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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

September 30, 2019

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MEMORANDUM

SUBJECT: **Triclopyr (Acid, Choline salt, TEA salt, BEE):** Draft Ecological Risk Assessment for Registration Review

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TO: Andrew Muench, Chemical Review Manager
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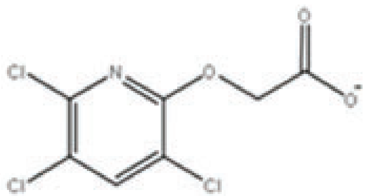
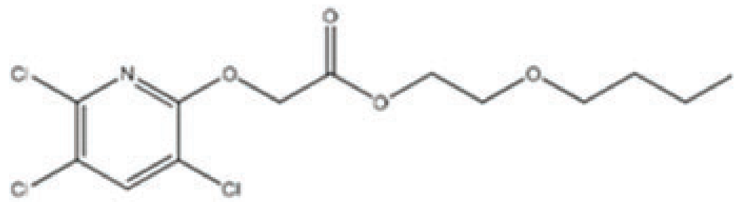
The Environmental Fate and Effects Division (EFED) has completed the draft environmental fate and ecological risk assessment in support of the Registration Review of the four active ingredients contained in formulated products of triclopyr: triclopyr acid, triclopyr choline; triclopyr triethylamine salt (TEA); and, triclopyr butoxyethyl ester (BEE).

Draft Ecological Risk Assessment for the Registration Review of Triclopyr Acid, Triclopyr Choline, Triclopyr TEA, and Triclopyr BEE



ACID



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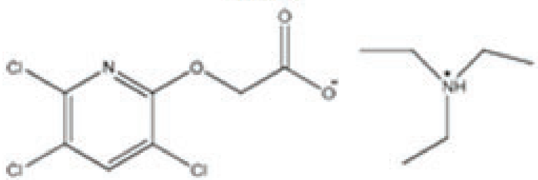

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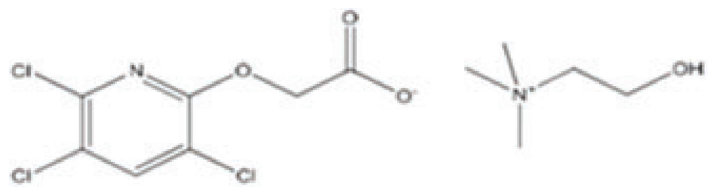

CHOLINE

Chemicals (USEPA PC Code/CAS No.):
Triclopyr acid (ACID; 55335-06-3/116001), Triclopyr Butoxyethyl Ester (BEE; 64700-56-7/116004),
Triclopyr Triethylamine Salt (TEA; 57213-69-1/116002) and Triclopyr Choline (CHOLINE; 104837-85-8/116000)

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1 Executive Summary

1.1 Overview

This risk assessment evaluates four registered active ingredients within the pyridine carboxylic acid family of systemic herbicides: triclopyr acid (ACID), triclopyr choline salt (COLN), triclopyr triethylamine salt (TEA) and triclopyr butoxyethyl ester (BEE). These herbicides are used in various formulated products on rice, orchards, range and pasture lands, forests, rights of way, commercial turf such as golf courses, residential turf and aquatic sites (lakes, ponds rivers, marshes and wetlands) to control herbaceous weeds and some woody plants. According to the Weed Science Society of America (WSSA) triclopyr herbicides mimic natural plant hormones (auxins) responsible for cell elongation and growth. At low concentrations, triclopyr causes uncontrolled cell division and growth resulting in vascular tissue destruction. At higher concentrations, they can inhibit cell division and growth, usually in the meristematic regions of the plant.[1]

Each of the triclopyr TEA and choline salts active ingredients rapidly dissociates in water (< 1 minute) to the triclopyr acid/anion (negatively charged ion) which can further degrade to the following major transformation products: 3,5,6-trichloro-2-pyridinol (TCP); 3,6-dichloro-2-pyridinol (DCP); 5-chloro-2hydroxypyridine (5-CLP); 6-chloro-2hydroxypyridine (6-CLP);and various minor transformation products. Triclopyr BEE metabolizes rapidly (half-life <1 d) to triclopyr acid in soil and water under aerobic and anaerobic conditions. As described in Section 5, this Draft Risk Assessment (DRA) examines the potential aquatic ecological risks associated with labeled uses of the ACID, TEA and COLN active ingredients of triclopyr (collectively assessed due to their similar fate and effects profiles) and the BEE active ingredient (assessed separately due to its different fate and effects profile). The ACID, TEA and COLN forms of triclopyr are highly water soluble (EFED solubility classes), highly mobile (FAO classification) and exhibit a low potential to bioaccumulate in aquatic food webs (KAPAM manual)[2]. The BEE form of triclopyr is much less soluble in water, is much more toxic to aquatic animals than the other active ingredients and has a potential to bioaccumulate given its higher octanol-water partition coefficient (log K_{ow}= 4.01). This bioaccumulation potential of BEE, however, is expected to be mitigated substantially by its aforementioned short persistence of the triclopyr BEE in the aquatic environment. The taxonomic focus of this assessment includes aquatic and terrestrial plants, bees, birds, terrestrial-phase amphibians, reptiles, mammals, and aquatic invertebrates.

1.2 Risk Conclusions Summary

Aquatic ecological risks were assessed for the ACID, TEA, COLN active ingredients based on two approaches: (1) Total Residue (TR) method to estimate exposure via all residues of concern

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[1] http://wssa.net/wp-content/uploads/WSSA-Mechanism-of-Action.pdf

[2] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/kabam-version-10-users-guide-and-technical

(ROC) which assumes equal toxicity among the parent (triclopyr ACID) and degradates (TCP + 3,6-DCP + 5-CLP + 6-CLP degradates); and (2) the Formation/Decline method which considers the TCP-specific chemical properties and toxicity. For the triclopyr BEE active ingredient, the Formation/Decline method was used to estimate exposure as represented by triclopyr BEE, ACID and the TCP degradate. Registered uses that were assessed include rice, aquatic weed control, citrus, forestry, range/pasture land, meadows, rights-of-way, turf and Christmas trees.

This analysis indicates that acute and chronic risk levels of concern (LOCs) are exceeded for terrestrial and aquatic taxa as summarized in **Table 1-1** below. For the ACID/TEA/COLN active ingredients, the highest rates of application were generally responsible for acute risk LOC exceedances that did occur. The exception was for triclopyr BEE which is classified as highly toxic to aquatic organisms on an acute exposure basis.

1.2.1 Triclopyr ACID, TEA, COLN

For the triclopyr ACID, TEA and COLN, no acute or chronic risks are identified for aquatic animals for any of the proposed uses based on the ROC using the TR method. However, chronic risks to freshwater fish and invertebrates are indicated with the 2,500 ppb and 5,000 ppb aquatic weed control use based on the formation of TCP (determined by the F/D method). The TCP degradate is several orders of magnitude more chronically toxic compared to triclopyr ACID or TEA. For aquatic plants, no risk is identified for vascular plants based on the ROC or TCP degradate. However, risk to non-vascular plants is indicated for the maximum (5000 ppb) aquatic weed control use. Monitoring data indicate maximum detected levels of triclopyr ACID are several orders of magnitude below toxicity endpoints for the most sensitive tested species.

There are no acute risks of concern for birds and mammals from registered uses of triclopyr ACID/TEA/COLN for the rice and turf uses which have application rates of 0.375 and 1 lb a.e./A, respectively). For the forest/campground and range/pasture land/rights-of-way uses, acute risks of concern occur due to their higher application rates (6 and 9 lb a.e./A, respectively) compared to the rice and turf uses. There are chronic risks of concern for birds via foraging on at least one dietary item for all four use patterns assessed. For the turf, forestry/campground and pasture/rangeland uses, the dietary-based EECs exceed the avian lowest observed adverse effect concentration (LOAEC) of 200 mg a.e./kg-diet at which there was a 14% reduction in the number of 14-day old survivors. Similarly, chronic risks of concern for mammals are identified among all four use patterns. Chronic risks associated with the rice use are sensitive to the use of upper bound vs. mean Kenega exposure values. Furthermore, the large gap between the mammalian no observed adverse effect level (NOAEL) of 25 mg/kg-bw/d and the LOAEL (250 mg/kg-bw/d based on 28%-39% reductions in litter size) introduces additional uncertainty in the interpretation of chronic risks; except for forestry/campground and range/pasture land uses, whereby the EECs exceed the LOAEC.

For bees, the acute contact-based risk estimates are below the acute risk LOC of 0.4 for all of the registered uses of triclopyr ACID/TEA/COLN active ingredients. However, acute oral exposure to adult forager bees estimated with the forestry/campground and pasture/rangeland uses exceeds the highest concentration tested in the acute oral toxicity test which failed to produce an LD_{50} due to lack of mortality. Therefore, acute oral risk to adult honey bees is considered uncertain for these uses due to the non-definitive toxicity values. Notably, chronic risks of concern to adult and larval bees are indicated for all triclopyr ACID/TEA/COLN use patterns; notably however, these are based on default estimates of residues in pollen and nectar and could not be refined due to lack of measured residue data and/or colony-level toxicity studies.

Risks to terrestrial plants are identified from aerial spray applications of triclopyr ACID, TEA, or COLN across all of the use patterns assessed. Due to the lack of a definitive toxicity endpoint from the seedling emergence study with TEA, risks associated with applications to dry and semi-aquatic areas could not be assessed. Numerous ecological incidents associated with terrestrial plants have been reported in association with the use of triclopyr active ingredients.

1.2.2 Triclopyr BEE

On an acute exposure basis, triclopyr BEE is consistently 2 to 3 orders of magnitude more toxic to aquatic animals compared to triclopyr ACID or TEA, with LC_{50} values ranging from 0.35 to 0.46 mg a.i./L. The chronic toxicity of triclopyr BEE is also several orders of magnitude greater than triclopyr ACID or TEA. However, triclopyr BEE is much less persistent than triclopyr ACID due to its rapid transformation to triclopyr ACID and results in lower aquatic EECs.

For aquatic animals, there acute risk concerns are indicated for freshwater and estuarine/marine fish with the assessed uses of triclopyr BEE when considering the parent (BEE) active ingredient but no chronic risk concerns are evident. For aquatic invertebrates, there are acute and chronic risks of concern for the range/pasture land and meadow uses which have the highest application rates of 6 and 9 lb a.i./A, respectively. Chronic risk concerns to estuarine/marine invertebrates are indicted for uses on citrus, range/pasture land, and meadows. There are no risks of concern for sediment-dwelling invertebrates exposed to triclopyr BEE via pore water. Risks to vascular aquatic plants is not indicated for triclopyr BEE, but risks to non-vascular plants are identified for citrus, range/pasture land, and meadows. Formation of triclopyr ACID or TCP from triclopyr BEE did not result in any acute or chronic risk concerns to aquatic organisms.

There are acute risks of concern for birds among all modeled use patterns due to the greater acute toxicity of triclopyr BEE to birds compared to ACID/TEA. Chronic risks to birds could not be assessed due to lack of data for triclopyr BEE. Chronic risks to mammals are indicated for all assessed uses for multiple size classes and dietary items. In most cases, these risks estimates are not sensitive to the use of mean vs. upper-bound Kenega residue values.

There are no acute risks of concern for bees since triclopyr BEE is practically non-toxic to bees on an acute contact basis. No other bee toxicity data were submitted for triclopyr BEE. However, the triclopyr BEE is expected to degrade relatively quickly to the ACID form based on submitted environmental fate data. Therefore, since there are chronic risks of concern for both adult and larval bees from the ACID, these risks would presumably extend to BEE which is serving as a source of the ACID.

The assessed uses of BEE present risks to terrestrial monocotyledonous (monocot) and dicotyledonous (dicot) plants involving multiple use areas from both ground and aerial applications. Reported ecological incidents for triclopyr BEE involving terrestrial plants represent a line of evidence supporting the risk findings for terrestrial plants.

Table 1-1. Summary of Risk Quotients (RQ for Taxonomic Groups from Current Uses of Triclopyr acid equivalents and Triclopyr BEE

Taxa	**Exposure Duration**	**Risk Quotient (RQ) Range**[2]	**RQ Exceeding the LOC for Non-listed Species**	**Additional Information/ Lines of Evidence**
Triclopyr Acid, TEA and Choline Salt (Including TCP degradate)				
Freshwater Fish	Acute	<0.01 - 0.05	No	–
	Chronic	< 0.01 – 1.8	**Yes** (TCP)	Exceeded only for the maximum aquatic use rate with the TCP degradate
Freshwater Invertebrates	Acute	<0.01 - 0.04	No	--
	Chronic	<0.01 – 6.0	**Yes** (TCP)	Exceeded for only maximum and middle rate aquatic use with the TCP degradate
Estuarine/ marine fish	Acute	< 0.01 - 0.04	No	--
	Chronic	Not calculated (no data)		
Estuarine/ Marine invertebrates	Acute	<0.01 - 0.12	No	--
	Chronic	<0.01 - 0.75	No	Acute to chronic ratio used
Aquatic Plants	Vascular	<0.01 - 0.79	No	--
	Non-vascular	<0.01 – 1.2	**Yes** (ROC)	Exceeded only for maximum aquatic use rate only with ROC
Birds	Acute	<0.01 - 2.8	**Yes**	Exceeded for forestry, campground, recreational area, range and pasture land, and rights of way uses (dose-based RQs; application rates 6.0 - 9.0 lbs a.i/A)
	Chronic	0.09 - 22	**Yes**	LOC exceeded for all use patterns; based on 14% reduction in number 14-day old survivors.
Mammals	Acute	<0.01 - 1.5	**Yes**	Exceeded for forestry, campground, recreational area, range and pasture land, and rights of way uses (application rates 6.0 - 9.0 lbs a.i/A)
	Chronic	0.2 - 37	**Yes**	Exceeded for all use patterns; based on 28%-39%reduction in litter size (dose and dietary based RQs)
Terrestrial Invertebrates[3]	Adult Acute Contact	<0.1 - <0.24	No	Non-definitive LD_{50} (> 100 µg a.e./bee)

Taxa	Exposure Duration	Risk Quotient (RQ) Range[2]	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
(Honey bee)	Adult Acute Oral	<0.32 - <2.9	**Uncertain**	Non-definitive LD_{50} (> 99 µg a.e./bee). EECs for forestry and rangeland uses exceed highest dose tested
	Adult Chronic Oral	2.3 - 20	**Yes**	Exceeded for all registered uses (rice not attractive); based on 35% reduction in adult survival.
	Acute Larval	Not calculated (no data)		
	Chronic Larval	22 - 211	**Yes**	Exceeded for all uses (rice not attractive), based on 10% reduction in emergence and 13% reduction in mortality.
Terrestrial Plants	Monocots	Not calculated	N/A	Non-definitive endpoints for monocots. For dicots, exceedances for all uses except rice; majority of incidents with Triclopyr products have been non-target plant damage incidents from spray drift
	Dicots	<0.01 - 83	**Yes**	
Triclopyr BEE (Including TCP Degradate)				
Freshwater Fish	Acute	<0.01 - 0.74	**Yes** (BEE)	Exceedances for range/pasture land and meadow uses only with triclopyr BEE (9.0 lbs a.i/A).
	Chronic	<0.01 - 0.38	No	--
Freshwater Invertebrates	Acute	<0.01 - 0.76	**Yes** (BEE)	Exceedances for range/pasture land and meadow uses only with triclopyr BEE (9.0 lbs a.i/A)
	Chronic	<0.01 - 0.16	No	--
Estuarine/Marine Fish	Acute	<0.01 - 0.59	**Yes** (BEE)	Exceedances for range and pasture land uses only for triclopyr BEE (9.0 lbs a.i/A)
	Chronic	<0.01 - 0.54	No	--
Estuarine/Marine Invertebrates (Water Column)	Acute	<0.01 - 0.58	**Yes** (BEE)	Exceedances for range/pasture land and meadow uses only with triclopyr BEE (9.0 lbs a.i/A).
	Chronic	<0.01 - 2.6	**Yes** (BEE)	Exceedances for citrus, range/pasture land, and meadow uses with BEE (LOAEC = 16% reduction in weight).
Freshwater Invertebrates (Sediment)	Acute	<0.01 - <0.01	No	Pore water EECs compared to water column endpoints
	Chronic	<0.01 - <0.29	No	
Estuarine/Marine Invertebrates (Sediment)	Acute	<0.01 - <0.01	No	Pore water EECs compared to water column endpoints
	Chronic	<0.01 - 0.04	No	
Aquatic Plants	Vascular	0.01 - 0.30	No	--

Taxa	Exposure Duration	Risk Quotient (RQ) Range[2]	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
	Non-vascular	0.1 - 2.7	**Yes** (BEE)	Exceedances for citrus, range/pasture land and meadow uses for BEE; based on reduction in cell counts.
Birds	Acute	<0.01 - 4.6	**Yes**	Exceedances for turf, forestry, campground, recreational area, range/pasture lands, and rights-of way uses (application rates of 1 - 9 lbs a.i/A)
	Chronic	Not calculated (no data)		
Mammals	Acute	<0.01 - 1.2	**Yes**	Exceedances for forestry, campground, recreational area, range/pasture lands, and rights-of way uses (application rates of 6 - 9 lbs a.i/A)
	Chronic	0.3 - 18	**Yes**	Exceeded for all registered uses; endpoint based on reduction in body weight
Terrestrial Plants	Monocot	0.14 - 18	**Yes**	Exceedances for all use patterns
	Dicots	0.32 - 51	**Yes**	Exceedances for all use patterns

Level of Concern (LOC) Definitions: Terrestrial Animals: Acute risk LOC=0.5; Chronic risk LOC=1.0; Terrestrial Invertebrates: Acute risk LOC=0.4; Chronic risk LOC=1.0; Aquatic Animals: Acute=0.5; Chronic=1.0; Terrestrial and Aquatic Plants: LOC=1.0

[1] Based on water-column toxicity data compared to pore-water concentration.

[2] For Triclopyr ACID, TEA, COLN active ingredients, RQ ranges reflect Triclopyr acid residues of concern (ROC) and the TCP degradate. For Triclopyr BEE, RQ ranges reflect parent BEE and the TCP degradate. Estimated exposure concentrations are based on the maximum application rates allowed on labels.

[3] RQs for terrestrial invertebrates are applicable to honey bees, which are also a surrogate for other species of bees. Risks to other terrestrial invertebrates (*e.g.,* earthworms, beneficial arthropods) are only characterized when toxicity data are available.

1.3 Environmental Fate and Exposure Summary

The environmental fate and transport data needed for this ecological risk assessment of the four forms of triclopyr (the ACID, TEA, COLN and BEE) and their major degradates are complete except for water[3] and sediment/soil environmental chemistry methods (ECMs) and associated independent laboratory validation ((ILVs).

In comparing the four forms of triclopyr active ingredients, the most persistent form is the ACID which is applied as ACID or result from rapid dissociation of TEA, COLN and BEE forms of triclopyr. The primary routes of surface water exposure to the triclopyr acid are run-off and

[3] Submitted Environmental chemistry method (ECM) for triclopyr and its major degradate 3,5,6-Trichloro and 2-Pyridinol (TCP) in water by gas chromatography (MRID No. 417143-08) was independently evaluated by EPA BEAD/ACB/Environmental Chemistry Section. The method provided satisfactory measurement for the residues of triclopyr with a limit of detection/limit of quantification (LOD/LOQ) of 10/50 for triclopyr and 50/150 ppb for 3,5,6-Trichloro-2-pyridinol. The respective LOQ is currently near/higher the lowest toxicological level of concern determined for TCP/BEE respectively. Therefore, the method is reclassified at this time as un-acceptable and a new method is requested.

spray drift while that for ground water is leaching to vulnerable shallow ground water (the chemical is classified as mobile). All forms of triclopyr are semi to non-volatile; although BEE has a log K_{ow} of 4.01, none of the actives are expected to bioconcentrate in aquatic animals such as fish. Triclopyr acid is highly vulnerable to abiotic photolysis ($t_{½}$ <1 d) and non-persistent in the aerobic soil/aquatic systems. In contrast, the chemical is moderately persistent in anaerobic soil/aquatic conditions and is stable to hydrolysis and soil photolysis (refer to Section 5).

The major degradates of triclopyr acid are TCP and 3,6 DCP and both are exposure concerns. Additionally, the degradates 5-CLP and 6-CLP could also be of exposure concerns as they are expected to form in major amounts in some aerobic aquatic systems (refer to **Section 5**). Exposure modeling was conservatively executed considering the maximum label rates and minimum application intervals.

1.4 Ecological Effects Summary

1.4.1 Aquatic Toxicity

Acute toxicity data for aquatic animals generally indicate that triclopyr ACID and TEA are practically non-toxic to fish and invertebrates, while triclopyr BEE is moderately to highly toxic to these same taxa on an acute exposure basis (**Table 6-1**). Specifically, triclopyr BEE median lethal concentrations for 50% of the organisms tested (LC_{50} values) are consistently 2 to 3 orders of magnitude lower (*i.e*., more sensitive) for aquatic animals compared to triclopyr ACID or TEA. The TCP degradate is classified as slightly toxic on an acute exposure basis to fish and aquatic invertebrates, except for the Eastern oyster (*Crassostrea virginica*), where it is classified as moderately toxic.

The chronic toxicity of triclopyr ACID and TEA to freshwater fish and invertebrates is relatively similar to acute toxicity values and range from 24 to 74 mg a.i./L. In contrast, the chronic toxicity of triclopyr BEE to freshwater fish and invertebrates tends is much greater than the ACID or TEA active ingredients. Chronic NOAECs for triclopyr BEE range from 0.011 mg ai/L for the estuarine/marine mysid shrimp (*Americamysis bahia*) to 0.17 mg ai/L for the freshwater invertebrate waterflea (*Daphnia magna*). The chronic toxicity of TCP, a major degradate of the four triclopyr active ingredients is similar to that of triclopyr BEE, with the lowest NOAEC occurring at 0.058 mg a.i./L for *D. magna*.

With respect to aquatic plants, triclopyr both ACID and TEA are toxic between 4.2 and 6.3 mg a.e./L whereas, triclopyr BEE is toxic about an order of magnitude lower (0.1 to 0.88 mg ai/L). The toxicity of the TCP degradate falls within the range to aquatic plant toxicity values for the ACID and BEE (2 – 8 mg ai/L).

No acute or chronic toxicity data are available for triclopyr COLN, but it is expected to exhibit similar toxicity as triclopyr ACID and TEA due to its rapid dissociation to the acid form. Similarly, no aquatic toxicity data are available for the other major degradates of triclopyr active ingredients (3,6 DCP; 5-CLP; 6-CLP). Further characterization of the potential toxicity of these degradates is provided later in the document using the Ecological Structure Activity Relationships (ECOSAR) model.

1.4.2 Terrestrial Toxicity

Similar to that observed with aquatic animals, the ACID and COLN are slightly to practically non-toxic to birds and mammals on an acute exposure basis (**Table 6-2**). This acute toxicity pertains to both dose and dietary-based exposures. Triclopyr BEE showed the lowest acute oral LD_{50} for birds (735 mg/kg-bw) which renders it as slightly toxic to avian species on an acute exposure basis. With mammals, triclopyr BEE, TEA and ACID are all classified as slightly toxic on an acute oral exposure basis. Triclopyr BEE and the TCP degradate were of similar acute toxicity as the ACID and TEA and are also classified as slightly toxic on an acute exposure basis.

Chronic avian toxicity data are only available for triclopyr ACID based on a single species, i.e., mallard duck (*Anas platyrhynchus*). This study indicates a NOAEC of 100 mg a.e./kg-diet based on 14-day old survivors. Although chronic toxicity data are not available for BEE, the compound degrades quickly to the ACID ($t_{½}$< 1 day). For mammals, a 2-generation reproduction study with ACID produced a NOAEL of 25 mg/kg-bw/d (LOAEL = 250 mg/kg-bw/d) based on reproductive and body weight effects, including a 28%-39% reduction in litter size. The 10-fold difference between the NOAEL and LOAEL introduces uncertainty in the interpretation of potential effects from exposures above the NOAEC.

With the honey bee (*Apis mellifera*), triclopyr ACID and BEE are both practically non-toxic on an acute contact basis (**Table 6-2**). Acute oral toxicity information is only available for triclopyr ACID, where it also is classified as practically non-toxic. On a chronic exposure basis, adult bees were less sensitive (NOAEL = 22 µg ai/bee/d) compared to larvae (0.58 µg ai/bee/d). No toxicity data were submitted on the acute toxicity to honey bee larvae.

As expected, the triclopyr herbicides are toxic to terrestrial plants. The 25% effect concentration (IC_{25}) value of triclopyr ACID (0.0054 lb a.e./A) is 3 orders of magnitude lower than the maximum single application rate of 9 lb a.e./A. The most sensitive dicot species is about 10 times more sensitive compared to monocots based on the vegetative vigor study with BEE. However, the most sensitive dicot and monocots are of similar sensitivity based on seedling emergence with triclopyr BEE.

1.5 Identification of Data Needs

Currently, nearly all ecological effects data requested in the 2014 Problem Formulation have been submitted, evaluated and found acceptable, with the exception of the following three studies:

- avian acute oral toxicity study with a passerine bird (OCSPP 850.2100);

- acute study with larval honey bees with triclopyr ACID (OECD test guideline No 237); and,
- chronic avian reproduction study with triclopyr BEE (OCSPP 850.2300).

2 Introduction

This Draft Risk Assessment (DRA) examines the potential ecological risks associated with labeled uses of triclopyr acid (ACID), triclopyr choline salt (COLN), triclopyr triethylamine salt (TEA) and triclopyr butoxyethyl ester (BEE) active ingredients on non-target organisms not listed under the Endangered Species Act. Federally listed threatened/endangered species ("listed") are not evaluated in this document. For additional information on listed species see **Appendix G**.

The Food Quality Protection Act (FQPA) requires EPA to screen pesticide chemicals for their potential to produce effects similar to those produced by estrogen in humans and gives EPA the authority to screen certain other chemicals and to include other endocrine effects. In response, EPA developed the Endocrine Disruptor Screening Program (EDSP). Additional information on the EDSP is available in **Appendix F.**

The DRA uses the best available scientific information on the use, environmental fate and transport, and ecological effects of all triclopyr active ingredients. The general risk assessment methodology is described in the *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs* ("Overview Document," USEPA, 2004a). Additionally, the process is consistent with other guidance produced by the Environmental Fate and Effects Division (EFED) as appropriate. When necessary, risks identified through standard risk assessment methods are further refined using available models and data. This risk assessment incorporates the available exposure and effects data and most current modeling and methodologies.

3 Problem Formulation Update

The purpose of problem formulation is to provide the foundation for the environmental fate and ecological risk assessment being conducted for the labeled uses of triclopyr ACID, TEA, COLN and BEE active ingredients. The problem formulation identifies the objectives for the risk assessment and provides a plan for analyzing the data and characterizing the risk. As part of the Registration Review (RR) process, a detailed preliminary Problem Formulation for this DRA was published to the docket in November 13, 2014 (DP Barcode 417819)[4]. As summarized in the 2014 preliminary Problem Formulation document, prior ecological risk assessments identified potential risks to birds, mammals, terrestrial plants and aquatic plants from the triclopyr ACID, TEA, COLN and BEE active ingredients. In addition, potential risks to fish and aquatic invertebrates were indicated with the BEE active ingredient.

As a result of the preliminary Problem Formulation, several data gaps were identified, and additional data were requested of the registrant. The following ecological effects and

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[4] Registration Review; Preliminary Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Human Health Drinking Water Exposure Assessments for Triclopyr [Triclopyr Acid (PC Code 116001), Triclopyr Triethylamine Salt (PC Code 116002), and Triclopyr Butoxyethyl Ester (PC Code 116004). DP Barcode 417819 dated November 13, 2014.

environmental fate studies were submitted in support of the RR process for the triclopyr active ingredients since the time of the preliminary Problem Formulation.

Ecotoxicity Data:

(1) Daphnid Chronic Toxicity Test of triclopyr BEE (MRID 49992406);
(2) Fish Early Lifestage Toxicity Test of triclopyr degradate TCP using Rainbow Trout (MRID 49992407);
(3) Chronic lifecycle toxicity of triclopyr BEE using mysid shrimp (MRID 50673901);
(4) Honey Bee Adult Acute Oral Toxicity Test of triclopyr ACID (MRID 49992409);
(5) Honey Bee Larvae Chronic (repeat dose) Toxicity Test of triclopyr ACID (MRID 50673902); and,
(6) Honey Bee Adult Chronic (repeat dose) Toxicity Test of triclopyr ACID (MRID 50673903).

These new ecological effects data are described in more detail in the aquatic and terrestrial effects characterization sections of this document (**Sections 8.2 and 10.2,** respectively**)**.

Fate and Chemistry Data:

(1) Photodegradation in Water using triclopyr ACID (MRID 49992401);
(2) Aerobic Soil Metabolism using triclopyr degradate TCP in four soils (MRID 499924-02);
(3) Anaerobic Soil Metabolism using triclopyr ACID in four soils (MRID 49992403);
(4) Aerobic Soil Metabolism using triclopyr BEE in two soils (MRID 47293801);
(5) Aerobic Aquatic Metabolism using triclopyr BEE in two systems (MRID 49992404);
(6) Anaerobic Aquatic Metabolism using triclopyr BEE in two systems (MRID 00151967);
(7) Uptake, metabolism, and depuration of triclopyr BEE in Coho Salmon (*Oncorhynchus kisutch*; MRID 49992408); and
(8) Environmental chemistry methods (ECMs) and associated independent laboratory validation (ILVs) for water and sediment (MRIDs: 44456105, 44456106, 44456109, 44456110 and 44456111).

These new fate and transport data are described in more detail in the environmental fate **Section 5**.

3.1 Mode of Action for Target Pests

According to the Weed Science Society of America (WSSA) triclopyr herbicides are part of Group 4 (synthetic auxins) Auxins, a natural plant hormone, is responsible for cell elongation and growth. At low concentrations, triclopyr herbicides cause uncontrolled cell division and growth resulting in vascular tissue destruction. At higher concentrations, the herbicides can inhibit cell division and growth, usually in the meristematic regions of the plant.[5] Triclopyr is a selective/systemic broadleaf herbicide that enters plants through their leaves, woody stems, cut surfaces in addition to hydrosol roots of aquatic plants.

3.2 Label and Use Characterization

3.2.1 Label Summary

The Biological and Economic Assessment Division (BEAD) prepared a Pesticide Label Use Summary (PLUS) Report summarizing registered uses of Triclopyr active ingredients based on a selection of actively registered labels in March 29, 2018[6]. The PLUS report was used as the source to summarize representative uses for this DRA. Additionally, most labels were consulted to complement the PLUS report.

The triclopyr active ingredients are found in one of the following forms:

- **ACID:** 3,5,6-trichloro-2-pyridinyloxyacetic acid;
- **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester;
- **TEA:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt; or,
- **COLN:** 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, choline salt.

However, many formulations contain one or more herbicide actives mixed with either, **BEE**, or **TEA** forms of triclopyr:

- Three formulations with BEE: 2,4-dichlorophenoxyacetic acid; fertilizer; and fluroxypyr; and

[5] http://wssa.net/wp-content/uploads/WSSA-Mechanism-of-Action.pdf

[6] Triclopyr (116001) Pesticide Label Use Summary (PLUS) Reports in Support of Registration Review Draft Risk Assessment (DRA) dated March 29, 2018; Triclopyr Choline Salt (116000) Pesticide Label Use Summary (PLUS) Reports in Support of Registration Review Draft Risk Assessment (DRA) date April 5, 2018; Triclopyr butoxyethyl ester (116004) Pesticide Label Use Summary (PLUS) Reports in Support of Registration Review Draft Risk Assessment (DRA) dated April 10, 2018; and Triclopyr triethylamine salt (116002) Pesticide Label Use Summary (PLUS) Reports in Support of Registration Review Draft Risk Assessment (DRA) dated April 11, 2018

Six formulation with TEA: clopyralid; 2,4-D, diethanolamine salt; (2,4-D, diethanolamine salt + dicamba, dimethylamine salt); (penoxsulam + sulfentrazone + quinclorac); (penoxsulam + quinclorac); and (clopyralid + fertilizer).

General Use Patterns

Nearly 80 active labels for representative triclopyr products were analyzed by BEAD for use in this analysis: 36 Section 3 (New Use); and, 43 Section 24c (Special Local Needs; SLN) labels. Most of the products are formulated as liquid concentrates (pressurized, soluble concentrate "SC", emulsifiable concentrate "EC", or flowable "Flowable") followed by dry products (granular "G" and water dispersible granules "WDG"), and ready to use solutions "RTU". Except for the granular products, all other formulations are applied as liquid spray using ground and/or aerial equipment. Two of the granular products contain fertilizers + **TEA** and fertilizers + **BEE** and are used as ground applications to turf for selective control of annual and perennial weeds and fertilization. The rest of the granular formulations are **TEA** products formulated for ground or aerial applications to aquatic areas.

The pesticide is used for the following purposes:

(1) To control annual and perennial broadleaf weeds, woody & herbaceous plant species, brushes, and vines in forestry, grassland, premises, range/pastureland, rice, turf and Christmas trees; and, for control of similar plant species in and around standing water sites (such as marshes, wetlands, and the banks of ponds and lakes);
(2) To control re-sprouts from cut stumps in Florida citrus groves; and, for controlling re-sprouts from cut stumps in forestry and in California orchards (after tree removal to hasten death of root system); and,
(3) To control floating/immersed/submersed aquatic plants in surface water bodies such as ponds, lakes, reservoirs, marshes, wetlands, and non-irrigation canals and ditches which have little or no continuous outflow.

Triclopyr **ACID**/**BEE**/**TEA**/**COLN** are labelled for use in many sites targeting unwanted terrestrial and aquatic weeds, woody plants and shrubs. A qualitative description of these use patterns, application sites and target plants are included in **Table 3-1**.

Table 3-1. Summary of Triclopyr Herbicide[1] Use Patterns, Application Sites Types/target(s) & Equipment.

Use Patterns	Application Sites	Application Type/Target
Aquatic sites	Lentic/Lotic water bodies in the terrestrial landscape	Broadcast/Aquatic plants & water
Citrus (Florida)	Citrus groves	Directed Spray/Cut stem

Use Patterns	Application Sites	Application Type/Target
Forestry	Coniferous/Evergreen/Softwood tree plantations; Woodland/Nature Areas (open space such as campgrounds, parks, prairie management, trails and trailheads, recreation areas; Animal habitat/ establishment and maintenance Wildlife openings	- Broadcast/foliage for control of weeds and susceptible (easy to control) woody plants and shrubs; and - Directed basal bark treatment, brush or injection/weeds, foliage, stump, bark, cut stem for woody plants
Non-crop areas	Non-crop land; Industrial areas; Non-irrigation ditch banks; Storage sites; Airports, Barrow/road side ditches; s; Fence/hedge rows; Gravel pits; Military lands; Mining and drilling areas; Oil and gas pads; Parking lots; Petroleum tank farms; Storm water retention areas; Farmstead; Substations, Unimproved rough turf grasses; vacant lots; Standing water sites such as marshes, wetlands, and the banks of ponds and lakes; Ditch banks; Seasonally dry wetlands, flood plains, deltas, marshes, swamps, bogs, and transitional areas between upland and lowland sites	- Broadcast/Foliage for weed control; and - Like forestry in case of the presence of unwanted woody plant and shrubs
Orchards (California)	Orchards	Directed Spray/Cut stem
Premises	Around farm/residential buildings; Cabins; Walkways	- Broadcast/Foliage for weed control; and - Like forestry in case of the presence of unwanted woody plant and shrubs
Range/Grass/Pastureland	Range/Permanent/ Perennial grass pastures; grasses grown for hay; Conservation Reserve Program (CRP) sites	
Rice	Pre/post-flood Rice fields	Broadcast/Foliage
Right-of-Way	Electrical power and utility; Communication/transmission lines or structures; oil and gas pipelines; Roadsides; Railroad	- Broadcast/Foliage for weed control; and - Like forestry in case of the presence of unwanted woody plant and shrubs
Turf	Residential, Commercial, and Recreational Turf; Golf course, excluding greens; Sod farms	
Christmas Trees	Christmas tree plantations	

[1]Triclopyr herbicide active ingredients include: 3,5,6-trichloro-2-pyridinyloxyacetic acid; 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt; and, 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, choline salt.

Several application methods are specified for applying triclopyr active ingredients depending on the formulation, target, and type of equipment. For liquid formulations and WDGs, a tank mix is prepared with an agriculturally labeled non-ionic surfactant and/or other herbicide, and the liquid is sprayed onto the plants to be controlled or onto aquatic weeds present on/in water (**Figure 3-1**). For granular formulations, granules are broadcasted onto wet conditions (following rainfall or pre-treatment irrigation) turf in case of two formulations and onto aquatic weeds present on the water surface and those present in the subsurface.

Figure 3-1. Broadcast Spray Treatment for Aquatic Weeds (source: label)

Other types of applications include:

(1) **Broadcast application:** This method may be made using ground (backpack or truck-mounted pressure sprayers) or aerial equipment (helicopter). Broadcast applications are used for control of weeds and specified woody plants in most labelled use areas by uniform spray targeting plant foliage. Ground equipment is used for spraying individual brushy plants, woody plants and vines or spot treatment of weeds (**Figure 3-2**).

Figure 3-2. Broadcast Application for Control of Woody Plants and Spot Treatment of Weeds (source: label)

(2) **Basal Bark treatment:** The method is used to control susceptible woody plants with stems <6" inches in basal diameter. This treatment uses low pressure knapsack or power sprayers to spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground. Thorough wetting of the indicated area is necessary for good control (**Figure 3-3a**).

(3) **Stump treatment:** The method is used in forestry, citrus and orchards for freshly cut tree stumps with undiluted liquid formulation by spraying/painting the cut surface especially the cambium area next to the bark. The purpose is to prevent regrowth of the tree (**Figure 3-3b**).

Figure 3-3. Basal Bark and Stump Treatments of Woody Plants (source: label)

(4) **Tree injection treatment:** The method is used to control unwanted trees by injecting the tree trunk through the bark with undiluted liquid formulation; injections (3 to 4" apart) are to surround the tree at any convenient height.

(5) **Hack and squirt treatment:** The method is used to control unwanted trees by making slightly overlapped cuts around the tree trunk with a hatchet. Cuts are to form a circle around the trunk to fill (using a squirt bottle) with undiluted or 1:1 diluted liquid formulation.

(6) **Frill or girdle treatment:** The method is used to control unwanted trees by making a single gridle through the bark completely around the tree. Diluted or undiluted liquid formulation is applied to frill which hold it to be absorbed into the plant.

Other application parameters were extracted from the BEAD PLUS report along with examination of the labels to clarify the data, identify missing use information, and suggest needed clarifications. It is noted that most of the labels specify the required information including the maximum annual rates for each type of application. These data are summarized in **Table 3-2**.

Label Restrictions

Common use restrictions were identified from various triclopyr labels including:

(1) Specific restrictions for application near drinking water intakes;
(2) Requirement that permits be obtained for direct application to water;
(3) Restrictions specific to application via surface irrigation waters, including:
    a. Waiting for a period of 4 months (or a season) before use;
    b. Levels of triclopyr are determined to be ≤1 ppb;
(4) A 20-day holding period for water in rice paddies; and,
(5) Lower than maximum application rates (*e.g.*, 2 lbs. acid equivalents (a.e)/A/year) in sites where grazing and haying is allowed.

Application Rates

Other application parameters were extracted from the BEAD PLUS report along with examination of the labels to clarify the data, identify missing information and suggest possible improvements in label language. It is noted that most of the labels specify the required information including the maximum annual rates for each type of application. These data are summarized in **Table 3-2.**

Table 3-2. Summary of Application Parameters for Triclopyr Active Ingredient Use (All Rates Are Maximum Use Rates in Acid Equivalent "a.e")

Use Pattern (Active Ingredient(s))	Application Equipment and Timing		Application Parameters[1]			
	Equip.	Timing	MSR (lb a.e./A)	No.	MYR (lb a.e./A)	MI
Aquatic Sites [2] (ACID, TEA, COLN): • Applied near drinking water intakes @ 400 ppb • Applied @ 2,500 ppb • Applied @ 5,000 ppb	A/G	Determined solely by pest pressure	Calculated by equation present in the label	1	Same as MSR	N/A
Citrus-FL (BEE)	G	When required for stump treatment of removed trees	6	1	6	N/A
Forestry (ALL)	A/G	Specified for certain woody plants and shrubs. Generally, timing of active growth (Not to be used in AZ)	6	1	6	N/A
Non-crop areas (ALL)	A/G	Dependent on weed pressure	9	1	9	N/A
Orchards-CA (TEA)	G	When required for stump treatment of removed trees	6	1	6	N/A
Premises (ALL)	A/G	Determined solely by pest pressure	9	1	9	N/A
Range/Grass/Pastureland (ALL)	A/G	PHI for Hay 14-d	9	1	9	N/A
Rice (ACID; TEA)	A/G	Pre- plant/flood; Post-flood; Before booting	0.375	2	0.75	20
Right-of-Way (ALL)		Determined solely by pest pressure	9	1	9	N/A
Turf (ACID, BEE, TEA)	A/G	Early spring through fall	1	4	4	28
X-mas Trees (ACID, BEE, TEA)	G	late summer or early autumn after terminal growth has hardened of, before leaf drop	6	1	6	N/A

[1]**Application Parameters: MSR=** Maximum single rate (lbs. a.e/A); **NO.=** Number of applications**; MYR=** Maximum yearly rate (lbs. a.e/A/Y); **MI=** Minimum intervals in days; **a.e=** Acid equivalent; N/A= Not applicable; **Equipment**: A= aerial, G= Ground.

