$$

where $C_{CZ,t}$ = the concentration in runoff across the contributing zone on any day t
$M_{CZi,t}$ = the mass of prometon in runoff in the contributing zone for scenario i on any day t

Daily stream concentrations were calculated from the PRZM output, the area of the scenario, the stream base flow, and the average base flow concentration as follows:

$$C_{stream,t} = \frac{\left(C_{CZ,t} \times V_{CZ,t} + C_{base} \times V_{base}\right)}{V_{stream,t}} \qquad \textbf{(3.6)}$$

where $C_{stream,t}$ = the concentration in contributing zone streams on any day t
C_{base} = the average concentration monitored in base flow

The stream volume ($V_{stream,t}$) calculated in Eqn. 3.4, along with its associated concentration ($C_{stream,t}$), calculated in Eqn. 3.6 are assumed to enter the recharge zone where they mix with recharge zone runoff.

Recharge Zone.

Runoff originating in the recharge zone was determined in a similar manner as for the contributing zone:

$$V_{RZ,t} = V_{RZright-of-way,t} + V_{RZnon-use,t} \qquad \textbf{(3.7)}$$

where V_{RZ} = runoff volume on day t in the recharge zone
$V_{RZright\text{-}of\text{-}way,\ t}$ = right-of-way runoff volume on day t in the recharge zone
$V_{RZnon\text{-}use}$ = non-use runoff volume on day t in the recharge zone

The concentration of prometon in recharge zone runoff was determined from the PRZM mass output, the area represented by the scenario, and the volume of runoff in the recharge zone as follows:

$$C_{RZ,t} = \frac{\left(M_{RZright-of-way,t}\right)}{V_{RZ,t}} \qquad \textbf{(3.8)}$$

where $C_{RZ,t}$ = the concentration in runoff across the recharge zone on any day t
$M_{RZright\text{-}of\text{-}way}$ = the mass of prometon in runoff in the recharge zone for right-of-way on any day t

Barton Springs Daily Concentrations.

The stream flow from the contributing area and the runoff from the recharge area are assumed to mix in the groundwater, flow through the karst, and then upwell into Barton Springs. Due to the assumption of instantaneous mixing of pesticide in the stream, the volume of groundwater not passing through the springs is unimportant. Therefore, the total discharge into the springs is calculated by:

$$V_{Springs,t} = V_{stream,t} + V_{RZ,t} \qquad \textbf{(3.9)}$$

where $V_{Springs,t}$ = the total flow through the Barton Springs on day t

Based on these calculations, runoff from the recharge zone provides 11% of discharge through the Barton Springs, on average. This corresponds with estimates by Slade *et al.* (1986) and Barrett and Charbeneau (1996) that 15% of recharge to the Barton Springs originates in the recharge zone and 85% originates in the contributing zone.

The concentration of prometon in Barton Springs is calculated:

$$C_{Springs,t} = \frac{C_{RZ,t}V_{RZ,t} + C_{stream,t}V_{stream,t}}{V_{Springs,t}} \qquad \textbf{(3.10)}$$

where $C_{Springs,t}$ = the daily concentration in Barton Springs

Daily EECs in the Barton Springs were post-processed (see Appendix E for details) in order to provide durations of exposure. Peak, 21-day, and 60-day, average concentrations were calculated across 30 years of daily EEC values. In order to match the standard PRZM/EXAMS output, the maximum values for each of the 30 years of daily averages were ranked and the 90th percentiles from the rankings were selected as the final 1-in-10-year EECs for use in risk estimation.

3.2.3 *Label Application Rates and Intervals*

Table 9 shows application rates, methods, and specific dates used in the exposure assessment.

Table 9 Label Application Rates

Application Rate (lbs ai /500ft^2)	Application Rate (lb ai/A)[1]	Application Date	Application Method	Reference
0.23	20.04	Jan 3[2]	Ground Spray	Prometon Use Closure Memorandum 1/22/07
0.23	20.04	Jan 3[2]	Granular	

1- Application rate calculated by lbs ai/500ft^2*43,560 ft^2/A
2- Based on emergence date in scenario

3.2.7 *Exposure Modeling Input and Output*

Table 10 shows input parameters for PRZM modeling, based on acceptable environmental fate data from guideline studies.

Table 10 Input Parameters for PRZM Modeling

Parameter	Value	Source
Application Rate (kg a.i./ha)[1]- ground spray	22.43	Use Closure Memorandum 1/22/07
Molecular Weight (grams/mole)	225.3	Calculated
Solubility (mg/L)	620	Product Chemistry
Vapor Pressure (torr)	2.32E-6	Product Chemistry
Henry's Constant (atm m^3/mol)	1.21E-9	Calculated
Koc (L/kg-OC)	117.6	MRID 40225803
Aerobic Soil Metabolism Half-life (days)	1422.49	MRID 40145501 MRID 42313501 90th percentile half-life Mean=697 SD=332.34 $t_{90,n-1}$=3.078 n=2
Aerobic Aquatic Metabolism Half-life (days)	2844.98	Estimated from 2X aerobic soil half-life
Anaerobic Aquatic Metabolism Half-life (days)	557	MRID 40145501
Photodegradation in Water (days)	Stable	MRID 40225801
Hydrolysis Half-life (days)	Stable	MRID 41114801
Spray Drift Fraction	1%	Default value for Ground

Table 11 shows the estimated concentrations of prometon in the standard EXAMS pond based on various application times and methods. This is for comparison purposes only, and these concentrations are not used to calculate RQs.

