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

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

August 12, 2015

PC Code: 085601, 108209, 118601, 118602, 119009, 119011, 122001, 122009, 122010, 122020, 122021, 128721, 128820, 128845, 128887, 128901, 128969, 128973, 129002, 129008, 129009, 129031

MEMORANDUM **DP Barcode: 427429**

SUBJECT: Drinking Water Exposure Assessment for the Registration Review of 22 Sulfonylurea Herbicides

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1. Executive Summary

This Environmental Fate and Effects Division (EFED) memorandum is an abbreviated drinking water exposure assessment based on labeled uses of the 22 currently active sulfonylureas (SU) in support of registration review. Coarse and refined screening drinking water exposure estimates were generated with PRZM-GW (v.1.07) and FIRST (v1.1.1) for use in the SU dietary risk assessments in support of human health assessment. A tiered approach was used in this assessment beginning with **coarse-screen** estimates that should exceed upper-bound chemical-specific estimated drinking water concentrations (EDWC) for all SUs. This was achieved by using model inputs that represent the use pattern of highest potential exposure from any SU, the highest soil mobility of any SU residue of concern, and stability to any route of degradation over time. The resulting highest coarse-screen EDWCs from PRZM-GW were proposed in all SU dietary risk assessments as a conservative estimate of exposure. Due to the screening nature of this assessment, EFED does not expect that the EDWCs reflect actual potential exposures. However, if the resulting dietary exposure was not of concern, then exposure modeling refinements, including chemical-specific modeling, were unnecessary. If the resulting dietary exposure was of concern, then simple chemical-specific refinements were made to generate lower **refined-screen** EDWCs that remained conservative for the chemical (*i.e.*, the refined-screen EDWCs are still coarse, but a step more refined than the coarse-screen EDWCs). For both screens, the SUs were conservatively treated as stable to all routes of degradation, making consideration of degradates of concern irrelevant. **Table 1.1** lists the coarse- and refined-screen EDWCs for the SUs. Due to the conservative nature of these screens, the EDWCs presented in this assessment are not expected to occur in drinking water.

Table 1.1. Screening-level Maximum EDWCs for Sulfonylureas

Sulfonylurea (Use)	PRZM-GW Scenario	Screen Level	Max. Daily Conc. (µg/L)	Post-breakthrough Mean (µg/L)	Mean Breakthrough Time (yrs)
Chlorsulfuron (non-ag areas)	NC cotton	Refined	78	52	5.9
Halosulfuron-methyl (fallow)	NC cotton	Refined	74	53	8.1
Nicosulfuron (rights-of-way)	NC cotton	Refined	39	26	6.2
Prosulfuron (corn)	NC cotton	Refined	15	13	12
Rimsulfuron (commercial areas)	NC cotton	Refined	105	71	6.5
Triasulfuron (rangeland)	NC cotton	Refined	21	19	16
Tribenuron-methyl (corn)	NC cotton	Refined	35	23	6.1
Triflusulfuron-methyl (sugarbeet)	FL citrus	Refined	23	20	9.5
All other sulfonylureas	NC cotton	Coarse	751	492	5.7-8.7

2. Use Characterization

The uses and use patterns of the assessed sulfonylureas (SU) are generally described by the LUIS reports that were prepared and posted to the dockets during the problem formulation phase of registration review. The risk managers assigned to the SUs were consulted to update the use patterns for this assessment to reflect any label changes that occurred after the LUIS reports were prepared. **Table 2.1** lists the resulting lowest, average, and maximum single application rates labeled for the SUs. Maximum agricultural single application rates are listed separately from maximum non-agricultural single application rates.

Table 2.2 lists the maximum seasonal or annual application rates for agricultural uses of SUs that were assessed to estimate drinking water exposure using the Tier I screening drinking water exposure models, PRZM-GW and FIRST. Maximum single application rates were often the same as maximum seasonal or annual application rates. Uses with single application rates less than seasonal or annual application rates generally did not provide a minimum reapplication interval, as indicated in **Table 2.2**. Upper-bound usage rates provided by the Biological and Economic Analysis Division (BEAD) were used to estimate maximum annual application rates for uses without maximum annual application rates on the label. Clarification of the maximum annual application rate and minimum reapplication interval is recommended for all labeled SU use sites for which these directions are not currently provided on the label.

