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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: Tier 1 Drinking Water Assessment for the New Use Registration on Turf and Aquatic Vegetation of Penoxsulam, and Six Degradation Products Identified to Be of Toxicological Concern

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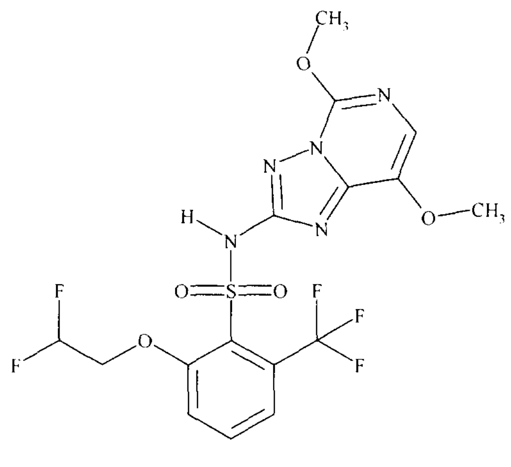
A screening level, upper bound, Tier 1 drinking water assessment for the proposed new uses on established turf and aquatic vegetation of the herbicide, penoxsulam, and six degradation products previously identified by HED to be of toxicological concern has been conducted. The penoxsulam degradation products included in this assessment are: BSTCA, 2-amino TCA, 5-OH-XDE-638, SFA, sulfonamide, and 5,8-di OH (molecular structures for degradates of toxicological concern appear in **Table 5**). Estimated drinking water concentrations (EDWCs) for these combined toxic residues resulting from the proposed new uses are not expected to exceed 150 ppb in the environment.

Environmental Fate Summary

Penoxsulam is stable to hydrolysis, and is expected to be somewhat persistent in non-aquatic environments. The major route of dissipation for penoxsulam in clear and shallow surface water under favorable light conditions is through direct aqueous photolysis ($t_{1/2}$ = 1.5-14 days). Penoxsulam is slightly more persistent in aerobic aquatic ($t_{1/2}$ = 12-38 days) and anaerobic environments ($t_{1/2}$ = 5-11 days), and even more persistent in aerobic soil environments ($t_{1/2}$ = 34-118 days). Penoxsulam is also very mobile (K_d = 0.13-1.96), and does have the potential to leach to ground water. The low vapor pressure and Henry's Law constant, limits the potential of penoxsulam to volatilization from soil and water.



Penoxsulam

Eleven major degradation products have been identified for penoxsulam (BSTCA, 2-amino-TCA, 5-OH-penoxsulam, SFA, sulfonamide, 5,8-di-OH-penoxsulam, BSA, 2-amino-TP, TPSA, BSTCA methyl, and 5-OH 2 amino TP). Data are not available to fully characterize these degradates and their respective degradation pathways. As stated earlier, six of these degradation products have been identified by HED as being of toxicological concern. These toxic residues are: BSTCA, 2-amino TCA, 5-OH-penoxsulam, SFA, sulfonamide, and 5,8-di OH. Specific data concerning the proper chemical names, molecular structure, and the formation and concentrations of these degradates can be found in **Table 5**.

Penoxsulam is expected to be very mobile in the environment. Environmental fate data submitted for the degradation products of toxicological concern indicate that they are even more mobile than the parent compound. However, EFED does not currently have a method for estimating a model input value for the mobility of combined toxic residues. Therefore, as a simplifying assumption, the lowest mobility values for one of the degradation product was used for this Tier 1 assessment.

Use Information

Penoxsulam has previously been registered as a herbicide for use on rice crops. The proposed new uses for penoxsulam are for established turf grass and aquatic uses. For turf use, areas including: residential lawns, golf courses, sports fields, sod farms, around commercial buildings and other commercial turf areas, and for the management of aquatic vegetation in: lakes, reservoirs, ponds, canals, seeps, rivers, streams, swamps, marshes, bogs, transition areas between terrestrial and aquatic sites, and seasonal wet areas. On turf penoxsulam can be applied as liquid ground spray, or in a granular form. The maximum proposed single application rate for both forms is 0.06 lbs. a.i./acre, with the maximum proposed annual application rate for both forms is 0.09 lbs. a.i./acre.