Table 11 Estimated Concentrations in the Standard Pond for Prometon Based on a Texas Rights-of-Way Scenario

Application Technique	Application Rate	Peak	21 days	60 days
		ug/L		
Ground Spray	20.04	1670	1669	1659
Granular	20.04	1628	1618	1608

Because there was no way to directly determine how much of the watershed might be treated with prometon, EFED used a process of what-if scenarios to determine what percentage of the rights-of-way portion of the watershed could be treated without exceeding the LOC for the most sensitive aquatic organism (freshwater algae, EC_{50} = 98 μg/L). Initially, the treated area was apportioned equally between the recharge zone and the contributing zone. Once an overall clearance level was determined, zone-specific clearance levels were determined. Table 12 shows the EECs for the 0.23/500ft^2 application rate (maximum supported by registrant). Values shown are for the ground spray, which is anticipated to be slightly higher than granular applications.

Table 12 Spring EECs Based on 0.23/500ft^2 Ground Spray Application

Percentage of right-of-way treated	Percent in contributing zone	Percent in recharge zone	Peak (μg/L)	21-day (μg/L)	60 day (μg/L)
What-if values					
100	50	50	2,720	233	84
50	50	50	1,342	89	35
25	50	50	1,246	82	32
10	50	50	593	32	27
1	50	50	65	4.1	1.6
Clearance values					
1.25	50	50	80	5.1	1.9
1	0	100	65	4.1	1.6
0.75	100	0	49	3.1	1.2

4.0 *Effects Assessment*

Acute toxicity data for prometon used to evaluate the assessment endpoints is presented in Table 13. EFED uses the most sensitive species in each evaluation category to assess risk. The complete set of toxicity data available to EFED at the time of the assessment is contained in Appendix B. The data set consists of toxicity data from acceptable guideline tests submitted to the Agency by the registrant and open literature toxicity data that meets established acceptability criteria (ECOTOX data).

Prometon is slightly toxic to both freshwater fish (surrogate for the salamander) and freshwater invertebrates. EC_{50} for non-vascular aquatic plants is 0.098 mg/L. EC_{50} for aquatic vascular plants is 0.624 mg/L. Some sublethal effects (potential endocrine disrupting) were noted in a open literature study located by ECOTOX. These effects occurred at prometon concentrations higher than concentrations in the assessment endpoints.

Table 13 Aquatic Toxicity Profile for Prometon

Assessment Endpoint	Surrogate Species	Toxicity Value Used	Source Citation	Comments
Direct Effects				
Acute Toxicity to Salamander	Rainbow trout	LC_{50} = 12 mg/L	ECOTOX 546[1]	No comments
		LC_{50} =19.6 mg/L 95% CI = 17.1-22.4 mg/L Slope = 8.6	MRID 41810908[2]	Sub-lethal effects: (11.4 mg/L) lethargy, hyperventilation
Chronic Toxicity to Salamander	Fathead minnow	NOAEC = 9.5 mg/L LOAEC = 19.7 mg/L	MRID 41810902	Reduced survival and hatching success at 19.7 mg/L
Indirect Effects (Prey Reduction)				
Acute Toxicity to Prey	Water flea	LC_{50} = 25.7 mg/L 95% CI =20.6-32.0 Slope = 3.2	MRID 41609109	No comments
Chronic Toxicity to Prey	Water flea	NOAEC = 3.5 mg/L LOAEC = 6.8 mg/L	MRID 41810903	Decreased reproduction
Indirect Effects (Habitat Modification)				
Acute Toxicity to Plants (non-vascular)	Green alga	LC_{50} = 0.098 mg/L	MRID 41725305	No comments
Acute Toxicity to Plants (vascular)	Duckweed	LC_{50} = 0.624 mg/L	ECOTOX 81431	Experimental pH (5.5) lower than most natural waters.

[1] Most sensitive endpoint, used to develop RQs

[2] Similar range to most sensitive endpoint, and fits probit curve. Used to develop probability of individual effects estimate.

4.1 Summary of Aquatic Ecotoxicity Studies

Information used to develop the toxicity profile for prometon included registrant-submitted guideline studies and open literature studies that met the criteria for inclusion into ECOTOX.

4.1.1 Toxicity to Freshwater Fish

4.1.1.1 Acute Exposure (Mortality) Studies

Three registrant-submitted acute studies for freshwater fish were available. The most recent study was one conducted on rainbow trout in 1991. This study determined the LC_{50} to be 19.6 mg ai/L (95% CI 17.1-22.4 mg ai/L). Sublethal effects were noted beginning at concentrations of 11.4 mg ai/L. These effects included discoloration, lethargy, loss of equilibrium, and hyperventilation. Based on the test, the NOAEC was 6.4 mg/L. Toxicity of prometon to rainbow trout and to bluegill sunfish was also evaluated in earlier tests (Accession # 231814, 1965). For the bluegill, the 96-hour LC_{50} was greater than the highest concentration tested (32 mg/L). No mortality occurred at any of the test concentrations, although at the highest concentration test fish exhibited darkened pigmentation on the skin. A definitive LC_{50} of 20 mg/L was determined for rainbow trout. The trout exhibited darkened pigmentation of the skin at concentrations of 10 and 18 mg/L.