Table 2.1 Sulfonylurea Single Application Rates [A]

Chemical	Lowest Max Application Rate	Highest Max Application Rate	Rate to Model - Ag	Rate to Model - Non-Ag	Average Rates Across Uses Where Available (Supplied by BEAD)	Application Methods	Notes
Bensulfuron-methyl	0.047	0.063	0.063 - only used on rice	none	0.032; up to 2 apps	Ground or Air	Labeled only for rice
Chlorimuron-ethyl	0.0039	0.08	0.08 - soybean	0.0313 - several non-ag uses	0.004 to 0.017	Ground or Air	–
Chlorsulfuron	0.0012	0.14	0.062 - rangeland/fallow	0.14	0.007 to 0.047	Ground or Air	–
Flazasulfuron	0.047	0.093	0.045	0.093	0.045	Ground only	–
Foramsulfuron	0.0009	0.052	0.038 - corn	0.052 - all non Ag	0.029 to 0.032	Ground only for tur and ground or air for corn	–
Halosulfuron-methyl	0.03	0.14	0.094 – corn (most uses at 0.047)	0.136	0.016 to 0.077	Ground or air	Most uses are ground only, but some allow aerial applications
Imazosulfuron	-	0.66	0.3 - melons, vegetables, rice	0.66	Not available	Ground or air	Uses are ground only, except aerial applications are allowed on rice
Iodosulfuron-methyl-Na	0.00013	0.0089	0.0089 - wheat	0.0089 - most turf	0.002	Ground only	–
Mesosulfuron-methyl	0.0028	0.013	0.013 - triticale and wheat	none	0.002 to 0.011	Ground or air	–
Metsulfuron-methyl	0.00023	0.15	0.15 - ag uncultivated areas and some forestry uses	0.15 - several non-ag uses	0.002 to 0.024	Ground or air	Labeled for mainly non-ag uses with several agricultural uses
Nicosulfuron	0.012	0.07	0.066 - corn	0.07 - several non-ag areas	0.011 to 0.043	Ground or air	–
Orthosulfamuron	0.066	0.066	0.066 - rice	none	0.061	Ground or air	Labeled only for rice
Primisulfuron-methyl	0.018	0.036	0.036 - corn	0.036 - bluegrass	0.009 to 0.022	Ground or air	Labeled only for bluegrass and corn
Prosulfuron	0.0089	0.036	0.036 – corn (most uses at 0.018)	none	0.003 to 0.018	Ground or air	No non-ag uses labeled

Chemical	Lowest Max Application Rate	Highest Max Application Rate	Rate to Model - Ag	Rate to Model - Non-Ag	Average Rates Across Uses Where Available (Supplied by BEAD)	Application Methods	Notes
Rimsulfuron	0.0078	0.063	0.063 - most uses	0.0625 - most uses	0.01 to 0.062	Ground or air	Numerous ag and non-ag uses; some uses only allow ground applications
Sulfometuron-methyl	0.0281	0.0281	0.38 – fallow, uncultivated areas	0.281 - forestry and more		Ground or air	Numerous ag and non-ag uses; some uses only allow ground applications, but most allow both
Sulfosulfuron	0.03	0.125	0.094 - pastures	0.094 - almost all uses	0.008 to 0.07	Ground or air	Most uses are non-cropped areas; most uses allow only ground applications
Thifensulfuron-methyl	0.0023	0.028	0.028 - almost all uses	none	0.002 to 0.015	Ground or air	Labeled for mainly agricultural uses
Triasulfuron	0.022	0.028	0.028 - most uses were 0.0275 or 0.028	none	0.013 to 0.019	Ground or air	–
Tribenuron-methyl	0.0012	0.0313	0.031 - field corn, blueberries	none	0.002 to 0.017	Ground or air	Labeled mainly for agricultural uses
Trifloxysulfuron-Na	0.007	0.036	0.028 – sugarcane	0.036 - turf	0.006 to 0.017	Ground or air	–
Triflusulfuron-methyl	0.016	0.031	0.031 - sugar beets (all other uses at 0.016)	none	0.008 to 0.012	Ground or air	Labeled only for beets, sugar beets, chicory, and endive

[A] All rates are in units of pounds of active ingredient per acre (lbs a.i./A). “Ag” means “agricultural”; “Non-ag” means “non-agricultural”.

Table 2.2. Sulfonylurea Application Rate Patterns of Highest Expected Exposure [A]

Sulfonylurea	Maximum Rate Pattern
Bensulfuron-methyl	0.0625 lbs/A/yr
Chlorimuron-ethyl	0.080 lbs/A/yr
Chlorsulfuron	0.14 lbs/A x ?/yr [B]
Flazasulfuron	0.15 lbs/A/yr
Foramsulfuron	0.052 lbs/A x ?/yr [B]
Halosulfuron-methyl	0.125 lbs/A/yr
Imazosulfuron	**0.66 lbs/A x 2/yr** [A]
Iodosulfuron-methyl-Na	0.009 lbs/A/yr
Mesosulfuron-methyl	0.013 lbs/A x ?/yr [B]
Metsulfuron-methyl	0.15 lbs/A x ?/yr [B]
Nicosulfuron	0.070 lbs/A x ?/yr [B]
Orthosulfamuron	0.067 lbs/A/yr
Primisulfuron-methyl	0.036 lbs/A x ?/yr [B]
Prosulfuron	0.036 lbs/A x ?/yr [B]
Rimsulfuron	0.0625 lbs/A x ?/yr [B]
Sulfometuron-methyl	0.375 lbs/A x 1/yr
Sulfosulfuron	0.125 lbs/A/yr
Thifensulfuron-methyl	0.031 lbs/A/yr
Triasulfuron	0.039 lbs/A/yr
Tribenuron-methyl	0.031 lbs/A x 1/yr
Trifloxysulfuron-Na	0.080 lbs/A/yr
Triflusulfuron-methyl	0.078 lbs/A/yr

[A] The highest maximum rate pattern is bolded and in red.
[B] Question marks indicate application rate patterns for which maximum annual application rates and maximum numbers of applications per year are not stated on the label.