[2]***Application to Aquatic Sites:*** One of the labels permits dividing the rate into three applications 8 hours apart

Use Pattern (Active Ingredient(s))	Application Equipment and Timing		Application Parameters[1]			
	Equip.	Timing	MSR (lb a.e./A)	No.	MYR (lb a.e./A)	MI

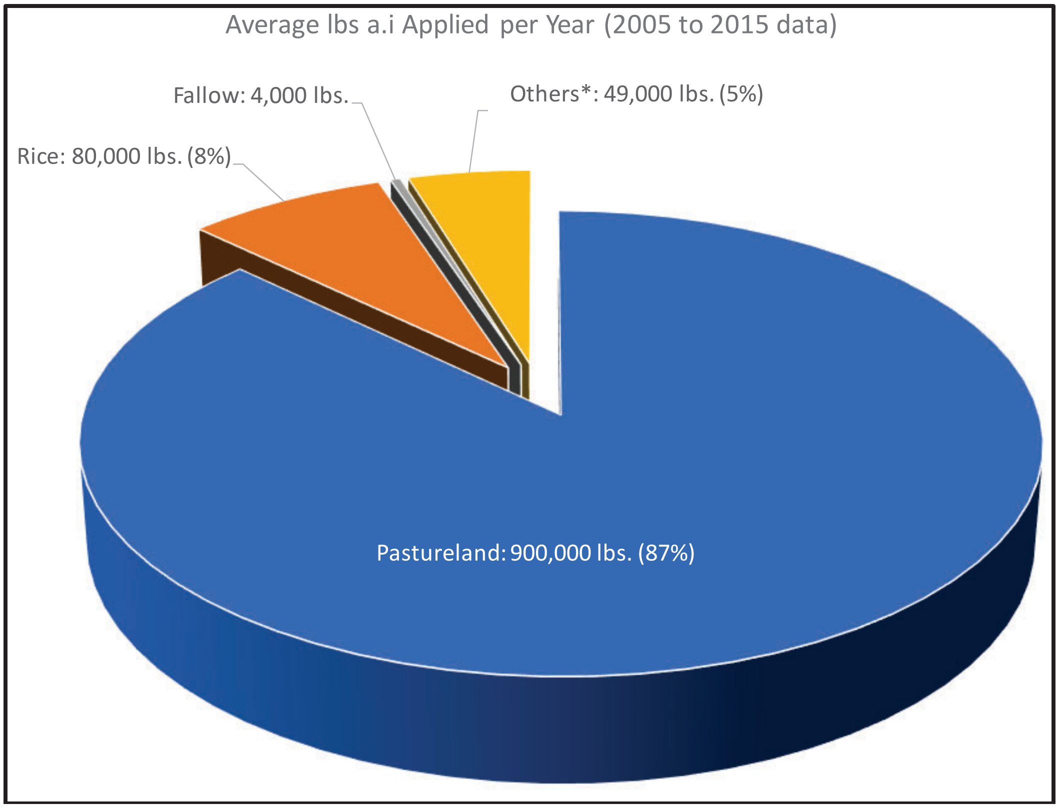
[3]Triclopyr herbicide active ingredients include: 3,5,6-trichloro-2-pyridinyloxyacetic acid (**ACID**); 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester (**BEE**); 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt (**TEA**); and, 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, choline salt (**COLN**); all actives combined (**ALL**).

Maximum rates presented in **Table 3-2** are based on statements specifying the maximum annual application rate for each use. For comparative purposes, application rates were adjusted to acid equivalents (*i.e.,* lb a.e. of triclopyr acid). Triclopyr labels allows for spot and/or individual tree treatment with rates within the maximum rates specified for the use patterns in **Table 3-2**. Most of these rates are expected to be much lower in case of small size, high susceptibility, younger actively growing, and low frequency of target plants present in areas to be treated within an acre. For this purpose, labels specify that the total rate for these types of treatments in an acre may not exceed the maximum rates. Additionally, it is noted that some labels give lower rates than the maximums presented in **Table** 3-2 (*e.g.*, 8 lbs. a.e/A/Y instead of 9 lbs. a.e/Y). Lower rates of triclopyr were also identified for formulations containing other herbicide(s).

3.2.2 Usage Summary

Agricultural Uses

BEAD provided a Screening Level Usage Analysis (SLUA; available in docket: EPA-HQ-OPP-2014-0576; https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0576-0006), summarizing usage data for triclopyr products including the ACID, BEE, TEA and COLN. The data indicate that the highest usage is in pasture land and rice and that the percent of crop treated is 25% for rice. **Figure 3-4** depicts 2005 – 2015 triclopyr usage data reported by BEAD.



* Others: include crops that are not currently registered noting that data do not include a major use: forestry

Figure 3-4. Average lbs. of Triclopyr Products applied (2005 to 2015 data)

Non-Agricultural Uses

Since usage data for non-agricultural use patterns are typically scarce, there is uncertainty regarding the scale and magnitude of non-crop uses for triclopyr active ingredients. This usage could be substantial as illustrated by nationwide estimates for rights-of-way and commercial turf operations as discussed below.

Use for vegetation control along transportation rights-of-way could potentially expose thousands of miles of roadways. Currently over 46,000 miles of interstate, 112,000 miles of national highway systems and 3,760,000 miles of other smaller roadways currently exist in the United States (U.S. Department of Transportation estimate).

The U.S. electrical grid contains 200,000 miles of high-voltage transmission lines and 5.5 million miles of local distribution lines, linking thousands of generating plants to factories, homes and businesses. These utility rights-of-way sites are all possible use areas for triclopyr products used to control vegetation which might interfere with transmission lines or access to the support structures. https://www.scientificamerican.com/article/what-is-the-smart-grid/

Uses in forest areas are generally made to control unwanted invasive (noxious weeds or woody shrubs and trees) plants, for site preparation, conifer and hardwood release and for right-of-way management. The United States Forest Service use of triclopyr active ingredients is concentrated in the Southeastern U.S. (over 80%) and involved application of approximately 12,500 pounds of triclopyr in 2004. In 2007, California reported 10,186 lbs of triclopyr BEE applied to timberland areas and 21,029 lbs applied to rights-of-way. Similarly, over 8900 lbs of triclopyr TEA was used for forestry-related applications. These are examples of forestry uses, but do not include plant management in millions of acres of other state, commercially owned, or privately-owned forest lands where these products are also registered for use.

In its 2017 report the Golf Course Superintendents Association of America (GCSAA) estimated the total 2015 acreage for golf courses in the United States at 2,301,808 acres on 14,289 facilities. Of this acreage, 1,408,412 acres were considered maintained turf and are considered potential turf use areas for triclopyr products used in weed control. Use in residential and other turf would add significant additional acreage to this total.

Label Uncertainties

A review of the labels indicates the following uncertainties:

(1) Except of application to rice, turf, and aquatic sites, the labels appear to indicate that yearly application is applied one time. Additionally, Labels do not specify multiple applications or re-application intervals.
(2) Some of the labels needed revisions to include the following:
    a. The maximum yearly rate for EACH ***use pattern*** in lbs. a.e/A/Y;
    b. The maximum single rate for ***each type of application*** lbs. a.e/A;
    c. When applicable, specify that the maximum yearly rate is applied ***one time*** and if not, indicate the ***number of applications per year and the minimum re-application intervals*** between applications in days.
(3) For aquatic use, some of the labels indicate that the maximum yearly rate is 6 lbs. a.e/A/Y without specifying the average depth/area of the water body or lbs. a.e./acre-foot of water to be treated to arrive at the effective acid concentration necessary to kill the weeds. This information would add clarity to the label.

4 Residues of Concern

In this risk assessment, the stressors are those chemicals that may exert adverse effects on non-target organisms at environmentally relevant concentrations. Collectively, these stressors are known as the Residues of Concern (ROC). The ROC usually include the active ingredient, or parent chemical, and may include one or more degradates that are observed in laboratory or field environmental fate studies. Inclusion of one or more degradates in the ROC is based on two factors: exposure (considering their percent formation relative to the application rate of the parent compound and modeled exposure) and toxicity (considering submitted toxicity data and/or predicted toxicity using structure-activity relationships (SARs). Structure-activity analysis may be qualitative, based on retention of functional groups in the degradate, or they may be quantitative, using programs such as ECOSAR, the Organization for Economic Cooperation and Development (OECD) Toolbox[7], the Assessment Tool for the Evaluation of Risk (ASTER[8]), or others.

For acute and chronic aquatic exposure, triclopyr ACID is considered representative of the acid form and the TEA and COLN active ingredients. This is based on the observed rapid or instantaneous dissociation of TEA and COLN into the ACID form and similar aquatic toxicity profile observed for the ACID and TEA active ingredients. Although triclopyr BEE shows relatively short persistence in water, it exhibits much greater acute and chronic toxicity to aquatic organisms compared to triclopyr ACID and is therefore modeled separately. Detailed information supporting the decision on acute and chronic exposures for the parent active ingredients is presented in **Section 5**.

Regarding the inclusion of degradates into the ROC, the degradation profile of the ACID (and by extension the TEA and COLN active ingredients) indicates that TCP and 3,6-DCP are major degradates (>10% formation) common to multiple degradation pathways (**Section 5**). Additionally, the degradates 5-CLP and 6-CLP are also expected to form in major amounts in certain aerobic aquatic systems. ECOSAR analysis indicates 3,6-DCP, 5-CLP and 6-CLP are similar in toxicity to aquatic plants and animals as the ACID active ingredient (representing ACID, TEA and COLN). In contrast, submitted aquatic toxicity data for the TCP degradate indicates it is at least 10X more toxic than the parent ACID active ingredient and forms at a maximum rate of 33% relative to parent ACID under aerobic aquatic conditions. Given this substantially greater toxicity of the TCP degradate with aquatic organisms, assuming equivalent toxicity of TCP to the parent and other degradates was not considered appropriate. Therefore, a separate analysis was conducted to quantify potential risks associated with TCP at this maximum observed formation rate.

With the BEE active ingredient, the major degradates include the ACID, TCP, 3,6 DCP, 5-CLP and 6-CLP. However, the BEE active ingredient and TCP degradate are much more toxic to aquatic animals and plants compared to ACID, 3,6 DCP, 5-CLP and 6-CLP degradates (*e.g.,* by 2-3 orders of magnitude). Therefore, a separate analysis was conducted to evaluate the risk associated with BEE and TCP in aquatic ecosystems.

In summary, the stressors of concern for aquatic organisms include:

(1) **The ROC: ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** for the ACID, TEA and COLN active ingredients (ROC and TCP were modeled separately: ROC using TTR approach and TCP using the F/D approach); and,

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[7] https://www.oecd.org/chemicalsafety/risk-assessment/oecd-qsar-toolbox.htm
[8] https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=&dirEntryID=2804

(2) **BEE + ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** for the BEE active ingredient (Modeled separately).

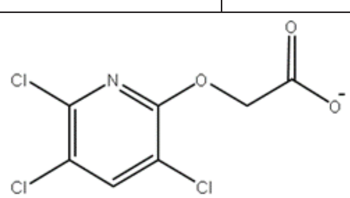
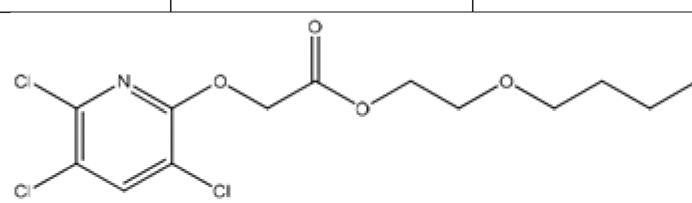
For terrestrial organisms, the BEE active ingredient is modeled separately from the ACID/TEA/COLN due to its different use pattern and some indication that BEE is more acutely toxic to birds compared to the ACID or TEA. For terrestrial plants, similar toxicity is seen with TEA and BEE based on vegetative vigor, but BEE appears more toxic on the basis of seedling emergence. Acute toxicity data to terrestrial animals are available for only one degradate (TCP) which indicates lower to similar acute toxicity to birds and mammals compared to ACID, BEE, and TEA. No toxicity data are available for the other potential degradates of triclopyr nor are SAR estimates of toxicity available for terrestrial organisms.

Therefore, given the similarities in toxicity among active ingredients to terrestrial organisms, the terrestrial ROC for the ACID, TEA and COLN active ingredients include ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP while that for BEE include BEE+ ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP [9].

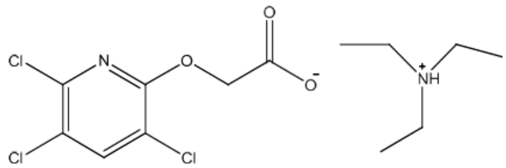
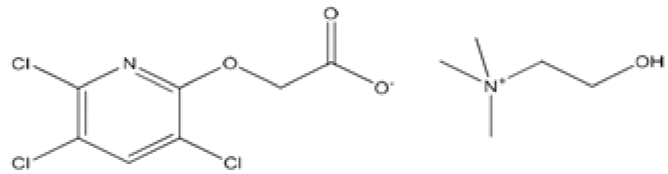
5 Environmental Fate Summary

Triclopyr herbicides consist of four separately formulated active ingredients: ACID, BEE, TEA and COLN. **Table 5-1** contains a summary of the chemical, physical properties of these compounds. Detailed information of the environmental fate of the parent and degradate chemicals is provided in **Appendix A.**

Table 5-1. Physical-Chemical Properties of Triclopyr ACID, BEE, TEA and COLN forms; Soil Water Distribution Coefficient for the ACID and Bioconcentration Properties for BEE[1]

Properties	Triclopyr ACID	Triclopyr BEE	Triclopyr TEA	Triclopyr COLN
Chemical Name	3,5,6-trichloro-2-pyridinyloxyacetic acid	3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester	3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, choline salt
Formula	$C_7H_4Cl_3NO_3$	$C_{13}H_{16}Cl_3NO_4$	$C_{13}H_{20}Cl_3N_2O_3$	$C_{12}H_{17}Cl_3N_2O_4$
CAS No.	55335-06-3	64700-56-7	57213-69-1	104837-85-8
Molecular Weight	256.5 g mol-1	356.6 g mol^{-1}	358.67 g mol^{-1}	345.6 g mol^{-1}
Structures	 ACID		 BEE	

[9] Currently used terrestrial exposure model do not enable combined exposure of parent and degradates to be modeled. If data had indicated a degradate was substantially more toxic than parent chemical, separate modeling would have been done for that degradate.

Properties	Triclopyr ACID	Triclopyr BEE	Triclopyr TEA	Triclopyr COLN
	 TEA		 COLN	

Properties	Triclopyr ACID	Triclopyr BEE	Triclopyr TEA	Triclopyr COLN
Water Solubility	440 ppm @ 25° C	7.4 ppm @ 25° C	412,000 ppm @ 25° C	Dissolve in seconds (MRID 493785-02; A)
Vapor Pressure (VP)[2]	1.3 x 10^{-6} torr @ 25° C	3.6 x 10^{-6} torr @ 25° C	3.6 x 10^{-7} torr @ 25° C	No Data
HLC @ 25° C	10.0 x 10^{-10} atm m^3 mol^{-1} (Calculated; non-volatile)	2.3 x 10^{-7} atm m^3 mol^{-1} (Calculated; non-volatile)	4.1 x 10^{-13} atm m^3 mol^{-1} (Calculated; non-volatile)	
Log Kow (K_{ow})[3]	-0.65 (0.2) (MRID 412191-06; A) Low potential for bioaccumulation	4.01 (10,233) High potential for bioaccumulation	-0.51 (0.3) (MRID 412191-06; A) Low potential for bioaccumulation	
pK_a	2.93 Rapid dissociation at environmentally relevant pHs (5 to 7)(MRID 412191-06; A)	No value	No value Dissociates/ in ≤1 minute (MRID 430114-01; A)	No value, Dissociates in seconds over various concentrations (pH not reported (MRID 493785-02; A)
Air-water Partition Coefficient (K_{AW}; Unitless)[4]	3.3×10^{-11} (log K_{AW} = -11)	3.3×10^{-11} (log K_{AW} = -11)	3.3×10^{-11} (log K_{AW} = -11)	Estimated from VP and H_2O solubility at 25°C; Nonvolatile from H_2O

Soil-Water Distribution Coefficients (K_d in L/kg-soil or sediment) Organic Carbon-Normalized Distribution Coefficients (K_{oc} in L/kg-organic carbon) for the ACID[5]	***Soil/Sediment***	***K_d***	***K_{OC}***	***Reference***
	Sand pH 5.0 and O.C 0.73%	**0.975**	**134**	407498-01 (A): Mobile (FAO classification system) [10]
	Silt loam, pH 7.7 and O.C 0.67%	**0.165**	**25**	
	Clay loam, pH 6.6 and O.C 1.38%	**0.733**	**53**	
	SL, pH 7.5 and O.C 2.25%	**0.571**	**25**	
	Mean	**0.611**	**59.2**	K_d better predictor of sorption based on lower CV
	Coefficient of Variation (CV)	**56%**	**87%**	
Bioconcentration in Fish for BEE[6]	Triclopyr BEE bioconcentrate in fish tissue relative to water for a brief period (a few hours or less), after which it is expected to be metabolized to the acid form. Furthermore, the acid is not expected to bioconcentrate in tissue relative to water; although indirectly, the acid ends up being higher in fish tissue vs. water because of its metabolism, in fish, from BEE to acid (MRID 499924-08[N])			

[10] Food and Agriculture Organization of the United Nations. FAO PESTICIDE DISPOSAL SERIES 8. Assessing Soil Contamination: A Reference Manual. Appendix 2. Parameters of pesticides that influence processes in the soil. Editorial Group, FAO Information Division: Rome, 2000.
URL: http://www.fao.org/DOCREP/003/X2570E/X2570E00.htm

Properties	Triclopyr ACID	Triclopyr BEE	Triclopyr TEA	Triclopyr COLN

[1] **General Notes:** [N] Studies submitted since the Problem Formulation was completed are designated with an N associated with the MRID number; **Studies classification:** A= Acceptable, S= Supplemental

[2] **Vapor Pressure for BEE and TEA:** Environmental Fate of Triclopyr. 1977, CA Department of Pesticide Regulation (CAdpr) URL: https://www.cdpr.ca.gov/docs/emon/pubs/fatememo/triclopyr.pdf

[3] **Log K_{ow} for BEE:** EPI Suite estimate, and the same value reported in USDA. 1996. Selected Commercial Formulations of Triclopyr – Garlon 3A and Garlon 4 Risk Assessment. Animal and Plant Health Inspection Service (APHIS). USDA. http://www.fs.fed.us/r5/hfqlg/publications/herbicide_info/1996b_triclopyr.pdf

[4] All estimated values were calculated according to "*Guidance for Reporting on the Environmental Fate and Transport of the Stressors of Concern in Problem Formulations for Registration Review, Registration Review Risk Assessments, Listed Species Litigation Assessments, New Chemical Risk Assessments, and Other Relevant Risk Assessments*" (USEPA, 2010a).

[5] **CV=**Coefficient of Variation

[6] **Bioconcentration in Fish**: Submitted study is not a BCF study but rather an uptake, metabolism, and depuration of triclopyr BEE by Coho Salmon under static exposure conditions.

Data in **Table 5-1** indicate that the ACID/TEA/COLN forms of triclopyr are moderatley to highly soluble in water while BEE form is practically insoluble (solubility of 7.4 mg/L; 7.4 parts per million [ppm]). All forms of triclopyr are classified as non-volatile from water and dry non-adsorbing surfaces (USEPA, 2010a). Furthermore, the ACID form of triclopyr is classified as mobile based on measured K_{oc} values and the FAO classification system (FAO, 2000). The ACID form of triclopyr and its degradate may be transported to surface water via spray drift and runoff or to groundwater via leaching.

The ACID form of triclopyr may be found in both water and sediment, the octanol-water partition coefficient (K_{OW}) and organic-carbon normalized soil-water distribution coefficient (K_{OC}) values are much lower than the values that would trigger the need to conduct a separate sediment exposure assessment (40 CFR Part 158.630).[11] Compounds with a log K_{OW} of 3.0 and above are generally considered to have the potential to bioconcentrate in aquatic organisms. Based on log K_{OW}'s of -0.65 and -0.51 for the ACID and TEA, bioconcentration of the ACID and TEA forms of triclopyr are not of primary concern.; however, with an estimated log K_{ow} of 4.01 for BEE, bioconcentration of BEE is of potential concern (based on log K_{OW} alone). An analysis of bioaccumulation of triclopyr BEE using the KABAM model indicates accumulation of BEE in aquatic food webs is not a risk concern to piscivorous birds and mammals, based on its Kow, available toxicity data, and 21-d aquatic EECs of 0.022 and 0.014 mg a.i./L obtained from the range/pasture land use with the highest EECs (**Table 8-5**).

In preparing the tank mix, the TEA and COLN forms of triclopyr dissolve and dissociate instantaneously into the ACID plus triethanol amine and choline moieties, respectively. Similarly (as will be shown later), BEE form of triclopyr is expected to ultimately convert into the ACID form plus the butoxy ethanol moiety within a relatively short period of time (hydrolysis $t_{½}$= 9 days; aerobic/anaerobic metabolism soil and aquatic systems $t_{½}$= <1 day in) (**Figure 5-1**). Triclopyr acid itself (the ACID) and that forming from BEE, TEA and COLN is a weak acid which will dissociate completely to the triclopyr anion at environmentally-relevant pH values

[11] Sediment data may be required if the soil-water distribution coefficient (K_d) is ≥ 50 L/kg, K_{OC}s are ≥1000 L/kg-organic carbon, or the log K_{OW} is ≥ 3 (40 CFR Part 158.630). Sediment data may also be requested if there may be a toxicity concern.

(dissociation constant pKa 2.93). Therefore, triclopyr anion will be the predominant moiety present in the environment when products containing the four forms of triclopyr are used (**Figure 5-1**).

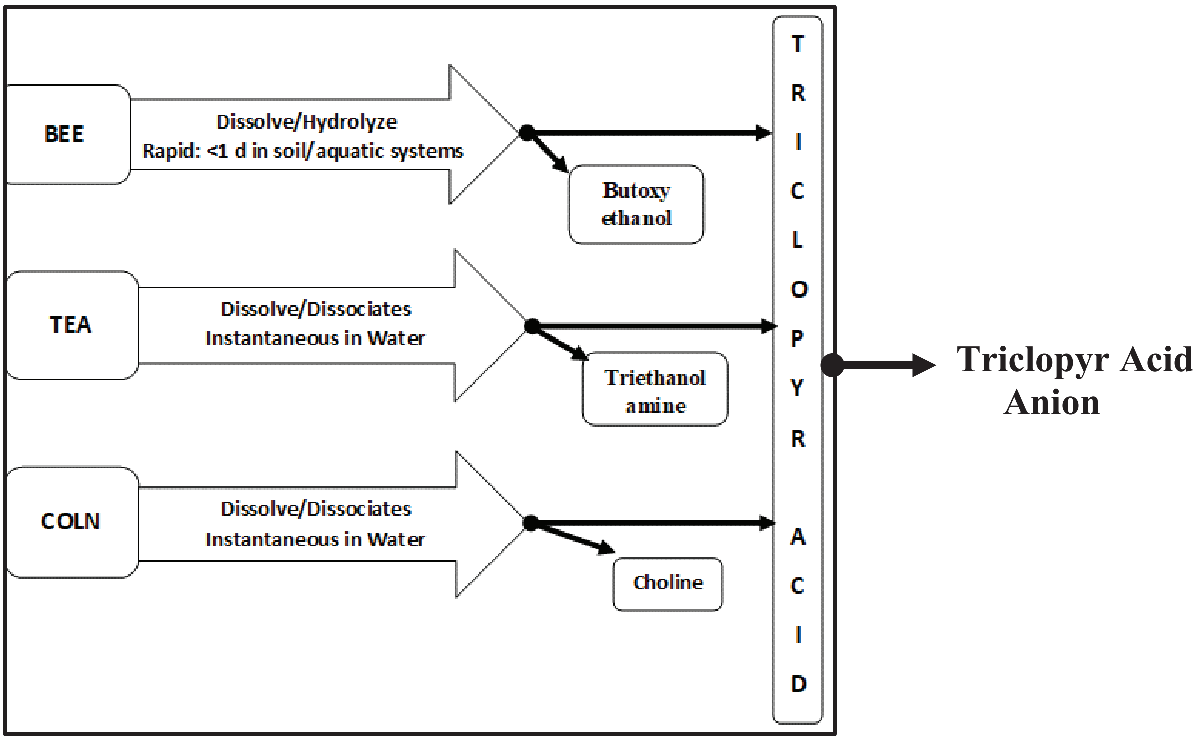


Figure 5-1. Expected Initial Dissolution/ Dissociation/Hydrolysis of Various Triclopyr Forms in the Environment. Triclopyr herbicides consist of the **ACID**: 3,5,6-trichloro-2-pyridinyloxyacetic acid (**ACID**); **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; **TEA**: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt; and, **COLN**: 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, and, choline salt.

As shown in **Figure 5-1**, dissociation of TEA and COLN and hydrolysis of the BEE are expected to produce, in addition to the ACID moiety, triethanolamine, choline and butoxyethanol moieties, respectively. These products were claimed, by the registrant, to dissipate rapidly by microbial degradation and/or of no toxicological concern. Other lines of evidence for rapid dissociation are presented in **Appendix A** support the registrant's claim and therefore triethanolamine, choline and butoxyethanol moieties were not considered as residues of concern in this assessment. In this assessment, two forms of triclopyr are considered: the ACID (representing itself, TEA and COLN forms) and BEE. Therefore, it is only necessary to present and discuss fate and transport data for these two forms of triclopyr (the ACID and BEE).

Hereunder, a complete review of new and previously submitted studies available for the ACID and BEE forms of triclopyr with the first representing the ACID, TEA and COLN forms.

Triclopyr ACID

Table 5-2 below summarizes representative half-life values derived using laboratory degradation data for triclopyr acid and its residue of concern.

Table 5-2. Summary of Environmental Degradation Data for Triclopyr Acid (ACID) plus Triclopyr Residue of Concern (ROCs).[1]

<table>
<tr><th rowspan="2">Study</th><th rowspan="2">System Details</th><th colspan="2">Representative Half-life (days)[2]</th><th rowspan="2">Source/ Study Classification</th></tr>
<tr><th>Parent</th><th>ROCs</th></tr>
<tr><td>Abiotic Hydrolysis</td><td>pH 5, 7, 9</td><td>Stable</td><td>Stable</td><td>418796-01 (A)</td></tr>
<tr><td>Atmospheric Degradation</td><td>Hydroxyl Radical</td><td>1.1 (SFO)</td><td>N/A</td><td>EPI Suite V 4.1</td></tr>
<tr><td>Aqueous Photolysis</td><td>pH 7, 25ºC, 40ºN sunlight</td><td>0.4 (SFO)</td><td>0.4[3]</td><td>499924-01 N (A)</td></tr>
<tr><td>Soil Photolysis</td><td>IL Loam, 25ºC, PH 7, 40ºN sunlight</td><td>Stable</td><td>Stable</td><td>MRID 12345-67 (A)</td></tr>
<tr><td rowspan="4">Aerobic Soil Metabolism</td><td>MO Silt loam, 25°C</td><td>6 (SFO)</td><td>14.9 (SFO)</td><td rowspan="4">499924-02 N (A)</td></tr>
<tr><td>TX Sandy clay loam, 25°C</td><td>21 (SFO)</td><td>29.0 (SFO)</td></tr>
<tr><td>ND Sandy loam, 25°C</td><td>18 (SFO)</td><td>33.4 (SFO)</td></tr>
<tr><td>CA Clay, 25°C</td><td>13 (SFO)</td><td>17 (SFO)</td></tr>
<tr><td rowspan="4">Anaerobic Soil Metabolism</td><td>WY Clay, 25°C</td><td>115 (SFO)</td><td>N/A</td><td rowspan="4">499924-03 N (A)</td></tr>
<tr><td>UK Silt Loam, 25°C</td><td>94 (SFO)</td><td>N/A</td></tr>
<tr><td>UK Sandy Loam, 25°C</td><td>170 (Slow DFOP)</td><td>N/A</td></tr>
<tr><td>UK Clay, 25°C</td><td>69 (SFO)</td><td>N/A</td></tr>
<tr><td rowspan="2">Aerobic Aquatic Metabolism[3]</td><td>Italy loam sediment: Water, 25°C</td><td>23 (SFO)</td><td>183.1 (SFO)</td><td rowspan="2">499924-04 N (S)</td></tr>
<tr><td>French Sand Sediment: Water, 25°C</td><td>26 (SFO)</td><td>127.3 (SFO)</td></tr>
<tr><td rowspan="2">Anaerobic Aquatic Metabolism[4]</td><td>GA Sandy Loam, 25°C</td><td>1,433 (SFO)</td><td>Stable</td><td rowspan="2">001519-67 N (S)</td></tr>
<tr><td>VA Sandy loam, 25°C</td><td>1,339 (SFO)</td><td>Stable</td></tr>
</table>

[1] **General Notes:** Studies submitted since the Problem Formulation was completed are designated with an N in association with the MRID number; **Studies classification:** A= Acceptable, S= Supplemental; N/A= Not applicable

[2] **Half-lives*:*** SFO=single first order; DFOP=double first order in parallel; DFOP slow DT_{50}=slow rate half-life of the DFOP fit

[3] The test substance is the 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester (BEE) form of triclopyr. BEE was a transient species transforming relatively quickly into the 3,5,6-trichloro-2-pyridinyloxyacetic acid (ACID) form of triclopyr. ACID maximums reached 98 & 90% in seven days. Therefore, starting from the 7-day time interval, the study can be considered to represent the fate of the ACID form of triclopyr in an aerobic aquatic system

[4] The test substance is the BEE form of triclopyr. BEE transformed completely into the ACID form of triclopyr. ACID maximums reached 101 & 98% in one-day. Therefore, the study can be considered to represent the fate of the ACID form of triclopyr in an aerobic aquatic system.

As shown in **Table 5-2**, triclopyr acid is highly vulnerable to abiotic photolysis ($t_{½}$ <1 d) and non-persistent in the aerobic soil/aquatic systems ($t_{½}$ range: 6 to 21 days at 25ºC in six soils; and, from 23 to 26 days in two aquatic systems; Goring *et al.*, 1975)[12]. In contrast, anaerobic

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metabolism is expected to be slower ($t_{½}$ range: 69 to 170 days) than aerobic metabolism as the chemical is moderately persistent in such systems according to Goring scale. Finally, the ACID is stable to abiotic hydrolysis at pH 5, 7, and 9/photolysis on soil and essentially stable to anaerobic aquatic metabolism ($t_{½}$ >1,000 days).

A summary of major/minor degradation products observed in laboratory fate studies with triclopyr is shown in **Table 5-3**.

Table 5-3. Summary of Major/Minor Degradation Products of Triclopyr Herbicides[1] Observed in Laboratory-based Environmental Fate Studies (refer to Appendix A, Table III-1 for acronyms, structures and other information on the degradates).

Study	Half-life (days)/Other Data
Aqueous photolysis (End of study= EOS= 30 d)	**Major:** 29% [(3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid @ 1 d declining to non-detect @ EOS; 27 to 28% mixture of chloromaleamic acid, fumaric acid, and chlorofumaric amide @ 6 d to EOS; 10% maleamic acid @ 0.5 d declining to 6% @EOS; and 60% CO_2 @ EOS. **Minor:** 8% fumaric amide; <1% TMP and mixture of succinamic succinic acids.
Aerobic soil (6 soils: EOS for the 1st two= 56 d @25°C while it is 120 d for the others) @20 °C	**Major: TCP:** Max range from 19-35% @ 14-59 d declining to 2-19% @ EOS (Estimated $t_{½}$ for TCP 20-70 days**);** and CO_2= 51-58% @ EOS. **Minor: TMP:** Max range from <1-5% @ 14 d-EOS then <1-5% @EOS; MTCP: <1-6% @ 59-90 d then <1-5 @ EOS; 3,5-DCMP**:** <1-1% @ 59 d-EOS then 0-1 @ EOS; and 5,6-DCMP**:** Max <1 @ EOS
Anaerobic soil (EOS= 120-122 days) @20 °C	**Major: TCP:** Max range 33-54% @ 19 d-EOS then to 13-54% @ EOS (Estimated $t_{½}$ for TCP 29-70 days)**;** and 3,6-DCP**:** Max 11-32% @ EOS; and CO_2= 4-20% @ EOS. **Minor: TMP:** 4-5% @ 7 d ranging from 2-4% @ 7-60 d with slight or no decline @ EOS; [(5,6-dichloropyridin-2-yl)oxy]acetic acid: Detected in one soil at a Max of 2.5% @ 60 d with no apparent decline; and X79402**:** Detected in one soil at a Max of 0.7% @ 60 d declining to no detection @ EOS.
Aerobic Aquatic[2] (EOS= 106 d @20 °C)	**Major: TCP:** Max 33 & 24% @ 59 d & EOS declining to 19% @ EOS in one system and remaining at 24% @ EOS in the other; 3,6-DCP**:** Max 34 & 52% @ 59-EOS declining to 30% @ EOS in one system and remaining at 52% @ EOS in the other; and the total of 5-CLP and 6-CLP: Max 26% @ 59 d declining to 21% @ EOS in one system while it was a minor degradate in the other (Max 1.2%) **Minor: 5-CLP** and **6-CLP**: Max 1% @EOS in one system only; TMP: Max 2% @ 29 Minutes declining to 0.04% @ EOS; and CO_2**:** 0.5-2% @ EOS.
Anaerobic Aquatic[3] (EOS= 365 d @25 °C)	**Major: TCP:** Max. 43% @ 201 d declining to 22% @ EOS in one system while the maximum was 26% @ EOS **Minor: CO_2:** 0.01%

Study	Half-life (days)/Other Data

[1] Triclopyr herbicide active ingredients include: 3,5,6-trichloro-2-pyridinyloxyacetic acid (**ACID**); 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester (**BEE**); 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt (**TEA**); and, 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, choline salt (**COLN**); degradates include: 3,5,6-Trichloro-2-pyridinol (**TCP**); ,6-Dichloro-2-pyridinol (**3, 6 DCP**)
[2]The test substance is the BEE form of triclopyr. BEE was a transient species transforming relatively quickly into the ACID form of triclopyr. ACID maximums reached 98 & 90% in seven days then decreased to 11 & 5% at the end of the 106-day studies (t ½= 0.6-0.7 days). Therefore, major and minor degradates observed in the study, are considered to be that of the ACID
[3] The test substance is the BEE form of triclopyr. BEE transformed completely into the ACID form of triclopyr. The ACID maximums reached 101 & 98% in one-day. The ACID form of triclopyr was highly persistent. Again, observed degradation products in the study, are considered to be that of the ACID.

Data in **Table 5-3** indicate that the major transformation products resulting from environmental degradation of triclopyr acid are:

- 3,5,6-trichloro-2-pyridinol (**TCP**): A slightly to moderately persistent degradate (estimated half-life of 20 to 70 days) that forms in aerobic/anaerobic soil and aquatic systems. The maximum formation levels range from 33 to 54%; and,
- 3,6-dichloro-2-pyridinol (**3,6-DCP**): A degradate that forms to a maximum of 21% in some anaerobic soil systems and up to a maximum of 52% in aerobic aquatic systems. This degradate show only a slight decline.

It is important to note the following:

- The total amount of the degradates **5-CLP** and **6-CLP** combined was observed as a major degradate in only one aerobic aquatic study (Max 26%) with only slight decline to 21% at the end of a 106-day study;
- Carbon dioxide forms as a major degradate in aerobic soil systems only; and,
- Many major/minor degradates were observed in the aqueous photolysis study (refer to **Table 5-3**, above). These degradates are expected to form in significant amounts in shallow clear water systems. However, aqueous photolysis is not expected to play a major role in dissipation of this chemical in other water bodies due to the limited penetration of light in these systems.

A table summarizing the maximum amounts of degradates formed in different studies and the structures (the Residue of Concern Knowledgebase Subcommittee "ROCKS" table) is available in **Appendix A**

Based on the degradation profile described, above and summarized in **Figure 5-2,** the major degradates of triclopyr acid are **TCP** and **3,6 DCP** and both are of exposure concern. Additionally, the degradates **5-CLP** and **6-CLP** could also be of exposure concern as they expected to form in major amounts in some aerobic aquatic systems. Except for the photolysis degradates, all other degradates are not included in the **ROC** because they form in minor amounts and most of them declined following maximum formation. Exposure to the major photolysis degradates, listed in **Table 5-3**, is limited to shallow clear water bodies.

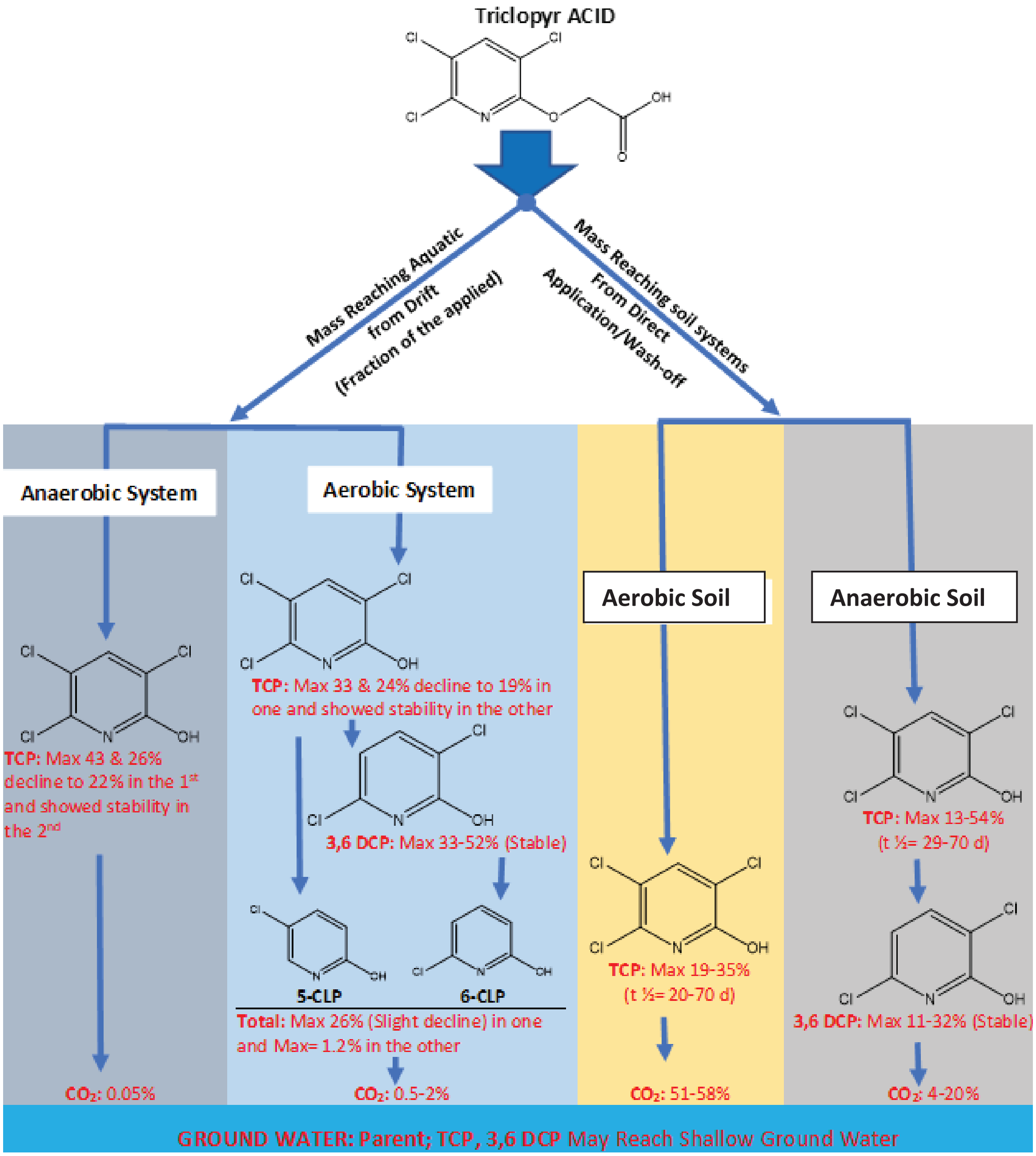

Figure 5-2. The Degradation Profile of Triclopyr Acid in Various Compartments of the Environment (Only major degradates are included)

Triclopyr BEE

As stated previously, acute and chronic risk resulting from the ACID form of triclopyr and its residue can be used to represent the ACID itself, and the acid equivalent of its TEA and COLN forms. Instantaneous dissociation of TEA and COLN forms of triclopyr to the ACID supports this equivalency. For BEE, despite the relatively short time lag (days) observed in the process of transformation of BEE to the ACID, its much greater toxicity to aquatic organisms combined with aquatic exposure modeling indicates that both acute and chronic (in terms of the uncertainty as to when the chronic effects would initiate) exposure to BEE are of toxicological concern. Fate data on BEE are necessary to characterize acute and chronic risk resulting from expected exposure and toxicity to this form triclopyr before its transformation to the ACID form. **Table 5-4** summarizes representative degradation half-life values from laboratory degradation data for BEE.