ECOTOX located a study of prometon toxicity to freshwater fish. The study examined five species of fish: rainbow trout, crucian carp, brown bullhead catfish, bluegill, and guppy (ECOTOX # 546). The 96-hour LC_{50}s for these species ranged from 12 mg ai/L to 70 mg ai/L. Rainbow trout and guppy were the most sensitive, with an LC_{50} of 12 mg ai/L, and crucian carp were the least sensitive. This study established an LC_{50} of 40 mg ai/L for the bluegill. Fish exhibited dose-dependent paling in this study.

4.1.1.2 Chronic Exposure (Growth/Reproduction) Studies

The registrant submitted an early-life stage (ELS) test for the fathead minnow (MRID 41810902). Endpoints affected included survival and hatching success. The NOAEC and LOAEC were 9.49 mg/L and 19.7 mg/L, respectively. Five test concentrations were used, with mean-measured concentrations of 4.85, 9.49, 19.7, 37.0 and 82.5 mg/L. In the 37.0 mg/L treatment group, hatching success was significantly reduced (2.5-20%) as compared to controls (68.6-72.6%). None of the fish in the 37.0 or 82.5 mg/L treatment groups survived more than 4 days post hatch.

4.1.2 Toxicity to Aquatic Phase Amphibians

No studies regarding the toxicity of prometon to aquatic phase amphibians were located.

4.1.3 *Toxicity to Freshwater Invertebrates*

4.1.3.1 Acute Exposure (Mortality) Studies

Two registrant-submitted studies were available for freshwater invertebrates, both using *Daphnia magna*. A study conducted in 1977 (Accession #231814) determined a 48-hr EC_{50} of 59.8 mg/L (95% CI 52.0-68.6 mg/L). No sublethal effects were described. A later study (MRID 41609109, 1991) determined a 48-hr EC_{50} of 25.7 mg ai/L (95% CI 20.6-32.0 mg ai/L). This data fit a probit curve, and the slope was determined to be 3.2. Immobilization and/or mortality, which were differentiated in this study, occurred at all concentrations ≥ 11.1 mg/L. No sublethal effects were noted below the EC_{50}.

ECOTOX located two open literature studies reporting effects of prometon on freshwater invertebrates. In one study (ECOTOX#2820) exposure conditions were similar to guideline studies, with the exception of the test duration, which the authors set at 26 hours (for operational convenience). Based on this study, the EC_{50} for *Daphnia magna* was 35 mg/L. The focus of this study was on optimizing rearing conditions for the animals, and developing a methodology for dose-response curves rather than determining endpoints for specific chemicals. No mention of analytical confirmation of pesticide concentrations is made, so values reported were assumed to be nominal. Neither a confidence interval nor a slope was reported.

The second study used OECD Guideline #202 as the protocol for evaluating the effects of a number of triazine herbicides (ECOTOX #13154). This study determined a 48-hr LC50 of 38 mg/L. No confidence interval or slope was included in study, and as raw data was not provided, it could not be recalculated.

4.1.3.2 Chronic Exposure (Growth/Reproduction) Studies

The registrant submitted a *Daphnia magna* life-cycle toxicity test (MRID 41810903, 1991). Growth, survival, and reproduction endpoints were all affected. Reproduction was the most sensitive endpoint, with a NOAEC of 3.5 mg ai/L and a LOAEC of 6.8 mg ai/L. At the test concentration of 6.8 mg ai/L, reproduction was significantly reduced compared to the controls. At a test concentration of 28.5 mg ai/L, reproduction ceased. Growth (length) was also reduced at the 6.8 mg ai/L test concentration. The percentage of daphnids surviving did not follow a dose-response curve. Mortality ranged from 0-45%, with the 45% kill occurring at the highest dose. The study was classified core. Sub-lethal effects other than measure endpoints were not reported.

4.1.3.3 Sublethal Effects

ECOTOX located a study evaluating potential endocrine disrupting effects of prometon and several other methoxytriazine herbicides (ECOTOX#86407). Paired fish were exposed to concentrations of prometon ranging from 19.6 to 999 μg/L (mean-measured) For prometon, the study also included a 21-day fathead minnow reproduction test. Exposure to prometon did not reduce cumulative fecundity, although there a slight decrease was noted in the first 7 days of the test. By the end of the test, fish appeared to have recovered and/or adapted. Authors measured a number of endocrine systemmediated endpoints, including plasma vitellogenin and estradiol concentrations, brain and ovary aromatase activity, male tubercle development, and development of the male fat pad (an androgen-responsive tissue). Exposure to ≥19.6 μg/L lowered the weight of the fat pad relative to body wet weight. Female plasma testosterone concentrations were increased at 19.6 μg/L, but not at higher concentrations. The authors concluded "prometon may cause subtle endocrine and/or reproductive effects in fathead minnows, but no clear mechanism of action was observed." Based on data presented, EFED concluded that modification of some endocrine-mediated activity occurred in this laboratory situation, but the majority of endpoints measured appeared unaffected. Likelihood of such effects occurring, and/or the ramifications of those modifications on the survival, growth, and reproduction of wild populations of fish are uncertain.

4.1.4 Toxicity to Aquatic Plants

A registrant-submitted guideline study on the effects of prometon on green algae (*Scenedesmus capricornutum*) was available (MRID 41725305). The study determined a 120 hr (5 day) EC_{50} of 0.098 mg/L (95% CI 0.088-0.108 mg/L) and a NOAEL of 0.032 mg/L. The study author calculated a 168 hr (7 day) EC_{50} of 0.210 mg/L (95% CI 0.133-0.334 mg/L), indicating there may be some recovery with longer exposures. EC_{50}s were determined based on reduction in cell growth.