3. Environmental Fate Characterization

Sulfonylureas tend to be anions. Therefore, the compounds tend to be hydrophilic and do not bioaccumulate in the environment. Water solubility limits range from 26 (trifloxysulfuron) to 3,180,000 mg/L (chlorsulfuron). The highest available whole fish bioconcentration factor (BCF) is 3.0x (tribenuron-methyl).

Based on the soil mobility data presented in **Table 5.1**, the SUs as a class may be characterized as "mobile" to "moderately mobile" on the FAO scale (USEPA, 2006). This means they will have some tendency for leaching into ground water and for transport away from the site of application dissolved in runoff.

Aerobic soil metabolism (ASM) half-lives for the SUs indicate a wide range of stability to metabolism by soil microbes, ranging from 3.6 days (shortest half-life for iodosulfuron-methyl) to 240 days (longest half-life for metsulfuron-methyl). Bensulfuron-methyl and chlorsulfuron are assumed stable to ASM in the absence of acceptable data. Iodosulfuron-methyl degrades with a half-life of 3.6-51 days to another SU, metsulfuron-methyl, that degrades slower with a half-life of 26-240 days. Thus, SU half-lives for ASM range from several days up to many months, for the same compound in some cases.

Aerobic aquatic metabolism (AAM) half-lives for the SUs indicate a wide range of stability to metabolism by aquatic microbes, similar to ASM half-lives, ranging from 9.1 days (shortest half-life for triflusulfuron-methyl) to 187 days (longest half-life for sulfometuron-methyl). Bensulfuron-methyl and chlorsulfuron are assumed stable to AAM in the absence of acceptable data.

Aquatic photolysis is not a significant degradation process for the SUs, except for a few SUs whose photolysis half-lives were on the order of a few days (flazasulfuron, imazosulfuron, sulfosulfuron, and thifensulfuron-methyl).

Overall, the data for the SUs indicate that their mobility and stability to degradation are conducive to leaching into ground water and off-site transport via runoff, resulting in the contamination of water resources.

4. Residues of Concern

The drinking water residues of concern (ROC) are clearly defined for eight SUs (see **Table 4.1**). For the 14 remaining SUs, the ROCs are unclear for a variety of reasons, *e.g.*, studies with new degradates may have been submitted after the ROCs were determined or the ROCs may not have been clearly determined in past assessments. The drinking water ROCs are irrelevant in this assessment, however, because the SUs are treated as completely stable to degradation in the screening approach used. Therefore, there was no need to clarify for this assessment the drinking water ROCs for any SUs.

Table 4.1. Status of SU Drinking Water Residues of Concern (ROC)

Pesticide	DW ROCs	Citation/Rationale
	SUs with Clearly Defined ROCs	
Chlorimuron-ethyl	Demethylated parent	Only deg with SU group (DP 358796, 2009 HHRA)
Flazasulfuron	DTPU, DTPP, HTPP, TPSA, ADMP, and GTF (all major degs)	ROCKS decision (DP 386767)
Imazosulfuron	HMS, IPSN, ADPM, UDPM, and SDPM	DEREK flags (DP 377141)
Mesosulfuron-methyl	AE F154851, AE F160459, AE F160460	2004 MARC decision (DP 298760+)
Nicosulfuron	IN-37740, IN-HYY21	DP 414505 (DWA) (1 new study w/ no new degradates)
Orthosulfamuron	DBS acid, DOP urea, DB amine, o-desmethyl orthosulfamuron	HHRA (DP 319264)
Tribenuron-methyl	None	SU degradates not major or not prominent (USEPA 2009 - DEA)
Trifloxysulfuron-Na	CGA-053052, CGA-382997, CGA-368732	2003 MARC decision (DP 293085)

Pesticide	DW ROCs	Citation/Rationale
SUs with Unclear ROCs		
Bensulfuron-methyl	Unclear	--
Chlorsulfuron		--
Foramsulfuron		--
Halosulfuron-methyl		--
Iodosulfuron-methyl-Na		--
Metsulfuron-methyl		--
Primisulfuron-methyl		--
Prosulfuron		--
Rimsulfuron		--
Sulfometuron-methyl		--
Sulfosulfuron		--
Thifensulfuron-methyl		2004 MARC included IN-L9226 - but 2 new SU degradates ID'ed since
Triasulfuron		--
Triflusulfuron-methyl		--