Application of liquid penoxsulam to aquatic sites can be injected under the surface of water to achieve a target concentration not to exceed 150 ppb, ground sprayed to exposed sediment after drawdown, or applied either aerially or by ground spray to floating or emerged aquatic vegetation.

Application rates and methods for aquatic uses are listed in **Table 1**. The proposed labels do not clearly specify the number of applications, the application intervals, or water depth (when applicable) for aquatic uses. In the absence of explicit instructions, conservative assumptions were made, for modeling purposes, that used one application of maximum rates to minimum water depth. Directions for sub-surface injection specify a target concentration, but are not clear concerning how to determine if that concentration had been achieved. For penoxsulam use on exposed or floating weeds it has been assumed that naturally occurring perennial water sources would not have a water depth less than 6 inches.

Table 1. Application Rates and Practices for Proposed New Aquatic Uses

Application Type	Application Method	Number of Applications	Application Rate or Target Concentration	Application Interval
In-Water Application (submerged or floating aquatic weeds)	sub-surface injection to ≥ 10% of target zone	single application	5 – 150 ppb	NA
		split or multiple applications	5 – 75 ppb (150 ppb annual maximum)	as needed to maintain ≥ 5 ppb minimum

				concentration
Foliar Application (floating and emergent weeds)	aerial (coarse droplets)	proposed label unclear	0.0313 – 0.0875 lb.a.i./acre	proposed label unclear
	boat or ground (boom-type backpack or hydraulic handgun; coarse or coarser droplets)	proposed label unclear	0.0313 – 0.0875 lb. a.i./acre	proposed label unclear
Exposes Sediment Application (pre- and post- emergence control of aquatic weeds)	spray from boat or truck	proposed label unclear	0.0875 – 0.175 lb. a.i./acre	proposed label unclear

Application rates and methods for turf uses are listed in **Table 2**. In order to better gauge the effects of differing application practices, several application rates were modeled. Included as an upper bound acute estimate, was a single application of the maximum annual application rate. This does exceed the proposed single application rate, but model limitations prohibit accepting differing application rates. It was necessary to run each application scenario in order to determine the maximum EDWCs from turf uses, so the results are all presented here.

Table 2. Modeled Application Rates for Proposed Turf Uses

Application Method	Application Rate (lbs. a.i./acre)	Number of Applications	Application Interval (days)
ground spray	0.060	1	--
ground spray	0.045	2	30
ground spray	0.090*	1	--
ground spray	0.030	3	30

* 0.09 lbs. a.i./acre exceeds proposed single application rate, however, due to limitations prohibiting the model accepting differing application rates, the maximum annual application rate was modeled as a single application

Estimated Drinking Water Concentrations (EDWCs)

Estimated drinking water concentrations (EDWCs) for penoxsulam and the combined toxic residues resulting from the proposed new uses are not expected to exceed 150 ppb in the environment. The upper bound of a Tier 1 estimate for the proposed new uses of penoxsulam, established turf and aquatic water bodies, have been calculated. The six identified residues of concern, along with maximum application rates, have been included to make the most conservative, upper bound estimates presented here.

Surface Water

Based upon results of the Tier 1, surface model, FIRST, the upper bound peak EDWC value resulting from the use of penoxsulam on turf is 9.4 ppb. The upper bound, Tier 1 chronic

The upper bound peak and chronic EDWC value resulting from the subsurface injection of penoxsulam to control submerged aquatic vegetation is 150 ppb. This value was taken directly from the maximum target concentration listed on the proposed labels.