ECOTOX located a study evaluating toxicity of several triazine pesticides to duckweed (*Lemna minor*). The study (ECOTOX#81431) determined an EC_{50} of 0.624 mg/L and an EC_{50} of 0.246 mg/L. The study also evaluated the effects of exposure to multiple triazines, and evaluated recovery response of the plants following removal to clean water. Authors concluded that the triazines tested (ametryn, atrazine, prometon, and prometryn) had an additive toxicity. They also noted the growth rate of the exposed plants displayed an almost complete recovery within 3 days after removal to clean water.

4.2 *Use of Probit Slope Response Relationship*

Generally, available toxicity data provides and LC_{50} or an EC_{50}, (the concentration at which 50% of the test populatin exhibits the designated endpoint, usually mortality). Because the Endangered Species Act (ESA) requires determination of potential effects at an individual level, this information must be extrapolated from existing data. The Agency uses the probit dose response relationship as a tool for deriving the probability of effects on a single individual (U.S. EPA, 2004). The individual effects probability associated with the acute RQ is based on the mean estimate of the probit dose response slope and an assumption of that probit model is appropriate for the data set. In some cases, probit is not the appropriate model for the data, and EFED has low confidence in extrapolations from these types of data sets. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope, if available. The upper and lower bounds of the effects probability are based on available information on the 95% confidence interval of the slope. Individual effect probabilities are calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). Probability of individual effects for the various assessment endpoints is provided below in Table 14.

Table 14 Probability of Individual Effects

Assessment Endpoint	Surrogate Species	LC_{50} and Slope	Fits Probit	Chance of Individual Effect
Direct Effects				
Acute Toxicity to Salamander	Rainbow trout	19.6 mg/L and 5.0 (lower bound) 19.6 mg/L and 8.6 19.6 mg/L and 12.2 (upper bound)	Yes	1 in 2.6×10^{10} 1 in 4.3×10^{28} 1 in 2.0×10^{56}
Chronic Toxicity to Salamander	Fathead minnow	Evaluated based on no effects level, chance of individual effects evaluation not applicable		
Indirect Effects (Prey Reduction)				
Acute Toxicity to Prey	Water flea	25.7 mg/L and 2.2 (lower bound) 25.7 mg/L and 3.2 25.7 mg/L and 4.1(upper bound)	Yes	1 in 4.8×10^{2} 1 in 6.4×10^{4} 1 in 2.1×10^{7}
Chronic Toxicity to Prey	Water flea	Evaluated based on no effects level, chance of effects evaluation not required		
Indirect Effects (Habitat Modification)				
Acute Toxicity to Plants (vascular)	Green algae	Evaluated based on no effects level, chance of individual effects evaluation not applicable		
Acute Toxicity to Plants (non-vascular)	Duckweed			

4.3 Incident Database Review

EFED's incident database contained only two incidents related to prometon. Based on information reported, one of these incidents (Incident ID I014409-078) appears to have been a case of misuse, where a paving contractor used prometon on a roadway and the resulting runoff killed trees and lawn plants near the road. The report notes that the application was not in accordance with the label. The second incident (Incident ID I005895-355) was a fish kill. The magnitude of the kill is listed as unknown, and the kill is attributed to an accidental spill of a prometon product into a contained pond.

EFED's incident database contains information regarding adverse effects associated with particular pesticide applications that are reported to the manufacturer/distributor of the chemical. While the registrant is required by law to report adverse effects to the Agency, reporting of incidents by the public and/or state and local agencies is largely voluntary. Thus, there may be incidents that are not reported to the Agency. Generally, a large number of reported incidents may indicate a high degree of hazard for non-target species exposed to the pesticide. However, the converse is not necessarily true, and a small number of reported incidents should not be interpreted as implying any degree of "safety" for non-target species.

5.0 *Risk Characterization*

5.1 *Risk Estimation*

Risk quotients (RQs) were calculated for all of the what-if scenarios and for the background concentration. Background concentration was estimated at 0.01 µg/L, based on the concentrations detected by USGS in Upper Springs and in the groundwater wells. Table 15 shows the RQs for background concentrations, for EECs when 100% of the right-of-way landuse (4.3% of the entire watershed) is treated and for EECs when 1% right-of-way landuse (4.3% of the entire watershed) is treated (0.043% of the entire watershed). No chronic risk LOCs are exceeded at any concentration. Acute risk LOCs are exceeded for all assessment endpoints if 100% of the right-of-way landuse area is treated at the rate of 0.23 mg ai/500 ft^2. No acute risk LOCs for any assessment endpoints are exceeded if only 1% of the right-of-way landuse area is treated, assuming the area is equally divided between recharge zone and contributing zone. If the treated area is exclusively in the contributing zone (which supplies more water to the springs complex), only 0.75% of the right-of-way landuse area can be treated without exceeding any acute risk LOCs. These estimations assume all areas are treated on the same day.

Table 15 Risk Quotients for Prometon

Assessment Endpoint	Surrogate Species	Concentration Estimate	RQ	LOC Exceedence[1]
Direct Effects				
Acute Toxicity to Salamander	Rainbow trout	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 0.23 <0.05	No *Yes* No
Chronic Toxicity to Salamander	Fathead minnow	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 <1.0 <1.0	No No No
Indirect Effects (Prey Reduction)				
Acute Toxicity to Prey	Water flea	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 0.11 <0.05	No *Yes* No
Chronic Toxicity to Prey	Water flea	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 <1.0 <1.0	No No No
Indirect Effects (Habitat Modification)				
Acute Toxicity to Plants (vascular)	Green algae	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 28 <1.0	No *Yes* No
Acute Toxicity to Plants (non-vascular)	Duckweed	Background Spring EEC (100% ROW treated) Spring EEC (1% ROW treated)	<0.05 4.4 <1.0	No *Yes* No

[1] LOCs used in this assessment:
- Aquatic animals acute risk endangered species 0.05
- Aquatic animals chronic risk 1.0
- Aquatic plants acute risk 1.0.