Table 5-4. Summary of Environmental Degradation Data for Triclopyr 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester (BEE).[1]

Study	System Details	Half-life (days)[2]/Other Data	Source (MRID)/ Study Classification
Hydrolysis	Sterile buffered solutions (End of study= EOS= 40 d @25 °C)	**84.0** days **@ pH 5**; **9.0** days **@ pH 7**; and **0.3** days **@ pH 9** Triclopyr **ACID** is the only degradate	001341-74 (A)
Aqueous photolysis	Sterile buffered aqueous solution @ pH 5; Natural sunlight (End of study= EOS= 30 d @25 °C)	**6.6** days **Major:** CO_2= 29.4% @ EOS **Minor:** dichloropyridinyloxy acetic acid; 2-hydroxy ethyl ester; and (5/6)-chloro-3-hydroxy-s-pyridinone	430076-01 (A)
Aerobic soil	**Soil 1:** MS Loamy soil (pH 8; O.C= 0.5%) **Soil 2:** GA Sandy loam soil (pH 5.1; O.C= Organic carbon= 1.0%) (EOS= 9 d @25 °C)	**0.2** day (SFO-LN) in **soil 1**; and **0.6** day (SFO-LN) in **soil 2**. **Major:** Triclopyr ACID increasing continuously to 83% @EOS **Minor:** CO2= <1% @EOS.	472938-01 [N] (S)
Aerobic aquatic	**System 1:** L sediment from Italy (pH 7.3; O.C= 4.89%): water (pH 7.9) **System 2:** S sediment from France (pH 5.3; O.C= 2.43%) : water (pH 6.2) (EOS= 106 d @20 °C)	**0.7** day (SFO) in **system 1**; **0.6** day (SFO) in **system 2** **Major & Minor Degradates in System1 & System 2:** Refer to the summary of fate studies for the ACID (**Table 5-3**)	499924-04 [N] (A)
Anaerobic aquatic	**System 1:** GA Sandy loam soil (pH 5.7; O.C= 0.95%): water **System 2:** VA Sandy loam soil (pH 6.3; O.C= 0.65%): water (EOS= 365 d @25 °C)	**<1 d[3]** in both systems **Major & Minor Degradates in System1 & System 2:** Refer to the summary of fate studies for the ACID (**Table 5-3**)	001519-67 [N] (S)

[1] **General Notes:** Studies submitted since the Problem Formulation was completed are designated with an [N] associated with the Master Record Identification (MRID) number **Studies classification:** A= Acceptable, S= Supplemental; Photolysis on soil and mobility studies were waived assuming that BEE will hydrolyze very quickly to the ACID
[2] ***Half-lives:*** SFO=single first order**; SFO-LN**=SFO calculated using natural log transformed data
[3] This is the ***observed*** half-lives, fitted half-lives could not be calculated due to the extremely rapid dissipation of BEE

Field Studies

Several aquatic, forestry and terrestrial field studies were submitted for TEA and BEE forms of triclopyr. Table 5-5 contains a summary of the results obtained from these studies

Table 5-5 Summary data for Aquatic, forestry and terrestrial field studies

Site	Application Type(s)/ Parameters	Tracked Degradate(s)	Reference and Results
Triclopyr TEA: Aquatic field studies			
Lake Seminole, Georgi (21 d study)	Surface and Aerial Applications/ 2500 ppm	ACID and TCP	MRID 417143-04 (S) **Water: ACID** DT_{50}= 0.5 for surface application DT_{50}= 3.5 for aerial application **Sediment: ACID** Sediment: ACID (up to 10 cm deep) <LOQ of 50 ppb **TCP** ND in surface and bottom sediment after one day (LOQ= 100 ppb)
Pond, TX	Ground Application 2,500 ppb		MRID 44561-04 ACID: DT_{50}= 6 d in water and 4 d in sediment Low formation of TCP and TMP. TMP not detected in the sediment
Lake Minnetonka at Phelps Bay, sub-surface applied and Carsons Bay sites, surface applied (42 d study)	Ground Broadcast subsurface and sub-surface Applications/ 2500 ppb mixed with a dye	ACID, TCP, and TMP	MRID 444561-02 **Water: ACID** DT_{50}= 3 d; Phelps Bay; DT_{50}= 5 d; Carsons Bay; **Sediment: ACID** DT_{50}= 3 d; Phelps Bay; DT_{50}= 7 d; Carsons Bay; **Water: Degradate** Not significant formation: **TCP** Max. 24/20 ppb @ 3 hrs. (DT_{50}= 1 d observed); **TMP** Max 4.0/4.0 ppb @ 3 d (DT_{50}= ND, no enough data) **Sediment: Degradate** Not significant formation (<1%/<0.1%): **TCP** Max. 27/65 ppb @ 3 wks **TMP** Not detected
Static man-made ponds located in CA, MO and TX (28 d study) Problems: no freezer Stabilty	Ground Application 2500 ppb	ACID, TCP, and TMP	MRID 444561-03 **Water: ACID** DT_{50}= 7-9 d; CA pond; DT_{50}= 6 d; MO & TX ponds; **Sediment: ACID** DT_{50}= 4 d; CA pond; DT_{50}= Not determined; MO pond; DT_{50}= 5 d; TX pond; **Water: Degradate** Not significant formation: **TCP** Max. ≤21.7 ppb @ 2 d **TMP** Max 4.0-7.4 ppb @ 2-5 d **Sediment: Degradate**

			Not significant formation: **TCP** Max. ≤0.16 ppb @ 7 d; **TMP** Not detected
Rice fields in AR (silty clay loam soil) and LA (silty clay loam soil) Before flood After flood (100 d study)	Ground application of 0.375 lbs a.e/A each	ACID, TCP, and TMP	MRID 439559-01 **Before flood (soil):** DT_{50} = 8 d; AR DT_{50} = 3 d; LA **After flood (Rice Paddy)** DT_{50} = 2 d; AR; DT_{50} = 3 d; LA **After flood (flooded soil)** DT_{50} = 12 d; AR and LA TCP Max found in Paddy water and flooded soil after the second application and was 10 times TMP Max (TCP Max 1%) TCP leached down to 12" in AR and to 9" in LA (concentration near LOQ of 10 ppb)
Triclopyr BEE: TFD Studies			
ROW: loam soil, CA, bare and vegetative with Native short grass plots (65 Wks study)	Ground application of 6.4 lbs. a.e/A each	BEE, ACID, TCP and TMP	MRID 427306-01 **ACID** DT_{50} = 39 d (top 6", un-vegetative); DT_{50} = 33 d (top 6", vegetative) **TCP Max** 21-25% (Weeks 12-16) reaching 4-ND @ EOS **TMP Max** 2-3% (Weeks 12-16) reaching ND @ EOS Neither triclopyr nor its degradates were detected below the 6-inch soil depth (sampled to 36")
ROW: loam soil, NC, bare ground sandy loam soil (52 Wks study)	Ground application of 8.1 lbs. a.e/A each	BEE, ACID, TCP and TMP	MRID 430334-01 **BEE and ACID** DT_{50} Of BEE= 1 d (top 7.5 cm) DT_{50} Of ACID+BEE= 11 d (top 7.5 cm) **TCP and TMP** TCP Max 23% (7 d) reaching 1% @ EOS TMP Max 5% (1 d) reaching 1% @ EOS (% of Max ACID observed) Neither triclopyr nor its degradates were detected below the 30-cm soil depth
Forest Site (364 days for soil and 29 days for foliage)	Aerial application of 3.1 to 3.4 lbs. a.e./A	BEE, ACID, TCP and TMP	**BEE** transformed to ACID in the stream within hours **ACID** DT_{50} = 26 d in soil; DT_{50} = 4-11 d in aquatic plants **TCP** detected up to 90 cm, TMP up to 30 cm **ACID** detected in foliage, soil, water, sediment, leaf litter and aquatic plants. **TCP** detected in foliage (<0.2% of the ACID), soil (DT_{50} = 85 d), **TMP** detected in soil only. Level of TCP in exposed soil 5-6% of the ACID and 10-20% in soils under litter. Level of TMP one order of magnitude less than TCP sporadically detected
Clear cut timberland, WA	Aerial application 6 lbs. a.e/A	ACID, TCP TMP	430116-01 **ACID** DT_{50} = 15 d in foliage; DT_{50} = 20 d in leaf litter; DT_{50} = 5 d in pond water; DT_{50} = 24 d in pond sediment; DT_{50} = 96 d in soil (loam soil)

In submitted aquatic field dissipation studies ACID and degradates TCP and TMP were tracked following application of TEA to non-static lakes in GA, TX and MN and static ponds in CA, MO, and TX. The ACID form of triclopyr is a result of quick dissociation of TEA and degradation of the ACID produce TCP and TMP. Dissipation half-life of the ACID in lake waters of non-static lakes ranged from 0.5 to 5 days while it was 7-9 days in static lakes (**Table 5-5**). Only small amounts of the ACID partitioned into the sediment and degraded with half-lives ranging from 3-7 days in non-static lakes and 4-5 days in static lakes. Although concentrations of the ACID following application were very near to the target concentrations of 2,500 ppb, the ACID dissipated very quickly (half-lives in the range of 0.5 to 9 days) indicating that movement rather than degradation played a role in its dissipation. In comparison, the ACID 90th percentile laboratory aerobic aquatic half-live is 29 days confirming the importance of transport over degradation in determining the half-life of the ACID in the field. Levels of TCP indicates no significant formation with no discrete formation and decline profile. The same is indicated for the degradate TMP with even lower levels of formation compared to TCP. In the laboratory, TCP forms at a maximum level of 24-33% which is much higher than observed in the field reflecting the importance of transport rather than degradation.

Two field studies were submitted for rice fields in AR and LA. Half-lives of the ACID in the soil before floods ranged from 3-8 days and after flood 2-3 days supporting non-persistence of the ACID observed in laboratory aerobic soil (t ½ = 11 to 20 days). Half-life of the ACID after flood was 12 days in both AR and LA compared to 90th percentile laboratory aerobic aquatic half-live of 29 days. Again, half-lives in the field are shorter because dissipation in the field involves transport in addition to degradation.

BEE form of triclopyr was used in submitted terrestrial field studies for CA, NC. In these studies, the laboratory predicted rapid transformation of BEE to the ACID was confirmed (BEE t ½ = 1 day compared to the same value in aerobic soil). Half-lives of the ACD ranged from 11 to 39 days compared to aerobic soil half-lives range of 8-29 days. Levels of TCP formation was close to those observed in the aerobic soil in the laboratory (21 to 25% compared to 11-25%). The maximum observed TMP formation range from 2-5% compared to 5 to 8% in laboratory.

BEE form of triclopyr was also used in forestry field dissipation studies in a forested site in WA. In ontario site it was observed that BEE reaching the stream transformed to the ACID within hours. Following aerial application, the herbicide distributed throughout the forest floor reaching soil (exposed and under leaf litter), foliage, stream water and sediment, leaf litter. Half-lives were determined for soil and aquatic plants in the Ontario forest site (half-lives 26 to 4-11 days, receptively). Half-lives were calculated for the ACID reaching foliage (15 days), Leaf litter (20 days), pond water (5 days), Pond sediment (24 days) and soil (96 days). The level of TCP varies from 5-6% in exposed soil to 10-20% in soils under leaf litter. The level of TMP was one order of magnitude less than TC

6 Ecotoxicity Summary

Ecological effects data are used to estimate the toxicity of the four triclopyr active ingredients to surrogate species. The ecotoxicity data for the active ingredients and their associated products have been reviewed previously in multiple ecological risk assessments, including the Registration Eligibility Decision document in 1998 (USEPA 1998), the California Red-Legged Frog (*Rana draytonii*) ecological risk assessment in 2009 (USEPA 2009) and the preliminary Problem Formulation for Registration Review (USEPA 2014, D417819). These data are summarized in **Section 6.1** for aquatic organisms and **Section 6.2** for terrestrial organisms. Various studies have been submitted with aquatic animals and honey bees exposed triclopyr active ingredients since the preliminary Problem Formulation was issued in 2014. These studies include:

Aquatic Toxicity Studies:

MRID 49992406: Lifecycle Chronic Toxicity for *Daphnia magna* exposed to triclopyr BEE;
MRID 49992407: Early Lifestage Testing with the triclopyr degradate TCP on Rainbow Trout; and,
MRID 50673901: Lifecycle Chronic Toxicity for Mysid shrimp exposed to triclopyr BEE.

Bee Toxicity Studies:

MRID 49992409: Acute (single dose) oral toxicity test with adult honey bees exposed to triclopyr ACID;
MRID 50673902: Chronic (repeat dose) toxicity test to honey bee larvae exposed to triclopyr ACID; and,
MRID 50673903: Chronic (repeat dose) oral toxicity test with adult honey bees exposed to triclopyr ACID.

The results of these studies are described briefly in this section and in more detail in **Appendix D**.

6.1 Aquatic Toxicity

As described previously, triclopyr TEA and COLN undergo near instantaneous dissociation to triclopyr ACID in water. Therefore, toxicity data for the ACID, TEA, COLN are all considered representative of the ACID active ingredient and are expressed as acid equivalents (a.e.) using the molar ratio relative to triclopyr ACID. Triclopyr BEE is being assessed separately due to its different physical/chemical and toxicological characteristics. A summary of the submitted aquatic toxicity data for the ACID, TEA and COLN are described separately from that of the BEE active ingredient below.

6.1.1 Triclopyr ACID, TEA, COLN

The submitted acute toxicity data for triclopyr ACID and TEA indicate that it is practically non-toxic to freshwater fish (which serve as surrogates for aquatic-phase amphibians) and slightly toxic to estuarine/marine fish indicate (LC_{50} values range from 93 to 172 mg a.e./L; **Table 6-1**). Similarly, the ACID and TEA are slightly to practically non-toxic to aquatic invertebrates on an acute exposure (LC/EC_{50} values range from 42 to 554 mg a.e./L).

The chronic toxicity of triclopyr ACID or TEA to freshwater fish and invertebrates is relatively similar to their acute toxicity values (*i.e.,* the chronic NOAECs are within a factor of 2 of the acute LC_{50}), with NOAECs ranging from 24.4 mg a.e./L (estimated for Grass Shrimp, *Palaemonetes pugio,* using an acute-to-chronic ratio of 9.6;) to 74.4 mg a.e./L (for fathead minnow). A chronic NOAEC could not be estimated for triclopyr ACID since acute and chronic toxicity values for freshwater fish were determined on different species, *i.e.*, Bluegill Sunfish (*Lepomis macrochirus*) and Fathead Minnow (*Pimephales promelas*). No acute or chronic toxicity data are available for triclopyr COLN, but the active is expected to exhibit similar toxicity as triclopyr ACID and TEA due to its rapid dissociation to the ACID form.

With respect to aquatic plants, the most sensitive IC_{50} for tested vascular aquatic plants (duckweed; *Lemna gibba*) is 6.3 mg a.e./L while that for non-vascular plants is 4.2 mg a.e./L (cyanobacteria; *Anabaena flos-aquae*). Toxicity data for sediment-dwelling organisms would not be triggered for triclopyr ACID, TEA or COLN given their low hydrophobicity (*i.e.,* log K_{ow} < 3).

6.1.2 Triclopyr BEE

In contrast to the slightly to practically non-toxic ACID and TEA forms of triclopyr to fish and aquatic invertebrates, BEE is moderately to highly toxic to these taxa (**Table 6-1**) on an acute exposure basis. Toxicity data are expressed on an a.i. basis (rather than a.e.) since BEE is being assessed separately from the ACID, TEA and COLN active ingredients. Specifically, triclopyr BEE is consistently 2 to 3 orders of magnitude more acutely toxic to aquatic animals compared to triclopyr ACID or TEA, with a LC_{50} values ranging from 0.35 to 0.46 mg a.i./L. The chronic toxicity of BEE is approximately 1 order of magnitude lower than acute toxicity to these same taxa (NOAECs range between 0.011 to 0.17 mg a.i./L). Due to lack of chronic toxicity data for BEE with estuarine/marine fish, a NOAEC of 0.018 mg a.i./L was estimated using ACR of 25 from Rainbow Trout.

The BEE active ingredient also appears to be more toxic to aquatic plants compared to the ACID and TEA active ingredients. Specifically, the most sensitive EC_{50} values for BEE with vascular and nonvascular plants (0.88 and 0.1 mg a.i./L, respectively) are roughly an order of magnitude lower than those for the TEA and ACID (8.8 and 5.9 mg a.i./L respectively).

Given its log K_{ow} of 4.01, sediment toxicity data would be triggered for triclopyr BEE in accordance with 40 CFR Part 158. However, the short persistence of BEE in water (half-life 1 day) would introduce significant challenges in ensuring adequate exposure of benthic invertebrates to BEE given that sediment studies are only spiked once with test material at the test initiation. Therefore, sediment toxicity data were not recommended based on the 2014 preliminary Problem Formulation. In absence of sediment toxicity data, the chronic NOAECs for water column-dwelling invertebrates are used to estimate risk associated with BEE in sediment pore water.

6.1.3 Degradates

TCP is the only major degradate of triclopyr for which toxicity data have been submitted (**Table 6-1)**. The aquatic toxicity of the TCP degradate generally falls in between that of the ACID/TEA and BEE active ingredients. Specifically, TCP is classified as slightly toxic on an acute exposure basis to fish and aquatic invertebrates (LC/EC_{50} values between 10.4 and 58.4 mg a.i./L), with the exception of the Eastern oyster, where BEE is classified as moderately toxic (EC_{50} = 9.3 mg a.i./L). The chronic toxicity of TCP to fish and invertebrates is in some cases up to 2 orders of magnitude below its acute toxicity to the same species. For example, the acute EC_{50} for *D. magna* is 10.4 mg a.i./L while its chronic NOAEC is 0.058 mg a.i./L. The NOAEC value of 0.825 mg a.i./L for estuarine/marine fish was estimated using an ACR of 71 derived from tests of TCP with Rainbow Trout and applied to the LC_{50} of 58.4 mg a.i./L for the Atlantic Silverside (*Menidia menidia*). A NOAEC of 0.463 mg a.i./L for estuarine/marine invertebrates was estimated using an ACR of 179 derived from tests with *D. magna* and applied to the acute LC_{50} of 83 mg a.i./L for Grass shrimp. The toxicity of TCP to aquatic vascular and non-vascular plants with EC_{50} values of 8.2 and 2.0 mg a.i./L, respectively, is similar to that of the ACID/TEA active ingredients.

No aquatic toxicity data are available for the other major degradates of triclopyr active ingredients (3,6 DCP, 5-CLP, and 6-CLP). Further characterization of the potential toxicity of these degradates is provided below using ECOSAR (**Section 6.3**).

6.1.4 Open Literature – ECOTOX database

A search of the public ECOTOXicology (ECOTOX) Knowledgebase in 2009 and updated in 2019, yielded no new data from studies with more sensitive (lower) toxicity endpoints than those previously used in risk assessments and which were considered reliable for use in regulatory risk assessment.

Table 6-1. Aquatic Toxicity Endpoints for Triclopyr ACID, TEA, COLN, BEE and the TCP degradate.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in mg a.e./L (unless otherwise specified)	MRID or ECOTOX No./ Classification	Comments (Effects at LOAEC)
Freshwater Fish (surrogates for vertebrates)					
Acute	Triclopyr ACID technical	Rainbow Trout *Oncorhynchus mykiss*	96-h LC_{50} = **117**	00049637 Acceptable	Practically non-toxic
	Triclopyr TEA Salt (47.8)	Bluegill Sunfish, *Lepomis macrochirus*	96-h LC_{50} = 172	00062622 Acceptable	Practically non-toxic
	Triclopyr BEE (97)	Bluegill Sunfish, *Lepomis macrochirus*	96-h LC_{50} = **0.36 mg a.i./L**	42917901 Acceptable	Highly toxic

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in mg a.e./L (unless otherwise specified)	MRID or ECOTOX No./ Classification	Comments (Effects at LOAEC)
	TCP Degradate (99.9)	Rainbow Trout *Oncorhynchus mykiss*	96-h LC_{50} = **12.6 mg a.i./L**	41829004 Acceptable	Slightly toxic
Chronic	Triclopyr acid	**No data**			Reliable acute-to-chronic ratio (ACR) for estimating NOAEC could not be determined
	Triclopyr TEA Salt (44.9)	Fathead Minnow, *Pimephales promelas*	28-d Early Life Stage LOAEC= 116; NOAEC= **74.4**	00151958 Acceptable	Larval length and survival reduced 8% & 20% at 162 ppm
	Triclopyr BEE (97)	Rainbow Trout *Oncorhynchus mykiss*	60-d Early Life Stage LOAEC = 0.048; NOAEC = **0.026 mg a.i./L**	43230201 Acceptable	Larval weight (↓92%), hatch success (↓2.3%) and survival (percent effect not available)
	TCP Degradate	Rainbow Trout *Oncorhynchus mykiss*	60-d Early Life Stage LOAEC = 0.278; NOAEC = **0.178 mg a.i./L**	49992407[N] Acceptable	Mean length (↓2.8%) and wet weight (↓5.6%)
Estuarine/marine Fish					
Acute	Triclopyr TEA Salt (44.7)	Inland silverside *Menidia beryllina*	96-h LC_{50} = **93**	41633703 Acceptable	Slightly toxic
	Triclopyr BEE (96.1)	Inland silverside *Menidia beryllina*	96-h LC_{50} = **0.45 mg a.i./L L**	42053901 Acceptable	Highly toxic
	TCP (99.9)	Atlantic silverside *Menidia menidia*	96-h LC_{50} = **58.4 mg a.i./L**	42245901 Acceptable	Slightly toxic
Chronic	Triclopyr ACID	**No Data**			Reliable ACR for estimating NOAEC could not be determined
	Triclopyr BEE	**No Data** (Inland Silverside)	NOAEC = **0.018 mg a.i./L** (estimated)	NA	Estimated using ACR of 25 for Rainbow Trout tested with BEE
	TCP degradate	**No Data** (Atlantic Silverside)	NOAEC = **0.825 mg a.i./L** (estimated)	NA	Estimated using ACR of 71 for Rainbow Trout tested with TCP
Freshwater Invertebrates (water-column)					
Acute	Triclopyr ACID (technical)	Water flea, *Daphnia magna*	48-h EC_{50}= **133**	40346504 Acceptable	Practically non-toxic
	Triclopyr TEA Salt (64.7)	Water flea, *Daphnia magna*	48-h EC_{50} = 554	00151956 Acceptable	Practically non-toxic
	Triclopyr BEE (62.4)	Water flea, *Daphnia magna*	48-h EC_{50} = **0.35 mg a.i./L**	43442603 Acceptable	Highly toxic

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in mg a.e./L (unless otherwise specified)	MRID or ECOTOX No./ Classification	Comments (Effects at LOAEC)
	TCP Degradate (99.9)	Water flea, *Daphnia magna*	48-h EC_{50} = **10.4 mg a.i./L**	41829005 Acceptable	Slightly toxic
Chronic	Triclopyr TEA Salt (44.9)	Water flea, *Daphnia magna*	21-d LOAEC= 107; NOAEC= 57.7	00151959 Acceptable	Total young and mean brood size effected -25% reduction
	Triclopyr BEE (96.5)	Water flea, *Daphnia magna*	21-d LOAEC= 0.52; NOAEC= **0.17 mg a.i./L**	49992406[N] Supplemental	Survival (↓13%), growth endpoints not measured
	TCP Degradate	Water flea, *Daphnia magna*	21-d LOAEC= 0.130; NOAEC= **0.058 mg a.i./L**	45861301 In Review	15% ↓ offspring/female at 0.13 mg/L; 58% ↓ @ 1.5 mg/L
Estuarine/ marine invertebrates (water-column) Crustacea and Mollusca					
Acute	Triclopyr TEA Salt (46.2)	Grass shrimp *Palaemonetes pugio*	96- h LC_{50} = 234	42646102 Acceptable	Practically non-toxic
	Triclopyr BEE (96.1)	Grass shrimp *Palaemonetes pugio*	96-h LC_{50} = 2.48 µg a.i./L	41971601 acceptable	Moderately toxic
	TCP Degradate	Grass shrimp *Palaemonetes pugio*	96- h LC_{50} = 83 µg a.i./L	42245902 Acceptable	Slightly toxic
	Triclopyr TEA Salt (46)	Eastern Oyster *Crassostrea virginica*	96-h EC_{50} = **41.5**	42646101 Acceptable	Slightly toxic (shell growth)
	Triclopyr BEE (96.1)	Eastern Oyster *Crassostrea virginica*	96-h EC_{50} = **0.46 mg a.i./L**	41971602 Acceptable	Highly toxic (shell growth)
	TCP degradate (99.9)	Eastern Oyster *Crassostrea virginica*	96-h EC_{50} = **9.3 mg a.i./L**	42245903 Acceptable	Moderately toxic
Chronic	Triclopyr TEA	**No Data** (Grass Shrimp)	NOAEC = 24.4 (estimated)	NA	Estimated using ACR of 9.6 from *D. magna* tested with TEA
	Triclopyr BEE	Mysid *Americamysis bahia*	28-day NOAEC = **0.0109**; LOAEC = 0.0204 **mg a.i./L**	50673901[N] Acceptable	Weight (↓16%)
	TCP degradate	**No Data** (Grass Shrimp)	NOAEC = **0.463 mg a.i./L** (estimated)	NA	Estimated using ACR of 179 from *D. magna* tested with TCP
Freshwater invertebrate (sediment)					
Chronic	Triclopyr BEE	**No Data**			Risk estimation based on water column invert toxicity and pore water exposure
Estuarine/ marine invertebrates (sediment)					

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in mg a.e./L (unless otherwise specified)	MRID or ECOTOX No./ Classification	Comments (Effects at LOAEC)
Chronic	Triclopyr BEE	**No Data**			Risk estimation based on water column invert toxicity and pore water exposure
Aquatic plants and algae					
Vascular	Triclopyr TEA Salt (45)	Duckweed, *Lemna gibba*	EC_{50} = **6.3**; NOAEC = < 5.9	41633709 Supplemental	NOAEC could not be determined due to significant effects at all treatment levels.
	Triclopyr BEE technical	Duckweed, *Lemna gibba*	EC_{50} = **0.88 mg a.i./L**; NOAEC < 0.16	42719101 Acceptable	Significant effects on frond number at all treatment levels
	TCP degradate (99.9)	Duckweed, *Lemna gibba*	EC_{50} = **8.2 mg a.i/L** ; NOAEC = 1.02	45312002 Acceptable	↓ Frond number (20% reduction at 2.3 mg ai/L)
Non-vascular	Triclopyr ACID (technical)	FW green algae *Pseudokirchneriella subcapitata*	EC_{50} = 32.5; NOAEC = 7.0	41736303 Supplemental	50% Reduced cell count 12% reduction at 13 mg/L (LOAEC)
	Triclopyr TEA Salt (45)	Bluegreen algae *Anabaena flos-aquae*	EC_{50} = **4.2;** NOAEC = 1.4	41633706 Acceptable	↓Cell count (percent reduction from control not available from DER)
	Triclopyr BEE (97)	Freshwater diatom, *Navicula pelliculosa*	24-h EC_{50} = **0.10 mg a.i./L**; NOAEC = 0.002	42721102 Supplemental	↓Cell count (percent reduction from control not available from DER)
	TCP Degradate (99)	Bluegreen algae, *Anabaena flos-aquae*	EC_{50} = **2.0 mg a.i./L**; NOAEC = 0.353	45312003 Acceptable	↓Cell density (56%)

ACID: 3,5,6-trichloro-2-pyridinyloxyacetic acid; **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; **TEA**: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt; **COLN**: 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, and, choline salt; **TCP**: 3,5,6-trichloro-2-pyridinol.
TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient
[N] Studies submitted since the problem formulation was completed are designated with an N associated with the Master Record Identification (MRID) number.
Bolded value represents most sensitive endpoint used for assessing risk for taxon/test material.
>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).
< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

6.2 Terrestrial Toxicity

6.2.1 Triclopyr ACID, TEA, COLN

Similar to that observed with aquatic animals, the ACID and TEA active ingredients of triclopyr are slightly toxic to practically non-toxic to birds (which serve as surrogates for reptiles and terrestrial-phase amphibians), mammals and bees on an acute exposure basis (acute oral LD_{50} values range from 1,698 to 2,271 mg a.e./kg bw for birds, from 630 to 1,321 mg a.e./kg bw for mammals, and >100 μg a.e.i/bee for the honey bee; **Table 6-2**). For birds, triclopyr ACID is also slightly to practically non-toxic on a subacute dietary exposure basis (LC_{50} = 2,934 to >7,151 mg a.e./kg-diet).

Chronic exposure of birds (Mallard duck) to triclopyr ACID at 200 mg a.e./kg-diet resulted in a significant (14%) reduction in 14-d old survivors (NOAEC = 100 mg a.e./kg-diet). Mallard duck was the only species of bird tested. For mammals, results from a 2-generation reproduction study with rat indicate significant (28%) reductions in first (F_1) generation litter size and a 39% reduction in second (F_2) generation litter size at the LOAEL of 250 mg a.e./kg bw/d with a corresponding NOAEL of 25 mg a.e./kg bw/d. The large difference (10X) between the NOAEL and LOAEL introduces uncertainty in the interpretation of potential effects from exposures above the NOAEC.

Food consumption of adult honey bees was significantly reduced by 26% following 10 days oral exposure to triclopyr ACID at 22.3 µg a.e./bee/d. At the next highest dose level (33.4 µg a.e./bee/d), adult bee mortality increased 35% relative to controls. The overall NOAEL for adult honey bees is 14.3 µg a.e./bee/d. Larval honey bees appear to be much more sensitive to chronic (repeat doses during 4-day larval development period) exposures of triclopyr ACID compared to adult honey bees. Specifically, adult emergence of larval honey bees was reduced by 17% relative to controls at 1.5 µg a.e./bee/d during the 22-d study, resulting in a NOAEL of 0.58 µg a.e./bee/d.

Terrestrial plants appear to be much more sensitive to triclopyr TEA based on the vegetative vigor study (direct foliar exposure) compared to the seedling emergence study (exposure via soil). A vegetative vigor EC_{25} of 0.0054 lb a.e./A was determined based on reductions in plant shoot length for the most sensitive dicot (sunflower; *Helianthus annuus*) while that for the most sensitive monocot (onion; *Allium cepa*) was determined as 0.119 lb a.e./A based on reductions in plant shoot weight. These endpoints are 1-3 orders of magnitude lower than the maximum registered application rate 9 lb a.e./A for triclopyr products. In contrast, EC_{25} values for seedling emergence exceeded the highest application rates tested for dicots and monocots (i.e., EC_{25}> 0.238 and > 0.715 lb a.e./A, respectively).

6.2.2 Triclopyr BEE

Triclopyr BEE exhibits similar acute and chronic toxicity to birds and mammals as triclopyr ACID/TEA in contrast to that observed for aquatic animals, where BEE was much more toxic to aquatic animals (**Table 6-2**). Triclopyr BEE is slightly to practically non-toxic to birds and mammals on an acute exposure basis (LD_{50} = 735 – 5,401 mg ai/kg-bw). No chronic toxicity study of birds was submitted for BEE active ingredient. For mammals, a 2-generation reproduction study was also not available; therefore, results from a subchronic 91-d study with rat were used for risk assessment purposes. Results from this study indicate that body weight was reduced by 25%-27% at the highest treatment level (LOAEL=350 mg a.i./kg-bw/d) depending on gender, thereby resulting in a NOAEL of 70 mg a.i./kg-bw/d. Food consumption was also reduced at 350 mg a.i./kg-bw/d but results were not statistically significant. Reduction in food consumption may be an indication of palatability issues at the highest test dose. No toxicity data are available for the effects of triclopyr BEE on honey bees.

Based on vegetative vigor studies, triclopyr BEE appears to affect dicots and monocots at similar levels as triclopyr TEA, with EC_{25} values of 0.0089 and 0.088 lb a.i./A based on reductions in plant shoot weight in sunflowers and onions. Unlike triclopyr TEA where definitive EC_{25} values could not be determined using the seedling emergence test, EC_{25} values of 0.062 and 0.073 lb a.i./A were calculated for triclopyr BEE for the most sensitive dicot and monocot tested, respectively.

6.2.3 Degradates

The TCP degradate of triclopyr is classified as practically non-toxic to birds on an acute oral and dietary exposure basis (**Table 6-2**). For mammals, the most sensitive acute oral LD_{50} values range 380 mg a.i./kg-bw for mouse to 794 mg a.i./kg-bw for rat, placing them into the "moderately toxic" and "slightly toxic" acute toxicity categories, respectively. On an acute exposure basis, TCP appears to be of similar toxicity as the ACID and TEA to birds and mammals. Notably, however, aquatic toxicity data indicate more sensitive chronic toxicity values for TCP relative to the acute toxicity values; it is not known if this same pattern in chronic toxicity would hold for terrestrial vertebrates due the lack of additional toxicity data on TCP or any other degradate for terrestrial animals or plants. The extent to which TCP forms in terrestrial plants that serve as food sources for terrestrial animals is unknown.

6.2.4 Open Literature – ECOTOX database

A search of the public ECOTOX in 2009 yielded some studies with more sensitive (lower) toxicity endpoints than those previously used in risk assessments as well as species not previously tested. One test in particular involved testing of the Zebra finch (*Taeniopygia guttata*) (Holmes, *et al*. 1994) with triclopyr BEE. This study yielded a dietary LC_{50} of 1,923 mg ai/kg diet which is somewhat lower (more sensitive) than the Bobwhite quail LC_{50} used in this assessment (5,401 mg a.i./kg-diet). However, inadequate raw data in the article precluded statistical verification of the results. Therefore, this study is considered qualitatively in risk characterization. Additional information can be found in **Appendix D**.

Table 6-2. Terrestrial Toxicity Endpoints for Triclopyr Acid, TEA, COLN, BEE and the TCP degradate

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments (Effect at LOAEC/ LOAEL)
Birds (surrogates for terrestrial amphibians and reptiles)					
Acute Oral	Triclopyr Acid (Technical)	Mallard duck, *Anas platyrhynchos*	LD_{50} = **1,698** mg a.e./kg-bw	40346601 Acceptable	Slightly toxic

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments (Effect at LOAEC/ LOAEL)
	Triclopyr TEA (64.7)	Mallard duck, *Anas platyrhynchos*	LD_{50} = 2271 mg a.e./kg-bw	00134178 Supplemental	Practically non-toxic
	Triclopyr BEE (96.1)	Bobwhite quail, *Colinus virginianus*	LD_{50} = **735** mg a.i./kg-bw	41902002 Acceptable	Slightly toxic
	TCP Degradate	Bobwhite quail, *Colinus virginianus*	LD_{50} > 2,000 mg a.i./kg-bw	41829001 Acceptable	Practically non-toxic
Sub-acute dietary	Triclopyr acid (99)	Bobwhite quail, *Colinus virginianus*	LC_{50} = **2,934** mg a.e./kg-diet	40346403 Acceptable	Slightly toxic
	Triclopyr TEA (64.7)	Bobwhite quail, *Colinus virginianus*	LC_{50} > 7,151 mg a.e/kg-diet	40346503 Acceptable	Practically non-toxic
	Triclopyr BEE (96.1)	Bobwhite quail, *Colinus virginianus*	LC_{50} = **5,401** mg a.i./kg-diet	41905501 Acceptable	Practically non-toxic
	TCP degradate	Mallard duck, *Anas platyrhynchos*	LC_{50} > 5,620 mg a.i./kg-diet	41829002 Supplemental	Practically non-toxic
Chronic	Triclopyr acid (99)	Mallard duck, *Anas platyrhynchos*	LOAEC = 200 mg a.i./kg-diet NOAEC = **100** mg a.i/kg-diet	00031250 Acceptable	14-day old survivors (↓ 14%)
Mammals					
Acute Oral	Triclopyr acid	Laboratory rat, *Rattus norvegicus*	LD_{50} = **630** mg a.e./kg-bw (females)	00031940 (Acceptable)	Slightly toxic
	Triclopyr TEA salt	Laboratory rat, *Rattus norvegicus*	LD_{50} = 1,321 mg a.e./kg-bw (males and females)	41443301	Slightly toxic
	Triclopyr BEE	Laboratory rat, *Rattus norvegicus*	LD_{50} = **803** mg a.i./kg/bw (males and females)	40557004	Slightly toxic
	TCP Degradate	Laboratory rat, *Rattus norvegicus*	LD_{50} = 794 mg a.i./kg/bw (males)	00064938	Slightly toxic
	TCP Degradate	Laboratory mouse	LD_{50} = 380 mg a.i./kg/bw (males)	00043243	Moderately toxic
Chronic	Triclopyr acid	Laboratory rat *Rattus norvegicus*	2 gen reproductive LOAEL =250 mg a.e./kg/day NOAEL= **25** mg a.e./kg/day	43545701 (Acceptable)	28%-39%↓litter size, 29-32% ↓ body wt, and 17% ↓ litter survival
	Triclopyr BEE	Laboratory rat *Rattus norvegicus*	90-day LOAEL=350 mg a.i./kg/day NOAEL=**70** mg a.i./kg/day	42274901 (supplemental)	25-27% ↓in mean body weight
Terrestrial Invertebrates					
	Triclopyr acid (99)	Honey bee *Apis mellifera L.*	LD_{50} > **100** µg a.e./bee	40356602 Acceptable	Practically non-toxic

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments (Effect at LOAEC/ LOAEL)
Acute contact (adult)	Triclopyr BEE (97.7)	Honey bee *Apis mellifera L.*	LD_{50} > **100** µg a.i./bee	41219109 Acceptable	Practically non-toxic
	TCP Degradate	**No data**			
Acute oral (adult)	Triclopyr acid (99)	Honey bee *Apis mellifera L.*	LD_{50} =>99 µg a.e./bee	49992409 Acceptable	Practically non-toxic
Chronic oral (adult)	Triclopyr Acid	Honey bee *Apis mellifera L.*	LOAEC = 973 NOAEC = 490 mg a.e./kg diet LOAEL=22.3 NOAEL=**14.3** ug ai/bee/day	50673903 Acceptable	26% ↓ in food consumption; mortality 35% ↓ @ 33.4
Acute oral (larval)	**No Data**				
22 Day Chronic repeat dose oral (larval)	Triclopyr Acid	Honey bee *Apis mellifera L.*	LOAEL = 1.5 NOAEL = **0.58** ug a.e./larvae/day NOAEC=14.6 LOAEC = 38.4 mg a.e./kg diet	50673902 Acceptable	Adult emergence ↓ 15%
Foliage on Residue	**No Data, but data requirement not triggered by 40 CFR Part 158**				
Semi-field study or full field study	**No Data**				
Terrestrial and wetland plants					
Vegetative Vigor	Triclopyr acid	**No data, but triclopyr TEA is considered representative of the acid**			
	Triclopyr TEA (46.5)	Dicot- Sunflower, *Helianthus annuus*	EC_{25} = **0.0054** lb a.e./A	43129801 Acceptable	Shoot length
		Monocot Onion *Allium cepa*	EC_{25} = **0.119** lb a.e./A	43129801 Acceptable	Shoot weight
	Triclopyr BEE (62.2)	Dicot- Sunflower, *Helianthus annuus*	EC_{25} = **0.0089** lb a.i./A	43650001 Acceptable	Shoot weight
		Monocot –Onion *Allium cepa*	EC_{25} = **0.088** lb a.i./A	43650001 Acceptable	Shoot weight
Seedling Emergence	Triclopyr acid	**No data**			
	Triclopyr TEA salt (46.5)	Corn, *Zea mays*	EC_{25} **>0.238** lb a.e./A	43129801 Acceptable	Non-definitive endpoint
		Dicot (all species)	EC_{25} **>0.715** lb a.e./A	43129801 Acceptable	Non-definitive endpoint
	Triclopyr BEE (62.2)	Dicot – Alfalfa, *Medicago sativa*	EC_{25} = **0.062** lbs a.i./A	43650001 Acceptable	% emergence
	Triclopyr BEE (62.2)	Monocot – Onion, *Allium cepa*	EC_{25} = **0.073** lb a.i./A	43650001 Acceptable	Shoot weight

ACID: 3,5,6-trichloro-2-pyridinyloxyacetic acid; **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; **TEA**: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt; **COLN**: 2-[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, and, choline salt; **TCP**: 3,5,6-trichloro-2-pyridinol.
TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient
[N] Studies submitted since the problem formulation was completed are designated with an N associated with the MRID number.
[1] NOAEC and LOAEC are reported in the same units.
>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).
< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

6.3 ECOSAR Analysis

An analysis of triclopyr parent and degradate acute and chronic aquatic toxicity was conducted using ECOSAR (v.2.0 2017) and is presented in **Table 6-3** and **Table 6-4**, respectively. The purpose of this analysis is to help in the identification of which degradates should be included as residues of concern. The first step in this analysis is to evaluate the reliability of ECOSAR predictions using available toxicity data (shown in bold in the tables below). If ECOSAR predicted toxicity is within a reasonable range of actual toxicity data (*e.g.*, within 10X), then the level of confidence in ECOSAR predictions for substances with no toxicity data is increased. The ECOSAR chemical class used for this analysis are:

- Triclopyr ACID and 3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid: (Halopyridines – acid);
- Triclopyr BEE: (Esters); and
- TCP, 3,6-DCP, 5-CLP, 6-CLP degradates: (Phenols)

With respect to acute toxicity, ECOSAR predictions with the ACID, BEE, and TCP degradate are within an order of magnitude of measured toxicity data (**Table 6-3**). For the ACID and TCP, ECOSAR predictions are lower (more sensitive) than measured values, while for the BEE active ingredient they are higher (less sensitive) than measured values. Therefore, it is concluded with confidence that ECOSAR predictions within an order of magnitude of actual values if measured. There were no predicted values from ECOSAR for aquatic algae for the ACID.