5. Exposure Modeling

5.1. Ground Water (PRZM-GW)

Screening ground water-sourced drinking water exposure estimates were generated with PRZM-GW (v.1.07) for use in the SU dietary risk assessments in support of human health assessment. Rather than produce chemical-specific EDWCs following the usual assessment procedures a tiered approach was used in this assessment beginning with **coarse-screen** estimates that should exceed upper-bound chemical-specific EDWCs for all SUs. This was achieved by using model inputs that represent the use pattern of highest potential exposure from any SU, the highest soil mobility of any SU residue of concern, and stability to degradation over time. The resulting highest coarse-screen EDWCs from PRZM-GW were proposed in all SU dietary risk assessments as a conservative estimate of exposure. Due to the screening nature of this assessment, EFED does not expect that the EDWCs reflect actual potential exposures. However, if the resulting dietary exposure was not of concern, then exposure modeling refinements, including chemical-specific modeling, were unnecessary. If the resulting dietary exposure was of concern, then simple chemical-specific refinements were made to generate lower **refined-screen** EDWCs that remained conservative for the chemical (*i.e.*, the refined-screen EDWCs are still coarse, but a step more refined than the coarse-screen EDWCs). Due to the conservative nature of these screens, the EDWCs presented in this assessment are not expected to occur in drinking water.

5.1.1. Coarse Screen

For the coarse screen, the application rate pattern of highest expected exposure (*i.e.*, maximum rate pattern) of any SU was modeled with PRZM-GW to produce coarse-screen EDWCs. The maximum application rate pattern for each SU is summarized above in **Table 2.2**. Many current labels do not provide maximum annual application rate limits, resulting in uncertainty in the maximum rate pattern for the individual SU in the product. Despite this uncertainty, the maximum rate pattern from all SUs appears to be for imazosulfuron use on turf (0.66 lbs/A x 2 applications/year).

The lowest sorption coefficients for any SU, considering the available data for residues of concern, were used as model inputs for PRZM-GW (representing orthosulfamuron's degradate DBS acid and primisulfuron-methyl). **Table 5.1** lists the SU-specific mean sorption coefficients for the residues of concern. K_d or K_F was used when the coefficient of variation (CV) for the parameter was less than the CV for K_{OC} or K_{FOC}. Otherwise, K_{OC} or K_{FOC} was used. Freundlich parameters were used when available and when less than similar non-Freundlich parameters, if available. The representative compound was the residue of concern with the lowest mean sorption coefficient if sorption coefficient data were available. Therefore, the parent compound was the representative compound for one of three reasons: 1) the mean sorption coefficient for the parent compound was less than that for the degradates of concern, 2) data were not available for degradates of concern, or 3) there were no degradates of concern.

Table 5.1. Sulfonylurea Mean Sorption Coefficients for Residues of Concern [A]

Sulfonylurea	Mean K_d or K_F	Mean K_{OC} or K_{FOC}	Representative Compound	Source
Bensulfuron-methyl		K_{OC}=315	Parent compound	Acc# 73657
Chlorimuron-ethyl		K_{OC}=91	Parent compound	MRID 143120
Chlorsulfuron		K_{FOC}=21	Parent compound	MRID 42156705
Flazasulfuron		K_{OC}=29	TPSA	MRID 46930001, 49030002 (in review)
Foramsulfuron		K_{FOC}=78	Parent compound	MRID 45109723
Halosulfuron-methyl		K_{FOC}=109	Parent compound	MRID 42139411
Imazosulfuron		K_{OC}=242	Parent compound	MRID 47305117
Iodosulfuron-methyl-Na		K_{FOC}=21	Metsulfuron	MRID 49154301
Mesosulfuron-methyl		K_{FOC}=78	AE F154851	MRID 45386433
Metsulfuron-methyl		K_{FOC}=21	Metsulfuron	MRID 49154301 (in review)
Nicosulfuron		K_{OC}=35	Parent compound	MRID 40924222
Orthosulfamuron	**K_F=0.11**		DBS acid	MRID 49308108 (in review)
Primisulfuron-methyl		**K_{FOC}=12**	Parent compound	MRID 41869304
Prosulfuron	K_F=0.22		Parent compound	MRID 42685257
Rimsulfuron		K_{FOC}=47	Parent compound	MRID 41356336
Sulfometuron-methyl		K_{FOC}=63	Parent compound	MRID 42789301
Sulfosulfuron	K_F=0.29		Parent compound	MRID 44295728
Thifensulfuron-methyl		K_{FOC}=28	Parent compound	MRID 161290
Triasulfuron	K_F=0.34		CGA-195660	MRID 42782002
Tribenuron-methyl		K_{FOC}=31	Parent compound	MRID 46101501
Trifloxysulfuron-Na	K_F=0.26		CGA-382997	MRID 45371821
Triflusulfuron-methyl	K_F=0.64		Parent compound	MRID 42496861

[A] The lowest mean sorption coefficient inputs are bolded and in red.

The PRZM-GW inputs for the coarse-screen EDWCs are listed in **Table 5.2**. Application inputs represent the maximum rate pattern for imazosulfuron, which is the highest of any SU (two applications per year at 0.66 lbs/acre, with a 21-day reapplication interval). The initial application date (7 days since emergence) is a post-emergence date within the application season. Alternative initial application dates of 37 and 67 days post-emergence were also explored with the North Carolina scenario.