Because no usage data was located, EFED opted to use the EECs to back calculate the amount of land area treated and amount of active ingredient that would need to be applied, and then make a reasoned decision regarding potential impacts of prometon use. Table 16 shows the number of acres treated and the amount of active ingredient applied that correspond with each what-if scenario and clearance values. The 1% treated area (50% recharge, 50% contributing) is the clearance level for direct effects on the salamander and effects on the freshwater non-vascular plant (algae), which would constitute a potential indirect effect on the salamander. Clearance levels for prey items, (represented by *Daphnia magna*), and for the freshwater vascular plants are at the 10% treated right-of-way area.

Table 16 shows the correlation between the percentage of land treated and the actual amount of acres that would be treated and the amount of prometon applied. As no usage data is available, and the use sites may actually be located anywhere within the action area, evaluating the amount of prometon necessary to cause exceedences and comparing it against the number of acres reasonably expected to be treated is essentially the only way for EFED to make a determination regarding potential impacts on the salamander.

Table 16 Correlation Between Percentage of ROW Treated and Amount of Prometon Applied

Percentage of Right-of-way Land use Treated	Percent in Recharge Zone	Percent in Contributing Zone	Acres Treated	Prometon Applied (lb ai)
What-if Scenarios				
100	50	50	10,978	220,006
50	50	50	5,489	110,003
25	50	50	2,745	55,001
10	50	50	1,098	22,001
1	50	50	110	2,200
Clearance				
1	100	0	110	2,200
0.75	0	100	82	1,650

5.2 *Risk Description*

The estimation of water concentration is based on the assumption that all locations in the watershed are treated simultaneously. For prometon, which is persistent in aquatic systems, and may typically be applied once a year, EFED has opted to consider the amount of active ingredient associated with each water concentration as a maximum per year. EFED believes that this is a reasonable method for evaluating risk associated with this chemical in the absence of usage data. The assumption of simultaneous applications, along with some conservative estimators in the modeling process, is anticipated to provide the benefit of doubt to the species. Effects determinations, described below, are made in terms of amount of active ingredient applied.

5.2.1 Direct Effects

Based on LOC exceedences, using the fish as a toxicity surrogate, acute effects from prometon application may occur if approximately 22,000 lbs of prometon are applied to the contributing zone and recharge zone, with the treatments divided equally between the two zones. Thus, application of this amount of prometon constitutes a may affect, and application of less than 22,000 lbs of prometon is no effect. Based on available toxicity data, chronic effects are not anticipated even if the entire right-of way acreage is treated with prometon.

5.2.2 Indirect Effects (Reduction in Prey Base)

LOC exceedences for aquatic invertebrates occur when 25% of the rights-of-way are treated, equivalent to application of approximately 55,000 lbs prometon in the contributing zone and recharge zone. This constitutes a may affect. At total yearly applications lower than this amount, it would be a no effect. Based on available toxicity data, chronic effects are not anticipated even if the entire right-of way acreage is treated with prometon.

5.2.3 Indirect Effects (Habitat Degradation)

As part of the indirect effects analysis, reduction of both non-vascular plants and vascular plants in the Barton Springs system is considered. Non-vascular plants (plankton, periphyton, and some bryophytes) are primarily a food source for the salamander's prey items. Vascular plants serve as structure in the Barton Springs system, providing attachment points for periphyton, and refugia for both the salamander and its prey.

Of the assessment endpoints selected for ecosystem supporting the Barton Springs salamander, the green algae is most sensitive to the effects of prometon. To clear the acute risk LOC for the algae, only 1% of the right-of-way landuse area can be treated with prometon, equivalent to application of 2,200 lbs in the watershed in a year. If the application is all in the contributing zone, only 1,650 lbs can be applied. Yearly applications of ≥1,650 lbs of prometon in the BSSEA constitute a may effect based on exceedences for aquatic non-vascular plants. Applications of less than 1,650 are considered no effect based on current determination criteria.

The freshwater vascular plants, represented by duckweed, are slightly less sensitive than the non-vascular plants represented by the green algae. Acute risk LOCs for the vascular plants are not exceeded when 10% of the watershed is treated with prometon, equivalent to 22,000 lbs. Yearly applications of ≥22,000 lbs of prometon in the BSSEA constitute a may effect based on exceedences for aquatic non-vascular plants. Applications of less than 22,000 are considered no effect based on current determination criteria.

Based on data (ECOTOX 81431) that indicate aquatic plants recover when prometon is removed from the systems, and the extent of impact that may be necessary to reduce plant growth sufficiently to affect the growth, survival, or reproduction of the salamander, exceedence of only the LOC for non-vascular plants for a short duration is not anticipated to have a measurable effect on the growth, survival, or fecundity of the salamander. This results in a determination of not likely to adversely affect (insignificant). Although fate modeling indicates the concentration of prometon in the static pond decreases very little in the 60-day period evaluated, decreases will occur in a flowing system like Barton Springs unless there is continuous loading of the pesticide. However, exceedence of both the vascular and non-vascular plant LOCs indicates that a substantial portion of the aquatic plant community could be at risk. Thus, yearly applications of ≥1,650 lbs but < 22,000 lbs prometon ai in the BSSEA is determined to be may affect, but not likely to adversely affect the Barton Springs salamander due to indirect effects on primary productivity. Yearly applications of ≥ 22,000 lbs prometon ai care deteremined to be may affect, likely to adversely affect.