The average, peak EDWC value resulting from the use of penoxsulam on floating or emerged aquatic vegetation is 64 ppb per application, *per one foot water depth.* This concentration is not an EDWC, but is a factor that has been derived by direct calculation using the application rate per acre and the volume of water covering one acre at a depth of one foot. This value is inversely proportional to water depth. At deeper water depths, aquatic concentrations would be lower, at shallower water depths, aquatic concentrations would be higher. EFED does not expect concentrations resulting from spray application to floating or emergent weeds to exceed the target injection concentration 150 ppb. The water depth would need to be less than 6 inches to exceed the 150 ppb concentration value. Such a shallow water depth is not expected to be found in naturally occurring, perennial water bodies. In situations where such shallow water depths might be encountered, such as irrigation or drainage ditches, it is reasonable to expect that the most efficient application of penoxsulam would involve interrupting the water flow, "drawing down", and making the application directly to the exposed sediment. Based upon results of the Tier 1, surface model, FIRST, the upper bound, peak and chronic EDWC values resulting from the use of penoxsulam on exposed sediment after drawdown are 18.2 ppb and 1.8 ppb, respectively.

Ground Water

The SCI-GROW, Tier I EDWC value for penoxsulam evaluated at the maximum annual application to turf is 12.0 ppb. The SCI-GROW, Tier I EDWC value for penoxsulam evaluated at the maximum single application to exposed sediment after drawdown is 23.3 ppb. While SCI-GROW was developed for estimating ground water concentrations resulting from agricultural uses, EFED currently has no other method for estimating ground water EDWCs from exposed sediments, and these results are expected to be adequately conservative. In the absence of an approved method for calculating ground water concentrations resulting from use of penoxsulam on submerged, floating or emergent aquatic vegetation EFED can only assume that ground water concentration would not exceed the maximum estimated peak surface water concentration of 150 ppb. EFED expects that the actual concentration found in ground water from these aquatic uses will be less than 150 ppb.

Water Modeling Parameters and Estimation Calculations

The EDWCs (Estimated Drinking Water Concentrations) in a perennial surface water body were calculated using the EPA Tier I FIRST (FQPA Index Reservoir Screening Tool; version 1.1.0, December 12, 2005) using the EFED Index Reservoir environment. FIRST is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and the environmental fate and transport of pesticides in surface water. All modeled metabolism input values were based upon total toxic residues. Values for the parent alone would be expected to be lower than these upper bound estimates. Modeling output files are appended to this document.

Table 3 contains the upper bound model predictions for the total toxic residues are based on maximum annual application rates of penoxsulam for the proposed new uses. In the case of turf uses, the maximum annual application rate modeled exceeds the proposed single application rate, but, due to limitations prohibiting the model accepting differing application rates, was modeled as a single application as an upper bound estimate. The exposure concentrations of drinking water were estimated for ground application to turf, and both ground and aerial applications to aquatic vegetation.

Table 3. Tier 1 Estimated Drinking Water Concentrations (EDWCs) for Total Toxic Residues of Penoxsulam Resulting from Turf and Aquatic Uses

Targeted Use	Application Method	Application Rate or Target Concentration	Number of Applications / Application Interval	Ground Water	Surface Water	
				acute[1] and chronic[2]	acute[1]	chronic[2]
Submerged or Floating Aquatic Vegetation	sub-surface injection	150 ppb annual maximum (5 ppb minimum)	1 / --	150 ppb	150 ppb	150 ppb
Emerged or Floating Aquatic Vegetation	aerial application	0.0875 lb./acre	1 / --	150 ppb[3]	150 ppb[3]	150 ppb[3]
Pre- and Post-Emergence Aquatic Vegetation on Exposed Sediment	spray from boat or truck	0.175 lb./acre	1 / --	23.3 ppb	18.2 ppb	1.8 ppb
Established Turf	ground spray	0.060	1 / --	8.0 ppb	6.2 ppb	0.61 ppb
Established Turf	ground spray	0.090	1 / --	12.0 ppb	9.4 ppb[4]	0.92 ppb[4]
Established Turf	ground spray	0.030	3 / 30 days	12.0 ppb	8.9 ppb	0.87 ppb
Established Turf	ground spray	0.045	2 / 30 days	12.0 ppb	9.1 ppb	0.89 ppb