The remaining predictions of toxicity for degradates that have no measured toxicity data are generally an order of magnitude more toxic than the ACID (2 orders for 3,6-DCP daphnid toxicity), for aquatic animals. For aquatic plants the degradates are predicted to be about one order of magnitude less toxic than BEE along with 3,6-DCP toxicity for daphnids. All other endpoints are predicted to be about two orders of magnitude less sensitive for the degradates relative to BEE. Therefore, the acute toxicity ECOSAR analysis supports the inclusion of these major degradates in the ROC for the ACID/TEA/COLN active ingredients, but not for triclopyr BEE, since they are at least 1 order of magnitude less toxic than BEE.

Table 6-3. Comparison of acute ecological toxicity endpoints with estimated endpoints using ECOSAR predictions (in parentheses).

Test Material	FW Fish 96 Hr	Daphnid 48 hr	Aquatic Algae 96 hr
ECOSAR predictions for substances with toxicity data			
Triclopyr Acid	**117 ppm** (18.34 ppm)	**132.9 ppm** (13 ppm)	**32.5 ppm** (None)
Triclopyr BEE	**0.36 ppm** (3.18 ppm)	**0.35 ppm** (5.3 ppm)	**0.1 ppm** (1.6 ppm)
TCP Degradate	**12.5 ppm** (5.5 ppm)	**10.4 ppm** (2.7 ppm)	**2.0 ppm** (0.502 ppm)
ECOSAR predictions for major degradates without toxicity data			
3,6-DCP*	12.6	6.42	1.12
3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid**	34.4	20.1	None
5-CLP, 6-CLP***	27.6	10.5	2.4

ppm=parts per million (mg/L)
* Highest % formation is 52%
** Highest % formation is 29%
***Highest % formation is 26%

With respect to chronic toxicity, ECOSAR predictions are again within an order of magnitude of measured chronic toxicity values for triclopyr BEE (ester SAR) and the TCP degradate (phenol SAR), suggesting reasonable reliability using these ECOSAR classes (**Table 6-4**). However, the ECOSAR predictions of chronic toxicity are 100X more toxic than measured values for the ACID active ingredient. This suggests that the ECOSAR predictions of chronic toxicity are not reliable for chemicals that have a similar structure/MOA as the ACID active ingredients (*e.g.,* those modeled with the halopyridine acid SAR, which include the ACID and 3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid). For aquatic animals, the remaining degradates are predicted to be 2-3 orders or magnitude more sensitive than the ACID but 1-2 orders of magnitude less sensitive than the BEE. Therefore, the chronic toxicity ECOSAR predictions also support the inclusion of these major degradates into the ROC for the ACID but not for the BEE.

Table 6-4. Comparison of chronic ecological toxicity endpoints with estimated endpoints using ECOSAR predictions (in parentheses).

Test Material	Fish Chronic	Daphnia Chronic
ECOSAR predictions for substances with toxicity data		
Triclopyr ACID/TEA	**117 ppm** (3.34 ppm)	**104 ppm** (0.408 ppm)
Triclopyr BEE	**0.026 ppm** (0.157 pm)	**0.17 ppm** (2.0 ppm)
TCP Degradate	**0.178 ppm** (0.602 ppm)	**2.7 ppm** (0.489 ppm)
ECOSAR predictions for major degradates without toxicity data		
3,6-DCP*	1.29	0.748
3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid**	23.1	1.25
5-CLP, 6-CLP***	2.65	1.1

ppm=parts per million (mg/L); **ACID**: 3,5,6-trichloro-2-pyridinyloxyacetic acid; **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; **TEA**: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt.
* Highest % formation is 52%
** Highest % formation is 29%
***Highest % formation is 26%

6.4 Incident Data

The Incident Data System (IDS) provides information on the available ecological pesticide incidents, including those that have been aggregately reported to the EPA since registration to when the database was searched in May 2019. **Appendix C** provides a listing of the available incident data by active ingredient along with summaries and details on year and location and type of plants or animals observed to have been adversely affected.

The IDS has recorded over 100 individual incidents from 1990 to 2019 in which triclopyr ACID, TEA, or BEE products were applied and implicated in adverse effects. Most involved damage to non-target terrestrial and aquatic plants and were considered "probable" (direct application to affected crop or drift verified) or "possible" in their causality classification (drift suspected- no residue analysis performed). Nine incidents involved losses of honey bee hives and although triclopyr products were confirmed as having been used in nearby areas, exposures were not verified by residue analysis. In no cases were bees killed immediately, but eventually (*i.e.*, over time) hives failed. In some cases, bees displayed sublethal effects such as disorientation, failure to produce larvae or starvation. Two incidents involved fish kills near a rice field and a railroad crossing adjacent to a river. As triclopyr use was verified and drift or runoff confirmed these incidents are considered probable, but mortality was potentially from secondary effects (oxygen depletion from algae die off). In this respect, labels suggest avoidance of one-time treatment of water bodies to prevent oxygen depletion. In many of these incidents, other herbicides were also used on site or as product mixtures with triclopyr active ingredients and thus may have been contributory.

Triclopyr Active and Product Unspecified:

Seventeen incidents specify only triclopyr and do not indicate the products used. These were placed under separate category for triclopyr product and active not specified.

Triclopyr Acid:

Four plant damage incidents involved triclopyr ACID (products identified) with three involving 1 or two other herbicides (*e.g.*, 2,4-D or glyphosate) used with the triclopyr ACID.

Triclopyr TEA:

Sixty incidents with TEA product applications were reported in IDS. Many involve plant damage to trees, shrubs, *etc.* in conjunction with lawn care products and residential uses, while others involved uses on or near rice. Many of the 25 rice incidents are crop injury complaints from weed control efforts within the crop itself which resulted in reduced yield, twisting or knotting of plants, rice tip burn and discoloration. Twenty-eight of the plant incidents were with the TEA product itself while 28 involved use as mixtures or multi-active application with dicamba, MCPA, metsulfuron, aminopyralid and 2,4-D herbicide products. Four of the TEA incidents involved bee hives near application sites, but no definitive determination has been made as to the causative agents. Additionally, a total of 1,383 incidents were reported in the aggregate as part of the IDS.

Triclopyr BEE:

Twenty-two incidents were recorded for products containing triclopyr BEE and most involved accidental non-target plant damage to ornamental bushes, trees, food crops or vineyards from spray drift when used along fence lines, utility rights-of-way, roads or aerially applied to pastureland. Eleven of the incidents resulted from usage with other herbicides such as 2,4-D, picloram, imazapyr, glyphosate, and tebuthiuron, which could also have contributed to the adverse effects observed.

An aggregation of all incidents involving triclopyr products is shown in **Table 6-5.**

Table 6-5. Triclopyr Products Aggregate Incidents from the Incident Data System (IDS)

Taxa	Number of Incidents 1995-2018
Triclopyr ACID- 2	
Vertebrate Wildlife (W-B)	0
Plant (P-B)	2
Non-vertebrate (ONT)	0
Triclopyr TEA- total 1397	
Vertebrate Wildlife (W-B)	13
Plant (P-B)	1383
Non-vertebrate (ONT)	1
Triclopyr BEE- total 67	
Vertebrate Wildlife (W-B)	8
Plant (P-B)	57
Non-vertebrate (ONT)	2

Aggregate incidents are only reported as a count-based measure. **ACID**: 3,5,6-trichloro-2-pyridinyloxyacetic acid; **BEE:** 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester; **TEA**: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt.

7 Analysis Plan

7.1 Overall Process

This assessment uses a weight of evidence approach that relies heavily, but not exclusively, on a risk quotient (RQ) method. The RQs are calculated by dividing an estimate environmental concentration (EEC) by a toxicity endpoint (*i.e.*, EEC/toxicity endpoint). This is a way to determine if an estimated concentration is expected to be above or below the concentration associated with the adverse effect. The RQs are compared to regulatory levels of concern (LOCs). The LOCs for non-listed species are meant to be protective of community-level effects. For acute and chronic risks to vertebrates, the LOCs are 0.5 and 1.0, respectively, and for plants, the LOC is 1.0. The acute and chronic risk LOCs for bees are 0.4 and 1.0, respectively. In addition to RQs, other available data (*e.g.*, incident data) can be used to help understand the potential risks associated with the use of the pesticide.

7.2 Modeling

Model inputs are based on a range of labeled use patterns, application scenarios, rates and other label information that best reflects typical uses of the actives assessed in this document. Various models are used to calculate aquatic and terrestrial EECs and risk quotients for these uses. The specific models used in this assessment are discussed further below (see **Table 7-1**).

Table 7-1. List of the Models Used to Assess Risk

Environment	Taxa of Concern	Exposure Media	Exposure Pathway	Model(s) or Pathway
Aquatic	Vertebrates/ Invertebrates (including sediment dwelling)	Surface and Porewater	Runoff and Spray drift	PWC version 1.52[1] PFAM version 2.0[2]
	Aquatic Plants (vascular and nonvascular)			
	Piscivorous birds and mammals	Aquatic food web	Runoff and Spray drift	KABAM version 1.0
Terrestrial	Vertebrate	Dietary items		T-REX version 1.5.2[3]
	Plants	Spray drift/runoff	Runoff and spray drift to plants	TERRPLANT version 1.2.2
	Bees and other terrestrial invertebrates	Contact Dietary items	Spray contact and ingestion of residues in/on dietary items as a result of direct application	BeeREX version 1.0
All Environments	All	Movement through air to aquatic	Spray drift	AgDRIFT version 2.1.1 (Spray drift)

Environment	Taxa of Concern	Exposure Media	Exposure Pathway	Model(s) or Pathway
		and terrestrial media		

[1] The Pesticide in Water Calculator (PWC) is a Graphic User Interface (GUI) that estimates pesticide concentration in water using the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM).
PRZM-VVWM.
[2] Pesticides in Flooded Applications Model (PFAM) is used to simulate EECs when pesticides are applied to flooded or intermittently flooded areas.
[3]The Terrestrial Residue Exposure (T-REX) Model is used to estimate pesticide concentration on avian and mammalian food items.

8 Aquatic Organisms Risk Assessment

8.1 Aquatic Exposure Assessment

8.1.1 Modeling

Surface water aquatic modeling was simulated using the Pesticide in Water Calculator (PWC version 1.52) for use patterns to terrestrial areas and the Pesticides in Flooded Applications Model (PFAM; version 2.0 dated September 27, 2016) for use on rice grown in flooded fields. Modeling was executed for the ACID ROC, and BEE and the degradate TCP. The ACID ROC modeling represents use patterns for the ACID formulation as well as TEA and COLN formulations. The degradates TCP + 3,6 DCP + 5-CLP + 6-CLP were included in the aquatic exposure modeling of the ACID using a Total Toxic Residue (TTR) approach, which assumes equivalent toxicity to ACID. As noted in Section 6, the chronic toxicity of TCP to freshwater invertebrates (*D. magna*) is much greater than the ACID or other degradates. Therefore, a separate risk analysis was conducted for TCP, the major degradate of all forms of triclopyr: the ACID, TEA, COLN and BEE. Exposure EECs for this degradate required using the formation and decline (F/D) approach in which separate EECs are calculated for TCP. Details for this exercise are included in **Appendix B**.

For BEE, the parent BEE and TCP are more toxic to aquatic animals by several 1-3 orders of magnitude compared to ACID and its other degradates (3,6 DCP + 5-CLP + 6-CLP). Therefore, modeling focused on the BEE and TCP degradate using the F/D approach, since the EECs for ACID and other degradates were confirmed to be 1-3 orders of magnitude below acute and chronic risk LOCs. Notably, the BEE does not include direct application to water as per ACID, TEA and COLN; therefore, EECs for the ACID component of BEE are well below Agency LOCs.

Table 8-1. Aquatic Modeling Input Parameters for Chemical Tab for BEE, the ACID and Triclopyr Residue of Concern (Designated with ROC)

Parameter (units)	Value (s)		Referenced MRID[1]	Comments
	BEE	ACID ROC (ACID only)		
K_d- K_{0c} (mL/g) [1]	0.611[2]	0.611- 611[3] (Same)	407498-01	Average of 4 values for the **ACID= ROC**
Water Column Metabolism t ½ (days) @ 25°C	0.8	241 (29.1)	499924-04*	Represents the 90 percent upper confidence bound on the mean (n=2)
Benthic Metabolism t ½ (days) @ 25°C	0.5	Stable (1,531)	001519-67*	**For BEE:** Assumed= 0.5 days[4]; **For** the **ACID/ROC:** Represents the 90 percent upper confidence bound on the mean (n=2)
Aqueous Photolysis t ½ (days)@ pH 5 and 40°N	6.6	0.4 (Same)	430076-01* 499924-01	One measured value for either **BEE** or the **ACID**; **ROC** value= **ACID** (Only species present)
Hydrolysis Half-life @ pH 7 (days)	9[5]	Stable (Same)	001341-74* 418796-01	One measured value for **BEE** or the **ACID**
Soil Half-life (days) at 25°C	1.0	31 (20)	472938-01* 499924-02	**For BEE:** Represents the 90 percent upper confidence bound on the mean (n= 4) For the **ACID/ROC**: Same
Molecular Weight (g/mol)	356.6	256.5	Chemical profile	
VP (Torr) at 25°C	3.6×10^{-6}	1.3×10^{-6} (Same)	Triclopyr ACID value/Chemical profile	
Solubility in Water (mg/L)	7.4	440 (Same)	Triclopyr ACID value/Chemical profile	
Heat of Henry (J/mol) @ 25°C	N/A[6]	54,041 (Same)	Calculated for triclopyr ACI from EPIWEB 4.1	

[1] **BEE studies** are marked with * all other studies are for the **ACID**
[2] **K_d for BEE** is assumed to be the same as the ACID based on the observed rapid conversion to the ACID
[3] 0.611-611: K_d=0.611 converted to Koc of 611 ml/g for use in PFAM modeling on the assumption that the organic carbon % equals 0.01.
[4] This is because the observed half-lives were <1 d and data could not be fitted due to the extremely rapid dissipation of BEE
[5] **Note:** The chemical is persistent to hydrolysis in acidic conditions (t ½ = 84 days); [5] No need to use PFAM (no use on rice)
[6] BEE formulation of triclopyr are not modeled with PFAM as the formulation is not used on rice

Except for the rice and aquatic use patterns, input parameters specific to the application scenario for *all other use patterns* are specified in **Table 8-2.** Based on the use information described in **Section 3.2.** It is noted that the PWC Scenarios are used to specify soil, climatic, and agronomic inputs in PRZM, and are intended to result in high-end water concentrations associated with a crop and pesticide within a geographic region. Each PWC scenario is specific to a vulnerable area where the crop is commonly grown. Soil and agronomic data specific to the location are built into the scenario, and a specific climatic weather station providing 30 years of daily weather values is associated with the location. **Table 8-2** identifies the use sites associated with each PRZM scenario.

Table 8-2. PWC Input Parameters Specific to Use Patterns for Triclopyr Residues of Concern (ROC) (Applications Tab and Crop/land Tab).

Run Name	Use Site	PWC Scenario	Application Parameters[1]		Other Parameters[2]
			Window	MSR X No.= MYR @ Days	
FL-CTRS	**Citrus (FL)**	FLcitrusSTD	**1**	6.73 X 1= 6.73 kg/ha @ N/A	**G=** See below
FORST-CA	**Forestry**	CAForestryRLF	**1**	6.73 X 1= 6.73 kg/ha @ N/A	**A=** Air/above crop: Application Efficiency (AE)= 0.95; Drift= 0.0125
Medw-TX	**Grass/Range/ Pasture land**	MeadowBSS	**1**	10.09 X 1= 10.09 kg/ha @ N/A	
		MeadowBSS			
Rang-CA		CArangelandhayRLF	**1**	10.09 X 1= 10.09 kg/ha @ N/A	
TX-ROW					
CA-ALMND	**Orchards (CA)**	CAalmond_WirrigSTD	**1**	6.73 X 1= 6.73 kg/ha @ N/A	**G=** Ground/ below crop: Application Efficiency= 0.99; Drift= 0.062
CA-CTRS		CAcitrus_WirrigSTD_			
CA-FRTS		CAfruit_WirrigSTD			
Res-CA	**Premises**	CAresidentialRLF/CAImpervious RLF	**1**	10.09 X 1= 10.09 kg/ha @ N/A	
Res-BSS		ResidentialBSS/ImperviousBSS			
Rice	**Rice**	Refer to the rice modeling parameters, below			
ROW-CA	**Right-of-Way**	CArightofwayRLF_V2/CAImpervi ousRLF	**1**	10.09 X 1= 10.09 kg/ha @ N/A	**G=** See above
ROW-TX		RightOfWayBSS/ImperviousBSS			
Turf-CA	**Turf**	CATurfRLF	**2**	1.12 X 4= 4.48 @ N/A	
Turf-FL		FLturfSTD			
Turf-PA		PAturfSTD			
Turf-TX		TurfBSS			
Christmas	**X-mass Trees**	ORXmasTreeSTD	**1**	6.73 X 1= 6.73 kg/ha @ N/A	**G=** See above

[1] ***Application Parameters: Window***= Simulated application window using batch feature in PWC: Three windows were chosen to represent possible application timing: **Window 1**: April to September in 5-day steps for all scenarios except **Window 2** for turf scenarios from February to June in 14-day steps; These windows were chosen based on BEAD recommended timing for similar herbicides. **MSR X No.= MYR @ Days=** Maximum single application X No. of applications per year= Maximum yearly application @ Minimum application intervals (days). **Example:** The application parameters for the first use pattern: Citrus= 6.73 X 1= 6.73 @ N/A= Maximum single rate= 6.73 kg a.e./ha applied One time @ N/A minimum application interval (only one application). Note: single label application rate for citrus is given in lbs. a.e./A= 6 x 1.121= 6.73 kg a.e./ha

[2] **Other Parameters Include:** Application equipment: **A=** Aircraft; **G=** Ground equipment and associated parameters including application efficiency and drift fraction.

The input parameters, inError! Reference source not found., were selected in accordance with EFED's guidance documents (USEPA, 2009b; USEPA, 2010b; USEPA, 2012b; USEPA, 2013a; USEPA, 2013b; USEPA, 2014a; USEPA, 2014b; USEPA and Health Canada, 2013).

Since the previous ecological risk assessment was completed, new aerobic soil metabolism, aerobic aquatic metabolism, and anaerobic aquatic metabolism data are available. These new data were incorporated into the risk assessment and resulted in some changes in the aquatic modeling inputs. Additionally, it is now recommended that the daily average value be used to calculate acute risk quotients for aquatic organisms rather than the peak value used in previous risk assessments (USEPA, 2017).

For the residential and rights-of-way uses, were executed for pervious and impervious areas. For the residential scenario simulation, 2% of the application rate was assumed to reach impervious services and the daily concentrations obtained from residential and impervious services were combined to arrive at required averages using a post-processing spreadsheet. Daily concentrations were combined using the following equation: [{daily EECs for pervious area X 0.5 “assume 50% pervious area” X 0.5 “assume 50% of the area is treated”}] + [{daily EECs for impervious area X 0.5 “assume 50% impervious area”}]. Required averages, maximum averages, and the 1-in-10-year averages were calculated (latter value is the 90th percentile values). The same process was used for the rights-of-way except that 5% of the application rate was assumed to reach impervious services.

For the rice use, aquatic modeling was conducted using PFAM. In modeling, the same PWC chemical parameters were used in addition to the following:

(1) Application rate: two application of 0.42 kg/ha each; and

(2) Application timing: Timing was chosen to abide by label directions/restrictions including: type of rice culture (pre-flood, post-flood, mixed or ratoon); post-harvest interval (PHI)= 60 days (no application 60-days pre-harvest); paddy is not drained within 20-day following application; stage of rice growth and agronomic practices related to modeled crop area. Information were obtained from labels, scenarios and the literature[13].

Based on the above, three application scenarios were established/modeled using applicable rice scenarios (**Table 8-3**).

Table 8-3. Triclopyr Modeled Rice Scenarios for Different Rice Areas, Applications, and Agronomic Practices.

Agronomic Practice	***AR[1]***	***CA[2]***	***LA[3]***	***MO[4]***	***MS[5]***	***TX[6]***
First scenario						
1st App Date (Dry field)	**17-Apr**	**29-Apr**	**31-Mar**	**21-Apr**	**18-Apr**	**26-Mar**
Flood	4-May	3-May	11-Apr	6-May	10-May	10-Apr
2nd App Date (Flooded field)	**24-Jun**	**7-Jul**	**31-May**	**29-Jun**	**20-Jun**	**27-May**
Drain	3-Sep	25-Sep	11-Aug	10-Sep	12-Sep	7-Aug
Second scenario						

[13] URLs for information obtained from the literature for rice modeling:
https://www.lsuagcenter.com/profiles/vdartez/articles/page1489673261615
https://www.lsuagcenter.com/portals/communications/publications/agmag/archive/2009/winter/evaluation-of-stubble-height-on-ratoon-growth-in-rice
https://www.uaex.edu/publications/pdf/mp192/chapter-2.pdf
https://www.uaex.edu/publications/pdf/mp192/chapter-2.pdf

Agronomic Practice	*AR*[1]	*CA*[2]	*LA*[3]	*MO*[4]	*MS*[5]	*TX*[6]
Flood	4-May	3-May	11-Apr	6-May	10-May	10-Apr
1st App Date (Flooded field)	**17-Jun**	**30-Jun**	**24-May**	**22-Jun**	**13-Jun**	**20-May**
2nd App Date (Flooded field)	**7-Jul**	**20-Jul**	**13-Jun**	**12-Jul**	**3-Jul**	**9-Jun**
Drain	3-Sep	25-Sdryep	11-Aug	10-Sep	12-Sep	7-Aug
Third scenario [7]						
Only in Gulf Coast rice growing areas represented by TX with the following agronomic practices and flood schedule: **Shallow flood**: 25-Aug; **1st App Date (Shallow flooded field): 10-Sep; Full flood:** 15-Sep; **2nd App Date (Flooded field): 30-Sep; and Drain:** 18-Nov						

Scenarios: [1] ECO AR noWinter; [2] ECO CA Winter; [3] ECO LA noWinter; [4] ECO MO noWinter; [5] ECO MS noWinter; [6] ECO TX noWinter; and [7] Ratoon Rice, TX

For the aquatic use, modeling was executed using PWC by applying mass that would result in a peak value of 400 (Labels call for application of mass up until the concentration reaches 400 µg /L (parts per billion; ppb). This requires application of 7.803 kg/ha of direct application to the standard pond. In this run both efficiency and drift were set to equal 100% so that all mass applied reaches the standard pond (one hectare; 20,000 cubic meter volume; 2.0-meter deep water-body).

Maximum surface water EECs representing use of triclopyr ACID, TEA and COLN are presented in **Table 8-4** based on the residue of concern (ROC) and the degradate, TCP. For each use pattern, the maximum of the range of ROC EECs obtained for April to late September window was taken to represent exposure for the use patterns. Ranges of representative exposure EECs ranges represented different crop scenarios or differences in the 1st application dates. For TCP, the F/D method was used to calculate the EEC using maximum and minimum molecular formation and decline ratio obtained from varied soil and aquatic systems. Only the maximum values are shown in **Table 8-4,** while both minimum and maximum EECs are provided in **Appendix B.**

Table 8-4. Maximum Surface Water and Pore Water Estimated Environmental Concentrations (EECs) for triclopyr ACID ROC and TCP Degradate Representing the ACID, TEA and COLN Active Ingredients (Estimated Using PWC version 1.52 and PFAM).

Use Site	**PWC Scenario (1st Appl. Date; Yearly Rate; Application Type)1**	**Chemical Species**[2]	**1-in-10-year Mean EECs**				
			Water Column (µg/L)			**Pore-Water (µg/L)**	
			1-day	**21-day**	**60-day**	**1-day**	**21-day**
Aquatic Weed Control	Applied @ 400 ppb	ROC (acid equivalent= a.e.)	396	343	255	152	151
		TCP (High MFDR)	27.6	27.7	25.5	18.1	16.6
	Applied @ 2,500 ppb	ROC (a.e.)	2,480	2,140	1,590	949	943
		TCP (High MFDR)	173	173	159	113	104
	Applied @ 5,000 ppb	ROC (a.e.)	4,950	4,290	3,180	1,900	1,890
		TCP (High MFDR)	346	347	319	226	208
Citrus (FL)	FLcitrusSTD (6; 26-May; G)	ROC (a.e.)	297	242	164	99	98.2
		TCP (High MFDR)	28.6	28.2	25.3	17.7	17.6
Forestry		ROC (a.e.)	86	71.6	53.5	38	37.6

Use Site	PWC Scenario (1st Appl. Date; Yearly Rate; Application Type)1	Chemical Species[2]	1-in-10-year Mean EECs				
			Water Column (µg/L)			Pore-Water (µg/L)	
			1-day	21-day	60-day	1-day	21-day
	CAForestryRLF (6; 11-Apr; A)	TCP (High MFDR)	4.45	4.32	4.12	3.17	3.16
Grass: Ranger/ Pasture	RangeBSS (9; 15-May; A)	ROC (a.e.)	403	336	232	138	137
		TCP (High MFDR)	36.6	36.2	33.1	23.5	23.4
Grass: Meadow	MeadowBSS (9; 15-May; A)	ROC (a.e.)	346	289	200	118	117
		TCP (Highest MFDR)	30.9	30.5	27.9	19.9	19.7
Orchards (CA)	CAalmond_WirrigSTD (6; 11-May; G)	ROC (a.e.)	29	25.4	18.5	11	11
		TCP (Highest MFDR)	2.59	2.57	2.4	1.76	1.75
Premises	ResidentialBSS /ImperviousBSS (9; 21-May; G)	ROC (a.e.)[3]	32	26.1	18.5	12	11.9
Rice		ECO MO noWinter: ROC (a.e.)[3]	369	84	54.9	39	36.7
Rights-of-Way	RightOfWayBSS/ ImperviousBSS (9; 1-May; A)	ROC (a.e.)	259	214	147.5	89	88.7
		TCP (Highest MFDR)	23.9	23.6	21.9	15.2	15.1
Turf	TurfBSS (4; 11-Apr; A)	ROC (a.e.)	23	18.2	15	11	10.9
		TCP (Highest MFDR)	2.87	2.82	2.57	2.06	2.05
Christmas Trees	ORXmasTreeSTD (6; 24-Aug; G)	ROC (a.e.)	24	20.8	16.2	10	10.7
		TCP (Highest MFDR)	2.27	2.24	2.06	1.76	1.83

[1] **PWC Scenario *(1st Application Date; Yearly Rate; Application Type):*** Scenario (Yearly application rate in lbs. a.e/A/Year; 1st application date in the window; Ground (if A= Aerial). Example: FLcitrusSTD (6; 3-Sep; G) = FL citrus scenario with an application rate of 6 lbs. a.e/A/Year (entered 6.73 Kg a.e./ha in PWC) applied on September 3 using ground equipment

[2] **ROC (acid equivalent= a.e.)** = Residue of Concern (total concentrations in µg/L of **ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** in acid equivalent); ACID= Triclopyr acid concentrations in µg/L; TCP (Highest MFDR)= TCP degradate concentrations in µg/L based on the highest molecular formation and decline ratio obtained from varied soil and aquatic systems[14]

[3] **For rice,** concentrations of the residue of concern in µg/L of **ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** in acid equivalent were only estimated and due to the low ROC concentrations, no values were estimated for the ACID or TCP because F/D method cannot be used in PFAM

Finally, maximum surface water EECs representing use of triclopyr BEE and its degradate, TCP are presented **Table 8-5.** Additional details including minimum and ACID EECs resulting from BEE application are provided in **Appendix B.**

[14] Estimated according to the formation and decline method guiding principles presented in Attachment 2 for Methods for Assessing Aquatic Exposure to Residue(s) of Concern, EFED division Director Memo dated June 20, 2019

Table 8-5. Maximum Surface and Pore Waters Estimated Environmental Concentrations (EECs) for the BEE and TCP Representing the Use of BEE Form of Triclopyr (Estimated Using PWC version 1.52)

Use Site	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	Chemical Species [2]	1-in-10-year Mean EECs				
			Water Column (µg/L)			Pore-Water (µg/L)	
			1-day	21-day	60-day	1-day	21-day
Citrus (FL)	FLcitrusSTD (8.342; 26-May; G)	BEE	140	11.30	3.94	5.4	0.33
		TCP (Highest MFDR)	20.5	20.2	18.2	12.7	12.6
Forestry	CAForestryRLF (8.342; 4-Aug; A)	BEE	47	6.33	2.46	2.4	0.25
		TCP (High MFDR)	2.61	2.57	2.44	2.00	2.02
Grass: Range/ Pasture/Non-Crop Lands	RangeBSS (12.512; 15-May; A)	BEE	267	28.00	9.79	3.2	0.48
		TCP (High MFDR)	26.2	25.9	23.7	16.8	16.7
Grass: Meadow	MeadowBSS (12.512; 15-May; A)	BEE	264	27.50	9.64	2.8	0.43
		TCP (High MFDR)	22.3	22.0	20.1	14.3	14.2
Premises	ResidentialBSS/ImperviousBSS (12.512; 21-May; G)	BEE[3]	10	0.90	0.30	0.1	0.13
Rights-of-Way	RightOfWayBSS/ImperviousBSS (12.512; 21-May; A)	BEE[3]	57	6.64	2.41	0.8	0.12
Turf	TurfBSS (5.561; 11-Apr; A)	BEE	9.3	1.50	0.97	0.12	0.03
		TCP (High MFDR)	2.06	2.03	1.86	1.49	1.48
Christmas Trees	ORXmasTreeSTD (8.342; 24-Aug; G)	BEE	22	2.32	0.81	0.24	0.05
		TCP (High MFDR)	1.88	1.82	1.57	1.31	1.38

[1] ***PWC Scenario (1st Application Date; Yearly Rate; Application Type):*** Scenario (Yearly application rate in lbs. a.i./A/Year (a.i is BEE active ingredient noting that a.i values used in modeling were in Kg a.i./ha) ; 1st application date in the window; Ground (if A= Aerial). **Example**: FLcitrusSTD (6; 3-Sep; G) = FL citrus scenario with an application rate of 8.34 lbs. a.i./A/Year (entered 9.35 kg a.i./ha) applied on September 3 using ground equipment: Note: BEE Label gave application rate= 6 lbs. a.e = 6 lbs. x (M. Wt. of BEE divided by M. Wt. of ACID)= 6 lbs. of BEE or a.i x (356.6 divided by 256.5) = 8.34 lbs. of BEE or a.i/A entered 9.35 kg a.i/ha in PWC (8.34 x 1.121= 9.35)

[2] **BEE** = Concentrations in µg/L of BEE; **ACID=** Triclopyr acid concentrations in µg/L; **TCP** (Highest MFDR)= TCP degradate concentrations in µg/L based on the highest Molecular formation and decline ratio obtained from varied soil and aquatic systems per the aforementioned 2019 guidance.

[3] **BEE** = Concentrations in µg/L of BEE were only estimated and due to the **low BEE** concentrations, no values were estimated for the **ACID or TCP**

8.1.2 Monitoring

The following databases and sources were searched for monitoring information on triclopyr in June 2019:

- Water Quality Portal[15]

[15] https://www.waterqualitydata.us/

- California Environmental Data Exchange Network (CEDEN) (State Water Resources Control Board, 2015)[16]
- California Department of Pesticide Regulation Surface Water Database (CAdpr)[17]
- Litrature[18]

Surface Water

Though not targeted, monitoring data are available for triclopyr with specified limits of detection/quantification (LOD/LOQ). Nearly 100% of the data obtained from the State of California and at the national level were associated with LOQs of <1 ppb. Data were for surface water, ground water, potable water intakes, and finished/treated water. Collected data may not be considered as targeted data as none were obtained from a field study in which sampling occurring after a known triclopyr application at a known location, with a well-described relationship to the sampling event. Sampling were collected without consideration of triclopyr use patterns, *i.e.*, the data represent non-targeted monitoring. Furthermore, most of the sampling frequencies were in 1-6 months followed by 1 week to a month with only few occurring one-week apart. As a result, the likelihood of capturing peak exposure is expected to be low. **Table 8-6** contains a summary of California data.

Table 8-6. California Surface Water Monitoring Data for Triclopyr

Sites: Counties & Water Body Type (Reference No.)	Monitoring Period (Month-Y)	No. of Sites (Samples)	Sampling Frequency	Maximum/Range Concentrations (ppb)	Detection Frequency
Aquatic Sites (Reference No. 2)					
Aquatic: Aquatic monitoring program	Jul-03-Aug-03	8 (1)	Irregular	250	13%
Urban Sites: Creeks and Streams (Reference No's. 3 & 4)					
Sacramento	2008- 2011	12 (NR)	24 hrs. after rainfall (Oct-Apr) & during dry season (May-Sep)	6.8 (wet season) and 1.5 (dry season)	40%
San Francisco Bay	2008- 2011	7 (NR)			65%
Orange County (4)	2008- 2011	11 (NR)			82%
Sacramento	Apr -16- Jun-17	1 (3)	6-8 Months	0.09- 1.4	100%
San Diego	Apr-08- Jun-17	2 (15)	1-10 Months	0.05- 0.27	33%
Los Angeles (3)	Aug-15- Jun-17	1 (4)	2-10 Months	0.13	25%
Other Areas: Drains, Creeks, Rivers & Lakes (Reference No's. 2 & 3)					
Alameda: Drainage	Apr-08- May-10	3 (30)		0.2- 0.3	40-70%
Alameda: Creek/Streams	Apr-08- Jun-17	2 (16)		0.11- 1.00	56%
Alpine: River	Jun-94- Jun-17	1 (3)		0.0- 0.79	0%
Amador: Drainage	Sep-04- Aug-12	1 (23)		1.10	4%

[16] http://www.ceden.org/
[17] http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm
[18] M. P. Ensminger, R. Budd, K. C. Kelley and K. S. Goh 2013. *Pesticide occurrence and aquatic benchmark exceedances in urban surface waters and sediments in three urban areas of California, USA, 2008–2011;* Environ Monit. Assess (2013) 185: 3697–3710

Sites: Counties & Water Body Type (Reference No.)	Monitoring Period (Month-Y)	No. of Sites (Samples)	Sampling Frequency	Maximum/Range Concentrations (ppb)	Detection Frequency
Calaveras: Creek	Jul-03- Aug-03	2 (8)		7.50- 15.00	38%
Colusa: Drainage	Mar-98- Jun-13	2 (55)		5.64- 14.5	81-100%
Contra Costa: Drainage	Apr-08- Aug-09	2 (16)		0.2- 0.3	63-88%
Contra Costa: Creek/Streams	Apr-08- Jun-17	4 (17)		0.09- 12.70	76%
Contra Costa: River	Apr-11- May-12	1 (20)		0	0%
Contra Costa: Others such as canals	Apr-11- May-12	7 (96)		0	0%
Del Norte, CA: Creek	May-99- Jul-16	9 (70)		0.12- 1.06	27%
Imperial: River	Mar-13	1 (1)		0.16	100%
Inyo: River	Mar-04- Mar-04	2 (2)		0.07	50%
Kern: Others	Jun-13- Jun-14	2 (6)		0	0%
Kings: Others	Mar-14- Jun-14	1(2)		0	0%
Los Angeles: Creek/Streams	May-04- Jun-17	3 (24)		0.06- 0.35	71%
Los Angeles: River	Jun-15- Jun-17	2 (9)		0.14- 0.20	33%
Los Angeles: Others	Jul-99	1 (1)		0	0%
Orange: Drainage	Apr-08- Jun-17	9 (243)		0.5- 6.4	62-100%
Orange: Drainage: Creek/Streams	Apr-08- Jun-17	2 (35)	**For Drains:** Irregular: <1 Wk. (13%); 1 Wk-1 Month (9%); 1-6 Months (71%); 6 Months-Year (6%); and >Year (2%)	0.05- 1.50	97%
Orange: Drainage: River	Oct-96- Apr-00	2 (37)		0	0%
Placer: Drainage	Apr-08- Jun-17	6 (97)		0.0- 3.5	0-73%
Placer: Drainage	Oct-98- Jun-17	5 (37)		0.06- 0.42	46%
Placer: Drainage	Aug-11- Jun-12	2 (8)		0.08- 2.98	88%
Placer: Drainage	Aug-98- Aug-98	2 (2)		0	0%
Riverside: River	Oct-96- Mar-18	1 (136)		0.09- 0.34	13%
Sacramento: Drainage	Aug-09- Apr-17	6 (71)		0.1- 2.5	31-60%
Sacramento: Creek	Nov-96- Apr-16	3 (89)		0.09- 0.46	21%
Sacramento: River	Dec-96- Feb-18	5 (153)		0.12- 0.62	7%
Sacramento: Others	May-14	1 (1)		0	0%
San Bernardino: Creek	Nov-97- May-04	3 (11)		0	0%
San Bernardino: River	Mar-04- Mar-04	1 (1)	**For creeks, Rivers & Lakes:** Irregular: <1 Wk. (35%); 1 Wk-1 Month (38%); 1-6 Months (21%); 6 Months-Year (2%) and >Year (4%)	0.06	100%
San Bernardino: Others	May-04- Jun-14	2 (4)		0	0%
San Diego: Drainage	Apr-08- Aug-09	5 (18)		0.0- 0.1	0-25%
San Diego: Creek	Feb-01- Jun-17	1 (4)		0	0%
San Diego: River	Feb-01- Jun-17	2 (17)		0	0%
San Diego: Lake	Apr-08- Aug-09	2 (7)		0	0%
San Diego: Others	Jun-02- Jun-06	4 (33)		0	0%
San Joaquin: Drainage	Sep-04- Sep-08	2 (39)		0.0- 1.7	0-19%
San Joaquin: River	Mar-93- Feb-18	1 (158)		0.09	1%
Stanislaus: Drainage	Jun-94- Aug-12	4 (18)		0.00	0%
Stanislaus: creek	Mar-93- Mar-17	4 (99)		0.03- 0.04	4%
Stanislaus: River	Dec-93- Jul-94	4 (24)		0	0%
Stanislaus: Others	Jun-94- Oct-08	3 (27)		0	0%
Stanislaus: Irrigation Water	Jul-04- Jul-08	1 (14)		1.10	1.10
Sutter: Drainage	Nov-96- Aug-12	3 (39)		0-6.4	0-74%
Monterey: Drainage	Mar-14- Mar-14	1 (1)		0.14	100%
Yolo: Drainage	Nov-96- Aug-12	1 (48)		5.20	15%

Sites: Counties & Water Body Type (Reference No.)	Monitoring Period (Month-Y)	No. of Sites (Samples)	Sampling Frequency	Maximum/Range Concentrations (ppb)	Detection Frequency
Merced; Modoc; Siskiyou; Solano, Yolo & Yuba, CA: Drainage	Mar-93- Jul-16	17 (107)		No Detects	
Tuolumne, El Dorado, Humboldt, Merced, Santa Barbara/Clara & Tulare: Creeks	Jun-94- Jun-17	13(22)		No Detects	
El Dorado, Mariposa, Merced, Nevada, Santa Clara, Sutter & Tulare: Mixed	Mar-93- Aug-14	17(110)		No Detects	
El Dorado, Mariposa & Tulare: Mixed (3)	Aug-98- Nov-13	7 (10)		No Detects	
California Central Valley: Irrigated Land Program	Jul-03- May-12	21 (258)	Irregular	0.14-11	62%
San Francisco Bay: Suisun Bay monitoring project (2)	Apr-11- May-12	6 (130)	Irregular	0.1	1%

ppb=parts per billion; µg/L, NR= Not reported

Data in **Table 8-6** show an observed concentration of 250 ppb reported for one out of 8 aquatic samples possibly reflecting direct applications for aquatic weed control some time before sampling. High treatment concentrations are expected as it is required for effective aquatic weed control. Observed concentrations in urban areas[4] are related to run-off and range from 1.5 ppb during the dry season and 6.8 ppb 24 hours after rainfall. These values are not far from modeled EECs for California turf (15 and 11 ppb for 1-d and 60-d averages) if exposure in these urban areas are related only to use on turf. Although watersheds for these study areas were selected so as to exclude agriculture, exposure contributions from applications to rights-of-way and forested sites may not be excluded. No related triclopyr usage data were reported in this study.