5.3 Risk Conclusions

After completing the analysis of the effects of prometon on the Federally listed endangered Barton Springs salamander *(Eurycea sosorum)* in accordance with methods delineated in the Overview document (USEPA 2004), EFED concludes that the use of prometon (PC 080804) in the BSSEA is anticipated to have the following effects:

Total yearly use	
<1,650 lbs ai	No effect
≥1,650 lbs ai but <22,000 lb ai	May affect, not likely to adversely affect (Indirect)
≥22,000 lbs ai	May affect, likely to adversely affect (Direct)

Rationale for each component assessed is provided in Table 17.

Table 17 Effects Determination for Prometon

Assessment Endpoint	Effects determination[1]	Basis for Determination
Direct Effects		
Survival, growth, and reproduction of Barton Springs salamander	<22,000 lbs yearly No effect ≥ 22,000 lbs yearly May affect LAA	No chronic risk LOCs are exceeded at any yearly application assessed. At applications of<22,000 lbs yearly, acute risk LOCs for the salamander are not exceeded. At applications of ≥ 22,000 lbs yearly, acute risk LOCs for the salamander are exceeded. Due to the uncertainties associated with actual usage, EFED has not attempted to discern an NLAA point for direct effects on the salamander.
Indirect Effects		
Reduction of prey (*i.e.,* freshwater invertebrates)	<55,000 lbs yearly No effect ≥ 55,000 lbs yearly May affect LAA	No chronic risk LOCs are exceeded at any yearly application assessed. At applications of<55,000 lbs yearly, acute risk LOCs for aquatic invertebrates are not exceeded. At applications of ≥55,000 lbs yearly, acute risk LOCs for aquatic invertebrates are exceeded. Due to the uncertainties associated with actual usage, EFED has not attempted to discern an NLAA point for indirect effects on the salamander.
Degradation of habitat and/or primary productivity (*i.e.,* aquatic plants)	<1,650 lbs yearly No effect ≥1,650 but <22,000 lbs yearly May affect NLAA (insignificant) ≥ 22,000 lbs yearly May affect LAA	No LOC exceedences at <1,650 lbs yearly. At 1,650 lbs yearly, acute risk LOCs exceeded for non-vascular aquatic plants, but not vascular aquatic plants. Recovery of plant community is expected. Reduction and/or modifications in plant community not anticipated to be severe enough to affect growth, survival, or reproduction of salamander. At applications of ≥22,000 lbs yearly, acute risk LOCs for both vascular and non-vascular aquatic plants are exceeded. Reduction and/or modifications in plant community may be severe enough to affect growth, survival, or reproduction of salamander.

[1] Determinations are based on total lbs of active ingredient used yearly in the BSSEA, assuming all applications are made simultaneously

6.0 Uncertainties

Risk assessment, by its very nature, is not exact, and requires the risk assessor to make assumptions regarding a number of parameters, to use data which may or may not accurately reflects the species of concern, and to use models which are a simplified representation of complex ecological processes. In this risk assessment, EFED has attempted to locate the best available data regarding such important parameters as the life history of the Barton Springs salamander, typical environmental conditions in the proximity of Barton Springs, toxicity of prometon, and uses of prometon in the action area. Frequently, such information are better expressed as ranges rather then points, and when this is the case, EFED has opted to make use of the end of range which would result in a conservative estimate of risk, in order to provide the benefit of doubt to the species. These uncertainties, and the directions in which they may bias the risk estimate, are described below.

6.1 Exposure Assessment Uncertainties

Overall, the uncertainties inherent in the exposure assessment tend to result in over-estimation of exposures. This is apparent when comparing modeling results with monitoring data. In particular, estimated peak exposures are generally 3-4 orders of magnitude above the highest detections in any of the four springs or surface waters in the Barton Springs area. In general, the monitoring data should be considered a lower bound on exposure, while modeling represents an upper bound. Factors influencing the over-estimation of exposure include the assumptions of no degradation, dilution, or mixing in the subsurface transport from the use site to the Barton Springs complex. The modeling exercise conservatively assumes that the spring and the application site are adjacent. In reality, they are not, and there are likely to be environmental processes not accounted for that will reduce the predicted exposures.

6.1.1 Modeling Assumptions

The uncertainties incorporated in the exposure assessment cannot be quantitatively characterized. However, given the available data and EFED's policy to rely on conservative modeling assumptions, it is expected that the modeling results in an over-prediction in exposure. Qualitatively, conservative assumptions which may affect exposure include the following:

- The assessment assumes all applications have occurred concurrently on the same day at the exact same application rate.
- The assessment assumes all applications are at maximum label rate.