1 maximum peak daily concentration
2 maximum annual average concentration
3 at 64 ppb for a one foot water depth, the depth would need to be <6 inches to exceed a 150 pbb concentration
4 0.09 lbs./acre exceeds proposed single application rate, however, due to limitations prohibiting the model accepting differing application rates, the maximum annual application rate was modeled as a single application

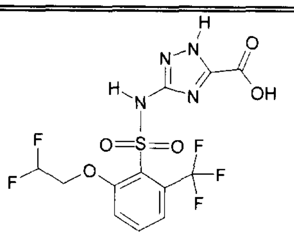
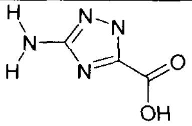
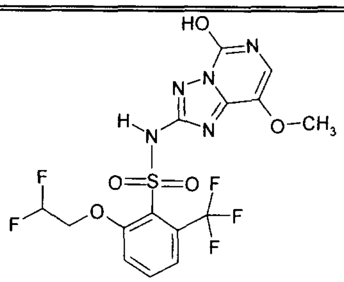
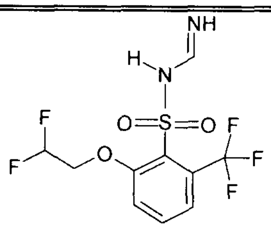
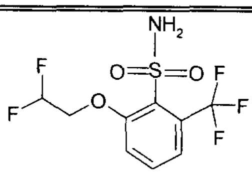
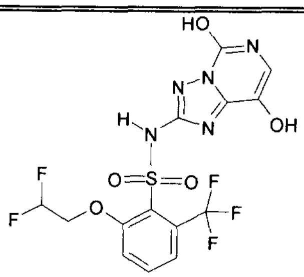
Table 4 contains input parameters for the Tier 1 modeling conducted for this assessment. Degradation parameters were calculated for total toxic residues. At each sampling interval, concentrations of the residues that were identified to be of concern were added, in terms of parent equivalents. These concentrations were converted to natural logarithms, and plotted against time. The slope of the resulting regression line was used to calculate the total toxic half-lives. All modeling degradation parameters for penoxsulam had more than one half-life available. Modeling inputs were calculated as the 90^{th} % tile for each value using the equations presented in the table. The solubility value for the parent compound, and the lowest mobility value (from a degradation product) were used in this Tier 1 screening assessment.

Table 4. Summary of Environmental Fate Data Used in Tier 1 Aquatic Drinking Water Modeling Input Values for Total Toxic Residues of Penoxsulam

Fate Property	Input Parameters for Surface Water Modeling	Input Parameters for Ground Water Modeling	MRID (or source)
Aqueous Solubility	**408 mg/L at pH 7**	--	45830726 (parent)
Aqueous Photolysis	**4.3 days** (1.33 + (1.886*1.51)/sqrt 3)	--	45834801 45830722
Aerobic Soil Metabolism Half-life	**467 days** (410 + (1.886*80)/sqrt 3)	**410 days** (average value)	45830724
Anaerobic Aquatic Metabolism Half-life	**88.3 days** (70 + (3.078* 8.4)/sqrt 2)	--	45830725
Hydrolysis	**stable** @ pH = 7	--	45830721
Aerobic Aquatic Metabolism	**36.6 days** (26.0 + (1.886*9.7)/sqrt 3)	--	45830726
Mobility in Soil	K_d = **0.13** (lowest non-sand value)	K_{oc} = **13** (lowest non-sand value)	45830802

The complete chemical names, molecular structures, maximum amount formed in terms of parent equivalents, and the type of study where the degradates of toxicological concern have been captured in **Table 5**. In some cases, maximum concentrations were reported at study termination. It is not possible to determine if concentrations would have increased if the study had been conducted for a longer duration. Those values are marked with an asterisk in the table below.