Chemical inputs (*i.e.*, sorption coefficients) for the sulfonylurea residues of concern follow the PRZM-GW Input Parameter Guidance (USEPA, 2012). The chemicals were modeled as stable to degradation (hydrolysis and aerobic soil metabolism) as part of the coarse-screen approach. Sorption coefficients reflect the highest soil mobility of any SU residue of concern, consistent with the coarse-screen approach.

Table 5.2. PRZM-GW Input Parameters for Sulfonylurea Coarse-Screen EDWCs

Input Parameter	Value	Justification	Source
Application Rate (kg a.i./ha)	0.74	Maximum labeled single application rate for use of imazosulfuron on turf (see **Table 2.2**)	EPA Reg. No. 59639-155 (Mar. 29, 2011)
Applications per Year	2; every year		
Reapplication Interval (days)	21	Minimum labeled interval	
Initial Application Date (days since emergence)	7	Post-emergence application date	(calculated)
Chemical Application Method	2	Foliar application	EPA Reg. No. 59639-155
Hydrolysis Half-life (days)	0	Stability was modeled as a screen	Screening assumption
Surface Soil Half-life (days)	0	Stability was modeled as a screen	Screening assumption
Sorption Coefficient (ml/g)	K_d=0.11 or K_{OC}=12	Represent the lowest mean K_d and K_{FOC} values for sulfonylurea residues of concern in **Table 5.1**	MRID 49308108 (in review); MRID 41869304

All six standard scenarios were modeled as surrogates for the use site (turf) with maximum application rates. PRZM-GW outputs are listed in **Table 5.3**. The K_{OC} of 12 produced shorter mean breakthrough times than the K_d of 0.11. Coarse-screen EDWCs were higher with the K_{OC} input as well, with two exceptions. The North Carolina scenario produced the highest daily and post-breakthrough mean EDWCs. The highest daily concentration was produced with the K_{OC} input and the 37-days post-emergence initial application date. The highest post-breakthrough mean concentration was produced with the K_d input and the 7-days post-emergence initial application date. The initial application date input was not as sensitive as the sorption coefficient, which is expected due to the assumptions that the residues are stable and are not allowed (by the PRZM-GW conceptual model) to run-off, leaving them available for leaching whenever precipitation or irrigation events occur.

Table 5.3. PRZM-GW Coarse-Screen EDWCs for Sulfonylureas [A]

Modeled Scenario	K_d or K_{OC}	Initial Application Dates (days post-emergence)	Max. Daily Conc. (µg/L)	Mean Breakthrough Time (yrs)	Post-breakthrough Mean (µg/L)
Wisconsin (WI) corn	K_d	7	449	11.5	415
	K_{OC}	7	504	6.9	425
Delmarva (DMV) corn	K_d	7	489	5.3	369
	K_{OC}	7	560	3.3	378
Florida (FL) citrus	K_d	7	429	3.2	351
	K_{OC}	7	467	2.3	349
Florida (FL) potato	K_d	7	375	2.6	272
	K_{OC}	7	407	2.2	275
Georgia (GA) peanut	K_d	7	197	5.2	156
	K_{OC}	7	206	3.9	158
North Carolina (NC) cotton	K_d	7	640	8.7	**492**
	K_d	37	641	8.7	491
	K_d	67	637	8.7	490
	K_{OC}	7	742	5.7	484
	K_{OC}	37	**751**	5.7	483
	K_{OC}	67	744	5.7	482

[A] Maximum values are bolded.

Figure 5.1 displays ground water concentrations over time for the North Carolina scenario with the K_d input and the 7-days post-emergence initial application date.

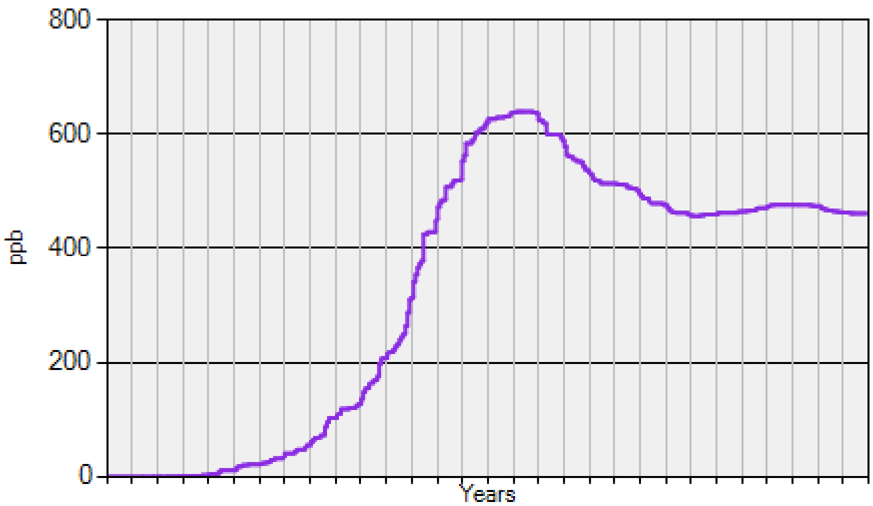

Figure 5.1 Sulfonylurea Coarse-screen Ground Water EDWCs (µg/L) per Time (years) for the North Carolina Scenario, K_d of 0.11, and 7-days post-emergence initial application date

