OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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MEMORANDUM **TG Barcode: 628816**

SUBJECT: **Metamitron:** Drinking Water Assessment for the Proposed Section 18 Emergency Use on CO, ID, NE, OR and WY Sugar Beets

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Metamitron is a new selective, systemic triazinone plant growth regulator (PGR) and herbicide that belongs to the class of triazinone herbicides developed by Makhteshim Agan of North America, Inc. (dba ADAMA) (herein referred to as ADAMA). The Environmental Fate and Effects Division (EFED) has completed a drinking water exposure assessment (DWA) for a Section 18 emergency use exemption (EUE) in support of the human health risk assessment conducted by

the Health Effects Division (HED). Metamitron is proposed to control glyphosate-resistant palmer amaranth (*Amaranthus palmeri*) in sugar beets grown in Colorado, Idaho, Nebraska, Oregon, and Wyoming.

The conclusions conveyed in this assessment were developed in full compliance with EPA Scientific Integrity Policy for Transparent and Objective Science, and EPA Scientific Integrity Program's Approaches for Expressing and Resolving Differing Scientific Opinions. The full text of EPA Scientific Integrity Policy for Transparent and Objective Science, as updated and approved by the Scientific Integrity Committee and EPA Science Advisor can be found here: https://www.epa.gov/system/files/documents/2023-12/scientific_integrity_policy_2012_accessible.pdf. The full text of the EPA Scientific Integrity Program's Approaches for Expressing and Resolving Differing Scientific Opinions can be found here: https://www.epa.gov/scientific-integrity/approaches-expressing-and-resolving-differing-scientific-opinions

1 Executive Summary

Metamitron is a new selective systemic triazinone herbicide. Metamitron is classified by the Herbicide Resistance Action Committee (HRAC) as a serine 264 binder (Group 5) which disrupts photosystem II, inhibiting electron transport (HRAC, 2022). The Colorado, Idaho, Nebraska, Oregon, and Wyoming Departments of Agriculture submitted a Section 18 request for the application of Goltix 700 SC herbicide (58.3% active ingredient (a.i.) of metamitron) on sugar beets at 2.92 lb a.i./A as a single pre-emergence application to control glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*). The proposed label allows an additional application of metamitron up to the same rate if crop failure occurs. Therefore, the maximum annual application for metamitron may be as high as 5.84 lb a.i./A. The proposed applications would be made by ground equipment (aerial applications are prohibited) and the proposed label instructs the applicator not to apply within 100 feet of aquatic areas and not to cultivate within 10 feet of an aquatic area to allow growth of a vegetative buffer strip. The proposed use is limited to 10 counties in Colorado, 7 counties in Idaho, 14 counties in Nebraska, Malheur County only in Oregon, and 7 counites in Wyoming.

In this DWA, the residues of concern (ROC) include metamitron and its four major degradates: desamino-metamitron, M1, M2, and M3 as recommended by the Residues of Concern Knowledgebase Subcommittee (ROCKS) (USEPA 2023, DP 465056). Degradation kinetics were calculated using the Total Residues (TR) method (USEPA, 2019). The Pesticide in Water Calculator (PWC) model (version 2.001 for groundwater (GW) and version 3.003 for surface water (SW), respectively) and new drinking water scenarios[1] for SW were used to estimate drinking water exposure for SW and GW that may be used as source water. Input half-lives for ROCs were calculated for aqueous photolysis, aerobic soil metabolism, aerobic aquatic metabolism, and anaerobic aquatic metabolism model inputs. Estimated drinking water

[1] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#aquatic

concentrations (EDWC) were modeled for SW and GW exposure based on the proposed emergency use exemption (EUE) use on sugar beets at the maximum single pre-emergence application rate of 2.92 lb a.i./A with an additional application at 2.92 lb a.i./A if crop failure occurs; therefore, the annual maximum application rate is 5.84 lb a.i./A/Yr (**Table 1-1**). If crop failure does not occur, the maximum single application rate of 2.92 lb a.i./A may result in lower SW and GW exposure. For SW, EDWCs based on two applications were **232** µg/L for the 1-in-10-year 1-day mean (acute), **127** µg/L for the 1-in-10-year annual mean (non-cancer chronic), and **75** µg/L for the 54-year mean (cancer chronic) for use on sugar beets (**Table 1-1**). The maximum modeled EDWCs for GW were **141** µg/L for acute and **44.5 µg/L** for chronic drinking water exposure for sugar beets. The maximum EDWCs for sugar beets from SW sources were ~ 1.6 times higher than those from GW sources for sugar beets (**Table 1-1**). Uses on apples and pears proposed under FIFRA Section 3 would result in lower EDWCs once granted. Therefore, EFED recommends the SW EDWCs of **232 µg/L** (1-in-10-year 1-day mean; acute), **127 µg/L (**1-in-10-year annual mean; non-cancer chronic), and **75 µg/L** (54-year mean; cancer chronic) for use in human health dietary risk assessment.

Table 1-1. Recommended Drinking Water Exposure Estimates for Metamitron Residues of Concern[1]

Use	**Source** (PWC ver. 2.001)	**Acute EDWC (µg/L)**	**Chronic EDWC (µg/L)**	**Cancer Chronic EDWC (µg/L)**
Sugar beets	Surface water exposure[1]	**232**	**127**	**75**
Sugar beets	Groundwater exposure [2]	141	44.5	

Bolded numbers are recommended in support of the human health risk assessment.

[1] EDWCs reflect ROCs including parent compound, desamino-metamitron, M1, M2, and M3.

[2] Based on uses on sugar beets with an annual application rate of 5.84 lbs a.i./A.

2 Use Characterization

The FIFRA Section 18 EUE applications submitted by the Colorado, Idaho, Nebraska, Oregon, and Wyoming Departments of Agriculture specifically request the use of Goltix 700® SC herbicide (currently unregistered) for preemergence use on sugar beets to control glyphosate-resistant Palmer amaranth in 10 counties in Colorado, 7 counties in Idaho, 14 counties in Nebraska, Malheur County only in Oregon, and 7 counties in Wyoming at a proposed maximum single application rate of 2.92 lb a.i./A using ground equipment after planting followed by incorporation to ¼ to ½ inch with irrigation, rainfall within 48 hours, or through tillage. The label indicates that metamitron may be re-applied at 2.92 lbs a.i./A 20 days later in the event of crop failure. The potential for 2 applications occurs at a low frequency in several states (0.8-6% of all acres planted were replanted on average from 2020-2024) (e-mail communication on replanting information provided by Rebecca Larson, Western Sugar, September 25, 2024), Therefore, the maximum annual application rate may be as high as 5.84 lb a.i./A/Yr but in most cases will be 2.92 lb a.i./A/Yr. Aerial applications are prohibited, and the label instructs the applicator not to apply within 100 feet of aquatic areas and not to cultivate within 10 feet of an

aquatic area to allow growth of a vegetative buffer strip, however, the label does not require a maintained vegetative buffer strip adjacent to the water body.

Table 2-1 summarizes the proposed uses, maximum application rates, application methods, and labeled use restrictions for metamitron. There are no label uncertainties. The following are the label restrictions for the S18 EUE:

- Do not apply by air.
- Do not apply within 10 feet of an aquatic area to allow growth of a vegetative filter strip.
- Do not apply to ground within 100 feet of aquatic areas.
- Do not apply through any type of irrigation system.
- Apply only as a medium or coarser spray (ASABE standard 572.1).
- Do not apply when wind speeds exceed a range of 3-10 miles per hour.

Table 2-1. Proposed Maximum Use Patterns for Metamitron.

Crop	Application Method	Maximum Single Application Rate (lb a.i./A)	Maximum Number of Applications per Year	Application Interval (days)	Maximum Annual Application Rate (lb a.i./A)	Restrictions/ Comments
Sugar beets	Ground (broadcast)[1]	2.92	2	N/A	5.84[2]	For use only in the Colorado Counties: Adams, Boulder, Larimer, Logan, Morgan, Phillips, Sedgwick, Washington, Weld and Yuma. For use only in the Idaho Counties: Canyon, Elmore, Gooding, Jerome, Minidoka, Owyhee, and Payette. For use only in the Oregon county: Malheur. For use only in the Nebraska counties: Banner, Box Butte, Chase, Cheyenne, Dawes, Deuel, Garden, Keith, Kimball, Morrill, Perkins, Scotts Bluff, Sheridan, and Sioux. For use only in the Wyoming Counties: Big Horn, Fremont, Goshen, Laramie, Park, Platte, and Washakie.

[1] Do not apply to ground within 100 feet of aquatic areas. Do not apply within 10 feet of an aquatic area to allow the growth of a vegetative filter strip. Aerial applications are prohibited.
[2]Maximum annual application rate of 5.84 lb a.i./A includes an additional application of 2.92 lb a.i./A if crop failure occurs.

3 Mode of Action

Metamitron is a selective, systemic herbicide and belongs to the class of triazinone herbicides. Metamitron is classified by the Herbicide Resistance Action Committee (HRAC) as a class C1 serine 264 binder, which disrupts photosystem II that results in the inhibition of electron transport (HRAC, 2022).

4 Environmental Fate and Transport

Selected physical and chemical properties of metamitron and its degradate desamino-metamitron (no environmental fate data are available for M1, M2, and M3) are summarized in **Table 4-1** and **Table 4-2.** Maximum formation fractions, mineralization to CO_2 and degradates formed from metamitron in environmental fate studies are identified as tabulated in **Appendix A**. Metamitron has a solubility limit in water of 1,680 mg/L (20°C) at neutral pH and a low volatility potential (vapor pressure of 1.05×10^{-8} torr at 20°C) under field conditions and from water surfaces (Kaw of 6.9×10^{-11} and Henry's Law constant 1.66×10^{-12} atm-m^3/mol). Therefore, metamitron is classified as non-volatile from water and dry non-adsorbing surfaces. Metamitron has a pKa of 2.97 indicating it may behave as a strong acid and is expected to be predominately ionized at environmental pHs. The log octanol-water partition coefficient (log K_{OW}) is 0.96; therefore, metamitron is not likely to accumulate in aquatic or terrestrial organisms.[2]

Metamitron (mean K_d = 0.99 mL/g and mean K_{oc} = 53 mL/g-organic carbon) and its degradate, desamino-metamitron (mean K_{oc} = 78 mL/g-o.c.) are both classified as mobile based on measured K_d/K_{oc} values and the FAO classification system (FAO, 2000). Based on the Goring persistence scale (Goring *et al*., 1975), metamitron is slightly to moderately persistent based on the aerobic soil metabolism DT_{50s} ranging from 3.4 to 39 days at 20°C in eight soils (See **Figure 4-1** for the proposed transformation pathway in soil). Metamitron is persistent in anaerobic soils (DT_{50s} ranging from 27 to 299 days at 20°C in seven soils). Metamitron is slightly persistent based on aerobic aquatic metabolism DT_{50s} ranging from 9-47 days at 20°C. Metamitron may be transported to surface water via spray drift and runoff or to groundwater via leaching.

[2] A recent FIFRA Scientific Advisory Panel (SAP) reported, "Gobas *et al* (2003) concluded that chemicals with a log K_{OA} greater than five can biomagnify in terrestrial food chains if log K_{OW} greater than two and the rate of chemical transformation is low. However, further proof is needed before accepting these limits without reservations" (SAP, 2009). This was also supported by the work of Armitage and Gobas (Armitage and Gobas, 2007).