Table 5 Maximum Reported Amounts of Degradation Products Identified to Be of Toxicological Concern

Degradate Name	Structure	Maximum % Applied	Study Type
BSTCA 3-[[[2-(2,2-Difluoroethoxy)-6-(trifluoromethyl)phenyl]-sulfonyl]amino]-1H-1,2,4-triazole-5-carboxylic acid		11.1% 7.2% 39.4%* 37.2%* 25.4%	soil photolysis aqueous photolysis aerobic aquatic metabolism aerobic soil metabolism anaerobic aquatic metabolism
2-Amino TCA 2-amino-1,2,4-triazole carboxylic acid		85%*	aqueous photolysis
5-OH-penoxsulam 2-(2,2-Difluoroethoxy) -N-(5,6-dihydro-8-methoxy-5-oxo[1,2,4] triazolo[1,5-c] pyrimidin-2-yl)-6-(trifluoromethyl) benzenesulfonamide		40.3% 62.6% 41.6%	aerobic aquatic metabolism aerobic soil metabolism anaerobic aquatic metabolism
SFA 2-2,2-Difluoroethoxy)-N-(iminomethyl-6-(trifluoromethyl)-benzenesulfonamide		14.7%*	aerobic soil metabolism
Sulfonamide 2-(2,2-Difluoroethoxy) -6-(trifluoromethyl)-benzenesulfonamide		33.0%*	aerobic soil metabolism
5,8-diOH 2-(2,2-Difluoroethoxy) -6-trifluoromethyl-N-(5,8-dihydroxy-[1,2,4] triazolo[1,5-c] pyrimidin-2-yl) benzenesulfonamide		11.0%*	anaerobic aquatic metabolism

*Maximum % of applied reported at study termination indicating that amounts may have continued to increased with time

FIRST Output Files

RUN No. 1 FOR penoxsulam ON aquatic we * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.175(.175)	1 1	.1	408.0	GROUND(6.4)	100.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
467.00	2	N/A	4.30- 533.20	36.60	34.25

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.0 DEC 12, 2005

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
18.211	1.781

RUN No. 2 FOR penoxsualm ON turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.060(.060)	1 1	.1	408.0	GROUND(6.4)	100.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
467.00	2	N/A	4.30- 533.20	36.60	34.25

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.0 DEC 12, 2005

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
6.244	.611

RUN No. 3 FOR penoxsulam ON turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.045(.088)	2 30	.1	408.0	GROUND(6.4)	100.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
467.00	2	N/A	4.30- 533.20	36.60	34.25

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.0 DEC 12, 2005

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
9.117	.892

RUN No. 4 FOR penoxsulam ON turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
.090(.090)	1 1	.1	408.0	GROUND(6.4)	100.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC DAYS UNTIL HYDROLYSIS PHOTOLYSIS METABOLIC COMBINED
(FIELD) RAIN/RUNOFF (RESERVOIR) (RES.-EFF) (RESER.) (RESER.)

467.00 2 N/A 4.30- 533.20 36.60 34.25

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.0 DEC 12, 2005

PEAK DAY (ACUTE) ANNUAL AVERAGE (CHRONIC)
CONCENTRATION CONCENTRATION

9.366 .916

RUN No. 5 FOR penoxsulam ON turf * INPUT VALUES *

RATE (#/AC) No.APPS & SOIL SOLUBIL APPL TYPE %CROPPED INCORP
ONE(MULT) INTERVAL Kd (PPM) (%DRIFT) AREA (IN)

.030(.086) 3 30 .1 408.0 GROUND(6.4) 100.0 .0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC DAYS UNTIL HYDROLYSIS PHOTOLYSIS METABOLIC COMBINED
(FIELD) RAIN/RUNOFF (RESERVOIR) (RES.-EFF) (RESER.) (RESER.)