6.2.2 Impact of Vegetative Setbacks on Runoff

EFED does not currently have an effective tool to evaluate the impact of vegetative setbacks on runoff and pesticide loadings. The effectiveness of such setbacks is highly dependent on the condition of the vegetative strip. A well-established, healthy vegetative setback can be a very effective means of reducing runoff and erosion from agricultural fields and may substantially reduce loading to aquatic ecosystems. However, a setback that is narrow, of poor vegetative quality, or channelized is likely to be ineffective at reducing loadings. The presence and quality of setbacks are site-specific, and may vary widely, even within a small geographic area. EFED does not currently incorporate any “buffer reduction” in its exposure estimates. Until such time as quantitative methods to estimate the effect of vegetative setbacks of various conditions on pesticide loadings become available, EFED’s aquatic exposure predictions are likely to overestimate exposure where healthy vegetative setbacks exist and may underestimate exposure where poorly developed, channelized or no setbacks exist.

6.2.3 PRZM Modeling inputs and Predicted Aquatic Concentrations

EFED currently typically uses the linked PRZM/EXAMS model which produces estimated aquatic concentrations based on site conditions and historical meteorological files (generally 30-year), although for this assessment, EXAMS has been decoupled, and other methods are used to estimate water concentrations. The “peak” pesticide concentration used in the assessment is probability-based, and is expected to be exceeded once within a ten-year period. PRZM is a process-based "simulation" model, which calculates what happens to a pesticide in a farmer's field on a day-to-day basis. It considers factors such as rainfall and plant transpiration of water, as well as how and when the pesticide is applied. The two major components affecting estimated pesticide loading are hydrology and chemical transport. Water movement in and off the field is simulated by the use of generalized soil parameters, including field capacity, wilting point, and saturation water content. Soils in each scenario are selected to represent high availability conditions for the pesticide. The chemical transport component simulates the method of pesticide application on the soil or on the plant foliage and the environmental processes acting on the pesticide. Dissolved, adsorbed, and vapor-phase concentrations in the soil are estimated by simultaneously considering the processes of pesticide uptake by plants, surface runoff, erosion, decay, volatilization, foliar wash-off, advection, dispersion, and retardation.

Uncertainty associated with each of these individual components adds to the overall uncertainty of the modeled concentrations. Equations in the model have not been shown to exert any directional bias. Model inputs from the required environmental degradation studies are chosen to represent the upper confidence bound of the mean, and are not expected to be exceeded in the environment 90% of the time. Mobility input values are selected to be representative of conditions in the open environment. Natural variation in soils adds to the uncertainty of modeled values. Factors such as application date, crop emergence date, and canopy cover can affect estimated concentrations. Ambient environmental factors, such as soil temperatures, sunlight intensity, antecedent soil moisture, and surface water temperatures may cause actual aquatic concentrations to differ from the modeled values..

6.2 *Effects Assessment Uncertainties*

6.2.1 Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. For guideline tests, young (and theoretically more sensitive) organisms are used. Testing of juveniles may overestimate toxicity at older age classes for active ingredients of pesticides which act directly (without metabolic transformation) on the organism, because younger age classes often have not developed enzymatic systems associated with the detoxification of xenobiotics. When the available toxicity data provides a range of sensitivity information with respect to age class, the risk assessors use the most sensitive life-stage information as measures of effect.

6.2.2 Use of Surrogate Species Data

Currently, there are no FIFRA guideline toxicity tests for amphibians. Therefore, in accordance with EFED policy, data for the most sensitive freshwater fish are used as a surrogate for aquatic-phase amphibians such as the Barton Springs salamander. Species sensitivity distribution data for amphibians indicates the range of sensitivity is similar to that of freshwater fish (Birge *et al.,* 2000). Therefore, the endpoint based on freshwater fish ecotoxicity data is assumed to be protective and extrapolation of the risk conclusions from the most sensitive tested species to the Barton Springs salamander is more likely to overestimate the potential risks than to underestimate the potential risk. At the time of the assessment, it was not known where Barton Springs salamanders may fall in a species sensitivity distribution.

6.2.3 Extrapolation of Effects

Length of exposure and concurrent environmental stressors (*e.g,* urban expansion, habitat modification, decreased quantity and quality of water in Barton Springs, predators) will likely affect the response of the Barton Springs salamander to prometon. Because of the complexity of an organism's response to multiple stressors, the overall "direction" of the response is unknown. Additional environmental stressors may decrease or increase the sensitivity to the herbicide. Timing, peak concentration, and duration of exposure are critical in terms of evaluating effects, and these factors will vary both temporally and spatially within the action area. Overall, the effect of this variability may result in either an overestimation or underestimation of risk

6.2.4 Acute LOC Assumptions

The risk characterization section of this assessment includes an evaluation of the potential for individual effects. The individual effects probability associated with the acute RQ is based on the assumption that the dose-response curve fits a probit model. It uses the mean estimate of the slope and the LC_{50} to estimate the probability of individual effects.

References

Birge, WJ, AG Westerman, and JA Spromberg. (2000) Comparative Toxciology and Risk Assessment of Amphibians, Chap 14 in Ecotoxicology of Amphibians and Reptiles, Sparling, DW, G Linder, and CA Bishop, (Eds.), SETAC Press, Pensacola, FL.

Chippindale, PT. (1993). Evolution, phylogeny, biogeography, and taxonomy of Central Texas spring and cave salamanders, *Eurycea* and *Typhlomolge* (Plethodontidae: Hemidactyliini). Dissertation, University of Texas at Austin, Austin, Texas.

City of Austin (COA). (2003a). Unpublished Land Use Data. http://www.ci.austin.tx.us/landuse/. Accessed 15 February 2005.

City of Austin. (2003b). Land Use Data (ftp://coageoid01.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html).

Davis, B. (2006). County Extension Agent, Texas Cooperative Extension (Hays County) Personal Communication with M. Corbin (OPP/EFED).