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Figure 4-1. Proposed Transformation Pathway for Metamitron (Phenyl-^{14}C) in Aerobic Soils (MRID 51173779, p.15).

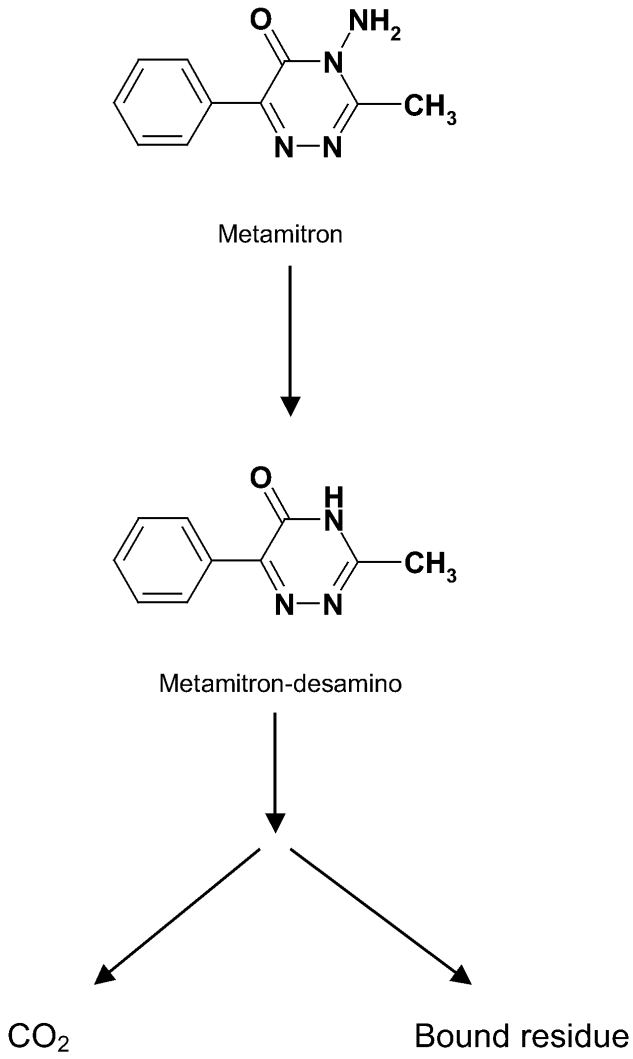


Table 4-1. Environmental Fate and Transport Properties of Metamitron

Parameter	Value[1]	Source/ Study Classification/ Comment
Molecular Weight (g/mole)	202.22	MRID 51173619
Water Solubility Limit at, pH 7 (mg/L)	1680	MRID 51173619/620
Vapor Pressure at 20°C (Torr)	1.05×10^{-8}	MRID 51173613/614 The compound is non-volatile under field conditions.

Parameter	Value[1]						Source/ Study Classification/ Comment
Air-Water Partitioning Coefficient (Kaw)	6.91 x 10^{-11}						Estimated from Henry's Law Constant
Henry's Law Constant at 20°C (atm-m^3/mol)	1.66 x 10^{-12}						Estimated from vapor pressure and water solubility. The compound is non-volatile from water.
Log Acid Dissociation Constant (pKa) at 20°C	2.97						MRID 51173895
Log Octanol-water partition coefficient (K_{OW}) at 20°C (unitless)	0.96						MRID 51173623 / Low potential for bioaccumulation.
Freundlich Soil-Water Distribution Coefficients (K_F) with units of L/kg-soil)$^{-1/n}$ Organic carbon normalized Freundlich distribution coefficients (K_{FOC}) with units of L/kg-OC)$^{-1/n}$	**Soil/Sediment**	**K_d**	**K_{OC}**	**K_F**	**K_{FOC}**	**1/N**	MRID 51173796/Supplemental. Study was conducted using only four soils. K_{oc} had lower variation across soils than K_d based on lower CV. All studies were conducted using foreign soils.
	Borstel soil	0.702	65	0.932	86	0.81	
	Lufa type 3A loam	1.36	52	1.75	67	0.79	
	Lufa type 2.2 Sandy loam	0.970	42	1.29	56	0.82	
	Parabraunerde Soest soil	0.945	51	1.19	64	0.83	
	Mean	0.99	53	1.3	68.3	0.81	
	C.V.	0.27	0.18	0.26	0.19	0.021	
	Soil/Sediment	**K_d**	**K_{OC}**	**K_F**	**K_{FOC}**	**1/N**	MRID 51173803/Supplemental. Sediment was sterilized with gamma irradiation prior to use in the study[1]. Mobile (FAO classification system)
	9WS California Sand	0.278	154	0.263	146	0.95	

[1]Sediment sterilized with gamma irradiation prior to use in the study was not included in exposure modeling.
CV=Coefficient of Variation

Table 4-2. Soil Sorption Coefficients of the Metamitron Degradate, Desamino-Metamitron

Parameter	Soil/ Sediment	K_d	K_{oc}	K_F	K_{FOC}	1/N	Source/ Study Classification/ Comment
Freundlich Soil-Water Distribution Coefficients (K_F) with units of L/kg-soil$^{)-1/n}$	Hofchen am Hohenseh 4a silt	1.25	48	1.73	66	0.76	MRID 51173805/Supplemental. Mobile (FAO classification system); K_{OC} better predicted sorption than K_d based on the lower CV.
	BBA 2.2 Soil	1.29	52	170	69	0.78	
	BBA 2.1 Sand	0.59	101	0.802	136	0.80	
Organic carbon normalized Freundlich distribution coefficients (K_{FOC}) with units of L/kg-OC$^{)-1/n}$	Laacher Hof AXXa Sandy loam	2.0	111	2.52	140	0.79	
	Mean	1.3	78	1.69	102.8	0.78	
	C.V.	0.45	0.42	0.42	0.40	0.02	

Table 4-3 summarizes the time for concentration/mass to decline by 50 percent (DT_{50}) and 90 percent (DT_{90}) and representative model input half-life values for metamitron. Representative model input half-life values may be different from the actual time to 50 percent decline of the residues as degradation kinetics were often biphasic with the rate of degradation slowing over time. The representative degradation half-life is designed to provide an estimate of degradation for biphasic degradation curves that will not overestimate degradation when assuming a single first-order decline curve in modeling.

Metamitron degrades in less than an hour in water under photolytic conditions with the longest half-life of 0.037 days, while, in soil, the photolysis half-life is 40 days. Metamitron is subject to alkaline-based hydrolysis, where hydrolysis half-lives decrease with increasing pH under alkaline conditions (half-life = 5.7 days at pH 9). Hydrolysis half-lives were 158 and 224 days at pH 7 and 4, respectively, at 20°C. Metamitron degrades under aerobic aquatic conditions with half-lives ranging from 9 to 49 days (See **Figure 4-2** for an example proposed transformation pathway in water) and in aerobic soil with half-lives ranging from 3.4 to 39 days. Under anaerobic aquatic (mainly alkaline) conditions, half-lives ranged from 3.7 to 6.1 days, and in anaerobic (mainly acidic to neutral) soil, half-lives ranged 27 to 299 days. This indicates the compound degrades in days in anaerobic (likely alkaline) aquatic conditions, in weeks under aerobic conditions, and in months in acidic to neutral anaerobic soil.

Unextracted residues (UR) formed up to 50% in the environmental fate studies. Solvents with a wide range of dielectric constants were used in most studies to conclude that the URs are strongly bound to soil and sediment and that exposure to these residues is unlikely. In addition, the degradation of pesticides with amine and hydroxyl groups may lead to an increased formation of bound residues as these functional groups are considered more reactive and compete between degradation and bound residue formation (Barriuso *et al*., 2007).

Table 4-3. Environmental Fate Properties of Metamitron

Study Type	System Details	Kinetic Model Fitted Value and Unit		Parent and ROC Representative Model Input Half-life (days)[2]		Source/ Study Classification/ Comment
		DT_{50} (days)	DT_{90} (days)	Parent	ROC	
Abiotic Hydrolysis	pH 4, 20 °C	224	745	224 (SFO)	NA	MRID 51173807, Supplemental. Phenyl ring radiolabeled.
	pH 7, 20 °C	158	523	158 (SFO)	NA	
	pH 9, 20 °C	5.7	19	5.7 (SFO)	NA	
Aqueous Photolysis[1]	pH 7, 25°C, adjusted to summer light, 40°N	0.037	0.13	0.037 (SFO)	5.6 (SFO) (Adjusted for 40°N)	MRID 51173813, Supplemental because there were limited data points to characterize the degradation curve due to rapid degradation. Phenyl ring radiolabeled. The 40°N non-adjusted TR half-life is 2.68 d
Soil Photolysis[3]	Speyer Germany Dry: loamy sand soil, 20°C, pH 5.6, adjusted to summer light at 40°N	40	133	NA		MRID 51173789, Supplemental. Phenyl ring radiolabeled.
Aerobic Soil Metabolism	Loamy sand soil, 20°C, pH 6.2	21	70	21 (SFO)	21 (SFO)	MRID 51173779, Supplemental. Phenyl ring radiolabeled.
	Silt loam, 20°C, pH 7.3	3.4	11	3.4 (SFO)	3.4 (SFO)	
	Silt soil, 20°C, pH 7.6	15	259	78 (IORE)	182 (DFOP slow)	MRID 51173780, Supplemental. Unextracted residues were a maximum of 40% and a range of solvents were not utilized in extractions. Phenyl ring radiolabeled.
	Sandy loam soil, 20°C, pH 7.2	13	83	25 (IORE)	49.6 (IORE)	MRID 51173782, Supplemental. Extraction did not include a range of solvents and unextracted residues were up to 39%. Phenyl ring radiolabeled.
	Silt loam, 20°C, pH 5.3	39	171	52 (IORE)	86 (IORE)	MRID 51173784, Supplemental. Triazine ring radiolabeled
	Sandy loam, 20°C, pH 6.4	9.3	31	9.3 (SFO)	9.3 (SFO)	
	Loamy sand, 20°C, pH 5.9	22	73	22 (SFO)	22 (SFO)	
	Clay soil, 20°C, pH 7.2	10.5	35	10.5 (SFO)	10.5 (SFO)	
Anaerobic Soil Metabolism[3]	Loamy sand, 20°C, soil pH 5.8	27	90	NA		MRID 51173786, Supplemental.
	Sandy loam, 20°C, soil pH 6.8	186	617	NA		MRID 51173787, Acceptable.