467.00 2 N/A 4.30- 533.20 36.60 34.25

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.0 DEC 12, 2005

PEAK DAY (ACUTE) ANNUAL AVERAGE (CHRONIC)
CONCENTRATION CONCENTRATION

8.889 .869

SCI-GROW Output Files

```
                              SCIGROW
                            VERSION 2.3
            ENVIRONMENTAL FATE AND EFFECTS DIVISION
                  OFFICE OF PESTICIDE PROGRAMS
              U.S. ENVIRONMENTAL PROTECTION AGENCY
                          SCREENING MODEL
                FOR AQUATIC PESTICIDE EXPOSURE

 SciGrow version 2.3
exposed aquatic vegetation
 chemical:penoxsulam
 time is  8/ 2/2006  16:32:12
 -------------------------------------------------------------------
  Application    Number of     Total Use   Koc     Soil Aerobic
  rate (lb/acre) applications  (lb/acre/yr) (ml/g)  metabolism (days)
 -------------------------------------------------------------------
    0.175         1.0          0.175     1.30E+01    410.0
 -------------------------------------------------------------------
 groundwater screening cond (ppb) =   2.33E+01
 ************************************************************************

                              SCIGROW
                            VERSION 2.3
            ENVIRONMENTAL FATE AND EFFECTS DIVISION
                  OFFICE OF PESTICIDE PROGRAMS
              U.S. ENVIRONMENTAL PROTECTION AGENCY
                          SCREENING MODEL
                FOR AQUATIC PESTICIDE EXPOSURE

 SciGrow version 2.3
 chemical:penoxsulam
 time is  8/ 1/2006  16:55:20
 -------------------------------------------------------------------
  Application    Number of     Total Use   Koc     Soil Aerobic
  rate (lb/acre) applications  (lb/acre/yr) (ml/g)  metabolism (days)
 -------------------------------------------------------------------
    0.030         3.0          0.090     1.30E+01    410.0
 -------------------------------------------------------------------
 groundwater screening cond (ppb) =   1.20E+01
 ************************************************************************
```

SCIGROW
VERSION 2.3
ENVIRONMENTAL FATE AND EFFECTS DIVISION
OFFICE OF PESTICIDE PROGRAMS
U.S. ENVIRONMENTAL PROTECTION AGENCY
SCREENING MODEL
FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:penoxsulam
time is 8/ 1/2006 16:54:44

Application rate (lb/acre)	Number of applications	Total Use (lb/acre/yr)	Koc (ml/g)	Soil Aerobic metabolism (days)
0.060	1.0	0.060	1.30E+01	410.0

groundwater screening cond (ppb) = 7.99E+00
****

SCIGROW
VERSION 2.3
ENVIRONMENTAL FATE AND EFFECTS DIVISION
OFFICE OF PESTICIDE PROGRAMS
U.S. ENVIRONMENTAL PROTECTION AGENCY
SCREENING MODEL
FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:penoxsulam
time is 8/ 1/2006 16:54:31

Application rate (lb/acre)	Number of applications	Total Use (lb/acre/yr)	Koc (ml/g)	Soil Aerobic metabolism (days)
0.090	1.0	0.090	1.30E+01	410.0

groundwater screening cond (ppb) = 1.20E+01
****

SCIGROW
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U.S. ENVIRONMENTAL PROTECTION AGENCY
SCREENING MODEL
FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:penoxsulam
time is 8/ 1/2006 16:55: 8

Application rate (lb/acre)	Number of applications	Total Use (lb/acre/yr)	Koc (ml/g)	Soil Aerobic metabolism (days)
0.045	2.0	0.090	1.30E+01	410.0

groundwater screening cond (ppb) = 1.20E+01
****