Drost, W., Backhaus, T., Vassilakaki, M., and Grimme, L. H. (2003). Mixture Toxicity of s-Triazines to Lemna minor Under Conditions of Simultaneous and Sequential Exposure. *Fresenius Environ.Bull.* 12: 601-607

Field, M. (2004). Forecasting Versus Predicting Solute Transport in Solution Conduits for Estimating Drinking-Water Risks. *Acta Carsologica*, XXXIII/II, pp 115-150.

Garcia, E. (2006). Natural Resources Conservation Service – District Conservationist (Travis County), Personal Communication with M. Corbin (OPP/EFED.

Hauwert, N., Johns, D. Hunt, B., Beery, J., Smith, B., and Sharp, J.M., Jr. (2004). Flow Systems of the Edwards Aquifer Barton Springs segment Interpreted from tracing and associated field studies.: So. Texas Geol. Soc. /Austin Geol. Soc. Symposium on the Edwards Aquifer, San Antonio, TX, in press.

Kaul, M. and J. Carter. (2005). Use Sites for Blanco, Hays, and Travis Counties in Texas for Atrazine, Simazine, Carbaryl, Prometon, Diazinon, and Prometon (D322226). Biological and Economic Analysis Division, Office of Pesticide Programs, U.S. EPA, Washington, DC.

Kaul, M., Kiely, T., Jones, A., and Widawsky, D. (2006). Atrazine, Simazine, Carbaryl, Prometon, Diazinon, and Prometon Usage for Blanco, Hays, and Travis Counties in Texas to Support the Barton Springs Endangered Species Assessment (D322226, D322266 & D322267). Biological and Economic Analysis Division, Office of Pesticide Programs, U.S. EPA, Washington, DC.

Perez, C. (2006) District Conservationist (Hays County), Personal Communication with M. Corbin (OPP/EFED).

Mahler, B. (2005a). The Case of the Anomalous Springs. Using all the clues to solve a karst mystery. USGS presentation to the ESI France-UT Karst Workshop; February 8, 2005.

Mahler, B. (2005b). Research Hydrologist, U.S. Geological Survey, Texas District. Personal Communication with M. Corbin and J. Hetrick (OPP/EFED).

Slade, R. J., Jr., Dorsey, M. E., Stewart, S. L. (1986). Hydrology and Water Quality of the Edwards Aquifer Associated with Barton Springs in the Austin Area, Texas, U.S. Geological Survey Water Resources Investigations Report 86-4036.

SRC (2006). *Surface Water Modeling Scenario Development for the Pesticide Root Zone Model (PRZM) for use in the Barton Springs Endangered Species Risk Assessment: Supplement to Metadata*. SRC TR-06-023, GSA Contract # GS-00F-0019L, Order # EP06H000149, Syracuse Research Corporation, North Syracuse, NY.

U.S. EPA (1992). Framework for Ecological Risk Assessment. EPA/630/R-92/001.

U.S.EPA. (1998). Guidance for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-95/002F, April 1998.

U.S. EPA. (2004). Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs. Office of Prevention, Pesticides, and Toxic Substances. Office of Pesticide Programs. Washington, D.C. January 23, 2004.

U.S. EPA. (2005). Pesticide Root Zone Model (PRZM) Field and Orchard Crop Scenarios: Guidance for Selecting Field Crop and Orchard Scenario Input Parameters, Version II. Water Quality Tech Team, Environmental Fate and Effects Division, Office of Pesticide Programs, U. S. Environmental Protection Agency. Washington, D.C. 20460. April, 2005.

U.S. EPA (2006) *Risks of Atrazine Use to Federally Listed Endangered Barton Springs Salamanders (Eurycea sosorum)*. August 22, 2006, DP 331218, Environmental Fate and Effects Division, Office of Pesticide Programs, Washington, DC.

U.S. EPA (2007a) *Risks of Metolachlor Use to Federally Listed Endangered Barton Springs Salamanders (Eurycea sosorum)*. May 3, 2006, Environmental Fate and Effects Division, Office of Pesticide Programs, Washington, DC.

U.S. EPA (2007b) *Risks of Diazinon Use to Federally Listed Endangered Barton Springs Salamanders (Eurycea sosorum)*. May 9, 2007, Environmental Fate and Effects Division, Office of Pesticide Programs, Washington, DC.

U.S. FWS. (2005). Barton Springs Salamander (*Eurycea sosorum*) Recovery Plan. Southwest Region, USFWS, Albuquerque, New Mexico.

Zinn, N. and A. Jones. (2006). Application Timing and Refined Usage Data for Atrazine, Simazine, Prometon, and Prometon in Three Texas Counties (Blanco, Hays, and Travis), D322539.

ECOTOX References

#546 Bathe, R., Ullmann, L., and Sachsse, K. (1973). Determination of Pesticide Toxicity to Fish. *Schriftenr.Ver.Wasser-Boden-Lufthyg.Berlin-Dahlem* 37: 241-256 (ENG TRANSL).

#9211 Walsh, G. E. (1972). Effects of Herbicides on Photosynthesis and Growth of Marine Unicellular Algae. *Hyacinth Control J.* 10: 45-48 (Author Communication Used).

#84131 Drost, W., Backhaus, T., Vassilakaki, M., and Grimme, L. H. (2003). Mixture Toxicity of s-Triazines to Lemna minor Under Conditions of Simultaneous and Sequential Exposure. *Fresenius Environ.Bull.* 12: 601-607.