Study Type	System Details	Kinetic Model Fitted Value and Unit		Parent and ROC Representative Model Input Half-life (days)[2]		Source/ Study Classification/ Comment
		DT_{50} (days)	DT_{90} (days)	Parent	ROC	
	Silt loam, 20°C, soil pH 6.4	299	993	NA		
	Sandy loam, 20°C, soil pH 7.4	194	643	NA		
	Loamy sand, 20°C, soil pH 6.9	71	237	NA		MRID 51173788, Acceptable.
	Silt loam, 20°C, soil pH 5.0	79	262	NA		
	Sandy loam, 20°C, pH 7.1	265	879	NA		
Aerobic Aquatic Metabolism	Rhineland-Palatinate surface water, water pH 8.24, 20°C-25°C	22	75	22 (SFO)	535 (IORE)	MRID 51173817, Supplemental. Surface water only. Not corrected for hydrolysis.
	Waldwinkel water: sediment, water pH 7.96, sediment pH 7.2, 20°C	11	36	11 (SFO)	317 (DFOP slow)	MRID 51173818, Supplemental. Not corrected for hydrolysis.
	Ruckhaltebecken water: sediment, water pH 8.0, sediment pH 7.4, 20°C	12	38	12 (SFO)	44 (DFOP slow)	
	Pond water: sandy clay loam, water pH 8.0, sediment pH 6.7, 20°C	22	74	22 (SFO)	88 (SFO)	MRID 51173819, Acceptable. Triazine ring radiolabeled.
	Creek water: silt loam, water pH 7.5, sediment pH 7.2, 20°C	9.0	30	9.0 (SFO)	89 (SFO)	
	Furwigge-sediment texture, water pH 6.0, sediment pH 4.5, 20°C	24	89	27 (IORE)	76 (DFOP slow)	MRID 51173823, Supplemental. Phenyl ring radiolabeled.
	Schwarzes Wasser-sediment, water pH 6.1, sediment pH 4.3, 20°C	49	163	49 (SFO)	121 (SFO)	

Study Type	System Details	Kinetic Model Fitted Value and Unit		Parent and ROC Representative Model Input Half-life (days)[2]		Source/ Study Classification/ Comment
		DT_{50} (days)	DT_{90} (days)	Parent	ROC	
Anaerobic Aquatic Metabolism	Golden Lake Water: loamy sand sediment, water pH 8.17, sediment pH 7.88, 20°C	3.7	12	3.7 (SFO)	511 (SFO)	MRID 51173820, Supplemental. Standard redox potential values could not be determined.
	Goose River Water: loam sediment, water pH 8.26, sediment pH 7.74, 20°C	4.2	14	4.2 (SFO)	444 (SFO)	
	Golden Lake Water: loamy sand sediment, water pH 8.99, sediment pH 7.71, 20°C	6.1	20	6.1 (SFO)	211 (SFO)	MRID 51173821, Supplemental. Standard redox potential values could not be determined.
	Goose River Water: loam sediment, water pH 8.87, sediment pH 7.83, 20°C	4.7	16	4.7 (SFO)	595 (DFOP slow)	

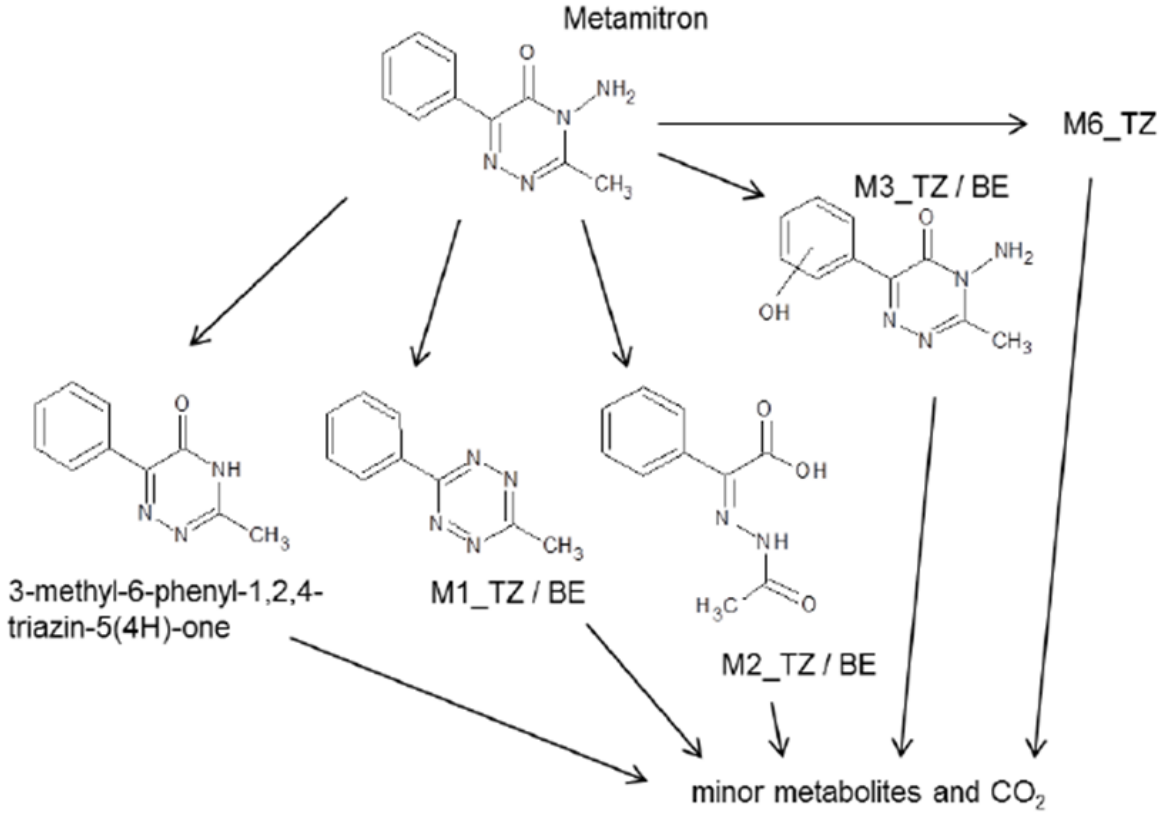
SFO=single first order; DFOP=double first order in parallel; IORE=indeterminate order (IORE); SFO DT_{50}=single first order half-life; T_{IORE}=the half-life of a SFO model that passes through a hypothetical DT_{90} of the IORE fit; DFOP slow DT_{50}=slow rate half-life of the DFOP fit, --=not available or applicable; SFO-LN=SFO calculated using natural log transformed data

[1] Aquatic phototransformation half-life was adjusted to summer light, 40°N using the dark control corrected DT_{50} of 0.0179 days and the conversion factor of 2.07 (MRID 51173813).

[2] The value used to estimate a model input value is the calculated SFO DT_{50}, T_{IORE}, or the DFOP slow DT_{50} from the DFOP equation. The model chosen is consistent with that recommended using the, *Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* (NAFTA, 2012).

[3] To be consistent with the, *Standard Operating Procedure for Using the NAFTA Guidance to Calculate Representative Half-life Values and Characterizing Pesticide Degradation,* "representative model half-life values" for anaerobic soil metabolism studies were not reported since they are not used in aquatic modeling.

Figure 4-2. A Proposed Transformation Pathway for Metamitron (Phenyl-^{14}C, Triazine-5,6-^{14}C, MRID 51173817, page 19) in Aerobic Water Bodies.



Thirteen major transformation products (≥10 % applied radioactivity (AR)) were identified across all environmental fate studies (**Appendix A**), including:

- Desamino-metamitron (MH 1)
- M1 (MH5, 3-Methyl-6-phenyl-1,2,4,5-tetrazine)
- M2 (2-(Acetylhydrazineylidene)-2-phenylacetic acid)
- M3 (4-Amino-6-(3-hydroxyphenyl)-3-methyl-1,2,4-triazin-5(4H)-one)
- M2a (4-Amino-3-methyl-5-oxo-4,5-dihydro-1,2,4-triazine-6-carboxylic acid)
- M4 (MTM-178-HD, N-acetylbenzohydrazide)
- Benzonitrile
- MH6 (Phenylglyoxylic acid)
- MH7 (Benzamide)
- MH11 (MTM-220E-HH, (2E)-(2-acetylhydrazineylidene)-2-phenylacetohydrazide)
- MH12 (benzoic acid)
- 4-Amino-3-methyl-5oxo-4,5-dihydro-1,2,4-triazine-6-carboxylic acid
- Carbon dioxide

Of these major degradates, four were identified to be the residues of concern (ROCs) for drinking water exposure; desamino-metamitron (Max AR 93%), M1 (Max AR 14%), M2 (Max AR 27%), and M3 (Max AR 20%) (see ROCs **Section 5**).

A summary of terrestrial field dissipation data is provided in **Table 4-4**. Dissipation half-lives (DT_{50}) ranged from 2 to 16 days at 4 sites in the United States. Time to 90% dissipation (DT_{90}) ranged from 14 to 53 days and no major degradates were detected. These results indicate that the persistence of metamitron is dependent on the environmental conditions. Most metamitron residues in terrestrial field dissipation studies conducted in California, New York, and North Carolina sites remained in the top-soil layer (7.5 cm), However, metamitron residues were detected up to the lowest sampling depth (90 cm) in the Washington state study site. These results indicate that metamitron may have the potential to leach to groundwater in some environments. Metamitron's field dissipation rates are within the same order of magnitude as the laboratory study degradation rates. While field dissipation studies are designed to capture a range of loss processes; laboratory studies are designed to capture loss from one process (*e.g.*, hydrolysis, aerobic metabolism). Thus, the values from laboratory studies are not directly comparable to the values from the field studies; however, it is informative to have some understanding of how the laboratory data compare to the loss rates in the field dissipation studies.

Table 4-4. Summary of Field Dissipation Data.

System Details	Analyte	Half-life (Kinetic Fitted Model)[1]		Max Leaching Soil Core Depth (cm)	Source, Study Classification
		DT_{50},	DT_{90}		
California, Bare Plot, Loamy sand, pH 8.5,	Metamitron	4.7 (IORE)	32 (IORE)	7.5	MRID 51173794, Acceptable
New York, Bare Plot, Loamy Sand, pH 6.3	Metamitron	7.5 (IORE)	39 (IORE)	7.5	
North Carolina, Bare Plot, Sandy loam, pH 6.6	Metamitron	2.0 (IORE)	14 (IORE)	7.5	
Washington, Bare Plot, Sand, pH 7.9	Metamitron	16 (SFO)	53 (SFO)	90	

SFO= single first-order; IORE = Indeterminate Order Rate Equation

5 Residues of Concern

The residues of concern (ROC) for this drinking water assessment are metamitron and four major degradates, desamino-metamitron, M1, M2, and M3, as defined by HED's Residues of Concern Knowledgebase Subcommittee (ROCKS) (USEPA 2023, DP 465056). Desamino-metamitron was the major degradate formed in all studies including field dissipation studies. M1, M2 and M3 may also form in substantial amounts in aerobic aquatic environments including those with drinking water intakes. The remaining nine major degradates of metamitron were not included in the ROCs because they only form under high temperatures

(50 °C), in abiotic alkaline conditions (pH 9), or in anaerobic environments. These nine degradates may be present in drinking water; however, the residues are likely to be less prevalent than those observed in the aerobic studies and/or would not impact exposure modeling results. In this drinking water assessment, the ROCs were modeled using the Total Residues (TR) modeling approach (USEPA 2019).

6 Drinking Water Exposure Modeling

6.1 Pesticide in Water Calculator (PWC) Model

Groundwater and surface water aquatic modeling was conducted using the Pesticide in Water Calculator (PWC v2.001 and v3.003, respectively). PWC uses soil, hydrology, land cover/land use, weather, and waterbody properties to simulate pesticide applications to an agricultural field and the subsequent pesticide transport to a surface water body by runoff, erosion, and drift. PWC generates daily concentrations over a long term (typically over 54 years) and calculates a 1-in-10-year EECs in the surface water bodies.