5.1.2. Refined Screen

Refined-screen exposure estimates were generated for 8 sulfonylureas (chlorsulfuron, halosulfuron-methyl, nicosulfuron, prosulfuron, rimsulfuron, triasulfuron, tribenuron-methyl, and triflusulfuron-methyl) for which the coarse-screen EDWCs (*i.e.*, acute EDWC of 751 µg/L and chronic EDWC of 492 µg/L) were problematic. The PRZM-GW inputs for refined-screen EDWCs are listed in **Table 5.4**. Application inputs represent the maximum application rate pattern for the chemical, considering the maximum single application rate first, then the maximum seasonal application rate, using national-scale upper-bound usage rates provided by BEAD if the labels do not provide a maximum seasonal rate. The modeled sorption coefficient is also chemical-specific. All other inputs, including the screening assumptions of stability to degradation and application every year, remained the same as for the coarse screen.

Table 5.4. PRZM-GW Input Parameters for Sulfonylurea Refined-Screen EDWCs

Sulfonylurea (Use)	App. Rate (kg a.i./ha)	App. per Year	Reapp. Interval (days)	Initial App. Date (days since emergence)	App. Method	Hydrolysis and Surface Soil Half-life (days)	Sorption Coefficient (ml/g)
Chlorsulfuron (non-ag areas)	0.157	1	N/A	7	2	0	K_{OC}=21
Halosulfuron-methyl (fallow)	0.157	1 [A]	N/A				K_{OC}=109
Nicosulfuron (rights-of-way)	0.078	1	N/A				K_{OC}=35
Prosulfuron (corn)	0.040	1	N/A				K_d=0.22
Rimsulfuron (commercial areas)	0.071	3 [B]	7 [C]				K_{OC}=47
Triasulfuron (rangeland)	0.031	2 [D]	7 [C]				K_d=0.34
Tribenuron-methyl (soybeans)	0.035	2 [E]	7 [C]				K_{OC}=31
Triflusulfuron-methyl (sugarbeet)	0.035	3 [F]	7 [C]				K_d=0.64

A One application per year was assumed in the absence of label directions based on national-scale usage data collected by BEAD indicating halosulfuron-methyl was not applied more than once to 27,303 acres of fallow land.
B Three applications per year were assumed in the absence of label directions, based on national-scale usage data collected by BEAD indicating that rimsulfuron was not applied more than three times per year to any crop.
C A 7-day reapplication interval was assumed in the absence of label directions, based on the assumption that herbicides are not applied more often, giving time to evaluate the impact of the previous application before the next.
D The 2nd application is at 0.013 kg a.i./ha to reach the seasonal maximum rate of 0.039 lbs a.i./A.
E Two applications per year were assumed in the absence of label directions based on usage data provided by BEAD that indicates tribenuron-methyl was never applied more than twice to 4,831,149 acres of soybeans.
F The 2nd and 3rd applications are at 0.026 kg a.i./ha each to reach the seasonal maximum rate of 0.078 lbs a.i./A.

All six standard scenarios were modeled as surrogates for the use sites listed in **Table 5.4**. PRZM-GW outputs for the most vulnerable scenario are listed in **Table 5.5**. The North Carolina scenario produced the highest daily and post-breakthrough mean EDWCs for each modeled use pattern except that for triflusulfuron-methyl on sugarbeets, for which the Florida citrus scenario provided the highest EDWCs. Additional EDWC refinements were not pursued because the refined-screen EDWCs were found by the Health Effects Division not to be a risk concern.

Table 5.5. PRZM-GW Refined-Screen EDWCs for Sulfonylureas

Sulfonylurea (Use)	PRZM-GW Scenario	Max. Daily Conc. (µg/L)	Post-breakthrough Mean (µg/L)	Mean Breakthrough Time (yrs)
Chlorsulfuron (non-ag areas)	NC cotton	78	52	5.9
Halosulfuron-methyl (fallow)	NC cotton	74	53	8.1
Nicosulfuron (rights-of-way)	NC cotton	39	26	6.2
Prosulfuron (corn)	NC cotton	15	13	12
Rimsulfuron (commercial areas)	NC cotton	105	71	6.5
Triasulfuron (rangeland)	NC cotton	21	19	16
Tribenuron-methyl (corn)	NC cotton	35	23	6.1
Triflusulfuron-methyl (sugarbeet)	FL citrus	23	20	9.5

5.2. Surface Water (FIRST)

5.2.1. Coarse Screen

Screening surface water-sourced drinking water exposure estimates were generated with FIRST (v.1.1.1) to confirm that estimated exposure to SUs via surface water sources is less than that via ground water sources. Rather than produce chemical-specific EDWCs, a coarse-screen estimation approach was used that should exceed upper-bound chemical-specific EDWCs for all SUs, similar to the coarse-screen assessment approach used for ground water exposure. This was achieved by using model inputs that represent the use pattern of highest exposure from any SU, the highest soil mobility of any SU residue of concern, and stability to any route of degradation over time.