The bulk of triclopyr monitoring data are for drains, creeks, streams, rivers and lakes (**Table 8-6). Figure 8-1** depicts the distribution of the data (no. of sites/samples) between various types of water bodies as well as the observed overall triclopyr detection frequencies. This figure indicates that triclopyr was most frequently detected in samples from drainage (49% detection frequency) and urban sites (41% detection frequency). It should be noted however, that detection frequency is one measure and should be viewed along with the extent to which those detections exceeded the limit of quantification. For this, the maximum and range of detected concentrations in **Table 8-6** should be considered.

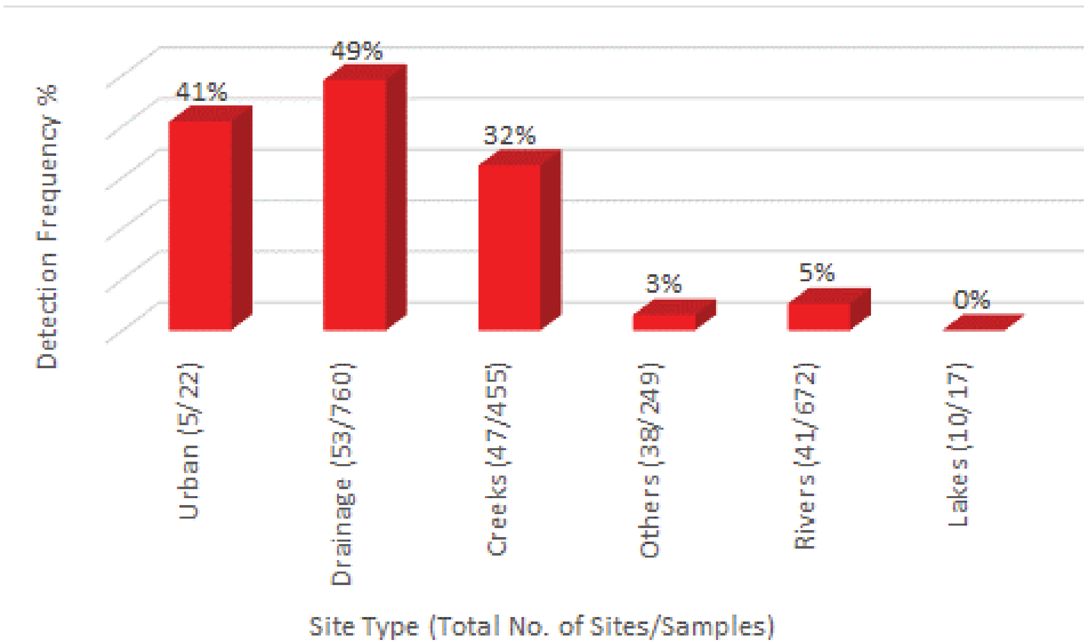

Figure 8-1. Observed Triclopyr Detection Frequencies in Various California Water Bodies

Finally, **Figure 8-2** contains detected concentrations of triclopyr in California surface waters with time from 1977 to end of 2016.

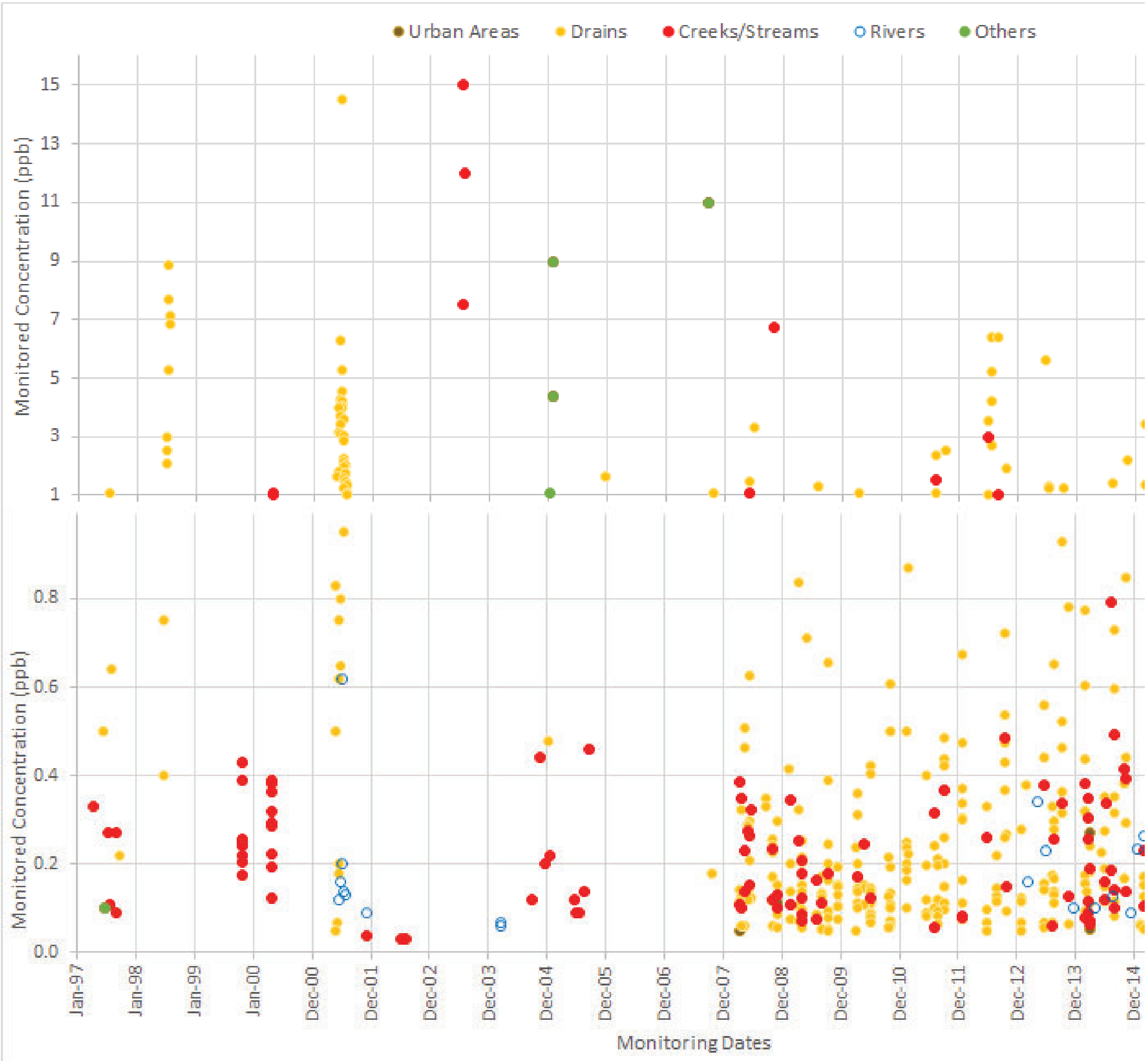

Figure 8-2. Monitored Concentrations of Triclopyr in California Surface Waters (1997-2016)

Data in **Figure 8-2** suggest the following:

(1) The frequency of low concentration detections appears to be higher in more recent years. This may be related to the increase in sensitivity of instrumentation to detect lower concentrations (low LOQ values).
(2) Although no apparent trend in observed concentrations with time there is an indication of detecting of lower concentration in recent years. This may be related to reported decline in triclopyr usage from 1.3 to 0.9 million lbs./year on its main uses (pasture and hay) from the year 2005 to 2016[19].

(3) Most of the observed concentrations were in the range of 0.01 (near the LOQ) to 1 ppb;

(4) Concentrations ranging from 1 to 15 ppb were sporadic and generally between 1 and 5 ppb;

(5) Relatively higher concentrations and frequency of detections were in urban areas, drains, creeks and streams as opposed to rivers;

(6) Low concentrations and frequencies of detections were observed in rivers and lakes possibly due to dilution;

(7) There was a relatively high frequency of detections in drains associated with rice production areas (*e.g.*, Colusa basin drain with detected concentrations of 5.6 to 14.5 ppb).

With the exception of rice, modeled concentrations for California scenarios were in the range of 12 to 99 ppb for the 1-day averages and 5 to 38 ppb for the 60-day averages. These modeled values are not far from concentrations detected at monitoring sites as they are within one order of magnitude for the 1-day average and the 60-day averages. However, it is important to note that modeled concentrations are for triclopyr residues of concern (ROC= ACID + TCP + 3,6 DCP + 5-CLP and 6-CLP degradates) while monitored concentrations were for triclopyr ACID alone. Fate data indicate that TCP + 3,6 DCP + 5-CLP and 6-CLP degradates are significant constituent of the triclopyr ROC (*i.e.,* the observed TCP maximum concentration alone represent 33% in aquatic systems and 54% of applied residues in aerobic soil systems). Modeled concentrations for rice are high because it represents concentrations in the rice paddy which are expected to decrease in surface waters outside the rice paddy due to dilution and possible degradation during the 20-day holding period and following release.

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[19] URL for USGS Estimated annual agriculture use of triclopyr: https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2016&map=TRICLOPYR&hilo=L&disp=Triclopyr

Monitoring data at the national level were also extensive in time (1993 to late 2018) and coverage; of the 38,172 samples there were 738 sites with detects. Data are characterized by low LOQs: 59% in the range of 0.01-0.10 ppb and 33% in the range of 0.1-0.5 ppb. While most of the data are not considered as targeted to triclopyr use sites/times, the data appear to reflect triclopyr use on rice in California. Frequency of sampling is distributed between few at 7-days, most at monthly intervals and some at intervals as high as several years. A summary of available data is included in **Table 8-7.**

Table 8-7. Nationwide Surface Water Monitoring Data for Triclopyr**.**

Water Body	Monitoring Dates (M-Year)	Monitored Sample Distribution			Detection Frequency	No. of Site with Detects	Max Observed Concentration (ppb)
		Non-detects	Detects	Total			
Drains	Mar-93- Oct-18	1,197	57	1,254	5%	19	14.1
Creeks & Streams	Aug-83- Nov-18	14,609	1,779	16,388	11%	389	16.0
Sewage Treatment Plants (STP)	Jul-10- Nov-10	188	9	197	5%	8	3.9
Rivers	Apr-92- Nov-18	17,146	1,440	18,586	8%	264	12.4
Canals	May-12- Oct-18	401	29	430	7%	16	13.0
Others	Mar-94- Sep-18	1,089	25	1,114	2%	14	11.0
Lakes	Aug-01- Jul-18	1,778	125	1,903	7%	17	0.7
Estuaries	Jun-94- Oct-18	268	5	273	2%	5	0.2
Springs	Jun-93- Aug-18	1,291	4	1,295	0%	4	0.1
Wetlands	Mar-93- Aug-17	205	2	207	1%	2	0.1
Overall	Aug-83- Nov-18	38,172	3,475	41,647	8%	738	0.1- 16.0

Data in **Table 8-7** indicate that the range of maximum observed concentration is as low as 0.1 ppb and as high as 16 ppb. Higher concentrations were observed in drains, creeks/streams, canals and rivers with lower concentrations in sewage treatment plant (STP) discharged waters, springs, wetlands and estuaries. Detections were observed in 738 sites with an overall detection frequency of 8%.

Figure 8-3 provides a summary of detected concentrations of triclopyr in surface waters with time from 1993 to end of 2018. Conclusions stated previously for California monitoring data are similar to those that may be obtained from data at the national scale. However, the number of detections in larger bodies of water (rivers) appears to be frequent and at higher concentrations.

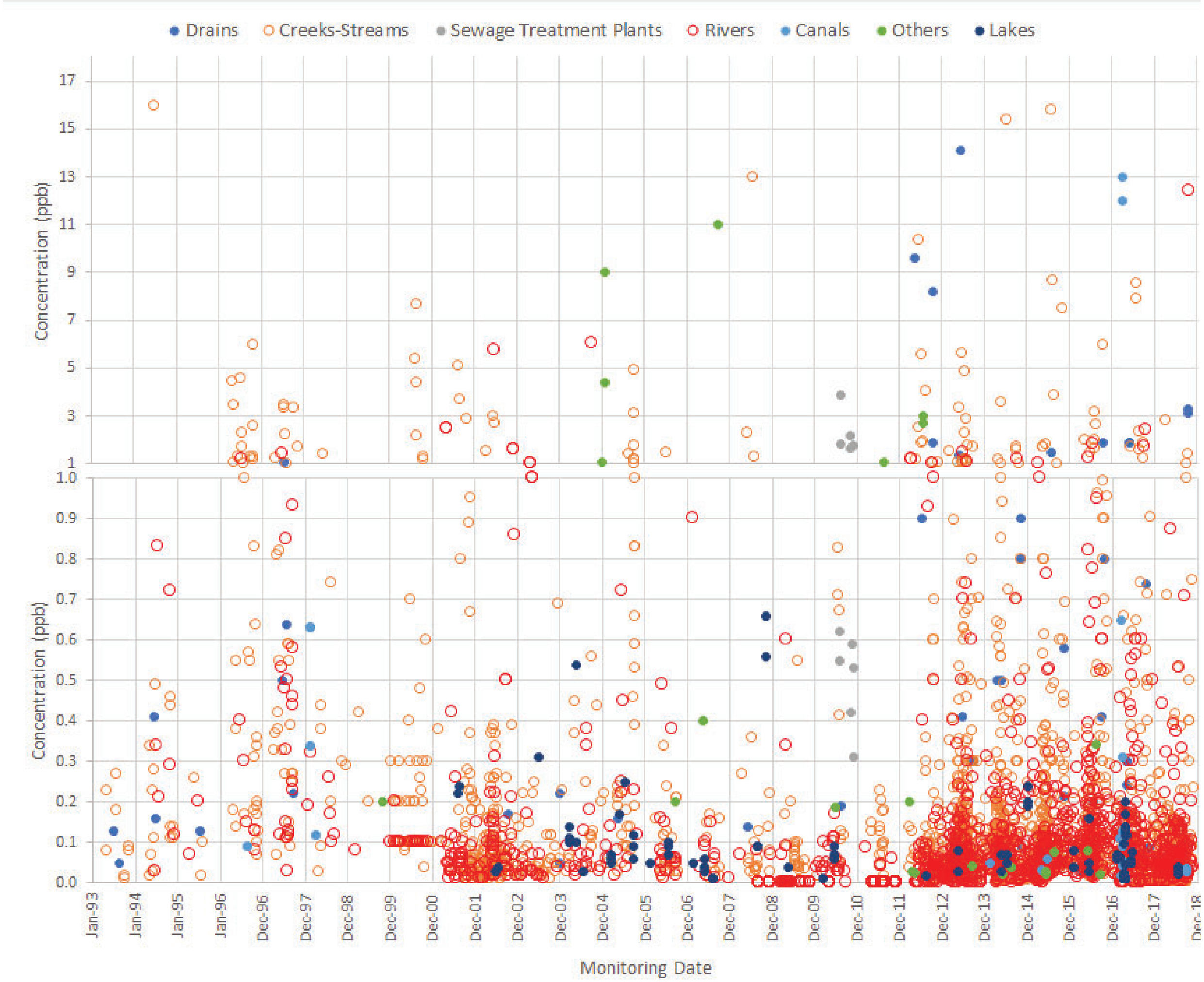

Figure 8-3. Monitored Concentrations of Triclopyr in California Surface Waters (1993-2018)

8.2 Aquatic Organism Risk Characterization

Aquatic RQs for triclopyr acid residues of concern (ROC) representing ACID, TEA and COLN active ingredients) and triclopyr BEE are based on the maximum EECs within each use scenario divided by the most sensitive toxicity value for each of the two groups of triclopyr active ingredients. In addition, since the TCP degradate is several orders of magnitude more toxic than other chemical components of the ROC, separate EECs are calculated for TCP and compared to the most sensitive TCP toxicity values in **Table 6-1**. For triclopyr BEE, aquatic risks are estimated BEE and TCP after confirming that the EECs for the ACID component are 1-3 orders of magnitude below Agency LOC values. The EECs for the ACID component of triclopyr BEE are shown in **Appendix B**.

8.2.1 Aquatic Vertebrates

The potential for acute and chronic risks to freshwater fish (used as a surrogate for aquatic-phase amphibians) or estuarine/marine fish is considered low for the ACID, TEA and COLN active ingredients of triclopyr based on the ROC EECs (ACID+TCP; 3,6-DCP; 5-CLP and 6-CLP) modeled using the Total Residue method (**Table 8-8**). This determination is based on the maximum exposure scenario (direct application to water at 5,000 ppb) with the resultant acute and chronic RQs all being below their LOCs of 0.5 and 1.0, respectively. Therefore, all other exposure scenarios which presented reduced ROC EECs from this highest exposure scenario would also result in acute and chronic RQs below their respective LOCs.

In contrast to the ROC, which assumes equal toxicity among the ACID and degradates (including TCP), a potential for chronic risk to freshwater fish is indicated for the highest aquatic use rate (5,000 ppb) based the more toxic TCP degradate which was separately modeled using the formation/decline (F/D; **Table 8-8**). This 60-d EEC for TCP (319 µg a.i./L) slightly exceeds the LOAEC of 278 µg a.i./L from rainbow trout chronic study, which reflects a 3% and 6% reduction in mean length and weight of fish. No other modeled uses of triclopyr ACID, TEA, of COLN result in exceedances of the acute or chronic risk LOCs.

Table 8-8. Triclopyr Acid Acute and Chronic Risk Quotients (RQs) for Non-Listed Fish Species Applicable to the ACID, TEA and COLN Triclopyr Active Ingredients

Use Sites/ Use scenario	1-in-10 Yr EEC Max (µg/L)		Risk Quotient			
			Freshwater Fish		Estuarine/Marine Fish	
	Daily Mean	60-day Mean	Acute	Chronic	Acute	Chronic
			LC_{50} = 117,000 µg a.e./L	NOAEC = 74,400 µg a.e./L	LC_{50} = 93,000 µg a.i./L	No Data
Residue of Concern[1]						
Aquatic: Weed Control-Applied at 5,000 ppb	4950	3180	0.04	0.04	0.05	
TCP Degradate[2]						
	Daily Mean	60-day Mean	Acute	Chronic	Acute	Chronic
			LC_{50} = 12,600 µg a.i./L	NOAEC = 178 µg a.i./L	LC_{50} = 58,400 µg a.i./L	NOAEC = 825 µg a.i./L[3]
Aquatic: Weed Control-Applied at 5,000 ppb	346	319	0.03	**1.8**	<0.01	0.39

ppb=parts per billion; µg/L. **Bold RQ** = exceeds acute or chronic risk LOC of 0.5 or 1.0, respectively.
The toxicity endpoints listed in the table are those used to calculate the RQ.
[1] Aquatic estimated environmental concentrations (EECs) for the ROC are from **Table 8-4** based on residues of concern via Total Residue method (ACID; TCP; 3,6-DCP; 5-CLP and 6-CLP) expressed as acid equivalents (ug a.e./L).
[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-4** based on TCP (ug a.i./L) via the F/D method.
[3] NOAEC estimated using acute-to-chronic ratio (see **Table 6-1**)

Risk concerns associated with modeled uses of triclopyr BEE are limited to the two uses with the highest EECs; **Table 8-9)**. Specifically, acute RQ values exceed of the acute risk LOC for fish are Range/Pasture Land and Meadow uses (RQs range from **0.59-0.74**). No exceedances of the chronic risk LOC of 1.0 for fish are indicated with the modeled uses of triclopyr BEE nor are acute risks indicated or any other modeled uses. Model results for the TCP degradate also indicate no exceedance of acute or chronic risk LOCs (0.5 and 1.0, respectively).

Table 8-9. Triclopyr BEE And TCP Acute and Chronic Risk Quotients (RQs) for Non-Listed Fish Species Applicable to the BEE Active Ingredient.

Use Sites or Use scenario	1-in-10 Yr EEC (µg/L)		Risk Quotient			
			Freshwater Fish		Estuarine/Marine Fish	
	Daily Mean	60-day Mean	Acute	Chronic	Acute	Chronic estimated
			LC_{50} = 360 µg a.i./L	NOAEC =26 µg a.i./L	LC_{50} = 450 µg a.i./L	NOAEC = 18 µg a.i./L (ACR)
BEE[1]						
Grass: Range/ Pasture land	267	9.8	**0.74**	0.38	**0.59**	0.54
Grass: Meadow	264	9.6	**0.73**	0.37	**0.59**	0.54
TCP Degradate[2]						
	Daily Mean	60-day Mean	Acute	Chronic	Acute	Chronic estimated
			LC_{50} = 12,600 µg a.i./L	NOAEC = 178 µg a.i./L	LC_{50} = 58,400 µg a.i./L	NOAEC = 825 µg a.i./L[3]
Grass: Range/ Pasture land	26	24	<0.01	0.13	<0.01	0.03
Grass: Meadow	22	20	<0.01	0.11	<0.01	0.02

Bolded RQ values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Aquatic estimated environmental concentrations (EECs) are from **Table 8-5** and are based on BEE residues modeled via the F/D method.

[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-5** based on TCP (ug a.i./L) modeled via the F/D method.

[3] NOAEC estimated using acute-to-chronic ratio (see **Table 6-1**)

8.2.2 Aquatic Invertebrates

The potential for acute and chronic risks to freshwater and estuarine/marine invertebrates is considered low for the ACID, TEA and COLN active ingredients of triclopyr based on the ROC EECs (ACID+TCP; 3,6-DCP; 5-CLP and 6-CLP) modeled using the Total Residue method (**Table 8-10**).). This determination is based on the maximum exposure scenario (direct application to water at 5,000 ppb) with the resultant acute and chronic RQs all being below their LOCs of 0.5 and 1.0, respectively. Therefore, all other exposure scenarios which presented reduced ROC EECs from this highest exposure scenario would also result in acute and chronic RQs below their respective LOCs.

When exposure to the TCP degradate was modeled for the registered uses of triclopyr ACID, TEA and COLN, chronic risk concerns are identified for freshwater invertebrates only with the aquatic weed control uses with the two highest application rates (2,500 and 5,000 ppb; **Table 8-10**). Specifically, chronic RQ values of **3.0** and **6.0** are determined for the 2,500 and 5,000 ppb aquatic uses based on a NOAEC of 58 µg a.i./L. In this study, a LOAEC of 130 µg a.i./L reproductive effects on the water flea, *D. magna* based on a 15% reduction in the number of young/female. The chronic EECs for TCP for the 2,500 and 5,000 ppb aquatic uses (173 and 346 µg a.i./L both exceed this LOAEC. At 1,500 µg a.i./L TCP, a 58% reduction in was observed the number of young/female. Therefore, the expected percent reduction in reproduction associated with the aquatic use EECs is expected to be between 15% and 58%. Acute or chronic risks concerns to freshwater or estuarine/marine invertebrates were not identified with any other modeled uses of triclopyr ACID, TEA, or COLN.

Table 8-10. Triclopyr acid acute and chronic risk quotients for aquatic invertebrates applicable to the ACID, TEA and COLN triclopyr active ingredients

Use Sites	1-in-10 Yr EEC Max (µg/L) [1]		Risk Quotient			
			Freshwater Invertebrate		Estuarine/Marine Invert.	
	Daily Mean	21-day Mean	Acute	Chronic	Acute	Chronic
			LC_{50} = 133,000 µg a.e./L	NOAEC= 57,700 µg a.e./L	EC_{50}= 41,500 µg a.e./L	NOAEC=24,400 µg a.e./L (ACR)
Residue of Concern[1]						
Aquatic: Weed Control-Applied at 5,000 ppb	4,950	4,290	0.04	0.07	0.12	0.18
TCP Degradate[2]						
	Daily Mean	21-day Mean	Acute	Chronic	Acute	Chronic estimated
			LC_{50} = 10,400 µg a.i./L	NOAEC = 58 µg a.i./L	LC_{50} = 9,300 µg a.i./L	NOAEC = 463 µg a.i./L[3]
Aquatic: Weed Control-Applied at 2,500 ppb	173	173	0.02	**3.0**	0.02	0.37
Aquatic: Weed Control-Applied at 5,000 ppb	346	346	0.03	**6.0**	0.04	0.75

ppb=parts per billion; µg/L. **Bold RQ** = exceeds the non-listed acute or chronic risk LOC of 0.5 or 1.0, respectively.
The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Aquatic estimated environmental concentrations (EECs) for the ROC are from **Table 8-4** based on residues of concern via Total Residue method (ACID; TCP; 3,6-DCP; 5-CLP and 6-CLP) expressed as acid equivalents (ug a.e./L).

[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-4** based on TCP (ug a.i./L) via the F/D method.

[3] NOAEC estimated using acute-to-chronic ratio (see **Table 6-1**)

Acute RQ values for triclopyr BEE only exceed the acute risk LOC of 0.5 for aquatic invertebrates with the Range/Pasture and Meadow uses (**Table 8-11**). In addition, chronic risk concerns to estuarine/marine invertebrates are identified for these uses in addition to Citrus. Chronic risk of BEE is driven by the sensitivity of mysid shrimp (NOAEC = 11 µg a.i./L) where a 16% reduction in mysid mean weight occurred at the LOAEC of 20 µg a.i./L. The chronic EECs from the Range/Pasture and Meadow uses (27.5 and 28 µg a.i./L) exceed the mysid LOAEC.

Table 8-11. Triclopyr BEE acute and chronic risk quotients (RQs) for non-listed aquatic invertebrates applicable to application of triclopyr BEE active ingredient.

Use Sites	1-in-10 Yr EEC (µg a.i./L) [1]		Risk Quotient			
			Freshwater		Estuarine/Marine	
	Daily Mean	21-day Mean	Acute	Chronic	Acute	Chronic
			LC_{50} =350 µg a.i./L	NOAEC = 170 µg a.i./L	EC_{50}= 460 µg ai/L	NOAEC =11 µg a.i./L
Citrus (FL)	140	11.3	0.40	0.07	0.30	**1.0**
Forestry	47	6.3	0.13	0.04	0.10	0.6
Grass: Range/ Pasture land	267	28	**0.76**	0.16	**0.58**	**2.6**
Grass: Meadow	264	27.5	**0.75**	0.16	**0.57**	**2.5**
Residential	10	0.9	0.03	<0.01	0.02	0.08
Right-of-Way	57	6.6	0.16	0.04	0.12	0.6
Turf	9	1.5	0.03	<0.01	0.02	0.14
X-mas Trees	22	2.3	0.06	0.01	0.05	0.21

Bolded RQ values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Aquatic estimated environmental concentrations (EECs) are from **Table 8-5** and are based on BEE residues modeled via the F/D method.

Acute and chronic risks to aquatic invertebrates were also evaluated for the TCP degradate of triclopyr BEE using the F/D method. Acute and chronic RQ values were all below their respective LOCs of 0.5 and 1.0, indicating a low potential for risk via the formation of this degradate from the modeled uses of BEE.

Table 8-12. TCP degradate acute and chronic risk quotients for non-listed aquatic invertebrates applicable to the triclopyr BEE active ingredient

Use Sites/ Use scenario [1]	1-in-10 Yr EEC Max (µg/L) [2]		Risk Quotient			
			Freshwater Invertebrate		Estuarine/Marine Invertebrate	
	Daily Mean	21-day Mean	Acute	Chronic	Acute	Chronic
			LC_{50} = 10,400 µg a.i./L	NOAEC = 58 µg a.i./L	LC_{50} = 9,300 µg a.i./L	NOAEC = 463 µg a.i./L (ACR)[3]
Citrus (FL)	20.5	20.2	<0.01	0.35	<0.01	0.04
Forestry	2.61	2.57	<0.01	0.04	<0.01	0.01
Grass: Range/ Pasture land	26.2	25.9	<0.01	0.45	<0.01	0.06
Grass: Meadow	22.3	22	<0.01	0.38	<0.01	<0.01
Turf	2.06	2.03	<0.01	0.04	<0.01	<0.01
Christmas Trees	1.88	1.82	<0.01	0.03	<0.01	<0.01

None of the RQ values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] TCP EECs were not estimated for the residential and rights of way uses. These uses have low BEE EECs and risk concerns are not expected.

[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-5** based on TCP (ug a.i./L) modeled via the F/D method.

[3] NOAEC estimated using acute-to-chronic ratio (see **Table 6-1**)

8.2.3 Benthic Invertebrate Risk Assessment

Of the four triclopyr active ingredients, only triclopyr BEE has chemical properties (*e.g.*, log K_{ow} >3.0) that would trigger submission of sediment toxicity data. However, triclopyr BEE is expected to degrade rapidly to the acid form (metabolism half-lives ≤1 day), rendering the conduct of spiked sediment assays as impractical. Therefore, sediment toxicity studies were not required for triclopyr products**.** In lieu of sediment toxicity data, toxicity endpoints for triclopyr BEE for water column invertebrates are compared with EECs in sediment pore water, in accordance with EFED risk assessment guidance (USEPA 2014). In addition, pore water EECs for TCP formed through degradation of triclopyr BEE were also calculated and compared to invertebrate toxicity endpoints for TCP.

Although triclopyr BEE is more toxic on an acute and chronic exposure basis than the ACID and TEA active ingredients, the corresponding EECs in sediment porewater are much lower due to the greater partitioning of BEE onto sediment particles. As a result, maximum RQs for triclopyr BEE and its TCP degradate are all well below either acute or chronic risk LOCs for benthic invertebrates (**Table 8-13**).

Table 8-13. Maximum Acute and Chronic Risk Quotients (RQs) for Benthic Invertebrates Representative of the Triclopyr BEE Active Ingredient

Use Sites	Risk Quotient				
	21-day Pore Water EEC µg a.i./L	Freshwater Invertebrates		Estuarine/Marine Inverts.	
		Acute	Chronic	Acute	Chronic
		LC_{50} =350 µg a.i./L	NOAEC = 170 µg a.i./L	EC_{50}= 460 µg ai/L	NOAEC =11 µg a.i./L
BEE[1]					
Range grass/ Pasture	0.48	<0.01	<0.01	<0.01	0.04
TCP Degradate[2]					
	21-day Pore Water EEC µg a.i./L	Acute	Chronic	Acute	Chronic estimated
		LC_{50} = 10,400 µg a.i./L	NOAEC = 58 µg a.i./L	LC_{50} = 9,300 µg a.i./L	NOAEC = 463 µg a.i./L (ACR)[3]
Range grass/ Pasture	16.7	< 0.01	0.29	< 0.01	0.04

No RQ values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Aquatic estimated environmental concentrations (EECs) are from **Table 8-5** and are based on BEE residues modeled via the F/D method.

[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-5** based on TCP (ug a.i./L) modeled via the F/D method.

[3] NOAEC estimated using acute-to-chronic ratio (see **Table 6-1**)

8.2.4 Aquatic Plants

With aquatic plants, only the aquatic weed control scenarios at 2500 and 5000 ppb are presented (**Table 8-14**) as they represent the highest EECs. The RQs based on aquatic EECs for triclopyr ACID ROC (applicable to ACID, TEA, COLN) are below the LOC for vascular plants with all modeled uses. However, a chronic risk concern for non-vascular plants is identified for the maximum rate (5,00 ppb) based on an RQ value of **1.2**.

TCP is noted to be more toxic to aquatic plants relative to other triclopyr active ingredients. Therefore, aquatic EECs calculated for TCP using the F/D method as described Section 8.1 and compared to TCP toxicity endpoints for aquatic plants. The resulting TCP RQ values are below the LOC of 1.0 for risk to both vascular and non-vascular aquatic plants from TCP (**Table 8-15**). Therefore, despite increased toxicity of degradate TCP to aquatic plants relative to triclopyr ACID, TEA and COLN, risk estimates are still below the LOC for risk to aquatic vascular and non-vascular plants due to the lower EECs for TCP relative to triclopyr ACID ROC.

Table 8-14. Maximum Triclopyr Acid and TCP Risk Quotients (RQs) for Non-Listed Aquatic Plants Representative of the Triclopyr ACID, TEA and COLN Active Ingredients

Use Sites	1-in-10 Year Daily Mean EEC (µg/L) Triclopyr ROC (TCP)[1, 2]	Risk Quotients	
		Vascular	Non-vascular
		IC_{50} = 6,300 µg a.e./L IC_{50} =8,200 µg a.i./L (TCP)	IC_{50} =4,200 µg a.e./L IC_{50} =2,000 µg a.i./L (TCP)
Aquatic Weed Control- Applied at 2500 ppb	2480 (173)	0.39 (0.02)	0.59 (0.09)
Aquatic Weed Control- Applied at 5000 ppb	4950 (346)	0.79 (0.04)	**1.2** (0.17)

ppb=parts per billion; µg/L. **Bold RQ** = exceeds acute or chronic risk LOC of 0.5 or 1.0, respectively.
The toxicity endpoints listed in the table are those used to calculate the RQ.
[1] Aquatic estimated environmental concentrations (EECs) for the ROC are from **Table 8-4** based on residues of concern via Total Residue method (ACID; TCP; 3,6-DCP; 5-CLP and 6-CLP) expressed as acid equivalents (ug a.e./L).
[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-4** based on TCP (ug a.i./L) via the F/D method.

With triclopyr BEE, RQ values exceed the LOC for risk to non-vascular aquatic plants for selected use scenarios only (Citrus, Range/pasture land, Meadows) but not for vascular aquatic plants (**Table 8-15**). No risk concerns for the TCP degradate of triclopyr BEE are indicated for any modeled use (**Table 8-16**).

Table 8-15. Triclopyr BEE Risk Quotients (RQs) for Aquatic Vascular and Non-vascular Plant Species Representative of the Triclopyr BEE Active Ingredient

Use Sites	1-in-10 Year Daily Mean EEC (µg/L) [1]	Risk Quotients	
		Vascular	Non-vascular
		IC_{50} = 880 µg a.i./L	24 hr IC_{50} = 102 µg a.i./L
Citrus (FL)	140	0.16	**1.4**
Forestry	47	0.05	0.5
Grass: Range/ Pasture land	267	0.30	**2.7**
Grass: Meadow	264	0.30	**2.6**
Premises	10	0.01	0.1

Use Sites	1-in-10 Year Daily Mean EEC (µg/L) [1]	Risk Quotients	
		Vascular	Non-vascular
		IC_{50} = 880 µg a.i./L	24 hr IC_{50} = 102 µg a.i./L
Right-of-Way	59	0.06	0.6
Turf	9	0.01	0.1
X-mas Trees	22	0.03	0.2

Bolded values exceed the risk to non-listed aquatic plant species level of concern (LOC) is 1. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Aquatic estimate environmental concentrations (EECs) are from **Table 8-5.**

Table 8-16. TCP Degradate Acute and Chronic Risk Quotients for Aquatic Vascular and Non-Vascular Plant Species Representative of the Triclopyr BEE Active Ingredient

Use Sites/ Use scenario [1]	1-in-10 Yr EEC Max (µg/L) [2]	Risk Quotients	
		Vascular	Vascular
	Daily Mean	IC_{50} =8,200 µg a.i./L	IC_{50} =2,000 µg a.i./L
Citrus (FL)	20.5	< 0.01	0.01
Forestry	2.61	< 0.01	< 0.01
Grass: Range/ Pasture land	26.2	< 0.01	0.01
Grass: Meadow	22.3	< 0.01	0.01
Turf	2.06	< 0.01	< 0.01
Christmas Trees	1.88	< 0.01	< 0.01

No RQ values exceed the risk to non-listed aquatic plant species level of concern (LOC) is 1. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] TCP EECs were not estimated for the residential and rights of way uses. These uses have low BEE EECs and risk concerns are not expected

[2] Aquatic estimated environmental concentrations (EECs) for TCP are from **Table 8-5** based on TCP (ug a.i./L) via the F/D method.

8.2.5 Aquatic Risk Summary

Based on the available toxicity data and ROC EECs determined for representative uses triclopyr ACID, TEA and COLN, risks of concern to aquatic organisms are indicated only with one use for non-vascular aquatic plants (aquatic weed control at 5,000 ppb). However, both the moderate (2,500 ppb) and maximum (5,000 ppb) aquatic weed control use have potential chronic risk concerns to freshwater invertebrates resulting from the formation of TCP (RQ values = **3.0** and **6.0**, respectively). The maximum aquatic use rate also poses a chronic risk to freshwater fish via degradation to TCP (RQ = **1.8**). With respect to aquatic vascular plants, it is noted that the tested species (*i.e.*, duckweed) may differ in its sensitivity compared to rooted vascular plants, particularly targeted aquatic weeds, in part due to its different physiology. Therefore, the lack of risk to vascular aquatic plants identified in this assessment should be considered with caution, particularly since triclopyr ACID, TEA and COLN are registered for control of aquatic weeds. Additional testing with other aquatic vascular plants (e.g., OECD guideline 239: *Myriophyllum spicatum*) could help address this uncertainty. Notably, only two ecological incidents were reported for triclopyr ACID/TEA/COLN products; however, these involved applications of more than one active ingredient which makes establishing causality to triclopyr ACID/TEA/COLN uncertain. Furthermore, available monitoring data for triclopyr ACID indicates that maximum measured concentrations (~ 16 ppb) among the more than 40,000 reported values are 2 orders of magnitude below toxicity endpoints for aquatic plants (*e.g.,* 4,200 µg a.e./L for non-vascular plants) and 3 to 4 orders of magnitude below those for aquatic animals. It is likely, however, that the aquatic monitoring data do not targeted high end uses such as direct application to aquatic ecosystems for weed control.

For TCP (a major degradate of triclopyr ACID), chronic risk to aquatic invertebrates is indicated only for the 5,000 ppb and 2,500 ppb aquatic weed control use scenarios. In addition, chronic risk to fish is identified with the 5,000 ppb aquatic weed control use.

Modeled usage of triclopyr BEE on range/pasture land and meadows resulted in acute risk concerns for freshwater and estuarine marine fish and for aquatic invertebrates. In addition, chronic risks to marine/estuarine invertebrates and risks to non-vascular aquatic plants were also indicated with these uses. Modeled usage of triclopyr BEE on citrus also resulted in chronic risk concerns to estuarine/marine invertebrates and non-vascular aquatic plants. No risk concerns to aquatic organisms were identified based on the formation of TCP degradate of triclopyr BEE.

9 Terrestrial Vertebrates Risk Assessment

9.1 Terrestrial Vertebrate Exposure Assessment

9.1.1 Dietary Items on the Treated Field

For triclopyr ACID, TEA, and COLN active ingredients, potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of triclopyr acid residues on food items following spray (foliar or soil) applications. Estimates from possible dietary ingestion of chemical granules were not presented because they are all below the acute risk LOC of 0.5. Dietary EECs for birds[20] and mammals from consumption of dietary items on the treated field were calculated using T-REX v.1.5.2. For the foliar uses, EECs are based on application rates, number of applications, and re-application intervals presented in 2018 BEAD PLUS reports. A default foliar dissipation half-life of 35 days was used which assumes the ROC degrades to non-toxic degradates according to a first order rate constant of 0.02^{-d}.

Four major use scenarios for triclopyr ACID (representative of ACID, TEA and COLN) were modeled which give a wide range of single maximum application rates ranging from 0.375 on rice (2 apps/year) to a single foliar application to pastures and rangeland at 9.0 lbs ai/A. Triclopyr BEE is not registered for use on rice, so this scenario is not applicable. Since the avian LD_{50} of triclopyr BEE (735 mg/Kg/bw) is over 50% lower than the LD_{50} acid (1,698 mg/Kg/bw) there is a separate run of T-REX for triclopyr BEE included for avian RQs.

[20] Birds are also used as a surrogate for reptiles and terrestrial-phase amphibians.

Upper-bound Kenaga nomogram values were used to derive EECs for triclopyr ACID exposures to terrestrial mammals and birds on the field of application based on a 1-year time period. Triclopyr TEA and COLN degrade quickly to the acid form, thus the assumption is that the estimates based on acute and chronic values for the acid are reflective of the TEA and COLN actives. Consideration is given to different types of feeding strategies for mammals, including herbivores, insectivores and granivores. Dose-based exposures are estimated for three weight classes of birds (20 g, 100 g, and 1,000 g) and three weight classes of mammals (15 g, 35 g, and 1,000 g). EECs on terrestrial food items range from 59 to 2,160 mg ai/kg-diet based on upper-bound Kenaga values. Dose-based EECs, adjusted for body weight, range from 2.0 to 2,640 mg ai/Kg/bw for birds and 2.0 to 2,950 mg/Kg/body weight for mammals. A summary of these EECs for several application scenarios is found in **Table 9-1**.

For Triclopyr BEE, the dietary- and dose-based EECs are the same as the ACID presented in **Table 9-1** except there is no use on rice.