The surface water estimated drinking water concentrations (EDWCs) for drinking water were generated using the surface water component of PWC to generate multi-decadal daily concentration time series and corresponding 1-in-10-year EDWCs in surface water bodies adjacent to application sites receiving runoff and spray drift. Drinking water exposure modeling included metamitron ROC environmental fate and transport processes from the application site to surface and groundwater used as drinking water sources, calculating EDWCs in these sources (USEPA 2009, USEPA 2010, USEPA 2013a, 2013b, 2013c, USEPA 2014a, 2014b. USEPA 2017 and USEPA 2022). The model assumes a standard 172.8 ha watershed that drains into an adjacent standard drinking water "index" reservoir of 5.26 ha, with a mean depth of 2.74 m. The PWC user's manual may be downloaded from the U.S. EPA Water Models web-page.

The development of new PWC scenarios is described in the document titled, "*Creating New Scenarios for Use in Pesticide Surface Water Exposure Assessments*" (USEPA, 2020). These new scenarios number in the millions and can be ranked by vulnerability, thus providing high-end estimated concentrations relative to each 2-digit Hydrologic Unit Code (HUC-2) region[3]. The scenarios were developed, analyzed, and ranked using an automated methodology to identify the 90th percentile scenario within each NHDPlus Hydroregion (**Figure 6-1**) (USEPA, 2020).

[3] Watersheds are delineated by United States Geological Survey (USGS) using a nationwide system based on surface hydrologic features. This system divides the country into 21 regions (2-digit), 222 subregions (4-digit), 370 basins (6-digit), 2,270 subbasins (8-digit), ~20,000 watersheds (10-digit), and ~100,000 subwatersheds (12-digit). A hierarchical hydrologic unit code (HUC) consisting of 2 additional digits for each level in the hydrologic unit system is used to identify any hydrologic area (see Federal Standards and Procedures for the National Watershed Boundary Dataset, 4th ed. 2013). A complete list of Hydrologic Unit codes, descriptions, names, and drainage areas can be found in the United States Geological Survey Water-Supply Paper 2294, entitled "Hydrologic Unit Maps" (https://nas.er.usgs.gov/hucs.aspx).

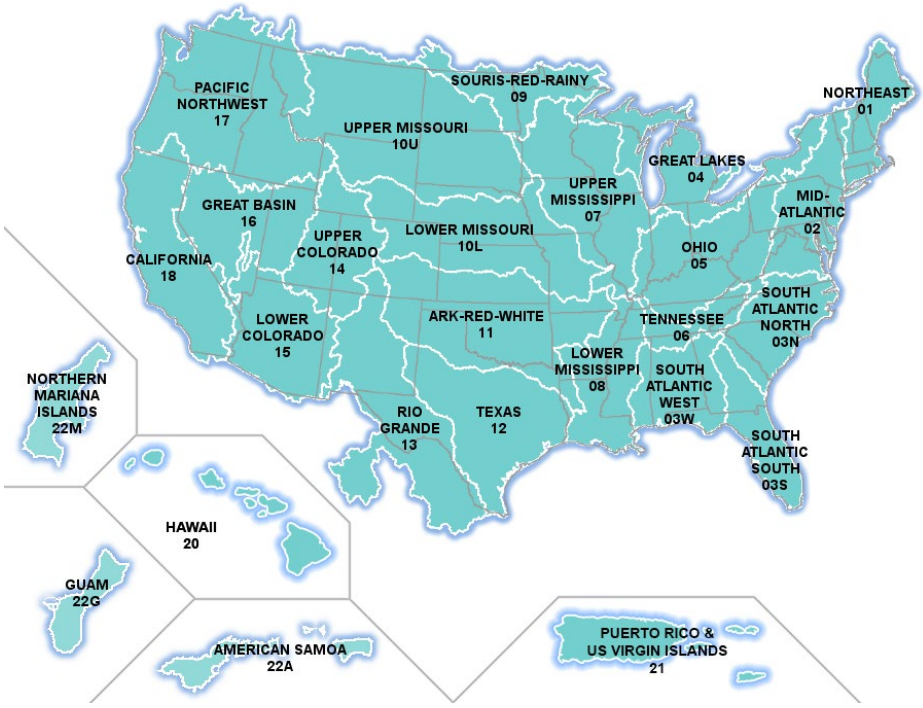


Figure 6-1. Map of the HUC-2 NHDPlus Hydroregions (USGS, 2020)

Figure 6-1 was downloaded from the National Hydrography Dataset Plus United States Regional Dataset (https://www.usgs.gov/media/images/epas-nhdplus-us-regional-dataset-map). The hydroregions generally align with the HUC-2 regions, except for regions 3 and 10, which are subdivided into multiple smaller subregions. For the scenarios, non-commodity crops were grouped based on agronomic practices to reduce the level of uncertainty in the spatial footprint for individual minor crops. A separate 90th percentile scenario was selected for each crop/group of crops within each hydroregion or subregion where the crop is present, for a total of up to 21 scenarios to represent each group of crops on a national scale. Three separate sets of 90th percentile scenarios were created to represent chemicals based on three sets of mean organic carbon-normalized sorption coefficients (K_{OC}). These different sets of scenarios are used to assess chemicals that have a mean K_{OC} that falls into different ranges: mean K_{OC} <100 L/kg-organic carbon, mean K_{OC} from 100 to 3000 L/kg-organic carbon, and mean K_{OC} >3000 L/kg-organic carbon. This assessment utilizes these Koc-based new surface water model scenarios (bin A: K_{OC} under 100 L/kg-oc) along with 54 years of weather data to generate EDWCs.

The new scenarios differ from the previously used scenarios as specified in **Table 6-1.**

Table 6-1. Summary of Parameters Assumed for Different Pesticide in Water Calculator (PWC) Scenarios.

Parameter	Pre-2020 PWC scenarios	Post 2020 Created PWC Scenarios
Vulnerability	Scenarios created to simulate a vulnerable area where a crop is grown, percentile of vulnerability unknown	90th percentile across a HUC-2 region or subregion
Weather File	1960-1991	1961-2014
Sediment Accounting	Sediment disappears	Sediment mass balance
PWC erosion routine**	Velocity Method	Lag Method
Runoff (Manning's N Value)**	N = 0.110	Not Needed
Distribution of Eroded Pesticide in Sediment*	Fixed 0.50	Variable According to K_{OC}

*In PWC version 1.52 the Distribution of Eroded Pesticide in Sediment was fixed at 0.50. In PWC versions 2.001 and 3.003 all modeling is completed with the assumption of varying pesticide distribution between sediment and water column.

**In PWC version 1.52 the All Erosion was calculated with the Velocity method. In PWC versions 2.001 and 3.003, the default erosion model is the Lag Method which does not require Manning's N.

6.2 Groundwater Modeling

The PWC model (via PRZM) also estimates potential concentrations of metamitron residues in groundwater sources of drinking water in vulnerable aquifers. The PWC groundwater modeling simulates leaching through the soil profile, to generate a groundwater concentration daily time series file, with maximum and post-breakthrough average concentrations as the main outputs. Pesticide sorption and degradation during transport through the soil are simulated. The aerobic soil degradation rate is assumed to decline linearly with depth, from its nominal, study result-based value at the soil surface, to a rate of zero at (and beneath) a soil depth of two meters (USEPA, 2022). Hydrolysis, by contrast, is assumed to proceed at an invariant rate throughout the entire soil profile and is assumed in the model to be the only process by which degradation occurs beyond a 2-meter depth. Model output concentrations represent a vertical average of depth-variable concentrations in the aquifer, from the water table to the bottom of the well screen.

Groundwater modeling permits the assessment of multiple years of pesticide application (up to 100 years) on a single site. For this assessment, thirty years of applications were used. Six standard scenarios, each representing a different region known to be vulnerable to groundwater contamination, are available for use with the PWC for exposure estimation purposes. In groundwater simulations, each of these standard scenarios were used, with applications each year for a period of thirty years. While the scenarios are calibrated based on conditions in each of the geographic regions they are named for, they may represent vulnerable conditions in other areas of the country as well.

6.3 Model Inputs

Metamitron-specific PWC chemical input parameters were based on TR half-lives of ROCs (USEPA 2013a). The input half-lives for ROCs were calculated for aerobic soil metabolism, aerobic aquatic metabolism, aqueous photolysis, and anaerobic aquatic metabolism inputs. The submitted hydrolysis data show that metamitron is persistent in acidic and neutral water but doesn't persist in alkaline water (**Table 4-3**). The input half-life calculated for ROCs in aerobic soil was 78.3 days, in aerobic water was 279 days, and in anaerobic water was 575 days. The input half-lives (DT_{50}) for hydrolysis are set to stable for surface water and 158 days for groundwater based on its persistence and the aquatic metabolism half-lives already account for hydrolysis. Metamitron's mean Koc of 53 mL/g was used to represent the ROCs in aquatic modeling since it was the parent compound had the most mobile Koc compared to that of the major degradate desamino-metamitron (78 mL/g) (**Table 6-2**). The groundwater modeling zone of biodegradation was modeled to a 2-meter depth (USEPA 2022).

Table 6-2. PWC Chemical Input Parameters for Metamitron ROCs

Parameter (units)	Value	Source	Comments
Koc (mL/g)	53	MRIDs: 51173796, 51173803	Represents the average K_{OC} value of metamitron. The coefficient of variation was 27% for K_d and 18% for K_{OC}.
[A] Water Column Metabolism Half-life (days) at 20°C	279.3	MRIDs: 51173817, 51173818, 51173819, and 51173823	Represents the 90% confidence bound on the mean of seven ROC representative modeling half-lives (535, 317, 44, 87.9, 89, 75.5, and 121 d) for metamitron, desamino-metamitron, M1, M2, and M3.
Benthic Metabolism Half-life (days) at 20°C	575.3	MRIDs:511737820 and 51173821	Represents the 90% confidence bound on the mean of four ROC representative modeling half-lives (511, 444, 211, and 595 d) for metamitron and desamino-metamitron.
Aqueous Photolysis Half-life (days) 20°C, 40°N	5.6	MRID: 51173813	Represents the value for metamitron and desamino-metamitron corrected for dark control and natural sunlight at 40 °N with a conversion factor of 2.07.
Hydrolysis Half-life (days) 20°C	0 (surface water) 158 (groundwater)	MRID: 51173807	Set to zero for surface water modeling since aquatic metabolism studies are not corrected for hydrolysis (158 d; parent). 158 d @ pH 7 hydrolysis half-life value used for groundwater modeling.
Soil Half-life (days) at 20°C	78.3	MRIDs: 51173779, 51173780, 51173728, 51173784	Represents the upper 90% confidence bound on the mean of five parent only and three ROC representative modeling half-lives (21.1, 3.42, 182*, 49.6*, 86.1*, 9.3, 21.8, and 10.5 d) for metamitron (*includes ROC desamino-metamitron).
Molecular Weight (g/mol)	202.22	Calculated	Molecular weight of the parent, metamitron.