The FIRST inputs for the coarse-screen EDWCs are listed in **Table 5.6**. Application inputs represent the maximum rate pattern for imazosulfuron, which is the highest of any SU (two applications per year at 0.66 lbs/acre, with a 21-day reapplication interval). A conservative Percent Cropped Area (PCA) of 100% was used. Chemical inputs (*i.e.*, sorption coefficients) for the SU ROCs were prepared following the Water Models Input Parameter Guidance (USEPA, 2009). The chemicals were modeled as stable to degradation (hydrolysis, photolysis, and metabolism processes) as part of the coarse-screen approach. Sorption coefficients reflect the highest soil mobility of any SU residue of concern, consistent with the coarse-screen approach.

Table 5.6. FIRST Input Parameters for Sulfonylurea Coarse-Screen EDWCs

<table>
<tr><th>Input Parameter</th><th>Value</th><th>Justification</th><th>Source</th></tr>
<tr><td>Application Rate (lbs a.i./A)</td><td>0.66</td><td rowspan="2">Maximum labeled single application rate for use of imazosulfuron on turf (see Table 2.2)</td><td rowspan="3">EPA Reg. No. 59639-155 (Mar. 29, 2011)</td></tr>
<tr><td>Applications per Year</td><td>2</td></tr>
<tr><td>Reapplication Interval (days)</td><td>21</td><td>Minimum labeled interval</td></tr>
<tr><td>PCA Decimal</td><td>1.0</td><td>Conservative value for screen</td><td>Screening assumption</td></tr>
<tr><td>K_d or K_{OC} value (L/kg)</td><td>K_d=0.11 or K_{OC}=12</td><td>Represent the lowest mean K_d and K_{FOC} values for sulfonylurea residues of concern in Table 5.1</td><td>MRID 49308108 (in review); MRID 41869304</td></tr>
<tr><td>Method of Application</td><td>Aerial</td><td>Conservative value for screen</td><td>Screening assumption</td></tr>
</table>

Input Parameter	Value	Justification	Source
Solubility (ppm)	26	Lowest SU value (input is well above and does not impact EDWCs)	MRID 45371702
Aerobic Soil Metabolism Half-life (days)	0	Stability was modeled as a screen	Screening assumption
Aerobic Aquatic Metabolism Half-life (days)	0	Stability was modeled as a screen	Screening assumption
Hydrolysis Half-life (days)	0	Stability was modeled as a screen	Screening assumption
Photolysis Half-life (days)	0	Stability was modeled as a screen	Screening assumption

The resulting coarse-screen EDWCs from FIRST using a K_d of 0.11 were 138 µg/L (1-in-10-year peak used for acute exposure) and 98 µg/L (1-in-10-year annual mean used for chronic exposure). Respective EDWCs using a K_{OC} of 12 were slightly less, at 137 µg/L and 97 µg/L. These values (using either K_d or K_{OC}) are 18-20% of the coarse-screen ground water EDWCs, indicating that the coarse-screen ground water exposure assessment is protective of surface water exposure for SUs with dietary exposure not of concern at the coarse screen.

5.2.2. Refined Screen

Screening surface water EDWCs were generated with FIRST (v.1.1.1) for the 8 SUs for which refined-screen ground water EDWCs were generated, in order to further confirm that estimated exposure to SUs via surface water sources is less than that via ground water sources. The same simple chemical-specific refinements as were made for ground water assessment were made for surface water assessment to generate lower refined-screen EDWCs that remained conservative for the chemical (see **Table 5.7**). Application inputs represent the maximum application rate pattern for the chemical, considering the maximum single application rate first, then the maximum seasonal application rate, using national-scale upper-bound usage data provided by BEAD if the labels do not provide a maximum seasonal rate. The modeled sorption coefficient is also chemical-specific. All other inputs, including the screening assumption of stability to degradation, remained the same as for the coarse screen.