Table 9-1. Summary of dietary- (mg a.i./kg-diet) and dose-based estimated environmental concentrations (EECs; mg a.i./kg-bw) of triclopyr acid as food residues for birds, reptiles, terrestrial-phase amphibians and mammals from labeled uses of triclopyr ACID, TEA and COLN products (T-REX v. 1.5.2, Upper-Bound Kenaga)

Food Type	Dietary-Based EEC (mg/kg-diet)	Dose-Based EEC (mg/kg-body weight)					
		Birds			Mammals		
		Small (20 g)	Medium (100 g)	Large (1000 g)	Small (15 g)	Medium (35 g)	Large (1000 g)
Rice at 0.375 lb a.i./acre, 2 apps, with 20 day interval[1]							
Short grass	150	171	98	44	144	99	23
Tall grass	69	79	45	20	66	45	11
Broadleaf plants/small insects	85	96	55	24	81	56	13
Fruits/pods/seeds (dietary only)	9.4	11	6	3	9.0	6.2	1.4
Arthropods	59	67	38	17	56	39	9.0
Seeds (granivore)[2]		2.4	1.4	0.6	2.0	1.4	0.3
Turf 1.0 lb a.i./acre, 4 applications/28-day intervals							
Short grass	502	572	326	146	479	331	77
Tall grass	230	262	150	67	220	152	35
Broadleaf plants/small insects	283	322	184	82	269	186	43
Fruits/pods/seeds (dietary only)	31	36	20	9.1	30	21	4.8
Arthropods	197	224	128	57	188	130	30
Seeds (granivore)[1]		7.9	4.5	2.0	6.7	4.6	1.1
Forestry and Open Campground and Recreation areas at 6.0 lb ai/acre. 1 application							
Short grass	1440	1640	935	419	1372	949	220
Tall grass	660	752	429	192	629	435	101

Food Type	Dietary-Based EEC (mg/kg-diet)	Dose-Based EEC (mg/kg-body weight)					
		Birds			Mammals		
		Small (20 g)	Medium (100 g)	Large (1000 g)	Small (15 g)	Medium (35 g)	Large (1000 g)
Broadleaf plants/small insects	810	922	526	236	772	534	124
Fruits/pods/seeds (dietary only)	90	102	58	26	86	59	14
Arthropods	564	642	366	164	538	372	86
Seeds (granivore)[1]		23	13	6.0	19	13	3.0
Range and Pastureland and Utility or Road Rights-of-Way at 9.0 lb ai/acre. 1 application							
Short grass	2160	2460	1403	628	2059	1423	330
Tall grass	990	1127	643	287	944	652	151
Broadleaf plants/small insects	1215	1383	789	353	1158	801	186
Fruits/pods/seeds (dietary only)	135	154	88	39	129	89	21
Arthropods	846	964	549	246	807	557	129
Seeds (granivore)[1]		34	19	8.7	29	20	4.6

[1]Triclopyr BEE is not registered for Rice use

[2] Seeds presented separately for dose – based estimated environmental concentrations (EECs) due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

9.2 Terrestrial Vertebrate Risk Characterization

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals by emphasizing the dietary exposure pathway. Triclopyr products are applied through aerial and ground application methods, which includes sprayers or direct injection into trees. Therefore, potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of triclopyr acid residues on or in food items following spray (foliar or soil) applications. The EECs for birds[21] and mammals from consumption of dietary items on the treated field were calculated using T-REX v.1.5.2.

9.2.1 Birds/Mammals: Triclopyr ACID, TEA, COLN

Table 9-2 summarizes the acute and chronic RQs for birds resulting from the registered uses of triclopyr ACID/TEA/COLN active ingredients. There were no acute and chronic risk LOC exceedances for the rice use with the exception of an exceedance of the chronic risk LOC for one food item (RQ = **1.5**). Chronic risk LOC exceedances were of a higher magnitude and were determined for a greater number of food items for the turf use, although dose- and dietary-based RQs were still below the acute risk LOC. For the forest, campground, recreation, range, pasture land, and rights-of-way uses, acute dose-based RQs for birds exceed the LOC with RQs up to **1.9** for the forestry, campground, and recreational field uses, and up to **2.8** for the range,

[21] Birds are also used as a surrogate for reptiles and terrestrial-phase amphibians.

pasture land, and rights-of-way uses. Acute dietary-based RQs for the range, pasture land, and rights-of-way uses are marginally above the LOC (max RQ of **0.74**). Chronic RQs for birds exceed the chronic risk LOC for these uses and range from **0.9 - 22**. The differential risk picture for the forestry, campground, recreational area, range/pasture land, and rights-of-way uses relative to rice is driven by their high application rates 6.0 - 9.0 lbs a.e./A. Lower application rates associated with rice largely do not result in LOC exceedances. The maximum single application rate at which all avian RQs are below the LOC is 0.4 lb a.e./A.

Table 9-2. Acute and Chronic RQ values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Triclopyr ACID, TEA and COLN products (T-REX v. 1.5.2, Upper Bound Kenaga)

Food Type	Acute Dose-Based RQ LD_{50} = 1,698 mg a.i./kg-bw			Acute Dietary-Based RQ LC_{50} =2,934 mg a.i./kg-diet	Chronic Dietary RQ NOAEC = 100 mg a.i./kg-diet
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Rice at 0.375 lb a.i./acre, 2 apps, with 20-day interval					
Herbivores/Insectivores					
Short grass	0.19	0.09	0.03	0.05	**1.5**
Tall grass	0.09	0.04	0.01	0.02	0.69
Broadleaf plants	0.11	0.05	0.02	0.03	0.85
Fruits/pods/seeds	0.01	0.01	<0.01	<0.01	0.09
Arthropods	0.08	0.03	0.01	0.02	0.59
Granivores					
Seeds[1]	<0.01	<0.01	<0.01		
Turf at 1.0 lb ai/acre. 4 apps, with 28-day intervals					
Herbivores/Insectivores					
Short grass	0.65	0.29	0.09	0.17	**5.0**
Tall grass	0.30	0.13	0.04	0.08	**2.3**
Broadleaf plants	0.37	0.16	0.05	0.10	**2.8**
Fruits/pods/seeds	0.04	0.02	0.01	0.01	0.31
Arthropods	0.25	0.11	0.04	0.07	**2.0**
Granivores					
Seeds[1]	0.01	0.01	<0.01		
Forestry and Open Campground and Recreation areas at 6.0 lb ai/acre. 1 application					
Herbivores/Insectivores					
Short grass	**1.9**	**0.83**	0.26	0.49	**14**
Tall grass	**0.85**	0.38	0.12	0.22	**6.6**
Broadleaf plants	**1.0**	**0.47**	0.15	0.28	**8.1**
Fruits/pods/seeds	0.12	0.05	0.02	0.03	0.90
Arthropods	0.73	0.33	0.10	0.19	**5.6**
Granivores					
Seeds[1]	0.03	0.01	<0.01		
Range and Pastureland and Utility or Road Rights-of-Way at 9.0 lb ai/acre. 1 application					
Herbivores/Insectivores					
Short grass	**2.8**	**1.2**	0.40	**0.74**	**22**
Tall grass	**1.3**	**0.57**	0.18	0.34	**9.9**
Broadleaf plants	**1.6**	**0.70**	0.22	0.41	**12**
Fruits/pods/seeds	0.17	0.08	0.02	0.05	**1.4**
Arthropods	**1.1**	**0.49**	0.16	0.29	**8.5**

Food Type	Acute Dose-Based RQ LD$_{50}$ = 1,698 mg a.i./kg-bw			Acute Dietary-Based RQ LC$_{50}$ =2,934 mg a.i./kg-diet	Chronic Dietary RQ NOAEC = 100 mg a.i./kg-diet
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Granivores					
Seeds[1]	0.04	0.02	0.01		

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.
[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

Acute RQs for mammals with the ACID/TEA/COLN active ingredients are below LOC for the rice and turf uses but exceed the acute risk LOC by up to 3X (RQs up to **1.5**) for the forestry, campground, recreation areas, range, pasture land, and rights-of-way uses (**Table 9-3**). These exceedances of the acute risk LOC are limited to small- and medium-sized mammals only and pertain primarily to mammals foraging on short grasses and broadleaf plants.

Table 9-3. Acute RQ values for Mammals from Labeled Uses of ACID, TEA and COLN products (T-REX v. 1.5.2, Upper-Bound Kenaga)

Food Type	Acute Dose-Based RQ LD$_{50}$ =630 mg a.e./kg-bw		
	Small (15 g)	Medium (35 g)	Large (1000 g)
Rice at 0.375 lb a.e./acre, 2 apps, with 20 day interval			
Herbivores/Insectivores			
Short grass	0.10	0.09	0.05
Tall grass	0.05	0.04	0.02
Broadleaf plants	0.06	0.05	0.03
Fruits/pods/seeds	0.01	0.01	<0.01
Arthropods	0.04	0.03	0.02
Granivores			
Seeds[1]	<0.01	<0.01	<0.01
Turf at 1.0 lb a.e./acre. 4 apps, 2with 28-day intervals			
Herbivores/Insectivores			
Short grass	0.35	0.30	0.16
Tall grass	0.16	0.14	0.07
Broadleaf plants	0.19	0.17	0.09
Fruits/pods/seeds	0.02	0.02	0.01
Arthropods	0.14	0.12	0.06
Granivores			
Seeds[1]	0.01	<0.01	<0.01
Forestry and Open Campground and Recreation areas at 6.0 lb a.e./acre. 1 application			
Herbivores/Insectivores			
Short grass	**0.99**	**0.85**	0.45
Tall grass	0.45	0.39	0.21
Broadleaf plants	**0.56**	**0.48**	0.26
Fruits/pods/seeds	0.06	0.05	0.03
Arthropods	0.39	0.33	0.18
Granivores			
Seeds[1]	0.01	0.01	0.01
Range and Pastureland and Utility or Road Rights-of-Way at 9.0 lb a.e./acre. 1 application			

Food Type	Acute Dose-Based RQ LD$_{50}$ =630 mg a.e./kg-bw		
	Small (15 g)	Medium (35 g)	Large (1000 g)
Herbivores/Insectivores			
Short grass	**1.5**	**1.3**	0.68
Tall grass	**0.68**	**0.58**	0.31
Broadleaf plants	**0.84**	**0.71**	0.38
Fruits/pods/seeds	0.09	0.08	0.04
Arthropods	0.58	0.50	0.27
Granivores			
Seeds[1]	0.02	0.02	0.01

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

Available data for the ACID/TEA/COLN active ingredients also show risk to mammals on a chronic basis (**Table 9-4**). Dose-based RQs exceed the chronic risk LOC for multiple size classes and multiple food items for every use pattern (RQs **0.07 - 2.6** for rice; **0.25 – 8.7** for turf; **0.7 - 25** for forestry, campground, and recreational sites; and **0.24 - 37** for range, pasture land, and rights-of-way). Dietary-based RQs are markedly lower than dose-based values, with all RQs below chronic risk LOC for rice; however, for the use on turf, one of the mammalian forage items (short grass) has a chronic risk concern (RQ = **1.0**). For the forestry, campground, recreational area, range, pasture lands, and rights-of-way uses, chronic RQs exceed the LOC for most food items (RQs up to **4.3**).

It is important to note that the LOAEL for the mammalian chronic toxicity study (250 mg a.i./kg-bw/d based on a 28%-39% reduction in F_1 and F_2 litter size, a 29%-31% reduction in pup body weight and a 17% reduction in pup survival) is 10X above the NOAEL. This wide range between the NOAEL and LOAEL introduces uncertainty in the interpretation of these chronic LOC exceedances because the threshold for chronic effects could be anywhere between 25 and 250 mg/kg-bw/d. However, even when based on the LOAEL of 250 mg/kg bw/d, RQs for forestry, campground, recreational area, range, pasture lands, and rights-of-way uses for multiple size classes and dietary items exceed the chronic risk LOC. Thus, there is greater certainty of the potential for chronic effects on mammals with these uses compared to uses on turf and rice.

Table 9-4. Chronic Risk Quotient (RQ) values for Mammals from Labeled Uses of Triclopyr ACID, TEA and COLN products (T-REX v. 1.5.2, Upper-Bound Kenaga)

Food Type	Chronic Dose-Based RQ NOAEL =25 mg a.e./kg-bw			Chronic Dietary RQ NOAEC = 500 mg a.e./kg-diet
	Small (15 g)	Medium (35 g)	Large (1000 g)	
Rice at 0.375 lb a.e./acre, 2 apps, with 20 day interval				
Herbivores/Insectivores				
Short grass	**2.6**	**2.2**	**1.2**	0.30
Tall grass	**1.2**	**1.0**	0.55	0.14
Broadleaf plants	**1.5**	**1.3**	0.67	0.17
Fruits/pods/seeds	0.16	0.14	0.07	0.02
Arthropods	**1.0**	0.87	0.47	0.12

Food Type	Chronic Dose-Based RQ NOAEL =25 mg a.e./kg-bw			Chronic Dietary RQ NOAEC = 500 mg a.e./kg-diet
	Small (15 g)	Medium (35 g)	Large (1000 g)	
Granivores				
Seeds[1]	0.04	0.03	0.02	
Turf at 1.0 lb a.e./acre. 4 apps, 2with 28-day intervals				
Herbivores/Insectivores				
Short grass	**8.7**	**7.4**	**4.0**	**1.0**
Tall grass	**4.0**	**3.4**	**1.8**	0.46
Broadleaf plants	**4.9**	**4.2**	**2.2**	0.57
Fruits/pods/seeds	0.54	0.47	0.25	0.06
Arthropods	**3.4**	**2.9**	**1.6**	0.39
Granivores				
Seeds[1]	0.12	0.10	0.06	
Forestry and Open Campground and Recreation areas at 6.0 lb a.e./acre. 1 application				
Herbivores/Insectivores				
Short grass	**25**	**21**	**11**	**2.9**
Tall grass	**12**	**9.8**	**5.2**	**1.3**
Broadleaf plants	**14**	**12**	**6.4**	**1.6**
Fruits/pods/seeds	**1.6**	**1.3**	0.72	0.18
Arthropods	**9.8**	**8.4**	**4.5**	**1.1**
Granivores				
Seeds[1]	0.35	0.30	0.16	
Range and Pastureland – Utility or Road Rights-of-Way at 9.0 lb a.e./acre. 1 application				
Herbivores/Insectivores				
Short grass	**37**	**32**	**17**	**4.3**
Tall grass	**17**	**15**	**8**	**2.0**
Broadleaf plants	**21**	**18**	**10**	**2.4**
Fruits/pods/seeds	**2.3**	**2.0**	**1.1**	0.27
Arthropods	**15**	**13**	**6.7**	**1.7**
Granivores				
Seeds[1]	0.52	0.44	0.24	

Bolded values exceed the chronic risk level of concern (LOC) of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

9.2.2 Birds/Mammals: Triclopyr BEE

Acute dose-based RQs for birds with the BEE uses are generally higher than those of the ACID and TEA active ingredients and were driven by the 2-fold greater sensitivity of BEE relative to the either the ACID or TEA (**Table 9-5**). There are acute risk LOC exceedances for at least 2 avian sizes classes and one food item for every registered use (RQs range from 0.01 - **4.6**). Dietary-based RQs for birds are markedly lower, with RQs for all uses below the acute risk LOC. No chronic toxicity data are available for birds with BEE and therefore, chronic RQs were not calculated. There is uncertainty as to how rapid BEE would degrade on foliage into triclopyr ACID, for which chronic LOC exceedances for birds are generally indicated with the use patterns that are associated with application rates of 0.5 lb a.i/A or more.

Table 9-5. Acute Risk Quotient (RQ) values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Triclopyr BEE products (T-REX v. 1.5.2, Upper Bound Kenaga)

Food Type	Acute Dose-Based RQ LD_{50} = 735 mg a.i./kg-bw			Acute Dietary-Based RQ LC_{50} =5,401 mg a.i./kg-diet	Chronic Dietary RQ NOAEC = No Data
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Turf at 1.0 lb ai/acre. 4 apps, with 28-day intervals					
Herbivores/Insectivores					
Short grass	**1.1**	**0.48**	0.15	0.09	
Tall grass	**0.5**	0.22	0.07	0.04	
Broadleaf plants	**0.6**	0.27	0.09	0.05	
Fruits/pods/seeds	0.07	0.03	0.01	0.01	
Arthropods	0.42	0.20	0.06	0.04	
Granivores					
Seeds[1]	0.02	0.01	<0.01		
Forestry and Open Campground and Recreation areas at 6.0 lb ai/acre. 1 application					
Herbivores/Insectivores					
Short grass	**3.1**	**1.4**	0.44	0.27	
Tall grass	**1.4**	**0.6**	0.20	0.12	
Broadleaf plants	**1.7**	**0.8**	0.25	0.15	
Fruits/pods/seeds	0.2	0.09	0.03	0.02	
Arthropods	**1.2**	**0.5**	0.17	0.10	
Granivores					
Seeds[1]	0.04	0.02	0.01		
Range and Pastureland and Utility or Road Rights-of-Way at 9.0 lb ai/acre. 1 application					
Herbivores/Insectivores					
Short grass	**4.6**	**2.1**	0.66	0.40	
Tall grass	**2.1**	**0.95**	0.30	0.18	
Broadleaf plants	**2.6**	**1.2**	0.37	0.22	
Fruits/pods/seeds	0.29	0.13	0.04	0.02	
Arthropods	**1.8**	**0.82**	0.26	0.16	
Granivores					
Seeds[1]	0.06	0.03	0.01		

Bolded values exceed the LOC for acute risk to non-listed species of 0.5 or the chronic risk LOC of 1.0. The endpoints listed in the table are the endpoint used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

For mammals, there are no acute risks of concern associated with triclopyr BEE use rates on turf (1 lb a.i./A x 4) but RQs exceed the acute risk LOC (0.5) for use rates for forestry/camp grounds (6 lb a.i./A) and range land/rights-of-way (9 lb a.i./A; **Table 9-6**). These acute risks are driven by the relatively high application rates associated with these uses, since triclopyr BEE is classified as being moderately toxic to mammals on an acute exposure basis.

Table 9-6. Acute Risk Quotient (RQ) values for Mammals from Labeled Uses of Triclopyr BEE products (T-REX v. 1.5.2, Upper Bound Kenaga)

Food Type	Acute Dose-Based RQ LD_{50} =630 mg a.i./kg-bw		
	Small (15 g)	Medium (35 g)	Large (1000 g)
Turf at 1.0 lb ai/acre. 4 apps, 2with 28-day intervals			

Food Type	Acute Dose-Based RQ LD_{50} =630 mg a.i./kg-bw		
	Small (15 g)	**Medium (35 g)**	**Large (1000 g)**
Herbivores/Insectivores			
Short grass	0.27	0.23	0.12
Tall grass	0.12	0.11	0.06
Broadleaf plants	0.15	0.13	0.07
Fruits/pods/seeds	0.02	0.01	0.01
Arthropods	0.11	0.09	0.05
Granivores			
Seeds[1]	<0.01	<0.01	<0.01
Forestry and Open Campground and Recreation areas at 6.0 lb ai/acre. 1 application			
Herbivores/Insectivores			
Short grass	**0.78**	**0.66**	0.36
Tall grass	0.36	0.30	0.16
Broadleaf plants	0.44	**0.37**	0.20
Fruits/pods/seeds	0.05	0.04	0.02
Arthropods	0.3	0.26	0.14
Granivores			
Seeds[1]	0.01	0.01	<0.01
Range and Pastureland and Utility or Road Right of Way at 9.0 lb ai/acre. 1 application			
Herbivores/Insectivores			
Short grass	**1.2**	**1.0**	**0.53**
Tall grass	**0.53**	**0.46**	0.24
Broadleaf plants	**0.66**	**0.56**	0.30
Fruits/pods/seeds	0.07	0.06	0.03
Arthropods	0.46	0.4	0.21
Granivores			
Seeds[1]	0.02	0.01	0.01

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

Dose-based RQs for BEE were above the chronic risk LOC for all size classes of mammals and most feeding strategies and for all registered uses (turf RQs range from 0.03 - **4.1**; forestry/ campground/recreational areas RQs ranges from 0.07 - **12**; and range, pasture land, and rights-of-way RQs ranges from 0.11 – **18; Table 9-7)**. It is noted that all modeled uses of triclopyr BEE except rice result in chronic dose-based EECs that exceed the LOAEC of 350 mg a.i./kg/d (*i.e.,* RQ values that exceed 5). Dietary based RQs were markedly lower than dose-based RQs, with LOC exceedances only for the range, pasture land, and rights-of-way uses (max RQ of **1.5**).

Table 9-7. Chronic Risk Quotient (RQ) values for Mammals from Labeled Uses of Triclopyr BEE products (T-REX v. 1.5.2, Upper-Bound Kenaga)

Food Type	Chronic Dose-Based RQ NOAEL =70 mg a.i./kg-bw			Chronic Dietary RQ NOAEC =1400 mg a.i./kg-diet
	Small (15 g)	**Medium (35 g)**	**Large (1000 g)**	
Turf at 1.0 lb ai/acre. 4 apps, 2with 28 day intervals				
Herbivores/Insectivores				

Food Type	Chronic Dose-Based RQ NOAEL =70 mg a.i./kg-bw			Chronic Dietary RQ NOAEC =1400 mg a.i./kg-diet
	Small (15 g)	Medium (35 g)	Large (1000 g)	
Short grass	**4.1**	**3.5**	**1.9**	0.36
Tall grass	**1.9**	**1.6**	**0.86**	0.16
Broadleaf plants	**2.3**	**2.0**	**1.1**	0.20
Fruits/pods/seeds	0.26	0.22	0.12	0.02
Arthropods	**1.6**	**1.4**	0.74	0.14
Granivores				
Seeds[1]	0.06	0.05	0.03	
Forestry and Open Campground and Recreation areas at 6.0 lb ai/acre. 1 application				
Herbivores/Insectivores				
Short grass	**12**	**10**	**5.4**	**1.0**
Tall grass	**5.4**	**4.6**	**2.5**	0.47
Broadleaf plants	**6.6**	**5.7**	**3.0**	0.58
Fruits/pods/seeds	0.74	0.63	0.34	0.06
Arthropods	**4.6**	**3.9**	**2.1**	0.40
Granivores				
Seeds[1]	0.16	0.14	0.07	
Range and Pastureland – Utility or Road Right of Way at 9.0 lb ai/acre. 1 application				
Herbivores/Insectivores				
Short grass	**18**	**15**	**8.1**	**1.5**
Tall grass	**8.1**	**6.9**	**3.7**	0.71
Broadleaf plants	**10**	**8.5**	**4.6**	0.87
Fruits/pods/seeds	**1.1**	0.94	0.51	0.10
Arthropods	**6.9**	**5.9**	**3.2**	0.60
Granivores				
Seeds[1]	0.25	0.21	0.11	

Bolded values exceed the chronic risk level of concern (LOC) of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

9.2.3 Terrestrial Vertebrate Risk Summary

Triclopyr is adsorbed into plant tissues which are expected to be ingested by terrestrial herbivores and spray applications are expected to coat other food sources. Based on the available toxicity data and upper-bound EECs for terrestrial food items, the acute risk level of concern for birds is met or exceeded with a single application of 1.5 lb a.e./A or greater in at least one dietary item for the ACID/TEA/COLN active ingredients. With mammals, the acute risk LOC is exceeded in at least one dietary item at approximately 3 lb a.e./A and greater.

Chronic risk levels of concern for birds are exceeded with one application of the ACID/TEA/COLN active ingredients at 0.4 lb a.i./A or greater and risks were identified with at least 1 food item and 1 size class for all registered used modeled. Notably, the one chronic risk LOC exceedance for rice (chronic RQ= 1.5 for short grass) is sensitive to the use of the default 35-d foliar dissipation half-life and the use of upper-bound Kenega residue values. The chronic risk LOC for rice would not be exceeded for birds if the foliar dissipation half-life was $\leq$10 days or if exposure was based on mean Kenega residue values. Chronic risk for mammals is indicated for all use patterns with at least one food group/size class. Chronic dose-based risk concerns are indicated with a single application rate of 0.25 lb a.i./A or greater. As discussed previously, there is greater uncertainty with interpretation of chronic risks to mammals due to the wide (10X) dose spacing used in the chronic test. With the forestry and range/pasture land uses (6 and 9 lb ai/A, respectively), the chronic risk LOC is exceeded for all weight classes of mammals among multiple food groups. It should be noted though that applications at these high rates would likely result in lethality to the target plants. Therefore, chronic risk from consumption of contaminated dietary items might be mitigated somewhat when plants die after treatment, assuming such forage would be unattractive to birds and mammals.

For triclopyr BEE, acute risk to birds is indicated for small- and medium-sized birds only. The acute risk identified for birds with the turf use is sensitive to the use of upper-bound vs. mean Kenega residue values (*i.e.,* risk would not be indicated with mean residue values which are approximately 3X lower than upper-bound residue values). Acute risk to mammals with triclopyr BEE are not indicated for the turf use, but are indicated for the forestry and rangeland uses. Notably, acute risk LOC exceedances for mammals are not indicated for any use based on mean Kenega residue values.

Chronic risk to mammals from triclopyr BEE is identified for all modeled uses for dose-based RQs and for all but the turf use for diet-based RQs. The chronic, diet-based RQs for mammals are sensitive to use of upper-bound Kenega values whereas, the dose-based chronic RQs are not sensitive to the choice of mean vs. upper bound values.

10 Terrestrial Invertebrate Risk Assessment

10.1 Bee Exposure Assessment

For agricultural uses, the primary source of information used to determine the potential exposure of bees to contaminated nectar and pollen is USDA's *Attractiveness of Agricultural Crops to Pollinating Bees for the Collection of Nectar and/or Pollen*[22]. Rice is primarily wind pollinated and not attractive to pollinators. However, most uses of triclopyr active ingredients involve non-crop areas which are not represented in USDA's crop attractiveness document. Potential exposure of bees via the turf uses depends on the use area, where residential turf is presumed to contain blooming weeds; whereas, commercial turf (sod farms) is generally presumed to be devoid of blooming weeds. For forestry, campground areas, recreational sites,

22 https://www.usda.gov/oce/opmp/Attractiveness%20of%20Agriculture%20Crops%20to%20Pollinating%20Bees%20Report-FINAL_Web%20Version_Jan%203_2018.pdf

range and pasture lands, and rights-of-way, it is presumed that these areas could contain flowering plants that are attractive to *Apis* and non-*Apis* bees (which is supported by further discussion below). Flowering ornamentals near turf or lawn use sites and wild flowers in pastures, rangeland and rights of way could provide potential locations for direct contact from spray drift if pollinators are visiting during the period of application[23,24]. Certain triclopyr labels specify that drift to flowers should be avoided while others do not mention such precautions.

A summary of the potential exposure of bees to triclopyr active ingredients via their registered uses is provide in **Table 10-1.**

Table 10-1. Summary of Information on the Attractiveness of Registered Non-Crop Use Patterns for Triclopyr Active Ingredients to Honey Bees (*Apis mellifera*), Bumble Bees (*Bombus spp*) and Non-*Apis* solitary bees. (source: USDA Crop Attractiveness to Pollinators; USDA 2018)

Use Area	**Honey Bee Attractive?[1,2]**	**Bumble Bee Attractive?[1, 2]**	**Solitary Bee Attractive?[1, 2]**	**Notes**
Rice	N (nectar and pollen)			Wind pollinated
Citrus, Apple, orchards (tree injection)	Yes (pollen and nectar)	Y	Y	May use managed pollinator services. Honey specifically from citrus trees (orange blossom) requires use of pollination services.
Rangeland/Pastures	Attractiveness not specified but assumed to be attractive based on potential presence of flowering plants and weeds in these use areas			
Utility Right of Way, fence line, railroad and roadside uses				
Forestry, Park and Campsite use				
Ornamental Flowering Plants				
Aquatic Shorelines				
Residential and Commercial Turf Golf course uses	Commercial turf (sod) not assumed to be pollinator attractive due to presumed control of flowering weeds; residential turf assumed not be attractive if weeds are similarly controlled, but may be potentially attractive if not.			

[1]Attractiveness rating is a single "+", denoting a use pattern is opportunistically attractive to bees.
[2] Attractiveness rating is a double "++" denoting a use pattern is attractive in all cases

10.2 Bee Tier I Exposure Estimates

Contact and dietary exposure are estimated separately using different approaches specific for different application methods. The Bee-REX model (Version 1.0) calculates default (*i.e.*, high end, yet reasonably conservative) EECs for contact and dietary routes of exposure for foliar, soil, and seed treatment applications. See **Appendix E** for a sample output from Bee-REX for

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[23] https://rangelands.org/pollinators-on-the-rangeland/
[24] https://royalsocietypublishing.org/doi/full/10.1098/rspb.2017.2140

triclopyr acid. Additional information on bee-related exposure estimates, and the calculation of risk estimates in Bee-REX can be found in the USEPA et al. 2014 document: *Guidance for Assessing Pesticide Risks to Bees*[25] Based on this risk assessment guidance, the Tier 1 acute and chronic risk LOCs for pollinator insects are 0.4 and 1.0, respectively. Furthermore, the European honey bee, *A. mellifera*, is considered a surrogate test species for representation of other non-*Apis* bee species if no other species data are available. In cases where the Tier I RQs exceed levels of concern, estimates of exposure may be refined using measured pesticide concentrations in pollen and nectar of treated crops (provided measured residue data are available), and further calculated for other castes of bees using their food consumption rates as summarized in the White Paper to support the FIFRA Scientific Advisory Panel (SAP) on the pollinator risk assessment process (USEPA, 2012c). If the refined Tier 1 RQ values exceed levels of concern, then risks may be evaluated at the colony level using Tier II (semi-field) and/or Tier 3 (full-field) studies. However, with triclopyr, higher-tier effects (colony-level) and exposure (residue) data are have not been submitted.

10.3 Bee Risk Characterization (Tier I)

10.3.1 Tier I Risk Estimation (Contact Exposure)

On-Field Risk

Since an exposure potential to bees is identified for many non-crop uses of triclopyr active ingredient products, the next step in the risk assessment process is to conduct a Tier I risk assessment. By design, the Tier I assessment begins with (high-end) model-generated (foliar and soil treatments) or default (seed treatments-not applicable for triclopyr). Estimates of exposure via contact and oral routes are assessed. For contact exposure, only the adult (forager and drones) life stage is considered since this is the relevant life stage for honey bees (*i.e.*, since other bees remain primarily in the hive, the presumption is that they would not be subject to contact exposure). Furthermore, acute toxicity testing protocols have been developed only for contact exposures. Effects are defined by laboratory exposures to groups of individual honey bees (which serve as surrogates for solitary non-*Apis* bees and individual social non-*Apis* bees).

With triclopyr ACID and BEE, acute contact LD_{50} values are both "non-definitive" >100 µg ai/bee (practically non-toxic) due to lack of effects at the highest test dose. Therefore, definitive acute RQ values cannot be calculated. As a proxy, the highest test dose is used in the RQ calculation and a "<" sign is assigned to the resulting RQ to indicate that the actual RQ would be lower than this value. This approach provides an the upper bound of the potential RQ value which is useful

[25] USEPA, Health Canada PMRA, & California Department of Pesticide Regulation. 2014. Guidance for Assessing Pesticide Risks to Bees. June 23, 2014. U.S. Environmental Protection Agency. Health Canada Pest Management Regulatory Agency. California Department of Pesticide Regulation. Available at http://www2.epa.gov/pollinator-protection/pollinator-risk-assessment-guidance.

when this "non-definitive" RQ is less than the LOC. When the non-definitive RQ exceeds the LOC, then the potential for risk is not known.

Based on acute contact data and expected exposure to adult honey bees, RQs range from < 0.1 to < 0.24 for triclopyr ACID and BEE products (**Table 10-2**). Although the exact value of the acute contact RQs are not known due to the non-definitive LD_{50} endpoints, acute contact risks of concern are not evident for any registered use of triclopyr since the non-definitive RQ values are all below the acute risk LOC of 0.4.

Table 10-2. Tier I Adult, Acute Contact Risk Quotients (RQs) for Triclopyr ACID and BEE Honey Bees (*Apis mellifera*) Foraging on Flowering Plants in Treatment Areas from Bee-REX (ver. 1.0)

Use Pattern	Bee Attractiveness	Max. Single Application Rate in lb ae/A	Total Dose (µg a.i./bee per 1 lb a.e./A)	Triclopyr acid Contact Dose (µg a.i./bee) Worker/Drone	Acute Contact RQ[1] Worker/Drone
Turf areas	Potential	4.0	2.7	10.8	<0.11
Forestry, Parks, Campgrounds	Yes	6.0	2.7	16.2	<0.16
Pasture/rangeland	Yes	9.0	2.7	24.3	<0.24

[1] Based on 48-h acute contact LD_{50} values of >100 µg a.i./bee for triclopyr ACID and BEE (MRID 40356602; 41219109). An LD_{50} value of 100 µg/bee was used as a proxy to calculate upper-bound (<) RQ values.

10.3.2 Tier I Risk Estimation (Oral Exposure)

The acute oral LD_{50} value for triclopyr ACID is >100 µg ai/bee (practically non-toxic) due to lack of effects at the highest test dose. Based on estimated acute oral exposure levels from single application rates of 4.0 to 9.0 lbs ai/A, RQs range from <0.32 to <2.9 for adult nectar foragers (**Table 10-3**). Therefore, it can be concluded that triclopyr ACID uses on residential turf do not exceed the acute risk LOC of 0.4. However, for uses on forestry/parks/campground and pastures/ rangelands, it is not known if the acute risk LOC of 0.4 is exceeded due to non-definitive endpoint. Also, no toxicity data were available to assess the acute oral toxicity of triclopyr products to larval honey bees. On a chronic oral exposure basis, RQs range from 2.3 to 20 for adult nectar-foragers and from 23 to 211 for larval worker honey bees.   Based on these analyses, acute oral RQs generated for triclopyr uses of 6.0 to 9.0 lbs ai/A have a potential to exceed the acute risk LOC for adult foragers, but the actual acute risk is considered uncertain. There are chronic risks of concern   for triclopyr uses for rates from 4.0-9.0 lb ai/A are indicated for both adult foragers and larval bees.

Table 10-3. Tier I (Default) Oral Risk Quotients (RQs) for Triclopyr ACID with Adult Nectar Forager and Larval Worker Honey Bees from Bee-REX (ver. 1.0)

Use Pattern	Max. Single Appl. Rate	Bee Caste/Task	5 Day Oral Dose (µg a.i./bee)	Acute Oral RQ[1,2]	Chronic Oral RQ[3]
Residential Turf areas	4.0	Adult nectar forager	128.5	<0.32	**2.3**
		Larval worker	54.4		**23**

Use Pattern	Max. Single Appl. Rate	Bee Caste/Task	5 Day Oral Dose (μg a.i./bee)	Acute Oral RQ[1,2]	Chronic Oral RQ[3]
Forestry, Parks, campground areas	6.0	Adult nectar forager	192.7	**<2.0**	**13**
		Larval worker	81.6		**141**
Pastures and rangeland, Utility and Road Right of Ways	9.0	Adult nectar forager	289.1	**<2.9**	**20**
		Larval worker	122.4		**211**

[1] Based on a 48-h acute oral LD_{50} of >99 μg a.i./bee for adults (MRID 49992409). No data for 7-d LD_{50} for larvae have been submitted.
[2] **Bolded** RQ value exceeds (or potentially exceeds) the acute risk LOC of 0.4 or chronic LOC of 1.0.
[3] Based on a 10-d chronic NOAEL of 14.3 μg a.i./bee/d for adult bees (MRID 50673903) and a 22-d chronic NOAEL of 0.58 μg a.i./bee/d for larvae (MRID 50673902).

It is further noted that the risks identified above for adult nectar forager and larval worker bees also extend to the nurse bee caste, with acute RQs ranging from 0.66 to 1.5 and chronic RQs ranging from 2.9 to 6.6 based on results from this caste from Bee-REX.

Off-Field Risk

In addition to bees foraging on the treated areas, bees may also be foraging areas adjacent to the treated application area in turf, rights-of-way or pasture/grassland areas. Aerial application of triclopyr to rice, forest lands and open range or pastureland is expected to provide potential for drift to non-target areas where pollinator insects may be foraging.

10.3.3 Bee Risk Characterization (Tier II) Bee Risk Characterization (Tier III)

No higher-tier, colony-level data at the semi-field (Tier II) and full field (Tier III) levels have been submitted to further characterize the risk concerns identified for triclopyr and honey bees at the Tier I level.

10.3.4 Bee Risk Characterization

The full battery of Tier I honey bee studies is available for triclopyr acid, with the exception of the acute study with larval honey bees. Based on the Tier I assessment, none of the registered uses of triclopyr active ingredients result in acute contact risks to honey bees. Similarly, acute oral risks to adult honey bees are not indicated with residential turf use. However, acute oral risks via the forestry and rangeland uses are considered uncertain because the resulting EECs exceed the non-definitive toxicity endpoint (LD_{50} >99 μg ai/bee.

Unlike acute risks, chronic oral risks to honey bees are indicated for all registered uses of triclopyr active ingredients at the Tier 1 (individual bee) level. Chronic effects observed in these studies at the LOAEL include decreased food consumption (adults) and decreased emergence (larvae). Notably, estimated exposures to adult and larval bees exceed the LOAELs from these studies which increases the potential for risk. Since the honey bee is used as a surrogate for non-*Apis* bees, these chronic risks extend to non-*Apis* bees as well. It is important to note that these Tier 1 oral risks are based on default (high-end) estimates of triclopyr in pollen and nectar. Field residue studies involving blooming weeds (*e.g.*, clover/turf) would be useful to refine these estimates of acute and chronic oral risk to bees.

Chronic risk above the LOC was indicated for adult and larval honey bees. Using the AgDrift model, distances of that risk extending off the field were estimated based on the default drift fraction assumptions, application rate, and toxicity endpoints (**Table 10-4**). For the adult chronic oral honey bee analysis, distances the risk would extend off field ranged form 7 - 184 feet, depending on the use pattern and its associated application rate. For larvae, the distance was 220 from residential turf areas, and greater than 1000 feet (upper limit of the model) for forestry, parks, campgrounds, pastures, rangelands, and rights-of-way areas.

Table 10-4. AgDrift analysis of off-field distances to adult and larval honey bees.

Aerial Applications[1]			
Chemical	**Application Rate**	**Adult Chronic Oral Distance in feet (fraction applied)**	**Larvae Chronic Oral Distance in feet (fraction applied)[2]**
Residental Turf	4	7 (0.435)	220 (0.043)
Forestry, Parks, Campground Areas	6	122 (0.077)	>1000 (0.007)
Pastures and rangeland, Utility and Road Right of Ways	9	184 (0.05)	>1000 (0.005)

[1] ASAE Droplet size fine to medium (default assumption)
[2] Fraction Applied = LOC/RQ to determine what fraction of the application rate would not result in an LOC exceedance.

Regarding other lines of evidence, one ecological incident involving bees (I028969) was reported for Garlon™ 4 Ultra (Triclopyr BEE) in which a spoil island (Travatine Island) was treated with Garlon™ 4 and Impel™ Red (a surfactant) on Jan. 20 to Feb. 1, 2016. A beekeeper in Pinellas County, Florida, reported that bees started walking away from the hives in a disoriented manner, unable to fly although no wing or other observed deformities were noted. The beekeeper noted the loss of six of the eleven hives. Following an investigation, the most likely cause was determined to be the use Garlon™ 4 and Impel™ Red on over 12 acres of land that was half a mile from the apiary. It was noted in the report that the bees did not produce young; however, no residue analysis in hive matrices (pollen, nectar, bee bread) was performed to confirm presence of triclopyr or its degradate, TCP. It is unknown whether triclopyr residues were systemically transported within the plant to the pollen and nectar within the plants or whether effects were associated with triclopyr or the Impel™ Red surfactant.

10.4 Other Terrestrial Invertebrates

No data on non-*Apis* pollinator species have been submitted for triclopyr acid, TEA or BEE. However, as noted above, the honey bee serves as a surrogate for other *Apis* and non-*Apis* species of bees. Therefore, the Tier I analysis indicating adult and larval chronic RQ values above the chronic risk LOC for all registered use patterns of triclopyr that are considered to be potentially attractive, applies to individual bees of all other species.

11 Terrestrial Plant Risk Assessment

Triclopyr is registered as an herbicide for broadleaf weed and woody plants control, and as such, toxicity to terrestrial plants is anticipated. Current label precautions include warnings about off-target drift to non-target vegetation or adjacent crops.

11.1 Terrestrial Plant Exposure Assessment

The EECs for terrestrial plants are calculated using TERRPLANT v.1.2.2. Exposure is estimated for a single application that evaluates exposure via spray drift and runoff. In the RQ table, the runoff RQs for dryland and semi-aquatic areas are based on the summation of the exposure from drift and runoff. Additionally, the spray drift RQs are based residues from spray drift alone. It is important to note that for spray drift, the TERRPLANT exposure estimate corresponds to an equivalent AgDrift™ estimated deposition for fine-medium droplets at approximately 200 feet from the edge of the treated field. For runoff, there are a few assumptions regarding the ratio of treated area to receiving non-target area that have an impact on the exposure estimation. In a dry area adjacent to the treatment area, exposure is estimated as sheet runoff. Sheet runoff is the amount of pesticide in water that runs off of the soil surface of a target area of land that is equal in size to the non-target area (1:1 ratio of areas). This differs for semi-aquatic areas, where runoff exposure is estimated as channel runoff. Channel runoff is the amount of pesticide that runs off of a target area 10 times the size of the non-target area (10:1 ratio of areas).