Vapor Pressure (Torr) at 25°C	1.05×10^{-8}	MRID 51173613/614	Measured vapor pressure of metamitron.
Solubility Limit in Water (mg/L) at 20°C, pH 7	1680	MRID 51173619/620	Measured solubility of the metamitron.
Henry's Law constant (unitless)	6.8×10^{-11}	Calculated by PWC	Unitless Henry's Law constant of metamitron.

[A] Metamitron undergoes rapid alkaline hydrolysis; therefore, half-lives from the alkaline aquatic system (Goose River, MRID 5040613/4) were not used in calculations.

[B] 90th percentile confidence bound on the mean = average half-life+($t_{90,n-1}$*standard deviation)/SQRT(N).

For SW and GW assessments, the maximum potential annual application rate of 5.84 lb a.i./A/year for the proposed use on sugar beets was modeled (**Table 6-3**). The proposed label indicates that metamitron is not permitted to be applied aerially or within 100-ft of aquatic areas. Since the metamitron label did not require an application height, but required a medium to coarse spray droplet size, the default ground application equipment with a high boom and a fine to medium/coarse droplet size distribution was selected as conservative estimates of the parameters for spray drift modeling. PWC assumes the spray drift fraction (i.e., a percentage of the application rate) is uniformly applied across the surface of the given waterbody (index reservoir in this case) on the day of application. Spray drift fractions for ground applications were based on these characteristics and the 100 ft aquatic buffer. For surface water modeling, a percent cropped area (PCA) adjustment may be considered for metamitron at a regional level. The current DWA assumes the highest all agriculture PCA for a water resource region in which metamitron is proposed for registration with an all agriculture PCA of 100% (USEPA 2014a)."

The proposed label application directions for one pre-emergence ground application were used to determine the first day of application for the simulated use pattern (see **Table 2-1**). The label indicates incorporating the application into the soil with a ¼ to ½ inch of irrigation or rainfall within 48 hours, or through tillage. PWC includes incorporation up to 4 cm by default for ground applications that are modeled "below crop". Therefore, the incorporation of metamitron application is considered in the assessment. **Table 6-3** summarizes the PWC scenarios, application date, application rate, and inputs specific to metamitron used to estimate ROC EDWCs.

Table 6-3. PWC Scenarios and Input Parameters Specific to Use Patterns for Metamitron

Use Site	PWC Scenario	Date of Initial App.[B]	Single Application Rate in lbs a.i./A (kg a.i./ha)	# App. Per Year	Minimum Retreatment Interval (days)	App Method	Application Efficiency/ Spray Drift [A]
Sugar beets	Row or field crop-r10L-A_V4	-22	2.92 (3.27)	2	20	Below Crop	0.99/0.014
	Row or field crop-r10U-A_V4						
	Row or field crop-r14-A_V4						
	Row or field crop-r16-A_V4						
	Row or field crop-r17-A_V4						

[A] Spray drift fractions for ground applications were calculated using AgDRIFT (Tier I, Agricultural) based on a fine to medium/coarse spray droplet size and a high boom height.
[B] Application timing for sugar beets is based on the label recommendation of pre-emergence direct spray and is in relation to model scenario crop emergence dates.

6.4 Modeling Results of Metamitron ROC

Surface Water Exposure

Table 6-4 summarizes the maximum SW EDWCs for metamitron ROCs from use on sugar beets, which are **232** µg/L for the 1-in-10-year 1-day mean (acute), **127** µg/L for the 1-in-10-year annual mean (non-cancer chronic), and **75** µg/L for the 54-year mean (cancer chronic). These estimated concentrations are based on the maximum potential annual use rate of 5.84 lbs a.i. /A for use on sugar beets.

Table 6-4. Proposed Maximum EDWCs of Metamitron ROCs[1] for Surface Water

Source	Annual Use Rate (PWC Scenario)	1-in-10-Year 1-day Mean (µg/L)	1-in-10-Year Annual Mean (µg/L)	54-Year Mean (µg/L)
Surface Water	(5.84 lb a.i./A/yr) Row or field crop-r17-A_V4	**232**	**127**	**75**

[1] EDWCs reflect ROCs including parent, desamino-metamitron, M1, M2, and M3.

Groundwater Exposure

Table 6-5 summarizes the estimated metamitron ROC concentrations in drinking water from GW with a 2-meter biodegradation zone. The maximum EDWCs in groundwater are **141** µg/L for the peak (acute) and **44.5** µg/L for the post-breakthrough mean (chronic and cancer chronic) based on the maximum annual use rate of 5.84 lbs/A for sugar beets. The groundwater concentrations may vary based on the water pH due the variable hydrolysis rates that may be pH-dependent. In more alkaline water, due to the increased hydrolysis, lower metamitron concentrations may be expected.

Table 6-5. EDWCs of Metamitron ROCs in Groundwater[1,2]

Use Pattern	Application Method	PWC Scenario	Peak (µg/L)	Post-breakthrough Mean (µg/L)
Sugar beets (5.84) ai lb/A/yr)	Ground	FL Central Ridge	**141**	**44.5**
		FL Northeast	22.4	8.99
		GA Southern Coastal Region	6.2	1.8
		Delmarva Peninsula	75.9	39.2
		NC Coastal Plain	7.7	2.5
		WI Central Sand Region	32.7	16.4

EDWCs for groundwater exposure were generated using PWC v2.0
Bold numbers denote maximum EDWC values in groundwater.
[1]Hydrolysis half-life of 158 d was used to generate ground water EDWCs.
[2] EDWCs were generated using a soil biodegradation zone at a 2-meter depth.

7 Monitoring Data

No monitoring data in surface and groundwater are available for metamitron since the chemical is being proposed for registration.

8 Drinking Water Treatment Effects

No data for drinking water treatment effects have been located for metamitron. The Drinking Water Treatability Database was searched for data on drinking water treatment effects on metamitron (https://oaspub.epa.gov/tdb/pages/general/home.do), with no information found. The surface water EDWCs reflect concentrations that may occur in water before entering a drinking water treatment plant. Metamitron is not stable, but slowly hydrolyzes at pH 7 and in acidic conditions and hydrolyzes less slowly in alkaline conditions. Therefore, hydrolysis is not likely to decrease metamitron concentrations during the time the compound travels through a drinking water treatment plant or during water softening processes. Metamitron is considered readily soluble in water based on the estimated water solubility limit and the FAO solubility scale (FAO, 2022). Generally speaking, standard treatment methods (*i.e.* sedimentation, flocculation, and oxidation) may be effective at removing contaminants with high K_d values that strongly sorb to sediment. These standard treatment methods may be ineffective at removing metamitron and its ROCs since their low Kd values indicate that they will not strongly sorb to sediments.

9 Uncertainties

There are no atypical major uncertainties in the current assessment.

10 Conclusion

Recommended EDWCs for surface water drinking water exposure are higher than that for groundwater exposure for sugar beets. Therefore, EFED recommends the surface water EDWCs of **232 µg/L** (1-in-10-year 1-day mean; acute), **127 µg/L (**1-in-10-year annual mean; non-cancer chronic), and **75 µg/L** (54-year mean; cancer chronic) for use in human health dietary risk assessment.

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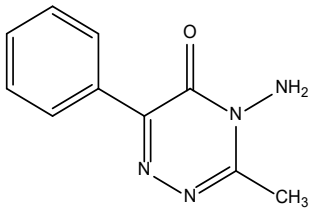
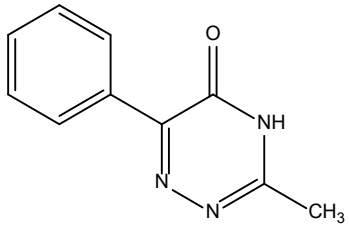
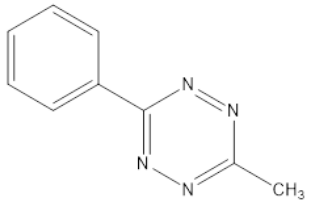
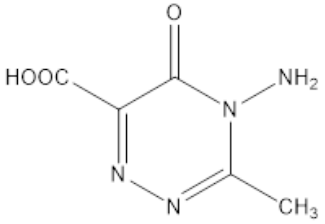
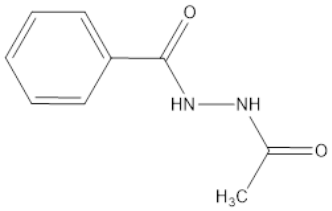
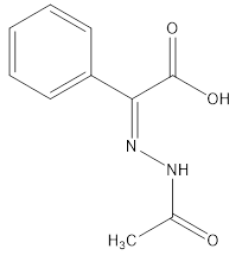
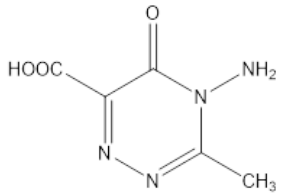
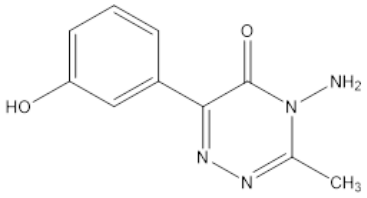
Appendix A. Summary of Metamitron and Its Environmental Transformation Products [A]

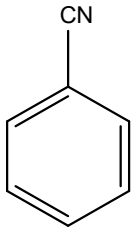
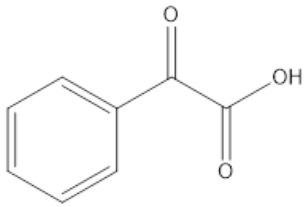
Table A-1. Metamitron and Its Environmental Transformation Products

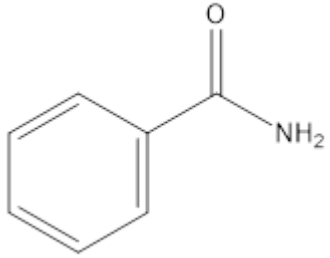
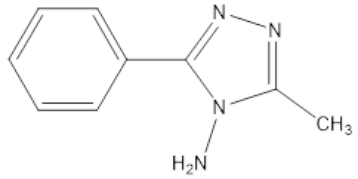
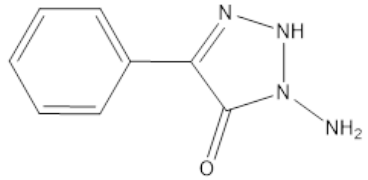
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
PARENT COMPOUND							
Metamitron	**IUPAC:** 4-Amino-4,5-dihydro-3-methyl-6-phenyl-1,2,4-triazin-5-one **CAS:** 4-Amino-3-methyl-6-phenyl-1,2,4-triazin-5(4H)-one **CAS No.:** 41394-05-2 **Formula:** $C_{10}H_{10}N_4O$ **MW:** 202.22 g/mol **SMILES:** c1ccccc1C2=NN=C(C)N(N)C2(=O)		N/A				
MAJOR (>10%) TRANSFORMATION PRODUCTS							
Desamino-metamitron (MH 1)	**IUPAC:** 3-Methyl-6-phenyl-1,2,4-triazin-5(4H)-one **CAS No.:** 36993-94-9 **Formula:** $C_{10}H_9N_3O$ **MW:** 187.2 g/mol **SMILES:** O=C1NC(C)=NN=C1C2=CC=CC=C2		Aerobic soil metabolism	51173779	Loamy sand	7.6% (28 d)	7.6% (56 d)
					Silt loam	9.2% (7 d)	9.2% (7 d)
				51173780	Silt	17.1% (30 d)	15.4% (120 d)
				51173782	Sandy loam	11.3% (14 d)	4.8% (120 d)
				51173784	Silt loam	10.3% (59 d)	10.3% (120 d)
			Anaerobic soil metabolism	51173786	Loamy sand	20.6% (72 d)	13.9% (134 d)
				51173787	Sandy loam	28.6% (32 d)	19.4% (149 d)
					Silt loam	13.6% (29 d)	4.9% (149 d)
					Sandy loam	12.2% (29 d)	10.8% (149 d)
				51173788	Loamy sand	22.2% (150 d)	22.2% (150 d)
					Silt loam	51.5% (88 d)	42.9% (150 d)
					Sandy loam	13.2% (44 d)	8.3% (150 d)
				51173813	Sterile, pH 7	93.2% (0.05 d)	40.4% (14.75 d)