Table 5.7. FIRST Input Parameters for Sulfonylurea Refined-Screen EDWCs

Sulfonylurea (Use)	App. Rate (lbs a.i./A)	App. per Year	Reapp. Interval (days)	Solubility (ppm)	PCA Decimal	App. Method	Degradation Half-lives (days)	Sorption Coefficient (ml/g)
Chlorsulfuron (non-ag areas)	0.14	1	N/A	26	1.0	Aerial	0	K_{OC}=21
Halosulfuron-methyl (fallow)	0.14	1 [A]	N/A					K_{OC}=109
Nicosulfuron (rights-of-way)	0.070	1	N/A					K_{OC}=35
Prosulfuron (corn)	0.036	1	N/A					K_d=0.22
Rimsulfuron (commercial areas)	0.063	3 [B]	7 [C]					K_{OC}=47
Triasulfuron (rangeland)	0.028	2 [D]	7 [C]					K_d=0.34
Tribenuron-methyl (corn)	0.031	2 [E]	7 [C]					K_{OC}=31
Triflusulfuron-methyl (sugarbeet)	0.031	3 [F]	7 [C]					K_d=0.64

A One application per year was assumed in the absence of label directions based on national-scale usage data provided by BEAD indicating halosulfuron-methyl was not applied more than once to 27,303 acres of fallow land.
B Three applications per year were assumed in the absence of label directions, based on national-scale usage data collected by BEAD indicating that rimsulfuron was not applied more than three times per year to any crop.

C A 7-day reapplication interval was assumed in the absence of label directions, based on the assumption that herbicides are not applied more often, giving time to evaluate the impact of the previous application before the next.
D The two applications (0.056 lbs a.i./A total) exceed the seasonal maximum rate of 0.039 lbs a.i./A because FIRST cannot accept multiple application rate values.
E Two applications per year were assumed in the absence of label directions based on usage data provided by BEAD that indicates tribenuron-methyl was never applied more than twice to 4,831,149 acres of soybeans.
F The three applications (0.093 lbs a.i./A total) exceed the seasonal maximum rate of 0.078 lbs a.i./A because FIRST cannot accept multiple application rate values.

FIRST outputs are listed in **Table 5.8**. As expected, acute and chronic surface water EDWCs are less than respective ground water EDWCs for each SU. Therefore, screening ground water exposure estimates rather than surface water exposure estimates are used to screen for exposure concerns in this assessment.

Table 5.8. FIRST Refined-Screen EDWCs for Sulfonylureas

Sulfonylurea (Use)	1-in-10-year Peak (µg/L)	1-in-10-year Annual Mean (µg/L)
Chlorsulfuron (non-ag areas)	14	10
Halosulfuron-methyl (fallow)	13	7.2
Nicosulfuron (rights-of-way)	7.0	4.7
Prosulfuron (corn)	3.7	2.6
Rimsulfuron (commercial areas)	19	12
Triasulfuron (rangeland)	5.7	3.9
Tribenuron-methyl (corn)	6.2	4.2
Triflusulfuron-methyl (sugarbeet)	9.0	5.8

6. Exposure Summary

Table 6.1 summarizes the maximum coarse-screen and refined-screen exposure model results for the sulfonylureas, which are not expected to occur in drinking water due to the conservative nature of these screens. Monitoring data were not collected for this assessment because of its screening approach that is not meant to estimate actual exposures at drinking water intake facilities.

Table 6.1. Coarse- and Refined-Screen Maximum EDWCs for Sulfonylureas

Sulfonylurea (Use)	PRZM-GW Scenario	Screen Level	Max. Daily Conc. (µg/L)	Post-breakthrough Mean (µg/L)	Mean Breakthrough Time (yrs)
Chlorsulfuron (non-ag areas)	NC cotton	Refined	78	52	5.9
Halosulfuron-methyl (fallow)	NC cotton	Refined	74	53	8.1
Nicosulfuron (rights-of-way)	NC cotton	Refined	39	26	6.2
Prosulfuron (corn)	NC cotton	Refined	15	13	12
Rimsulfuron (commercial areas)	NC cotton	Refined	105	71	6.5
Triasulfuron (rangeland)	NC cotton	Refined	21	19	16
Tribenuron-methyl (corn)	NC cotton	Refined	35	23	6.1
Triflusulfuron-methyl (sugarbeet)	FL citrus	Refined	23	20	9.5
All other sulfonylureas	NC cotton	Coarse	751	492	5.7-8.7

7. References

USEPA. 2006. Standardized Soil Mobility Classification Guidance. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division. Internal memorandum. Apr. 21, 2006.

USEPA. 2009. Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, Oct. 22, 2009. http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm

USEPA. 2012. Guidance for Selecting Input Parameters for Modeling Pesticide Concentrations in Groundwater Using the Pesticide Root Zone Model. Version 1.0. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division; Health Canada, Pesticide Management Regulatory Agency, Environmental Assessment Directorate. Oct. 15, 2012.

Appendix A. Aquatic Model Calculations

Aquatic model input and output files are contained in the attached WinZip file.

085601+_427429_DWA_SU-RR.zip

Appendix B. Environmental Fate Data

In support of this assessment, environmental fate data regarding the sulfonylureas and their degradates were collected from the problem formulations for registration review and, in some cases, directly from studies submitted to EPA. The data are tabulated in the attached Microsoft Excel workbook.

SU PRA Fate Data FINAL.xls

Appendix C. Chemical Structures

In support of this assessment, the chemical structures of the sulfonylureas and their degradates were collected from the problem formulations for registration review and from studies submitted to EPA after the problem formulations were prepared. The data are tabulated in the attached Microsoft Word document.

SU PRA Chemical Structures.doc