The EECs used to assess risks to terrestrial plants are based on the maximum single application rate for terrestrial uses, solubility, and spray drift fraction. The EECs represent residues from off-site exposure via spray drift and/or run-off to non-target plants found near application sites.

Currently, only triclopyr TEA and triclopyr BEE have available terrestrial plant toxicity data. Although the uses of TEA and BEE are similar in terms of application rate and use site (except for rice), the EECs were modeled separately due to differences in solubility for TEA (440 ppm) and BEE (7.4 ppm) and this effect on the resulting terrestrial plant EECs. As was the case with aquatic taxa and other terrestrial taxa, TEA is assumed to convert rapidly (less than one minute) to ACID, and therefore the EECs summarized in **Table 11-1**, refer to ACID, regardless of whether triclopyr is applied as the ACID or TEA while those in **Table 11-2** pertain to BEE.

Table 11-1. TerrPlant Calculated Estimated Environmental Concentrations (EECs) for Terrestrial and Semi-Aquatic Plants near Triclopyr ACID, TEA, and COLN Use Areas

Use Site	Single Max. Application Rate (lb a.i./A)	EECs (lb a.e./A)[1]					
		Ground[2]			Aerial[3]		
		Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift	Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift
Rice	0.375	0.02	0.19	0.004	0.04	0.21	0.02
Residential and Commercial Turf; Golf course uses	1.0	0.05	0.5	0.01	0.1	0.55	0.05
Forestry, Park and Campsite use; aquatic shoreline vegetation control; and X-mass Trees (ground only)	6.0	0.3	3.1	0.06	0.6	3.3	0.3
Utility Rights-of-Way, fence line, railroad and roadside uses; Rangeland/Pasture	9.0	0.54	4.6	0.09	0.9	5.0	0.45

[1] Based on solubility in water of 440 ppm for the acid
[2] Based on a drift fraction of 1% (*i.e*., 0.01). for ground applications flowable solutions of triclopyr ACID and TEA
[3] Based on a drift fraction of 5% (*i.e*., 0.05). for aerial applications of flowable solutions of triclopyr ACID and TEA

Table 11-2. TerrPlant Calculated Estimated Environmental Concentrations (EECs) for Terrestrial and Semi-Aquatic Plants near Triclopyr BEE Terrestrial Use Areas

Use Site	Single Max. Application Rate (lb a.i./A)	EECs (lb a.i./A)[1]					
		Ground[2]			Aerial[3]		
		Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift	Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift
Residential and Commercial Turf; Golf course uses	1.0	0.02	0.11	0.01	0.06	0.15	0.05
Forestry, Park and Campsite use; aquatic shoreline vegetation control; and X-mass Trees (ground only)	6.0	0.12	0.66	0.06	0.36	0.9	0.3
Utility Rights-of-Way, fence line, railroad and roadside uses; Rangeland/Pasture	9.0	0.18	0.99	0.09	0.54	1.4	0.45

[1] Based on solubility in water of 7.4 ppm for BEE
[2] Based on a drift fraction of 1% (*i.e*., 0.01). for ground applications flowable solutions of BEE
[3] Based on a drift fraction of 5% (*i.e*., 0.05). for aerial applications of flowable solutions of BEE

11.2 Terrestrial Plant Risk Characterization

Exposures from runoff and spray drift are compared to measures of survival and growth (*e.g.*, effects to seedling emergence and vegetative vigor) to estimate RQ values. The resulting upper-bound exposure estimates to terrestrial and semi-aquatic (wetland) plants adjacent to the treated field are expressed in lbs ai/A.

The available toxicity data for TEA and BEE products on terrestrial plants indicate greater sensitivity for dicots relative to monocots by at least one order of magnitude, as well as increased sensitivity of plants through the vegetative vigor design relative to the seedling emergence. Triclopyr BEE demonstrated increased toxicity by at least one order of magnitude relative to TEA in the seedling emergence design. This was finding was less pronounced when comparing the two active ingredients in the vegetative vigor design. Across all active ingredients, designs, and types of species (*i.e.* monocot or dicot), the most common significant effects observed were related to growth (*i.e.* inhibited plant shoot length and weight).

A summary of the RQs associated with the registered uses for ACID and TEA for terrestrial plants is provided in **Table 11-3**. Non-definitive endpoints for both monocots and dicots in the seedling emergence study precluded the estimation of RQs for Dry and Semi-Aquatic areas. The EC_{25} values in the TEA seedling emergence study were >0.33 and >1 lbs a.e/A for monocots and dicots, respectively. Although RQs were not estimated, single application rates for the registered use patterns of ACID and TEA range from 0.375 - 9 lbs a.e/A. Therefore, it is uncertain as to the potential for adverse impacts to non-target plants at these rates. The TEA vegetative vigor study determined EC_{25} values of 0.119 and 0.0054 lbs a.e/A, respectively based on effects to shoot length for monocots and dicots, respectively. The RQs associated with spray drift exposure only, range from 0.16 - 83. Dicots were more sensitive relative to monocot and were associated with RQs that exceeded the LOC for all registered uses. For monocots, RQ range from 1.8 to 2.7 with the uses of 6 lbs a.i/A and higher.

Species and toxicity values used for monocot was corn with an EC_{25} of >0.238 lb a.e/A and >0.715 lb a.e/A for all species of dicots tested in the seedling emergence study. The monocot and dicot NOAELs from this study are 0.238 and 0.715 lb a.e/A, respectively. For vegetative vigor the most sensitive monocot was onion with EC_{25} of 0.119 lbs a.e/A, and the most sensitive dicot was sunflower with an EC_{25} of 0.0054 lb a.e/A. Values for vegetative vigor were much lower than endpoints for seedling emergence using the same test material. This could be due to the way in which the product is applied and adsorbed systemically into plant tissues.

Table 11-3. Terrestrial Plant Risk Quotients (RQs) for Triclopyr ACID, TEA, and COLN Use Areas

Type of Plant	Ground Spray RQs			Aerial Spray RQs		
	Dry Areas	Semi-Aquatic Areas	Spray Drift Only	Dry Areas	Semi-Aquatic Areas	Spray Drift Only
Rice uses at 0.375 lb a.e/A - Ground or aerial application						
Monocot	NC	NC	<0.1	NC	NC	0.16
Dicot	NC	NC	0.69	NC	NC	**3.5**

Type of Plant	Ground Spray RQs			Aerial Spray RQs		
	Dry Areas	Semi-Aquatic Areas	Spray Drift Only	Dry Areas	Semi-Aquatic Areas	Spray Drift Only
Residential and Commercial Turf Golf course uses – 1 ground or aerial application at 1.0 lb a.e./A						
Monocot	NC	NC	<0.1	NC	NC	0.42
Dicot	NC	NC	**1.85**	NC	NC	**9.3**
Forestry, Park and Campsite use - 1 ground or aerial application at 6.0 lbs a.e./A						
Monocot	NC	NC	0.50	NC	NC	**2.5**
Dicot	NC	NC	**11**	NC	NC	**55**
Rangeland/Pastures/Utility Right of Way/fence line/ railway/roadside uses - 1 ground or aerial application at 9 lbs a.e/A						
Monocot	NC	NC	0.76	NC	NC	**3.8**
Dicot	NC	NC	**17**	NC	NC	**83**

NC = Not calculated
Bolded RQ values exceed the risk to plant level of concern (LOC) of 1.0.

An AgDrift analysis was conducted to evaluate the potential risk off the treated field to triclopyr ACID, TEA, and COLN use areas (**Table 11-4**). For monocot species, distances ranged for aerial applications from 463 to 801 feet off the treated field, depending on the use pattern. For dicot species, distances ranged from 191 to greater than 100 feet (upper limit of the model), depending on the application rate that is associated with the use area for ground applications. These distances ranged from 699 to greater than 1000 feet for aerial applications. It is noted that for the forestry uses, higher tiers of the model with varying assumptions could be explored to investigate the level of impact these parameters would have on a spray drift distance.

Table 11-4. Spray drift distances off the field for Triclopyr ACID, TEA, and COLN uses areas

Use Area	Application Rate	Distance off the treated field in feet			
		Monocot		Dicot	
		Ground	Aerial	Ground	Aerial
Rice	0.375	NC	NC	NC	699
Residential Turf/Golf Course	1	NC	NC	191	>1000
Forestry, Parks, Campground Areas	6	NC	463	>1000	
Pastures and rangeland, Utility and Road Right of Ways	9	NC	801		

NC: Not calculated
A: ASAE fine to medium droplet size
G: Low boom, ASAE very fine to fine; EC25 Monocots: 0.119 lb a.e./A; Dicots 0.0054 lb a.e./A
Acid rates/endpoints in terms of a.e.

Terrestrial plant data for BEE generally demonstrated greater toxicity to monocot and dicots species relative to the TEA. Definitive EC_{25} values were achieved in both the seedling emergence and vegetative vigor that allowed for the risk estimation of all areas evaluated within TerrPlant. As previously noted, the BEE products do not have registrations on rice, as well as being associated with a lower solubility relative to TEA.

Table 11-5 summarizes the RQs associated with the BEE use areas. The RQs for all areas and use sites were generally higher for dicot species relative to monocot, and for ground sprays, were highest for semi-aquatic areas (RQs range from **1.5** to **22**) relative to sprays drift only RQs, which were highest for aerial sprays (RQs range from **0.14** to **51**). There were RQs that exceeded the LOC for one or more types of RQs for monocots and dicots for all registered uses of BEE.

Table 11-5. Terrestrial Plant RQs for Triclopyr BEE use areas

Type of Plant	Ground Spray RQs			Aerial Spray RQs		
	Dry Areas	Semi-Aquatic Areas	Spray Drift Only	Dry Areas	Semi-Aquatic Areas	Spray Drift Only
Residential and Commercial Turf Golf course uses – 1 ground or aerial application at 1.0 lb ai/A						
Monocot	0.27	**1.5**	0.14	0.82	**2.1**	0.68
Dicot	0.32	**1.8**	**1.1**	0.97	**2.4**	**5.6**
Forestry, Park and Campsite use - 1 ground or aerial application at 6.0 lbs ai/A						
Monocot	**1.6**	**9.0**	**0.82**	4.9	**12**	**4.1**
Dicot	**1.9**	**11**	**6.7**	5.8	**15**	**34**
Rangeland/Pastures/Utility Right of Way/fence line/ railway/roadside uses - 1 ground or aerial application at 9 lbs a.i/A						
Monocot	**2.5**	**14**	**1.2**	**7.4**	**18**	**6.2**
Dicot	**2.9**	**16**	**10**	**8.7**	**22**	**51**

NC = Not calculated
Bolded RQ values exceed the risk to terrestrial plant level of concern (LOC) of 1.0.

An AgDrift analysis was conducted to evaluate the potential risk off the treated field to triclopyr BEE use areas (**Table 11-6**). For monocot species, distances ranged for ground applications from 14 - 63 feet off the treated field, depending on the use pattern. For aerial applications these distances ranged from 112 to greater than 1000 feet. For dicots, that were notably more sensitive, the ranges from ground applications ranged from 109 to 978 feet of the treated field and were greater than 1000 feet for all registered use patterns. It is noted that for the forestry uses, higher tiers of the model with varying assumptions could be explored to investigate the level of impact these parameters would have on a spray drift distance.

Table 11-6. Spray drift distances off the field for Triclopyr BEE uses areas

Use Area	Application Rate	Distance off the treated field in feet			
		Monocot		Dicot	
		Ground	Aerial	Ground	Aerial
Residential Turf/Golf Course	1	14	112	109	>1000
Forestry, Parks, Campground Areas	6	63	680	689	
Pastures and rangeland, Utility and Road Right of Ways	9	99	>1000	978	

A: ASAE fine to medium droplet size
G: Low boom, ASAE very fine to fine; EC25 Monocots: 0.088 lb a.i./A; Dicots 0.0089 lb a.i./A
BEE rates/endpoints are in terms of a.i.

Based on the risk estimation of triclopyr TEA and BEE, RQs for both monocots and dicots exceeded the LOC for all use areas of both active ingredients (for TEA and monocot risk, this finding was only for spray drift RQs). This finding is consistent with triclopyr's use as an herbicide for broadleaf weed control. Additionally, several dozen terrestrial plant and crop damage incidents have been reported to the Agency that originate from legal uses of these products.

12 Final Conclusions

Triclopyr ACID, TEA, COLN and BEE were analyzed under current risk assessment methodology utilizing a range of registered use patterns and application rate scenarios for rice and the many non-crop uses. Ecological risks were assessed separately for the ACID, TEA, COLN active ingredients and the BEE active ingredient. This analysis has concluded that acute and chronic risk levels of concern are exceeded for terrestrial and aquatic taxa as summarized previously in **Table 1-1**. Monitoring data for triclopyr ACID in aquatic systems, however, indicate detected concentrations are 2 to 4 orders of magnitude below acute and chronic risk levels of concern. High application rates were generally responsible for acute risk LOC exceedances that did occur, even though acute toxicity endpoints indicated that triclopyr was practically non-toxic to moderately toxic for most species. The exception was for triclopyr BEE which was highly toxic to aquatic organisms on an acute exposure basis.

12.1.1 Triclopyr ACID, TEA, COLN

Aquatic ecological risks were assessed for the ACID, TEA, COLN active ingredients based on two approaches: (1) Total Residue (TR) method to estimate exposure via all residues of concern (ROC) which assumes equal toxicity among the parent (triclopyr ACID) and degradates (TCP + 3,6-DCP + 5-CLP + 6-CLP degradates); and (2) the Formation/Decline method which considers the TCP-specific chemical properties and toxicity. For the triclopyr BEE active ingredient, the Formation/Decline method was used to estimate exposure as represented by triclopyr BEE, ACID and the TCP degradate. Registered uses that were assessed include rice, aquatic weed control, citrus, forestry, range/pasture land, meadows, rights-of-way, turf and Christmas trees.

This analysis indicates that acute and chronic risk levels of concern (LOCs) are exceeded for terrestrial and aquatic taxa as summarized in **Table 1-1** below. For the ACID/TEA/COLN active ingredients, the highest rates of application were generally responsible for acute risk LOC exceedances that did occur. The exception was for triclopyr BEE which is classified as highly toxic to aquatic organisms on an acute exposure basis.

12.1.2 Triclopyr ACID, TEA, COLN

For the triclopyr ACID, TEA and COLN, no acute or chronic risks are identified for aquatic animals for any of the proposed uses based on the ROC using the TR method. However, chronic risks to freshwater fish and invertebrates are indicated with the 2,500 ppb and 5,000 ppb aquatic weed control use based on the formation of TCP (determined by the F/D method). The

TCP degradate is several orders of magnitude more chronically toxic compared to triclopyr ACID or TEA. For aquatic plants, no risk is identified for vascular plants based on the ROC or TCP degradate. However, risk to non-vascular plants is indicated for the maximum (5000 ppb) aquatic weed control use. Monitoring data indicate maximum detected levels of triclopyr ACID are several orders of magnitude below toxicity endpoints for the most sensitive tested species.

There are no acute risks of concern for birds and mammals from registered uses of triclopyr ACID/TEA/COLN for the rice and turf uses which have application rates of 0.375 and 1 lb a.e./A, respectively). For the forest/campground and range/pasture land/rights-of-way uses, acute risks of concern occur due to their higher application rates (6 and 9 lb a.e./A, respectively) compared to the rice and turf uses. There are chronic risks of concern for birds via foraging on at least one dietary item for all four use patterns assessed. For the turf, forestry/campground and pasture/rangeland uses, the dietary-based EECs exceed the avian lowest observed adverse effect concentration (LOAEC) of 200 mg a.e./kg-diet at which there was a 14% reduction in the number of 14-day old survivors. Similarly, chronic risks of concern for mammals are identified among all four use patterns. Chronic risks associated with the rice use are sensitive to the use of upper bound vs. mean Kenega exposure values. Furthermore, the large gap between the mammalian no observed adverse effect level (NOAEL) of 25 mg/kg-bw/d and the LOAEL (250 mg/kg-bw/d based on 28%-39% reductions in litter size) introduces additional uncertainty in the interpretation of chronic risks; except for forestry/campground and range/pasture land uses, whereby the EECs exceed the LOAEC.

For bees, the acute contact-based risk estimates are below the acute risk LOC of 0.4 for all of the registered uses of triclopyr ACID/TEA/COLN active ingredients. However, acute oral exposure to adult forager bees estimated with the forestry/campground and pasture/rangeland uses exceeds the highest concentration tested in the acute oral toxicity test which failed to produce an LD_{50} due to lack of mortality. Therefore, acute oral risk to adult honey bees is considered uncertain for these uses due to the non-definitive toxicity values. Notably, chronic risks of concern to adult and larval bees are indicated for all triclopyr ACID/TEA/COLN use patterns; notably however, these are based on default estimates of residues in pollen and nectar and could not be refined due to lack of measured residue data and/or colony-level toxicity studies.

Risks to terrestrial plants are identified from aerial spray applications of triclopyr ACID, TEA, or COLN across all of the use patterns assessed. Due to the lack of a definitive toxicity endpoint from the seedling emergence study with TEA, risks associated with applications to dry and semi-aquatic areas could not be assessed. Numerous ecological incidents associated with terrestrial plants have been reported in association with the use of triclopyr active ingredients.

12.1.3 Triclopyr BEE

On an acute exposure basis, triclopyr BEE is consistently 2 to 3 orders of magnitude more toxic to aquatic animals compared to triclopyr ACID or TEA, with LC_{50} values ranging from 0.35 to 0.46 mg a.i./L. The chronic toxicity of triclopyr BEE is also several orders of magnitude greater than triclopyr ACID or TEA. However, triclopyr BEE is much less persistent than triclopyr ACID due to its rapid transformation to triclopyr ACID and results in lower aquatic EECs.

For aquatic animals, there acute risk concerns are indicated for freshwater and estuarine/marine fish with the assessed uses of triclopyr BEE when considering the parent (BEE) active ingredient but no chronic risk concerns are evident. For aquatic invertebrates, there are acute and chronic risks of concern for the range/pasture land and meadow uses which have the highest application rates of 6 and 9 lb a.i./A, respectively. Chronic risk concerns to estuarine/marine invertebrates are indicted for uses on citrus, range/pasture land, and meadows. There are no risks of concern for sediment-dwelling invertebrates exposed to triclopyr BEE via pore water. Risks to vascular aquatic plants is not indicated for triclopyr BEE, but risks to non-vascular plants are identified for citrus, range/pasture land, and meadows. Formation of triclopyr ACID or TCP from triclopyr BEE did not result in any acute or chronic risk concerns to aquatic organisms.

There are acute risks of concern for birds among all modeled use patterns due to the greater acute toxicity of triclopyr BEE to birds compared to ACID/TEA. Chronic risks to birds could not be assessed due to lack of data for triclopyr BEE. Chronic risks to mammals are indicated for all assessed uses for multiple size classes and dietary items. In most cases, these risks estimates are not sensitive to the use of mean vs. upper-bound Kenega residue values.

There are no acute risks of concern for bees since triclopyr BEE is practically non-toxic to bees on an acute contact basis. No other bee toxicity data were submitted for triclopyr BEE. However, the triclopyr BEE is expected to degrade relatively quickly to the ACID form based on submitted environmental fate data. Therefore, since there are chronic risks of concern for both adult and larval bees from the ACID, these risks would presumably extend to BEE which is serving as a source of the ACID.

The assessed uses of BEE present risks to terrestrial monocotyledonous (monocot) and dicotyledonous (dicot) plants involving multiple use areas from both ground and aerial applications. Reported ecological incidents for triclopyr BEE involving terrestrial plants represent a line of evidence supporting the risk findings for terrestrial plants.

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161-1 Hydrolysis

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161-2 Photodegradation-water

MRID	Citation Reference
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161-3 Photodegradation-soil

MRID	Citation Reference
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162-1 Aerobic soil metabolism

MRID	Citation Reference
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162-2 Anaerobic soil metab.

MRID	Citation Reference
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162-3 Anaerobic aquatic metabolism

MRID	Citation Reference
43837502	Wolt, J. (1995) Anaerobic Aquatic Metabolism of (carbon 14)-Triethylamine: Lab Project Number: ENV94086. Unpublished study prepared by DowElanco’s North American Environmental Chemistry Lab. 102 p.
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162-4 Aerobic aquatic metabolism

MRID	Citation Reference
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MRID	Citation Reference
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MRID	Citation Reference
42730601	Buttler, I.; Roberts, L.; Siders, L.; et al. (1993) Non-Crop Right-of-Way Terrestrial Dissipation of Triclopyr in California: Lab Project Number: ENV91019. Unpublished study prepared by DowElanco and A&L Great Lakes Labs. 228 p.
43033401	Petty, D.; Gardner, R. (1993) Right-Of-Way Terrestrial Dissipation of Triclopyr in North Carolina: Lab Project Number: ENV92049. Unpublished study prepared by DowElanco Chemistry Lab. 125 p.
43955901	Poletika, N.; Phillips, A. (1996) Field Dissipation of Triclopyr in Southern U.S. Rice Culture: Lab Project Number: ENV94015. Unpublished study prepared by A&L Great Lakes Laboratories, Inc.; North American Environmental Chemistry Laboratory, DowElanco; and Mid-South Weed Scientists, Inc. 429 p.

164-2 Aquatic field dissipation

MRID	Citation Reference
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MRID	Citation Reference
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164-3 Forest field dissipation

MRID	Citation Reference
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165-4 Bioaccumulation in fish

MRID	Citation Reference
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42493901	Racke, K.; Lubinski, R. (1992) Sorption of 3,5,6-Trichloro-2-Pyridinol in Four Soils: Lab Project Number: ENV91081. Unpublished study prepared by DowElnco. 44 p. (Submitted to PC Code 059101 (chlorpyrifos) and PC Code 206900 (2(1H)-pyridinon, 3,5,6-trichloro))

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71-1 850.2100 Avian Single Dose Oral Toxicity

MRID	Citation Reference
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	TEA Salt studies
134178	Fink, R.; Beavers, J.; Brown, R. (1978) Acute Oral LD50--Mallard Duck: Triclopyr-ethylene Glycol Butyl Ether Ester: Project No. 103-175. Final rept. (Unpublished study received Nov 13, 1979 under 464-554; prepared by Wildlife International Ltd. and Washington College, submitted by Dow Chemical U.S.A., Midland, MI; CDL:241360-B) PDF 2045559
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	Triclopyr BEE Studies
41902001	Ormand, J.; Bell, C. (1991) Triclopyr Bee: Stability in Prepared Game Bird Starter Ration: Lab Project Number: ES-DR-0133-7242-6. Unpublished study prepared by Dow Chemical Co. 14 p. **Stability in feed see 4192002-2003**
41902002	Campbell,S.; Lynn,S. (1991) Triclopyr Bee: An Acute Oral Toxicity Study With the Northern Bobwhite: Lab Project Number: ES-DR- 0133-7242-9. Unpublished study prepared by Dow Chemical Co. 25 p. 2022125
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71-2 850.2200 Avian Dietary Toxicity

MRID	Citation Reference
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50115901 Protocol	Hubbard, P. (2016) Triclopyr Acid: A Dietary LC 50 Study with the Canary. Unpublished study prepared by Wildlife International, Ltd. 16p.
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42090404	Mayes, M. (1991) Response to Phase 3 Submission on Triethylammonium Triclopyr.... ?Acute Avian Dietary LC50 Test--Quail|: Lab Project Number: GHRC 130. Unpublished study prepared by Dow Chemical Co., Tox & Chem Res. Lab. 4 p. **Study response for project GHRC 130.**
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41905502	Lynn, S.; Smith, G.; Grimes, J. (1991) Triclopyr Bee: A Dietary LC50 Study With the Mallard: Lab Project No: ES-DR-0133-7242-11. Unpublished study prepared by Wildlife International LTD. 21 p. PDF 2022122
134179	Fink, R.; Beavers, J.; Brown, R. (1977) Eight-day Dietary LC50-- Mallard Duck: Triclopyr-ethylene Glycol Butyl Ether Ester: Project No. 103-173. Final rept. (Unpublished study received Nov 13, 1979 under 464-554; prepared by Wildlife International Ltd. and Washington College, submitted by Dow Chemical U.S.A., Mid- land, MI; CDL:241360-C) PDF 2022124
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71-4 850.2300 Avian Reproduction

MRID	Citation Reference
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31251 DOWCO 233	Beavers, J.B.; Fink, R.; Grimes, J.; et al. (1979) Final Report: One-Generation Reproduction Study--Bobwhite Quail: Project No. 103-191. (Unpublished study received Apr 29, 1980 under 434-546; prepared by Wildlife International, Ltd., submitted by Dow Chemical U.S.A., Midland, Mich.; CDL:242368-D**)** **PDFs 2035110 2035111**
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72-1 850.1075 Acute Toxicity to Freshwater Fish

MRID	Citation Reference
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151964 Batchelder, T. (1975) Environmental Analysis and Special Fish Toxi- cities of Two Triclopyr Formulations. Unpublished study pre- pared by Dow Chemical Co. 20 p.

41714301 Barron, M.; Ball, T. (1989) Garlon 3A Herbicide: Evaluation of the Toxicity to the Channel Catfish (Ictalurus punctatus): Lab Pro- ject Number: ES-DR-0121-6064-8: ES-2097. Unpublished study pre-pared by The Dow Chemical Co. 15 p. PDF 2045578

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151963 ACC 259512 Milazzo, D.; Batchelder, T. (1981) Evaluation of Garlon 4 Formu- lation in the Aquatic Environment: Report No. ES-426. Unpub- lished study prepared by Dow Chemical U.S.A. 21 p. PDF 2022115

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72-2 850.1010 Acute Toxicity to Freshwater Invertebrates

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	Triclopyr TEA Salt Studies
151956	McCarty, W.; Alexander, H. (1978) Toxicity of Triclopyr, Triethyl- amine Salt to Freshwater Organisms: ES-199. Unpublished study prepared by Environmental Research Lab., Dow Chemical U.S.A. 14 p. PDF 2045560
151959	Gersich, F.; Mandoza, C.; Hopkins, D.; et al. (1982) The **Acute and Chronic Toxicity of Triclopyr (...) Triethylamine Salt Solution** to Daphnia magna Straus: ES-583. Unpublished study prepared by Environmental Sciences Research, Dow Chemical U.S.A. 19 p. PDF 2045562
151960	Gersich, F.; Hopkins, D.; Milazzo, D. (1985) The Development of Flow-through Acute and Chronic Test Methods for Daphnia magna Straus: ES-756. Unpublished study prepared by Dow Chemical U.S.A. 20 p. Test Methods
41736301	Barron, M.; Mayes, M.; Ball, T. (1989) Garlon 3A Herbicide Evaluation of The Toxicity to The Crayfish: Lab Project Number: ES-DR- 0121-6064-78. Unpublished study prepared by The Dow Chemical Co. 15 p. PDF 2045580
92189009	Mayes, M. (1990) Dow Chemical U S A **Phase 3 Summary** of MRID 00151956. Toxicity of Triclopyr, Triethylamine Salt to Freshwater Organisms: Project ID: ES-199. Prepared by Dow Chemical Co.. 10 p.
42090409	Mayes, M. (1991) **Response** to Phase 3 Submission on Triethylammonium Triclopyr... ?Acute Toxicity Test for Freshwater Invertebrate|: Lab Project Number: ES-199. Unpublished study prepared by Dow Chemical Co., Environmental Tox & Chem Res. Lab. 7 p.
	Triclopyr BEE Studies
151963	Milazzo, D.; Batchelder, T. (1981) Evaluation of Garlon 4 Formulation in the Aquatic Environment: Report No. ES-426. Unpublished study prepared by Dow Chemical U.S.A. 21 p. PDF 2022116
151965 ACC 259512	Milazzo, D.; Batchelder, T. (1981) Environmental Screening of Chemicals: Garlon 4 Triclopyr EB Ester: Report No. ES-427. Un- published study prepared by Dow Chemical U.S.A. 26 p. PDF 2022115

43442603	Weinberg, J.; Hugo, J.; Massaro, L. et al. (1994) Evaluation of the Acute Toxicity of Garlon 4 Herbicide to the Daphnid, Daphnia magna Straus: Lab Project Number: DECO-ES-2855. Unpublished study prepared by The Dow Chemical Co. 25 p. PDF 2022129

72-3 850.1025, 850.1035, or 850.1075

Acute Toxicity to Estuarine/Marine Organisms

MRID	Citation Reference
	Triclopyr Acid studies
	None submitted
	Triclopyr TEA Salt Studies
62623 or 40346406	Heitmuller, T. (1975) Acute Toxicity of M-3724 to Larvae of the Eastern Oyster (Crassostrea virginica), Pink Shrimp (Penaeus duorarum), and Fiddler Crabs (Uca pugilator). (Unpublished study received Nov 4, 1975 under 464-EX-46; pre- pared by Bionomics, EG&G, Inc., submitted by Dow Chemical U.S.A., Midland, Mich.; CDL:233134-H) PDF 2045563
40346406	Bionomics--EG&G, Inc. (1975) Acute Toxicity of M-3724 to Larvae of the Eastern Oyster (Crassostrea virginica), Pink Shrimp (Penaeus duorarum), and Fiddler Crabs (UCA pugilator). Unpublished study. 11 p. PDFs 2045563, 2045564, 2045565, 2045566
41633703	Ward, T.; Boeri, R. (1989) Acute Flow-through Toxicity of Triclopyr TEA Sala to the Tidewater Silverside, Menidia beryllina: Lab Project Number: 8990/D. Unpublished study prepared by Resource Analysts, Inc. 26 p. PDF 2045571
42646101	Ward, T.; Kowalski, P.; Boeri, R. (1993) Acute Flow-Through Mollusc Shell Deposition Test with Triclopyr TEA Salt: Lab Project Number: 51-DO: ES-2498. Unpublished study prepared by T. R. Wilbury Labs., Inc. 24 p. PDF 2045584
42646102	Ward, T.; Kowalski, P.; Boeri, R. (1992) Acute Toxicity of Triclopyr TEA Salt to the Grass Shrimp, Palaemonetes pugio: Lab Project Number: 50-DO: ES-2497. Unpublished study prepared by T. R. Wilbury Labs., Inc. 25 p. PDF 2045585
	Triclopyr BEE Studies
41971601	Ward, T.; Boeri, R. (1991) Triclopyr Bee: Acute Flow-Through Toxic- ity to the Grass Shrimp, palaemonetes pugio: Lab Project Number: ES-DR-0133-7242-12. Unpublished study prepared by Resource Ana- lysts, Inc. 27 p. PDF 2022109
41971602	Ward, T.; Boeri, R. (1991) Triclopyr Bee: Acute Flow-Through Shell Deposition Test with the Eastern Oyster, Crassostrea virginica: Lab Project Number: ES-DR-0133-7242-14. Unpublished study prep- ared by Resource Analysts, Inc. 25 p. PDF 2022110
41969901	Ward, T.; Boeri, R. (1991) Garlon 4 Herbicide: Acute Flow-through Toxicity to the Tidewater Silverside, Menidia beryllina: Lab Project Number: ES-DR-0224-6186-6. Unpublished study prepared by Resource Analysts, Inc. 26 p. PDF 2022105

41969902 Ward, T.; Boeri, R. (1991) Garlon 4 Herbicide: Acute Flow-through Toxicity to Grass Shrimp, pugio: Lab Project No: ES-DR-0224- 6186. Unpublished study prepared by Resource Analysts, Inc. 27 p. PDF 2022108

42948001 Alexander, H. (1993) **Supplemental to MRID No. 41969902**--Garlon 4 Herbicide: Acute Flow-through Toxicity to Grass Shrimp Palaemonetes pugio: Lab Project Number: MWM093093. Unpublished study prepared by Dow Chemical Co., Environmental Tox. & Chem. Research Lab and DowElanco. 14 p. Supplement

41969903 Ward, T.; Boeri, R. (1991) Garlon 4 Herbicide: Acute Flow-through Shell Deposition Test with the Eastern Oyster, Crassostrea virginica: Lab Project Number: ES-DR-0224-6186-7. Unpublished study prepared by Resource Analysts, Inc. 26 p. PDF 2022111

41971601 Ward, T.; Boeri, R. (1991) Triclopyr Bee: Acute Flow-Through Toxic- ity to the Grass Shrimp, palaemonetes pugio: Lab Project Number: ES-DR-0133-7242-12. Unpublished study prepared by Resource Ana- lysts, Inc. 27 p. PDF 2022109

41971602 Ward, T.; Boeri, R. (1991) Triclopyr Bee: Acute Flow-Through Shell Deposition Test with the Eastern Oyster, Crassostrea virginica: Lab Project Number: ES-DR-0133-7242-14. Unpublished study prep-ared by Resource Analysts, Inc. 25 p. PDF 2022110

42053901 Ward, T.; Boeri, R. (1991) Triclopyr BEE: Acute Flow-Through Toxic- ity to the Tidewater Silverside, Menidia beryllina: Lab Project Number: ES-DR-0133-7242-13. Unpublished study prepared by EnviroSystems Division & Resource Analysts, Inc. 26 p. PDF 2022121

TCP Degradate

42245901 Graves, W.; Smith, G. (1991) 3,5,6-Trichloro-2-Pyridinol: A 96-Hour Flow-through Acute Toxicity Test with the Atlantic Silverside (Menidia menidia): Amended Report: Lab Project Number: 103A-101A: ES-DR-0037-0423-9. Unpublished study prepared by Wildlife International Ltd. 48 p Amended report 2066446 in PC 059101

72-4 850.1400 850.1300

Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study

MRID	Citation Reference

Triclopyr Acid

No Data

Triclopyr TEA Salt Studies

46269 Swabey, Y.H.; Schenk, C.F. (1963) Report on Algicides and Aquatic Herbicides. (Ontario, Water Resources Commission, Laboratory Division, Biology Branch, unpublished study; CDL:107773-B)

49637 ACC 259511 and 259512 Batchelder, T.L. (1973) Acute Fish Toxicity of Dowco 233 (3,5,6- Trichloro-2-pyridyloxyacetic acid) and Two Derivatives ?sic|: Report WCL--73014. (Unpublished study received Feb 26, 1974 under unknown admin. no.; submitted by Dow Chemical U.S.A.; Midland, Mich.; CDL:222240-E) PDF 2045521 pg 11

151958 Mayes, M.; Dill, D.; Mandoza, C.; et al. (1983) The Acute and Chronic Toxicity of Triclopyr (...) Triethylamine Salt Solution to Fathead Minnows (...): ES-582. Unpublished study prepared by Environmental Sciences Research, Dow Chemical U.S.A. 18 p. **ACC 259511** PDF 2045561

151959 Gersich, F.; Mandoza, C.; Hopkins, D.; et al. (1982) The Acute and Chronic Toxicity of Triclopyr (...) Triethylamine Salt Solution to Daphnia magna Straus: ES-583. Unpublished study prepared by Environmental Sciences Research, Dow Chemical U.S.A. 19 p. **ACC 259511** PDF 2045562

151960 ACC 259511 Gersich, F.; Hopkins, D.; Milazzo, D. (1985) The Development of Flow-through Acute and Chronic Test Methods for Daphnia magna Straus: ES-756. Unpublished study prepared by Dow Chemical U.S.A. 20 p. Methods development

42090410 Mayes, M. (1991) **Response** to Phase 3 Submssion on Triethylammonium Triclopyr...?Fish Early Life-Stage Test--Fathead Minnow|: Lab Project Number: ES-582. Unpublished study prepared by Dow Chemical Co., Environmental Tox and Chem Res. Lab. 45 p.

42090411 Mayes, M. (1991) **Response** to Phase 3 Submission on Triethylammonium Trichlopyr...?Invertebrate Life-Cycle Test (Daphnia)|: Lab Project Number: ES-583. Unpublished study prepared by Dow Chemical Co., Environmental Tox & Chem Research Lab. 18 p.

43230201 Weinberg, J.; Hugo, J.; Martin, M.; et al. (1994) Evaluation of the Toxicity of Triclopyr Butoxyethyl Ester to the Early Life Stages of the Rainbow Trout, Oncorhynchus mykiss Walbaum: Lab Project Number: DR/0133/7242: DECO/ES/2699. Unpublished study prepared by The Environmental Toxicology & Chemistry Research Lab. 47 p. PDF 2022128

41736304 Barron, M.; Mayes, M.; Murphy, P.; et al. (1989) Pharmacokinetics And Metabolism of Triclopyr Butoxyethyl Ester In Coho Salmon: Lab Project Number: ES-DR-0133-7242-5: ES-1082. Unpublished Study prepared by The Dow Chemical Co. 31 p.

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49992406 Douglas M., Bell G., and Macdonald I. 1993. Triclopyr BEE Prolonged Toxicity to *Daphnia Magna*. Unpublished study performed by Huntingdon Research Center Ltd., Huntingdon, Cambridgeshire, England. Laboratory Study No. DWC 651(a)/931342. Study sponsored by Dow AgroSciences LLC, Indianapolis, Indiana. Study initiated November 27, 1992 and completed November 9, 1993.

50673901 Gallagher, S.; Milligan, A.; Lockard, L. (2017) Triclopyr BEE: A Flow-Through Life-Cycle Toxicity Test with the Saltwater Mysid (Americamysis bahia). Project Number: 379A/213, 161020, 1191/03A. Unpublished study prepared by EAG Laboratories. 155p

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44997301 (found in 116002) Marino, T.; Gilles, M.; Rick, D. et al. (1999) Evaluation of the Toxicity of 3,5,6-Trichloro-2-Pyridinol **(TCP)** to the Early Life Stages of the Rainbow Trout, Oncorhynchus mykiss Walbaum: Lab Project Number: 991173. Unpublished study prepared by The Dow Chemical Co. 56 p. PDF 2045587 invalidated

46033201 Marino, T.; McClymont, E.; Hales, C.; et. al. (2003) **Revised Report** for 3,5,6-Trichloro-2-Pyridinol **(TCP):** Evaluation of the Toxicity to the Early Life Stages of the Rainbow Trout, Oncorhynchus mykiss Walbaum. Project Number: 011150, 011150R. Unpublished study prepared by The Dow Chemical Co. 69 p. See 44997301

45861301 Machado, M. (2003) Triclopyr Metabolite 3,5,6-TCP--Full Life-Cycle Toxicity Test with Water Fleas, Daphnia magna, under Static-Renewal Conditions: Lab Project Number: 12550.6286: 021300. Unpublished study prepared by Springborn Smithers Laboratories. 66 p.