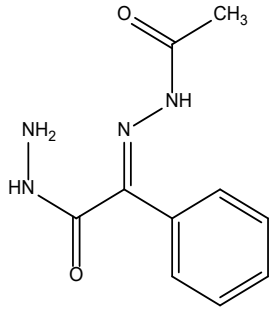
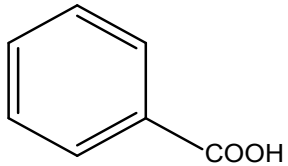
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
			Aqueous photolysis		Natural pond water	81.5% (0.13 d)	8.1% (14.75 d)
			Aerobic aquatic metabolism	51173817	Surface water 100 µg/L	11.8% (61 d)	11.8% (61 d)
					Surface water (100 µg/L)	8.9% (21 d)	5.2% (61 d)
				51173818	Water:sediment (pH 7.04)	76.0% (58 d)	68% (100 d)
					Water:sediment (pH 7.7)	79.0% (58 d)	72.0% (100 d)
				51173819	Pond water: sandy clay loam	59.0% (59 d)	33% (100 d)
					Creek water: silt loam	71.9% (30 d)	50.8% (100 d)
				51173823	Water:sediment (pH 6.0)	15.7% (100 d)	15.7% (100 d)
					Water sediment (pH 6.1)	37.9% (100 d)	37.9% (100 d)
			Anaerobic aquatic metabolism	51173820	Lake water: loamy sand	82.0% (100 d)	76.4% (100 d)
					River water: loam	83.9% (100 d)	83.9% (100 d)
				51173821	Lake water: loamy sand	77.3% (100 d)	77.3% (100 d)
					River water: silt loam	78.7% (61 d)	78.7% (61 d)
			Hydrolysis	51173807	pH 4, 20°C	3.2% (14 d)	3.2% (14 d)
					pH 4, 25°C	3.2% (14 d)	3.2% (14 d)
					pH 4, 50°C	2.9% (14 d)	2.9% (14 d)
					pH 7, 20°C	2.4% (14 d)	1.1% (30 d)
					pH 7, 25°C	2.6% (14 d)	1.5% (30 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
					pH 7, 50°C	2.0% (0.25 d)	ND (30 d)
					pH 9, 20°C	1.6% (1 d)	ND 30 d)
					pH 9, 25°C	1.4% (0.083 d)	0.5% (30 d)
					pH 9, 50°C	1.3% (0.083 d)	ND (30 d)
			Aerobic soil metabolism	51173779	Loamy sand	7.6% (56 d)	5.9% (100 d)
					Silt loam	9.2% (7 d)	3.1% (100 d)
M1 (MH5; MTM-172-MPT)	**IUPAC:** 3-Methyl-6-phenyl-1,2,4,5-tetrazine **CAS No.:** 38634-12-7 **Formula:** $C_9H_8N_4$ **MW:** 172.2 g/mol **SMILES:** CC(N=N1)=NN=C1C2=CC=CC=C2		Aerobic aquatic metabolism	51173817	Surface water (10 µg/L)	4.3% (14 d)	ND (61 d)
					Surface water (100 µg/L)	13.6% (61 d)	13.6% (61 d)
			Anaerobic aquatic metabolism	51173820	Lake water: loamy sand	9.9% (2 d)	1.0% (100 d)
				51173821	River water: loam	7.7% (22 d)	<LOD (100 d)
			Hydrolysis	51173807	pH 7, 20°C	2.5% (30 d)	2.5% (30 d)
					pH 7, 25°C	5.7% (30 d)	5.7% (30 d)
					pH 7, 50°C	19.9% (7 d)	5.1% (30 d)
					pH 9, 20°C	5.0% (30 d)	5.0% (30 d)
					pH 9, 25°C	6.1% (14 d)	5.9% (30 d)
					pH 9, 50°C	9.9% (2 d)	<LOD (30 d)
4-Amino-3-methyl-5-oxo-4,5-dihydro-1,2,4-triazine-6-carboxylic acid	**IUPAC:** 4-Amino-3-methyl-5-oxo-4,5-dihydro-1,2,4-triazine-6-carboxylic acid **CAS No.:** 2168393-43-7 **Formula:** $C_5H_6N_4O_3$ **MW:** 170.13 g/mol **SMILES:** O=C1N(N)C(C)=NN=C1C(O)=O		Anaerobic soil metabolism	51173788	Loamy sand	10.8% (33 d)	ND (150 d)

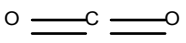
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
MTM-178-HD (M4)	**IUPAC:** N-acetylbenzohydrazide **CAS No.:** 14331-27-2 **Formula:** $C_9H_{10}N_2O_2$ **MW:** 178.2 g/mol **SMILES:** O=C(NNC(C)=O)C1=CC=CC=C1		Aqueous photolysis	51173813	Sterile water, pH 7	2.6% (0.05 d)	1.9% (14.75 d)
					Natural pond water	10.0% (0.25 d)	4.2% (14.75 d)
M2	**IUPAC:** (2-(Acetylhydrazineylidene)-2-phenylacetic acid **CAS No.:** 80238-38-6 **Formula:** $C_{10}H_{10}N_2O_3$ **MW:** 206.2 g/mol **SMILES:** OC(/C(C1=CC=CC=C1)=N\NC(C)=O)=O		Aerobic aquatic metabolism	51173817	Surface water (10 µg/L)	20.1% (61 d)	20.1% (61 d)
					Surface water (100 µg/L)	27.2% (61 d)	27.2% (61 d)
M2a	**IUPAC:** 4-Amino-3-methyl-5-oxo-4,5-dihydro-1,2,4-triazine-6-carboxylic acid **CAS No.:** 2168393-43-7 **Formula:** $C_5H_6N_4O_3$ **MW:** 170.13 g/mol **SMILES:** O=C1N(N)C(C)=NN=C1C(O)=O		Anaerobic soil metabolism	51173786	Loamy sand	19.2% (44 d)	1.4% (134 d)
M3	**IUPAC:** 4-Amino-6-(3-hydroxyphenyl)-3-methyl-1,2,4-triazin-5(4H)-one **Formula:** $C_{10}H_{10}N_4O_2$ **MW:** 218.2 g/mol **SMILES:** O=C1N(N)C(C)=NN=C1C2=CC(O)=CC=C2		Aerobic aquatic metabolism	51173817	Surface water (10 µg/L)	20.3% (30 d)	20.2% (61 d)
					Surface water (100 µg/L)	18.9% (61 d)	18.9% (61 d)

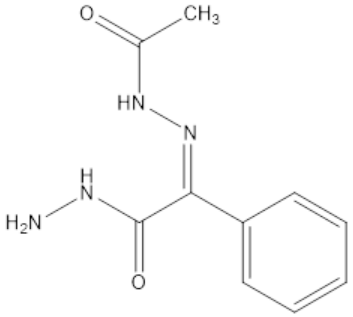
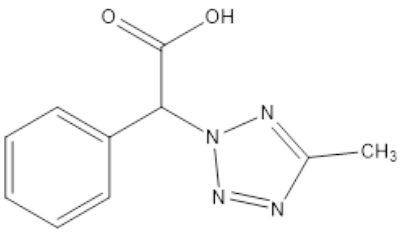
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
Benzonitrile	**IUPAC:** Benzonitrile **CAS No.:** 100-47-0 **Formula:** C_7H_5N **MW:** 103.1 g/mol **SMILES:** N#CC1=CC=CC=C1		Hydrolysis	51173807	pH 7, 50°C	28.1% (30 d)	28.1% (30 d)
					pH 9, 20°C	27.9% (30 d)	27.9% (30 d)
					pH 9, 25°C	28.4% (30 d)	28.4% (30 d)
					pH 9, 50°C	32.9% (14d)	30.2% (30 d)
Phenylglyoxylic acid (MH6)	**IUPAC:** 2-Oxo-2-phenylacetic acid **CAS No.:** 611-73-4 **Formula:** $C_8H_6O_3$ **MW:** 150.1 g/mol **SMILES:** O=C(C(O)=O)C1=CC=CC=C1		Hydrolysis	51173807	pH 4, 50°C	24.0% (30 d)	24.0% (30 d)
					pH 9, 20°C	26.9% (14 d)	13.9% (30 d)
					pH 9, 25°C	28.5% (7 d)	6.8% (30 d)
					pH 9, 50°C	25.7% (1 d)	ND (30 d)

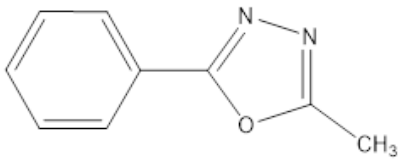
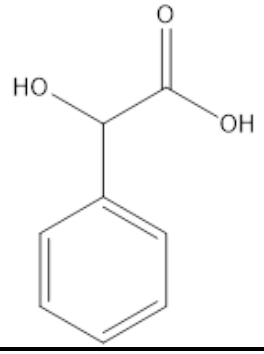
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
MH7	**MH7a** **IUPAC:** Benzamide **CAS No.:** 55-21-0 **Formula:** C_7H_7NO **MW:** 121.1 g/mol **SMILES:** NC(C1=CC=CC=C1)=O		Hydrolysis	51173807	pH 4, 50°C	15% (21 d)	15% (21 d)
					pH 7, 20°C	0.9% (14 d)	ND (30 d)
	MH7b (MTM-174-AM) **CAS No.:** 38345-25-4 **IUPAC:** 3-Methyl-5-phenyl-4H-1,2,4-triazol-4-amine **Formula:** $C_9H_{10}N_4$ **MW:** 174.2 g/mol **SMILES:** CC1=NN=C(N1N)C2=CC=CC=C2				pH 7, 50°C	32.5% (30 d)	32.5% (30 d)
					pH 9, 20°C	3.7% (30 d)	3.7% (30 d)
	MH7c **IUPAC:** 3-Amino-5-phenyl-2,3-dihydro-4H-1,2,3-triazol-4-one **Formula:** $C_8H_8N_4O$ **MW:** 176.2 g/mol **SMILES:** NN1C(C(C2=CC=CC=C2)=NN1)=O			51173807	pH 9, 25°C	3.8% (2 d)	3.6% (30 d)
					pH 9, 50°C	14.2% (30 d)	14.2% (30 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
MH11 (MTM-220E-HH) (E isomer of MH2)	**IUPAC:** (2E)-(2-acetylhydrazineylidene)-2-phenylacetohydrazide **CAS No.:** 56735-29-6 **Formula:** $C_{10}H_{12}N_4O_2$ **MW:** 220.2 g/mol **SMILES:** O=C(NN)/C(C1=CC=CC=C1)=N/NC(C)=O	 **(E) isomer**	Hydrolysis	51173807	pH 4, 50°C	17.5% (30 d)	17.5% (30 d)
					pH 7, 25°C	2.0% (30 d)	2.0 % (30 d)
					pH 7, 50°C	4.1% (21 d)	ND (30 d)
Benzoic acid (MH12)	**IUPAC:** Benzoic acid **CAS No.:** 65-85-0 **Formula:** $C_7H_6O_2$ **MW:** 122.1 g/mol **SMILES:** O=C(O)c(cccc1)c1		Hydrolysis	51173807	pH 7, 50°C	21.9% (30 d)	21.9% (30 d)
					pH 9, 20°C	48.5% (30 d)	48.5 % (30 d)
					pH 9, 25°C	53.6% (30 d)	53.6% (30 d)
					pH 9, 50°C	50.8% (30 d)	50.8% (30 d)
			Aqueous photolysis	51173813	Sterile water, pH 7	10.8% (14.75 d)	10.8% (14.75 d)
					Natural pond water	49.4% (14.75 d)	49.4% (14.75 d)
Unextracted residues	NA	NA	Aerobic aquatic metabolism	51173818	Water:sediment (pH 7.04)	25.0% (100 d)	25.0% (100 d)
					Water:sediment (pH 7.7)	26.0% (100 d)	26.0% (100 d)
				51173819	Pond water: sandy clay loam	41.0% (100 d)	41.0% (100 d)
					Creek water: silt loam	39.6% (100 d)	39.6% (100 d)
				51173823	Water:sediment (pH 6.0)	49.9% (100 d)	49.9% (100 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
					Water: sediment (pH 6.1)	26.7% (100 d)	26.7% (100 d)
			Anaerobic aquatic metabolism	51173820	Lake water: loamy sand	16.9% (100 d)	16.9% (100 d)
					River water: loam	22.7% (100 d)	22.7% (100 d)
				51173821	Lake water: loamy sand	15.0% (61 d)	11.8% (100 d)
					River water:silt loam	16.5% (100 d)	16.5% (100 d)
			Aerobic soil metabolism	51173779	Loamy sand	40.5% (56 d)	24.1% (100 d)
					Silt loam	41.2% (7 d)	23.8% (100 d)
				51173780	Silt	43.5% (90 d)	41.2% (120 d)
				51173782	Sandy loam	39.0% (91 d)	37.3% (120 d)
				51173784	Silt loam	38.0% (120 d)	38.0% (120 d)
					Sandy loam	53.7% (14 d)	32.6% (120 d)
					Loamy sand	41.2% (59 d)	34.5% (120 d)
					Clay	49.3% (30 d)	38.4% (120 d)
			Anaerobic soil metabolism	51173786	Loamy sand	43.3% (72 d)	42.4% (134 d)
				51173787	Sandy loam	28.1% (30 d)	26.1% (149 d)
					Silt loam	32.3% (149 d)	32.3% (149 d)
					Sandy loam (pH 7.4)	24.7% (149 d)	24.7% (149 d)
				51173788	Loamy sand	41.5% (31 d)	23.4% (150 d)
					Silt loam	24.3% (150 d)	24.3% (150 d)
					Sandy loam	20.3% (150 d)	20.3% (150 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
Carbon dioxide	Carbon dioxide **Formula:** CO_2 **MW:** 44 g/mol **SMILES:** C(=O)=O		Aerobic Aquatic metabolism	51173817	Surface water (pH 8.2)	42.0% (61 d)	42% (61 d)
				51173818	Water: sediment (pH 7.04)	1.0% (100 d)	1.0% (100 d)
					Water: sediment (pH 7.7)	1.0% (100 d)	1.0% (100 d)
				51173819	Pond water: sandy clay loam	8.4% (100 d)	8.4% (100 d)
					Creek water: silt loam	4.6% (100 d)	4.6% (100 d)
				51173823	Water:sediment (pH 6.0)	20.4% (100 d)	20.4% (100 d)
					Water: sediment (pH 6.1)	14.4% (100 d)	14.4% (100 d)
			Anaerobic aquatic metabolism	51173820	Lake water: loamy sand	2.5% (100 d)	2.5% (100 d)
					River water: loam	1.4% (22 d)	1.4% (100 d)
				51173821	Lake water: loamy sand	**9.6%** (61 d)	3.7% (100 d)
					River water:silt loam	7.8% (61 d)	3.1% (100 d)
			Aerobic soil metabolism	51173779	Loamy sand	49.1% (100 d)	49.1% (100 d)
					Silt loam	57.4% (100 d)	57.4% (100 d)
				51173780	Silt	23.3% (120 d)	23.3% (120 d)
				51173782	Sandy loam	44.6% (120 d)	44.6% (120 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
				51173784	Silt loam	33.4% (120 d)	33.4% (120 d)
					Sandy loam	65.9% (120 d)	65.9% (120 d)
					Loamy sand	58.7% (120 d)	58.7% (120 d)
					Clay	57.6% (120 d)	57.6% (120 d)
			Anaerobic soil metabolism	51173786	Loamy sand	54.7% (134 d)	54.7% (134 d)
				51173787	Sandy loam	27.0% (149 d)	27.0 (149 d)
					Silt loam	14.0% (149 d)	10.4% (149 d)
					Sandy loam (pH 7.4)	21.3% (149 d)	21.3 (149 d)
				51173788	Loamy sand	28.2% (31 d)	25.7% (150 d)
					Silt loam	17.3% (150 d)	17.3% (150 d)
					Sandy loam	13.9% (150 d)	13.9% (150 d)
MINOR (<10%) TRANSFORMATION PRODUCTS							
MTM-220Z-HH (MH2) (Z-isomer of MH11)	**IUPAC:** (2Z)-(2-acetylhydrazineylidene)-2-phenylacetohydrazide **CAS No.:** 62191-12-2 **Formula:** $C_{10}H_{12}N_4O_2$ **MW:** 220.2 g/mol **SMILES:** O=C(NN)/C(C1=CC=CC=C1)=N\NC(C)=O	 **(Z) isomer**	Hydrolysis	51173807	pH 7, 20°C	7.0% (21 d)	6.0% (30 d)
					pH 7, 25°C	6.8% (21 d)	5.3% (30 d)
					pH 7, 50°C	7.2% (2 d)	ND (30 d)
					pH 9, 20°C	6.7% (21 d)	2.6% (30 d)
					pH 9, 25°C	5.2% (1 d)	2.1% (30 d)
					pH 9, 50°C	3.7% (1 d)	ND (30 d)
MTM-218-5MT (MH4)	**IUPAC:** 2-(5-Methyl-2H-tetrazol-2-yl)-2-phenylacetic acid **Formula:** $C_{10}H_{10}N_4O_2$ **MW:** 218.2 g/mol **SMILES:** O=C(O)C(N1N=NC(C)=N1)C2=CC=CC=C2		Hydrolysis	51173807	pH 7, 20°C	1.0% (21 d)	ND (30 d)
					pH 7, 25°C	2.1% (30 d)	2.1% (30 d)
					pH 7, 50°C	8.0% (30 d)	8.0% (30 d)
					pH 9, 20°C	5.9% (30 d)	5.9% (30 d)
					pH 9, 25°C	8.8% (30 d)	8.8% (30 d)
					pH 9, 50°C	9.1% (14 d)	7.8% (30 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Study Condition	Maximum %AR (day)	Final %AR (study length)
MTM-160-2MPO (MH10)	**IUPAC:** 2-Methyl-5-phenyl-1,3,4-oxadiazole **CAS No.:** 4046-03-1 **Formula:** $C_9H_8N_2O$ **MW:** 160.2 g/mol **SMILES:** CC1=NN=C(O1)C2=CC=CC=C2		Hydrolysis	51173807	pH 9, 25°C	2.7% (30 d)	2.7% (30 d)
					pH 9, 50°C	3.4% (1 d)	2.1% (30 d)
Mandelic acid (MH14)	**IUPAC:** 2-Hydroxy-2-phenylacetic acid **CAS No.:** 90-64-2 **Formula:** $C_8H_8O_3$ **MW:** 152.2 g/mol **SMILES:** OC(C(O)=O)C1=CC=CC=C1		Hydrolysis	51173807	pH 9, 50°C	2.4% (0.25 d)	ND (30 d)

[A] ND= means “not detected”. AR means “applied radioactivity”. MW means “molecular weight”. LOQ means “limit of quantitation”. Bolded values are laboratory study values >10%AR.

Appendix B. Summary of Surface Water Estimated Drinking Water Concentrations

Table B-1. Surface Water Estimated Drinking Water Concentrations for Metamitron ROCs for Use on Sugar Beets.

PWC Scenario	1-in-10 Year 1-day Mean	1-in-10 Year Annual Mean	54-Year Mean
Row or field crop-r10L-A	117	66	35
Row or field crop-r10U-A_V4	141	78	38
Row or field crop-r14-A_V4	45	21	9
Row or field crop-r16-A_V4	144	75	53
Row or field crop-r17-A_V4	**232**	**127**	**75**

Appendix C. Examples of PWC Surface Water and Groundwater Modeling Inputs and Outputs for Sugar Beets

PWC v3.003 Example Surface Water Model Inputs and Outputs

Figure C-1. Model Inputs for Metamitron.

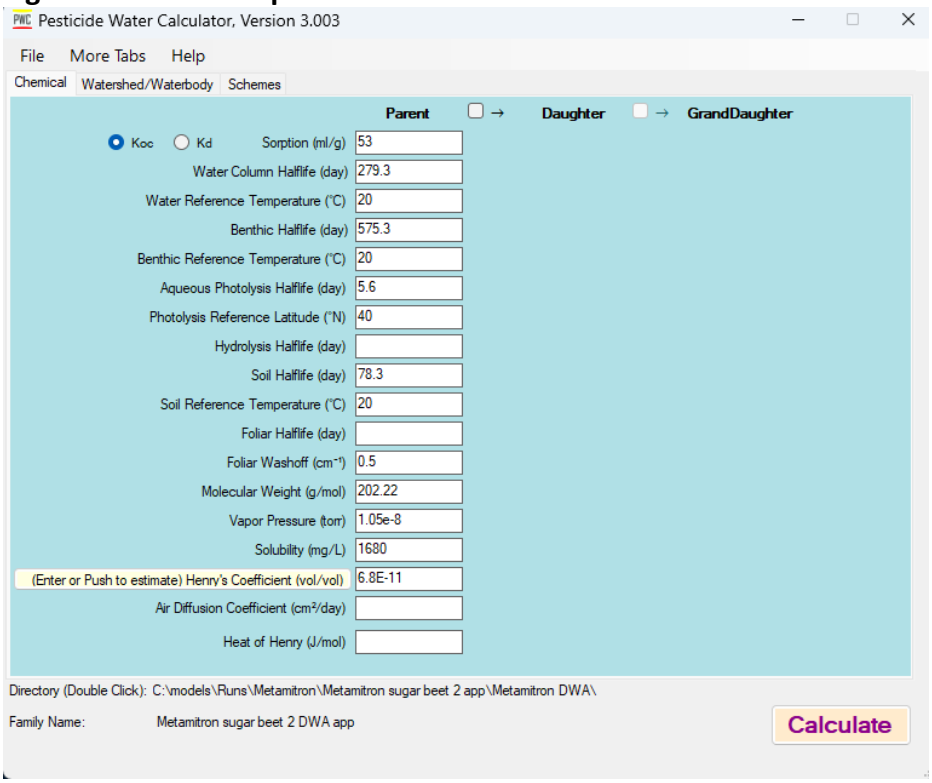


Figure C-2. Model Inputs for Metamitron.

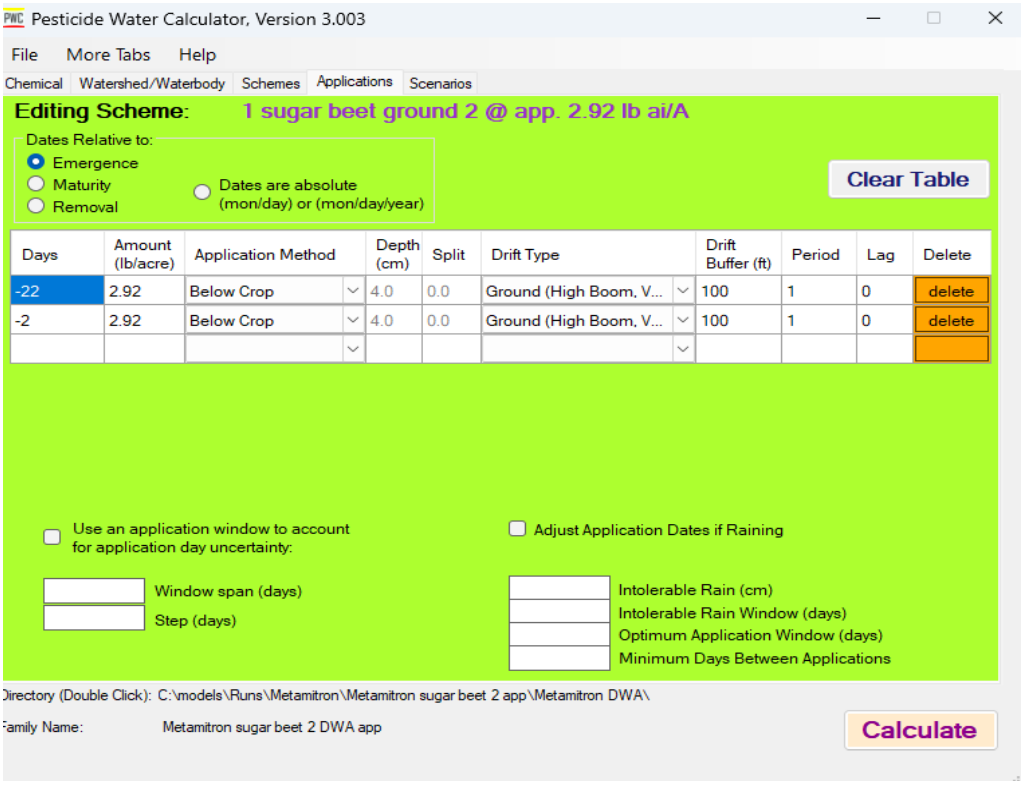


Figure C-3. Model Inputs for Metamitron.

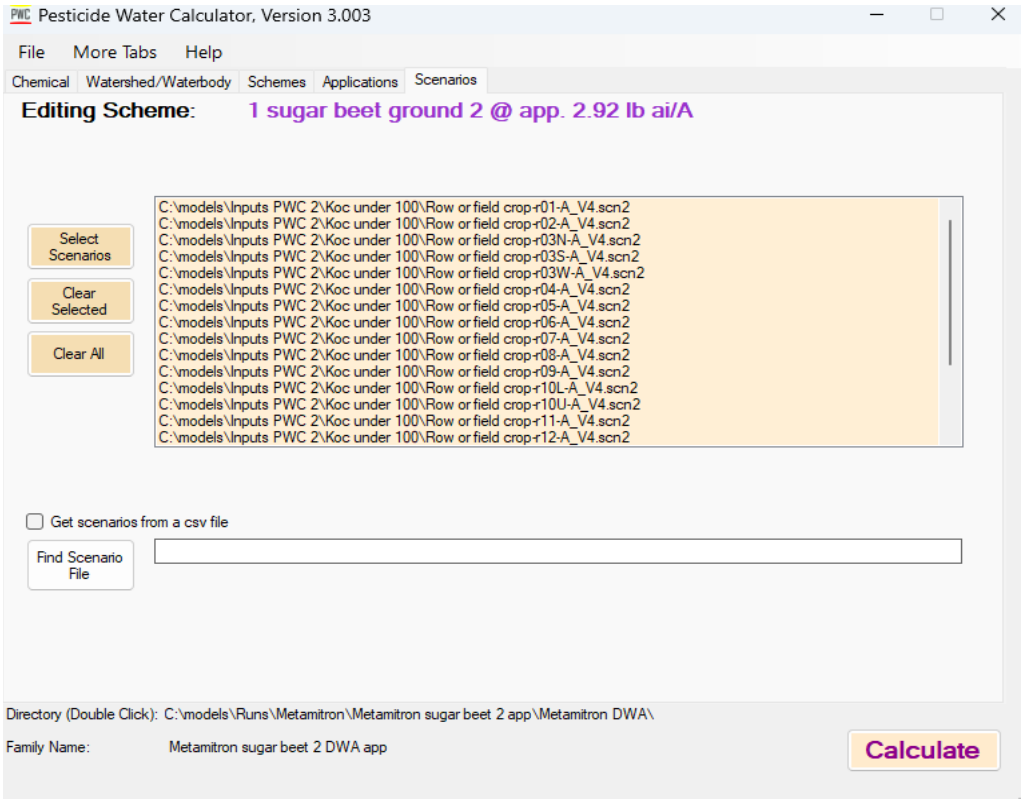


Figure C-4. Model Inputs for Metamitron.

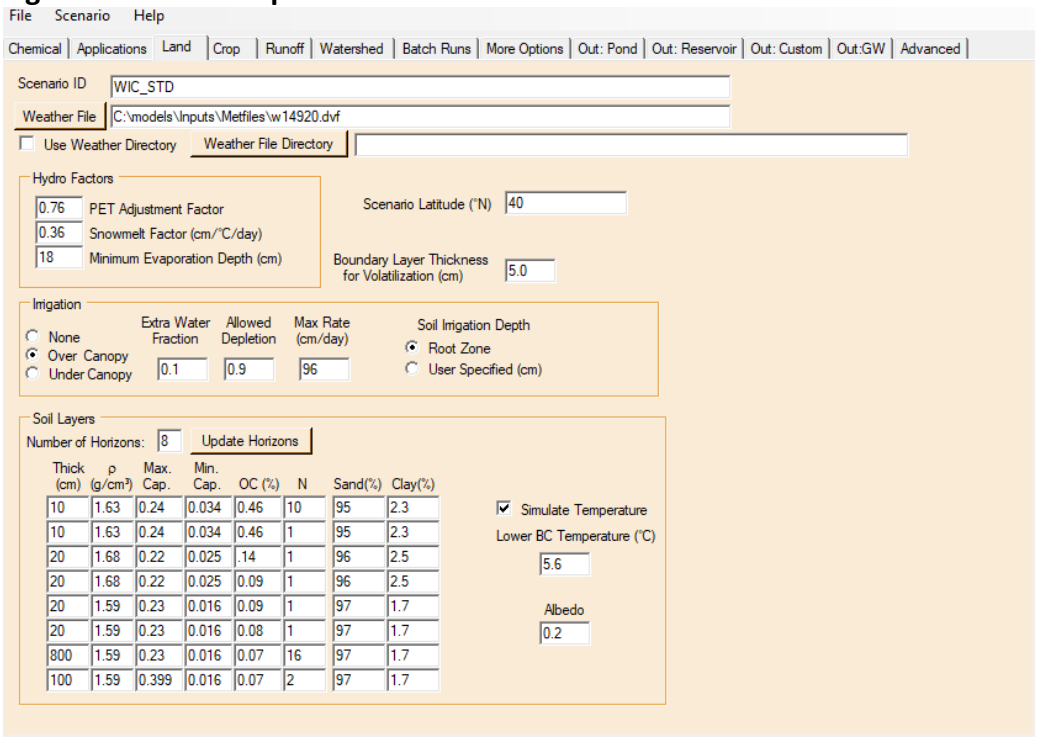


Figure C-5. Model Inputs for Metamitron.

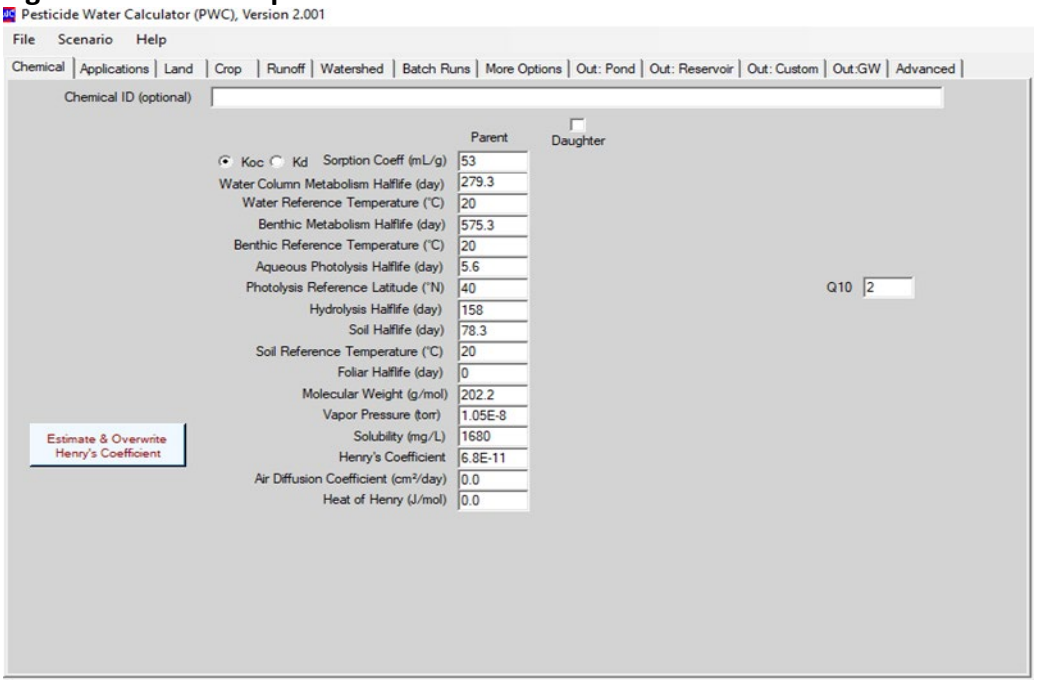


Figure C-5. Advanced Model Inputs for Metamitron.