49992407 Marino, T. *et al*. 2003. Revised Report for 3,5,6-trichloro-2-pyridinol (TCP): Evaluation of the Toxicity to the Early Life Stages of the Rainbow Trout, *Oncorhynchus mykiss* WALBAUM. Unpublished study performed by Toxicology & Environmental Research and Consulting, The Dow Chemical Company, Midland, Michigan. Laboratory Study No. 011150. Study sponsored by Dow AgroSciences LLC, Indianapolis, Indiana. Study initiated August 29, 2001, completed December 9, 2002, and revised July 2, 2003

72-7 Simulated or Actual Field Testing

MRID	Citation Reference
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151961	Washburn & Gillis Associates Ltd. (1983) Assessment of the Effects of the Herbicide Garlon 4 on Aquatic Fauna [Including Methods for Analysis of Soils and Water]. Unpublished study. 88 p. **ACC 259512**

122-1 850.4400 and 850.4150

Seedling Emergence and Vegetative Vigor Tier 1

MRID	Citation Reference
	Triclopyr Acid – No data
	Triclopyr TEA Salt Studies
41784401	Weseloh, J.; Stockdale, G. (**1990**) A Study to Determine the Effects of Triclopyr on Vegetative Vigor: Lab Project Number: GH-P 1474. Unpublished study prepared by DowElanco/Midland Field Research Station. 47 p. **TEA Salt at 9.0 Lbs ae per Acre** PDF 2022103
42908301	Weseloh, J. (1993) **Supplemental Information for MRID 41734301**: A Study to Determine the Effects of Triclopyr on Seed Germination and Seedling Emergence: Lab Project Number: MLJ083093. Unpublished study prepared by DowElanco. 11 p.
41734301	Weseloh, J.; Stockdale, G. (1990) A Study to Determine the Effects of Triclopyr on Seed Germination and Seedling Emergence: Lab Project Number: GH-P 1475: 90032. Unpublished study prepared by DowElanco. 55 p. **TEA Salt at 9.0 Lbs ae per Acre** PDF 2022101
	Triclopyr BEE Studies
41734301	Weseloh, J.; Stockdale, G. (1990) A Study to Determine the Effects of Triclopyr on Seed Germination and Seedling Emergence: Lab Project Number: GH-P 1475: 90032. Unpublished study prepared by DowElanco. 55 p. . **Triclopyr BEE at 8.0 Lbs ae per Acre** PDF 2022101

41784401	Weseloh, J.; Stockdale, G. (1990) A Study to Determine the Effects of Triclopyr on Vegetative Vigor: Lab Project Number: GH-P 1474. Unpublished study prepared by DowElanco/Midland Field Research Station. 47 p. **Applied Triclopyr BEE at 8.0 Lbs ae per Acre** PDF 2022103

123-1 850.4400 and 850.4150
Seed germination/seedling emergence and vegetative vigor

MRID	Citation Reference
	Triclopyr TEA Salt Studies
43129801	Schwab, D. (1993) Evaluating the Effects of Triclopyr TEA on the Germination, Emergence, and Vegetative Vigor of Non-Target Terrestrial Plants: Final Report: Lab Project Number: 40874. Unpublished study prepared by ABC Lab., Inc. 168 p. PDF 2045586
40346508	Smith, L.; Geronimo, J. (1977) Response of Seven Crops to Six Auxin-like Herbicides. Unpublished study prepared by Dow Chemi- cal. 29 p. PDF 2045591
49256001	Eley, R. (2008) Evaluation of the Phytotoxicity of GF-1883 190.44 g ai I SL GLP Vegetative Vigour Test Terrestrial Non Target Plants Based on OECD Guideline 227 Europe 2007: Final Report. Project Number: 71132, ACE/07/040 prepared by AgroChemex Ltd (Mixture with Aminopyralid TPA)
	Triclopyr BEE Study
43650001	Schwab, D. (1995) Evaluating the Effects of Triclopyr BEE on the Seedling Emergence and Vegetative Vigor of Non-Target Terrestrial Plants: Lab Project Numbers: 41964: RES94090. Unpublished study prepared by ABC Labs., Inc. 152 p. PDF 2022132

123-2 850.4400 and 850.5400 Aquatic plant growth

MRID	Citation Reference
	Triclopyr Acid Study
41736303	Cowgill, U.; Milazzo, D. (1989) Triclopyr Acid: Evaluation of The Five Day Toxicity to The Green Alga Selenastrum Capricornutum: Lab Project Number: ES-DR-0040-8195-8: ES-2047. Unpublished Study prepared by The Dow Chemical Co. 15 p. PDF 2035116
	Triclopyr TEA Salt Studies
41633705	Dill, D.; Milazzo, D. (1987) Triclopyr Triethylamine Salt: Evalua- tion of the Toxicity to a Freshwater Green Alga, Selenastrum Ca- pricornutum Printz: Lab Project Number: ES/DR/0287/8071/2. Un- published study prepared by The Dow Chemical Co. 16 p. PDF 2045573
41633706	Hughes, J. (1987) Triclopyr Triethylamine Salt: the Toxicity to An- abaena flos-aquae: Lab Project Number: 0460/02/1100/1. Unpub- lished study prepared by Malcolm Pirnie, Inc. 25 p. PDF 2045574

41633707 Cowgill, U.; Milazzo, D. (1987) Triclopyr Triethylamine Salt: The Five Day Toxicity of Skeletonema Costatum Grev. Cleve Bacillari- ophyceae, Clone Skel, A Marine Diatom: Lab Project Number: ES/ dr/0287/8071/3. Unpublished study prepared by The Dow Chemical Company. 18 p. PDF 2045575

41633708 Hughes, J. (1987) Triclopyr Triethylamine Salt: The Toxicity to Navicula pelliculosa: Lab Project Number: 0460/02/1100/2. Un- published study prepared by Malcolm Pirnie, Inc. 24 p. PDF 2045576

41633709 Cowgill, U.; Milazzo, D. (1987) Triclopyr Triethylamine Salt: The Fourteen-Day Toxicity to Lemna Gibba L. G-3 Duckweed: Lab Pro- ject Number: ES/DR/0287/8071/1. Unpublished study prepared by The Dow Chemical Company. 19 p. PDF 2045577

41736302 Cowgill, U.; Milazzo, D.; Landenberger, B. (1988) A Comparison of the Effect of Triclopyr Triethylamine Salt (Garlon 3A) on Two Species of Duckweed Examined For Seven-Day and Fourteen Day Period: Lab Project Number: ES-DR-0003-7070-2. Unpublished study prepared by Dow Chemical Co. 49 p. PDF 2045581

42090413 Mayes, M. (1991**) Response** to Phase 3 Submission on Triethylammonium Triclopyr...?Growth and Reproduction of Aquatic Plants Tier 2: Lemna gibba|: Lab Project Number: ES-970. Unpublished study prepared by Dow Chemical Co., Environmental Tox & Chem Res. Lab. 21 p.

42090414 Mayes, M. (1991) **Response t**o Phase 3 Submission on Triethylammonium Triclopyr...?Growth and Reproduction of Aquatic Plants Tier 2: Skeletonema costatum|: Lab Project Number: ES-971. Unpublished study prepared by Dow Chemical Co., Environmental Tox & Chem. Res. Lab. 11 p.

48939403 Wemhoner, U. (2006) GF-1883 - Growth Inhibition Test with Freshwater Diatom (Navicula pelliculosa). Project Number: 060393/OCR, 1072/010/440. Unpublished study prepared by Springborn Smithers Laboratories (Europe). 71p.

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41633704 Cowgill, U.; Milazzo, D. (1989) GARLON 4 Herbicide: Evaluation of the Five Day Toxicity to the Green Alga Selenastrum Capricornu- tum: Lab Project Number: ES/DR/0224/6186/1. Unpublished study prepared by The Dow Chemical company. 18 p. PDF 2022097 or 2045572

42090422 Mayes, M. (1991) **Response** to Phase 3 Submission on Butoxyethyl Tri- clopyr...?Growth and Reproduction of Aquatic Plants Tier 2: Selenaestrum capricornutum|. Unpublished study prepared by Dow Chemical Co., Environmental Tox & Chem Res. Lab. 16 p.

42719101 Milazzo, D.; Servinski, M.; Weinberg, J.; et al. (1993) Triclopyr Butoxyethyl Ester: Toxicity to the Aquatic Plant, Duckweed, Lemna gibba L. G-3: Lab Project Number: ES-2592: DECO-ES-2592. Unpublished study prepared by The Dow Chemical Co. 38 p. PDF 2022120

42721101 Hughes, J.; Alexander, M. (1993) The Toxicity of Triclopyr Butoxyethyl Ester (Triclopyr BEE) to Anabaena flos-aquae: Lab Project Number: ES-DR-0133-7242: ES-2529. Unpublished study prepared by Malcolm Pirnie, Inc. 37 p. PDF 2022118

42721102 Hughes, J.; Alexander, M. (1993) The Toxicity of Triclopyr Butoxyethyl Ester (Triclopyr BEE) to Navicula pelliculosa: Lab Project Number: ES-DR-0133-7242: ES-2530. Unpublished study prepared by Malcolm Pirnie, Inc. 37 p. PDF 2022118

42721103 Hughes, J.; Alexander, M. (1993) The Toxicity of Triclopyr Butoxyethyl Ester (Triclopyr BEE) to Skeletonema costatum: Lab Project Number: ES-DR-0133-7242: ES-2531. Unpublished study prepared by Malcolm Pirnie, Inc. 38 p. PDF 2022119

42645901 Hughes, J.; Williams, T. (1993) The Toxicity of **Access** Herbicide Formulation to Selenastrum capricornutum: Lab Project Number: ES-2587: B460-152-1. Unpublished study prepared by Malcolm Pirnie, Inc. 35 p. PDF 2039127

43230301 Ward, T.; Kowalski, P.; Boeri, R. (1994) **Access** Herbicide: Toxicity to the Freshwater Diatom, Navicula pelliculosa: Lab Project Number: 430/DO: ES/2766. Unpublished study prepared by T. R. Wilbury Laboratories, Inc. 25 p. Triclopyr BEE/Picloram EHE PDF 2039127

43230304 Ward, T.; Kowalski, P.; Boeri, R. (1994**) Access** Herbicide: Toxicity to the Marine Diatom, Skeletonema costatum: Lab Project Number: 431/DO: ES/2767. Unpublished study prepared by T. R. Wilbury Laboratories, Inc. 25 p. PDF 2001400

43230307 Boeri, R.; Kowalski, P.; Ward, T. (1994) **Access** Herbicide: Toxicity to the Freshwater Blue-Green Alga, Anabaena flos-aquae: Lab Project Number: 432/DO: ES/2768. Unpublished study prepared by T. R. Wilbury Laboratories, Inc. 25 p. PDF 2039125

43230310 Milazzo, D.; Kirk, H.; Humbert, L.; et al. (1994) The Toxicity of **Access** Herbicide Formulation to the Aquatic Plant, Duckweed, Lemna gibba L.G-3: Lab Project Number: DECO/ES/2762. Unpublished study prepared by The Environmental Toxicology & Chemistry Research Lab. 33 p. PDF 2039124

TCP Degradate Studies

45312001 Kirk, H.; Gilles, M.; Hugo, J. et al. (1999) Effect of 3,5,6-Trichloro-2-Pyridinol (TCP) on the Growth of the Freshwater Green Alga, Selenastrum capricornutum, PRINTZ: Lab Project Number: 991194. Unpublished study prepared by The Dow Chemical Company. 43 p. PDF 2082443

45312002 Kirk, H.; Gilles, M.; McClymont, E. et al. (2000) 3,5,6-Trichloro-2-Pyridinol (TCP): Growth Inhibition Test with the Freshwater Aquatic Plant, Duckweed, Lemna gibba L. G-3: Lab Project Number: 001148. Unpublished study prepared by The Dow Chemical Company. 39 p. PDF 208244

45312003 Kirk, H.; Gilles, M.; McClymont, E. et al. (2000) 3,5,6-Trichloro-2-Pyridinol (TCP): Growth Inhibition Test with the Bluegreen Alga, Anabaena flos-aquae: Lab Project Number: 001149. Unpublished study prepared by The Dow Chemical Compamy. 38 p. PDF 2082445

141-1 850.3020 Honey bee acute contact

MRID **Citation Reference**

Triclopyr Acid Studies

40356602 Dingledine, J. (1985) Triclopyr Acid: An Acute Contact Toxicity Study with Honey Bees: Final Report: Laboratory Project ID 103-239. Unpublished study prepared by Wildlife International, Ltd. 14 p. PDF 2035115

Triclopyr TEA Salt

No data

Triclopyr BEE Studies

41219109 Dingledine, J. (1985) Triclopyr BE Ester: An Acute Contact Toxicity Study with Honey Bees: Final Report: Project Study ID: 103-240. Unpublished study prepared by Wildlife International Ltd. 15 p. PDF 2022104

42625901 Hoxter, K.; Bernard, W.; Smith, G. (1992) **Access** Herbicide: An Acute Contact Toxicity Study with the Honey Bee: Lab Project Number: ES-2602: 103-389. Unpublished study prepared by Wildlife International Ltd. 20 p. PDF 2039123

Honeybee Non-Guideline Studies

MRID **Citation Reference**

Triclopyr Acid Studies

49992409 Hahne, R. (2001) Triclopyr Acid: Acute Oral Toxicity Test with the Honeybee (Apis mellifera). Project Number: 46610, 011100. Unpublished study prepared by ABC Laboratories, Inc. 20p

50673902 Moore, S.; Leonard, J. (2018) Triclopyr: A Repeated- Exposure Laboratory Toxicity Study in Larvae, Pupae and Emergent Adults of the Honey Bee Apis mellifera Linnaeus. (Hymenoptera: Apidae): Final Report. Project Number: 014SRUS17C0057

50673903 Leonard, J.; Moore,S. (2018) Triclopyr: A Laboratory Study to Determine the Chronic Oral Toxicity to the Adult Worker Honey Bee Apis mellifera L. (Hymenoptera: Apidae). Project Number: 014SRUS17C0064, 170089 by SynTech Research Laboratory

Non-Guideline Selections

MRID **Citation Reference**

151964 Batchelder, T. (1975) Environmental Analysis and Special Fish Toxicities of Two Triclopyr Formulations. Unpublished study pre- pared by Dow Chemical Co. 20 p. **ACC 259512**

42305500
42305501 Texas Dept. of Agriculture (1992) Submission of a Report of the Investigation of a Complaint of Adverse Effects of Garlon 3A and Rodeo on Horses and Property in Accordance with FIFRA 6(a)2 Requirements. Transmittal of 1 study. **Incident Report**

151957 Batchelder, T.; Milazzo, D. (1981) Evaluation of Garlon 3A Herbi- cide in the Aquatic Environment: ES-362. Unpublished study pre- pared by Environmental Sciences Research Laboratory, Dow Chemi- cal U.S.A. 46 p. **General summary**

42411805 Woodburn, K. (1992) Fish Metabolism Study on Triclopyr Requested by EPA for Aquatic Registration: Lab Project Number: KBW-792. Unpublished study prepared by DowElanco. 5 p.

43474200 DowElanco (1994) Submission of DERBI Numbers for Adverse Effect Incidents in Support of FIFRA 6(a)(2) for Chlorpyrifos and Other Chemicals. Transmittal of 1 Study.

44292003 Wolt, J.; Weglarz, T.; Wright, J.; et al. (1997) Triclopyr Non-Target Plant Risk Assessment: Lab Project Number: GH-C 4357. Unpublished study prepared by DowElanco. 95 p.

44385901 Eisenbrandt, D.; Nolan, R.; McMaster, S. et al. (1997) Triclopyr: An Assessment of Common Mechanism of Toxicity: Lab Project Number: HET K-042085-097. Unpublished study prepared by The Dow Chemical Co. 15 p.

44015101
44456102
44456103
44456104
44456108
44456112
45170901

Triclopyr in Fish and Shellfish: Evaluation of Residue Data and Analytical Methods.

HED Studies listed on FOIA website

45022501 Ward, T.; Boeri, R. (1999) 3,5,6-Trichloro-2-pyridinol (TCP): Acute Toxicity to the Earthworm, Eisenia foetida: Lab Project Number: 1860-DO: 990149. Unpublished study prepared by T.R. Wilbury Laboratories, Inc. 32 p.

47164601 Moore, D.; Breton, R.; Rodney, S.; et al. (2007) Generic Problem Formulation for California Red-Legged Frog. Project Number: 89320, 05232007. Unpublished study prepared by Cantox Environmental Inc. 87 p. Registrant assessment

47164602 Holmes, C.; Vamshi, R. (2007) Data and Methodology Used for Spatial Analysis of California Red Legged Frog Observations and Proximate Land Cover Characteristics. Project Number: 3152007, WEI/252/03. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 19 p. ESA report from consulting firm

47164600 Croplife America (2007) Submission of Environmental Fate and Exposure and Risk Data in Support of the Preservation of the California Red Legged Frog. Transmittal of 2 Studies. Registrant assessment

48216801 Patterson, B. (2010) Co-Occurrence of 2,4-D and Triclopyr in Water Monitoring Samples within Threatened and Endangered Salmonid: Evolutionarily Significant Units. Project Number: 102388/F. Unpublished study prepared by Stone Environmental, Inc. 70 p.

48216802 Patterson, B. (2010) Land Cover Characterization and Water Monitoring Data Summaries for Triclopyr Butoxyethyl Ester Within Threatened or Endangered Salmonid Evolutionarily Significant Units. Project Number: 102388/G. Unpublished study prepared by Stone Environmental, Inc. 112 p.

48304701 Gelis, C. (2008) (Green S): Measurement of Ground Contamination Underneath Brushwood Canopies: Final Report. Project Number: DOW/GRE/07001. Unpublished study prepared by ADME Bioanalyses. 170 p.

APPENDIX A. Residue of Concern Justification, Detailed Fate and Transport Data, and ROCKS Table

I. Other Lines of Evidence to Support the Decision for NOT Including Triethanolamine, 2-Butoxyethanol and Choline Moieties in the Residues of Concern (ROC)

As described in the **Introduction Section** of this document and **Figure 5-1**, dissociation of TEA and COLN forms of triclopyr and hydrolysis of the BEE form are expected to produce, in addition to the ACID moiety, TEA, BEE and COLN moieties, respectively. These products were claimed, by the registrant, to dissipate rapidly by microbial degradation and/or of no toxicological concern. Hereunder the other lines of evidence for their expected behavior in the environment.

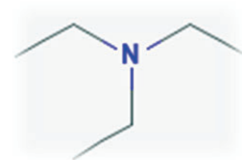
Triethylamine[26]	
Physical/Chemical Properties	**Structure**
CAS No.: 121-44-8 **Smiles Code:** CCN(CC)CC **Molecular Weight:** 101.2 g $mole^{-1}$ **Vapor Pressure:** 52 torr @ 20 °C (High) **pKa:** 10.75 (Present as protonated moiety in environmentally relevant pHs) **Solubility in Water:** 112 g L^{-1} (High)	

Table A-1 contains a summary of available fate data for the triethanolamine moiety of TEA form of triclopyr. In these studies, labeled ([^{14}C-l-ethyl]triethylamine hydrochloride was used to avoid loss due to the high volatility of the chemical.
https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3#chemical-list

Table A-1 Summary of Environmental Degradation Data for Triethanolamine moiety.

Study	System Details	Half-life (days)/Other Data	Source (MRID)/ Study Classification
Aerobic Soil Metabolism	Harford Sandy Loam soil (pH 7.4; OC= 0.99%) (End of study= EOS= 182 d @ 25 °C) Commerce Silty Loam Soil (pH 7.6; OC= 0.49%) (EOS= 182 d @ 25 °C)	**5.6 and 13.7 d** Degrades to CO_2 to a Max of Max of 70.2% and 69.5% @ EOS, respectively. Unknown non-persistent metabolite was also observed with Max concentrations of 8% at 7 d declining to non-detect at 14 d in Harford soil. A more persistent Unknown metabolite was also observed in Commerce soil with Max concentrations of 37% at 24 d declining to 2% at 91 d	438375-01 (Acceptable)[1]

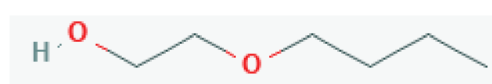
[26] https://pubchem.ncbi.nlm.nih.gov/compound/8471#section=2D-Structure

Study	System Details	Half-life (days)/Other Data	Source (MRID)/ Study Classification
Aerobic Aquatic Metabolism	**System 1:** Silt Loam sediment from a Pond in Wayside, MS (pH= 5.8, O.C= 0.95%): Water (pH 6.7) (EOS= 30 d @ 25 °C)	**9.3 d** Degrades to CO_2 and unextractable residues to a Max of Max of 67.7% and 18%, respectively @ EOS. No degradation products were observed	438375-03 (Acceptable)[2]
Anaerobic Aquatic Metabolism	**Same System 1** MRID 438375-03, above (EOS= 184 d @ 25 °C)	**2 Years** Minimal degradation to a Max CO_2 of 0.3% @ EOS) with formation of 19% unextractable residues and No degradation products were observed	438375-02 (Acceptable)[3]

[1] **MRID 438375-01** Merrit, D. A. 1995. Aerobic Soil Metabolism of ^{14}C Triethylamine an unpublish study performed by North American Environmental Chemistry Laboratory, Indiana and submitted by DowElanco.
[2] **MRID 438375-03** Merrit, D. A. 1995. Aerobic Aquatic Metabolism of ^{14}C Triethylamine an unpublish study performed by North American Environmental Chemistry Laboratory, Indiana and submitted by DowElanco.
[3] **MRID 438375-02** Wolt, J. D. 1995. Anaerobic Aquatic Metabolism of ^{14}C Triethylamine an unpublish study performed by North American Environmental Chemistry Laboratory, Indiana and submitted by DowElanco.

Data in **Table A-1** indicates that triethanolamine moiety of TEA is non-persistent in aerobic soil and aquatic systems (Goring et al., 1975)[27] as it mineralizes ultimately to CO_2. In contrast, it is highly persistent in anaerobic aquatic system. Based on this fate data, exposure concern due to the triethanolamine moiety of TEA is low when it forms in aerobic soil/aquatic systems due to non-persistent. Persistence is expected for the triethanolamine moiety when it forms in anaerobic aquatic systems.

It is noted that triethylamine may reach the environment from many sources other than the application of the herbicide triclopyr. The chemical is used as catalytic solvent in chemical synthesis; accelerator activators for rubber; wetting, penetrating, and waterproofing agents of quaternary ammonium types; curing and hardening of polymers; corrosion inhibitor; propellant[28]. The chemical is among the EPA's third contaminant candidate list (CCL 3)[29].

2-Butoxyethanol [30]	
Physical/Chemical Properties	**Structure**
CAS No.: 111-76-2 **Smiles Code:** CCCCOCCO **Molecular Weight:** 118.2 g $mole^{-1}$ **Vapor Pressure:** 0.88 torr @ 25 °C (High) **Solubility in Water:** ≥100 mg L^{-1} (High)	

[27] *Goring et al. (1975) provides the following persistence scale for aerobic soil metabolism half-lives:*
- *Non-persistent less than 15 days*
- *Slightly persistent for 15-45 days*
- *Moderately persistent for 45-180 days, and*
- *Persistent for greater than 180 days.*

[28] https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+896
[29] https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3#chemical-list
[30] https://pubchem.ncbi.nlm.nih.gov/compound/2-Butoxyethanol

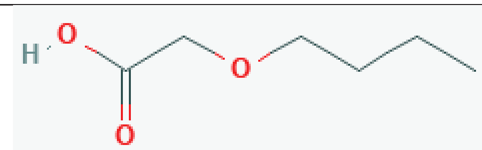
2-butoxyacetic acid: The main degradation product of butoxyethanol in aerobic soil/aquatic systems as well as anaerobic aquatic system (refer to Table I-2, below **CAS No.:** 2516-93-0	

Table A-2 contains a summary of available fate data for the butoxyethanol moiety of BEE form of triclopyr. These studies we submitted in support of registration of 2,4-D butoxyethyl ester (2,4-D BEE) with the understanding that it would be referenced for other DowElanco products as appropriate.

Table A-2 Summary of Environmental Degradation Data for Butoxyethanol moiety.

Study	System Details	Half-life (days)/Other Data	MRID)/ Study Classification
Aerobic Soil	Harford SL soil (pH 7.4; OC= 0.99%) (EOS= 4 d @ 25 °C) Commerce SiL Soil (pH 7.6; OC= 0.49%) (End of study= EOS= 4 d @ 25 °C)	**0.9 and 1.4 Hours** Degrades to 2-butoxyacetic acid Max 85 & 101% @ 4 &24 hours declining with an observed t ½= 0.6 & 1.5 d, respectively producing CO_2 and unextracted residues (50% and 19%, respectively in both soils @ EOS)	**437991-01** (Acceptable)[1]
Aerobic aquatic	**System 1:** Silt Loam sediment from a Pond in Wayside, MS (pH= 5.8, O.C= 0.95%): Water (pH 6.7) (EOS= 10 d @ 25 °C)	**0.6 to 3.4 d** Degrades to 2-butoxyaceticacid Max 54% @ 3 d declining with an observed t ½ = 1.3 d producing CO_2 (69% @ EOS) and 10% of unextracted residue	**437991-06** (Acceptable)[2]
Anaerobic aquatic	**Same System 1** MRID 437991-06, above (EOS= 193 d @ 25 °C)	**1.4 d** Degrades to 2-butoxyaceticacid Max 72% @ 7 d declining with an observed t ½ = 73 d producing CO_2 (57% @ EOS) and 10% of unextracted residue	**437991-03** (Acceptable)[3]

[1] **MRID 437991-01** Batzer, F.R, 1995. Aerobic Soil Metabolism of ^{14}C-2-Butoxyrthanol, Laboratory Study ID ENV94094. Unpublished study performed and submitted by DowElanco, Indianapolis, Indiana.
[2] **MRID 437991-06** Batzer, F.R, 1995. Aerobic Aquatic Metabolism of ^{14}C-2-Butoxyrthanol, Laboratory Study ID ENV94096. Unpublished study performed and submitted by DowElanco, Indianapolis, Indiana.
[3] **437991-03** Batzer, F.R, 1995. Anaerobic Aquatic Metabolism of ^{14}C-2-Butoxyrthanol, Laboratory Study ID ENV94095. Unpublished study performed and submitted by DowElanco, Indianapolis, Indiana.

Data in **Table A-1** indicates that butoxyethanol moiety of BEE is non-persistent in aerobic soil systems (Goring et al., 1975) as it first degrades almost completely to 2-butoxyacetic acid within hours. The degradate 2-butoxyacetic acid is also non-persistent as it mineralizes to CO_2 within days (t ½= 0.6 day in one soil and 1.5 day in another soil). Similarly, butoxyethanol moiety of BEE is non-persistent in an aerobic aquatic system (Goring et al., 1975) as it first degrades to 2-butoxyacetic acid within 3 days into the degradate 2-butoxyacetic acid which is also non-persistent as it mineralizes to CO_2 within days (t ½= 1.3 days). In anaerobic aquatic system, butoxyethanol moiety of BEE degrades within days (t ½= 1.4 days) into the degradate 2-butoxyacetic acid which is moderately persistent (Goring et al., 1975). Based on this fate data, exposure concern due to the butoxyethanol moiety of BEE is low when it forms in aerobic soil/aquatic systems due to non-persistent. Although butoxyethanol moiety of BEE is non-persistent in anaerobic aquatic systems, it degrades into a moderately persistent degradate; 2-butoxyaceticacid.

It is noted that 2-butoxyethanol may reach the environment from many sources other than the application of the herbicide triclopyr. Reported main use of 2-butoxyethanol is as a solvent in paints and surface coatings, followed by cleaning products and inks. Other products which contain 2-butoxyethanol include acrylic resin formulations, asphalt release agents, firefighting foam and others. 2-Butoxyethanol is a primary ingredient of various whiteboard cleaners, liquid soaps, cosmetics, dry cleaning solutions, lacquers, varnishes, herbicides, and latex paints[31].

Choline

Choline is a ubiquitous water-soluble essential nutrient that is grouped with the B-vitamins and is not considered a xenobiotic. It is considered essential for overall health and function of both terrestrial and aquatic organisms. Furthermore, choline, as choline hydroxide (CAS Reg No. 123-41-1), is listed in 40CFR §180.920 as an approved inert ingredient for pre-harvest use with an exemption from the requirement of a tolerance[32]. For these reasons, exposure resulting from formation of choline is not of concern.

II. Detailed Fate and Transport Data

Table A-3 Detailed Fate and Transport Data for Triclopyr

Study	System Details	Half-life (days)/Other Data	Source (MRID)/ Study Classification
Hydrolysis	Sterile buffer solutions	**Stable** @ pHs 5, 7 and 9	418796-01 (A)
Aqueous photolysis	Sterile buffered aqueous solution @ pH 7 under xenon arc lamp @25 °C (End of study= EOS= 30 d)	**0.4** days **Major Degradates:** 29% [(3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid @ 1 d declining to non-detect @ EOS; 27 to 28% mixture of Chloromaleamic acid, Fumaric acid, and Chlorofumaric amide @ 6 d to EOS; 10% Maleamic acid @ 0.5 d declining to 6% @EOS; and 60% CO_2 @ EOS **Minor Degradates:** 8% Fumaric amide; <1% TMP and Mixture of succinamic succinic acids	499924-01 [N] (A)
Aerobic soil	**Soil 1:** Commerce soil, SiL from MS (pH 6.6; O.C= 0.86%) **Soil 2:** Flanagan soil, SiCL from GA (pH 5.2; O.C= 2.1%) (EOS= 56 d representing the aerobic phase with acceptable moisture content for an aerobic soil system @25 °C)	**20** days (SFO) in **soil 1**; and **11** days (SFO) in **soil 2** **Major Degradate:** Max 11% **TCP** @ 28 d declined to 3.8% @ EOS in **soil 1**; and 25% @ 14 d declined to 8% @ 28 d in **soil 2** **Minor Degradate:** Max 8% **TMP** @ EOS in **soil 1**; and 5% @ 28 d declined to 3% @EOS in **soil 2**. **CO_2**= 50% and 62% @EOS in soil1 and 2, respectively	403463-04 (A)

[31] https://pubchem.ncbi.nlm.nih.gov/compound/2-Butoxyethanol

[32] Choline hydroxide; Exemption from the Requirement of a Tolerance. 2010. EPA–HQ–OPP–2010–0233; FRL–8841–6. Federal register, Vol 75, No 169, 53577-81

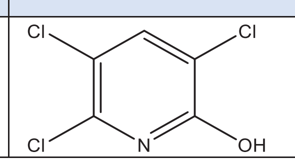
Study	System Details	Half-life (days)/Other Data	Source (MRID)/ Study Classification
	Soil 1: SiL soil from MO, USA (pH 4.7, 1.6% O.C) **Soil 2:** SCL soil from TX (pH 7.6, 0.65% O.C) **Soil 3:** SL soil from ND (pH 6.2, 1.7% O.C) **Soil 4:** CL soil from CA (pH 6.4, 1.3% O.C) (EOS=120 d @ 20 °C)	**8** days (SFO) in **soil 1**; **6** days @25 °C **29** days (SFO) in **soil 2**; **21** days @25 °C **25** days (SFO) in **soil 3**; 1**8** days @25 °C **18** days (SFO) in **soil 4;** **13** days @25 °C **Major Degradate: TCP in soil 1/2/3/4:** Max 35/19/28/24% @ 14/59/59/30 d declined to 4/3/19/2% @ EOS. t ½ for **TCP in soil 1/2/3/4: 34 d** (SFO)/**23 d** (SFO)/**70 d** (SFO)/**20 d** (SFO); Approximated for **soils 2** and **3** (only three data points) **Minor Degradate: Max in Soil 1/2/3/4, respectively:** **TMP:** 3/<1/4/4% @ 3/14/EOS/30 d then to 1/<1/5/1% @ EOS; **MTCP:** 6/1/5/4% @ 59/59/EOS/90 d then to 5/<1/4/1% @ EOS; **3,5 DCMP:** 1/1/<1/1% @ EOS/EOS/90/59 d then to 1/1/0/1% @ EOS **5,6 DCMP:** Max <1/<1/<1/1% @ EOS **CO_2**= 58/58/51/53% @EOS in **soil1/2/3/4**	90^{th} %= 18.4 Day 499924-02 ^{N} (A)
Anaerobic Phase Only	**Soil 1:** Clay soil from WY, USA (pH 7.6, 0.8% O.C) **Soil 2:** SiL soil from Derbyshire, UK (pH 6.6, 3.5% O.C) **Soil 3:** SL soil from , Longwoods, Lincolnshire, UK (pH 6.9, 2.2% O.C) **Soil 4:** CL soil from South Witham, Lincolnshire, UK (pH 7.1, 3.1% O.C) **Aerobic phase** length (% average of undegraded ACID): 30 d (74.5%); 9 d (50.9%); 30 d (25.9%); and 12 d (44.7%), respectively **Anaerobic phase** length= 122 days for **soils 1** to **3** and 120 days for **soil 4**, respectively conducted @20 °C)	**162** days (SFO) in **soil 1**; **115** days @25 °C **133** days (IORE) in **soil 2;** **94** days @25 °C **240** days (Slow DFOP) in **soil 3;** and **170** days @25 °C **98** days (SFO) in **soil 4** **69** days @25 °C **Major Degradate: TCP in soil 1/2/3/4:** Max 54/40/43/33% @ EOS/90/60/7 d then to 54/27/18/13% @ EOS. t ½ for **TCP in soil 1/2/3/4: Stable/Slight degradation**/**29 d** (SFO)/**70 d** (SFO); and **3,6-DCP in soil 1/2/3/4:** Max 0/11/32/21% all soils @ EOS **Minor Degradate: Max in Soil 1/2/3/4, respectively:** **TMP:** 4/8/6/5% all soils @ 7 d then declined to 0/2/1/0% @ EOS; **X124085:** detected only in soils 2 at Max 4% @ 60 d with slight decline and in soil 3 at a Max of 2% @ 7 d declining to no detection @ EOS; **[(5,6-Dichloropyridin-2-yl)oxy]acetic acid:** Detected in one soil (soil 4) at a Max of 2.5% @ 60 d with no apparent decline @ EOS; and **X79402:** Detected in one soil (soil 3) at a Max of 0.7% @ 60 d declining to no detection @ EOS	499924-03 ^{N} (A)

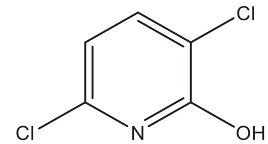
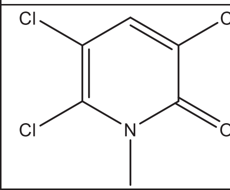
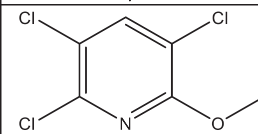
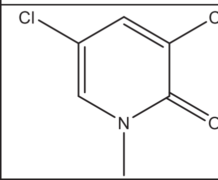
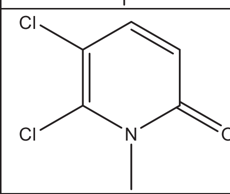
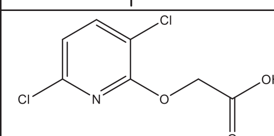
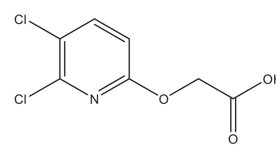
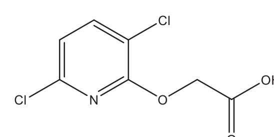
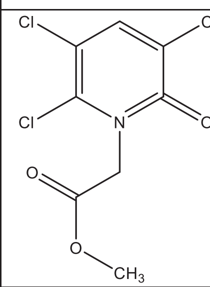
Study	System Details	Half-life (days)/Other Data	Source (MRID)/ Study Classification
Aerobic Aquatic	**System 1:** L sediment from Italy (pH 7.3; O.C= 4.89%) : water (pH 7.9) **System 2:** S sediment from France (pH 5.3; O.C= 2.43%) : water (pH 6.2) (EOS= 106 d @20 °C)	Test substance for this study is **BEE,** However, **BEE** degraded into the **ACID** with a half-life of **0.7** day in **system 1**; and **0.6** day in **system 2**. Data for the **ACID** is taken from the 7-day maximum formation of 98% in **System 1** and 90% in **system 2**. This data is used to represent the degradation profile of the **ACID** in these two aerobic aquatic systems **32 days** (SFO) in **System 1**; **23** days @25 °C **36 days** (SFO) in **System 2**; **26** days @25 °C **Major Degradate: TCP** Max in **System 1 & 2**= 33 & 24% @ 59 d decreasing to 19 & 24% @ EOS (persistent); **3,6-DCP** Max 52% @ EOS in **system 1** & 34% @ 59 d in **system 2** decreasing to 30% @ EOS; and **5-CLP** Max 26% in **system 1** only @ 59 d decreasing to 21% @ EOS **Minor Degradates: 6-CLP** Max 1% @EOS in **system 2** only; and **TMP** Max 2% @ 29 Minutes in both systems decreasing to 0.04% @ EOS CO_2= <1-2% @EOS.	90^{th} %= 29.1 Day 499924-04 [N] (S)
Anaerobic Aquatic	**System 1:** SL Cecil soil from GA (pH 5.7; O.C= 0.95%) amended with alfalfa: water (possibly tap water, not characterized) **System 2:** SL Norfolk soil from VA (pH 6.3; O.C= 0.65%) amended with alfalfa: water (not characterized) (EOS= 365 d @25 °C)	Test substance for this study is **BEE,** However, **BEE** degraded into 99 to 100% **ACID** within a day (t ½ = < **1** day in both **systems**. Data for the **ACID** from the maximum formation is used to represent the degradation profile of the **ACID** in these two anaerobic aquatic systems **1,433 days** (SFO) in **System 1**; **1,339 days** (SFO) in **System 2** **Major Degradate: TCP** Max. 26% @ EOS in system 1 and 43% @ 201 d declining to 22% @ EOS CO_2= 0.01 to 0.01% @ 14 and 20 days	90^{th} %= 1,531 Day 001519-67 [N] (S)

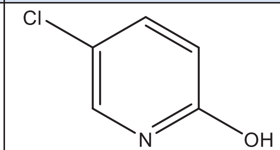
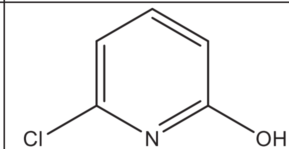
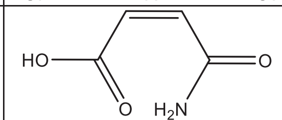
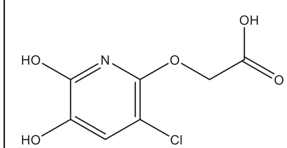
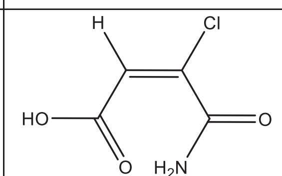
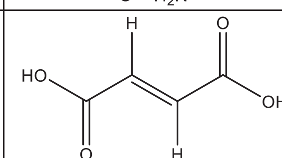
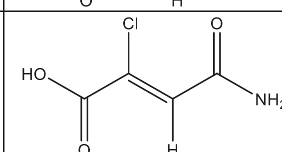
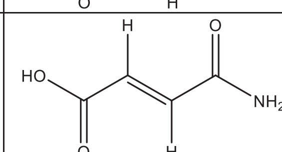
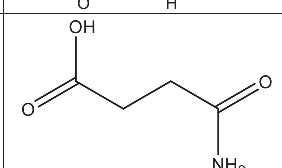
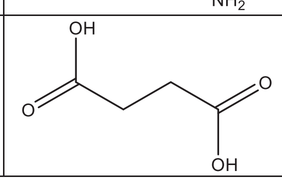
III The ROCKS Table

Table A-4 contains available chemical structures while **Table A-5** contains fate information for the major and minor degradates for triclopyr acid.

Table A-4. A Summary of Available Data on the Major/Minor Degradation Products of Triclopyr Acid Observed in Laboratory Fate Studies.

Acronym (M Weight)	IUPAC Name (Formula)	CAS No	SMILES Code	Structure
TCP (198 $g\ mol^{-1}$)	3,5,6-Trichloro-2-pyridinol **($C_5H_2Cl_3NO$)**	6515-38-4	Oc1nc(Cl)c(Cl)cc1Cl	

Acronym (M Weight)	IUPAC Name (Formula)	CAS No	SMILES Code	Structure
3,6-DCP (164 $g\ mol^{-1}$)	3,6-Dichloro-2-pyridinol **($C_5H_3Cl_2NO$)**	57864-39-8	ClC1=CC=C(Cl)N=C1O	
MTCP (213 $g\ mol^{-1}$)	N-methyl-3,5,6-trichloro-2(1H)-pyridinone **($C_6H_4Cl_3NO$)**		ClC1=C(Cl)N(C)C(C(Cl)=C1)=O	
TMP (213 $g\ mol^{-1}$)	2,3,5-Trichloro-6-methoxypyridine **($C_6H_4Cl_3NO$)**	31557-34-3	n1c(OC)c(Cl)cc(Cl)c1Cl	
3,5 DCMP (178 $g\ mol^{-1}$)	3,5-Dichloro-1-methylpyridin-2(1H)-one **($C_6H_5Cl_2NO$)**	NR	ClC1=CN(C)C(C(Cl)=C1)=O	
5,6 DCMP (178 $g\ mol^{-1}$)	5,6-Dichloro-1-methylpyridin-2(1H)-one **($C_6H_5Cl_2NO$)**	NR	ClC1=C(Cl)N(C)C(C=C1)=O	
X124085 (222 $g\ mol^{-1}$)	[(3,6-Dichloropyridin-2-yl)oxy]acetic acid **($C_7H_5Cl_2NO_3$)**	NR	ClC1=CC=C(Cl)N=C1OCC(O)=O	
[(3,6-Dichloropyridin-2-yl)oxy]acetic acid (222 $g\ mol^{-1}$)	2-[(5,6-Dichloropyridin-2-yl)oxy]acetic acid **($C_7H_5Cl_2NO_3$)**		ClC1=C(Cl)C=CC(OCC(O)=O)=N1	
[(5,6-Dichloropyridin-2-yl)oxy]acetic acid (222 $g\ mol^{-1}$)	2-[(3,6-Dichloropyridin-2-yl)oxy]acetic acid **($C_7H_5Cl_2NO_3$)**	NR	ClC1=CC=C(Cl)N=C1OCC(O)=O	
X79402 (270 $g\ mol^{-1}$)	(Methyl (3,5,6-trichloro-2-oxopyridin-1(2H)-yl)acetate **($C_8H_6Cl_3NO_3$)**	NR	ClC1=CC(Cl)=C(Cl)[N](CC(OC)=O)=C1=O	

Acronym (M Weight)	IUPAC Name (Formula)	CAS No	SMILES Code	Structure
5-CLP (130 *g mol*$^{-1}$)	5-Chloropyridin-2-ol **(C_5H_4ClNO)**	4214-79-3	OC1=NC=C(Cl)C=C1	
6-CLP (130 *g mol*$^{-1}$)	6-Chloropyridin-2-ol **(C_5H_4ClNO)**	73018-09-4	OC1=NC(Cl)=CC=C1	
Maleamic acid (115 *g mol*$^{-1}$)	4-Amino-4-oxobut-2-enoic acid **($C_4H_5NO_3$)**	557-24-4	O=C(O)C=CC(=O)N	
[(3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy] acetic acid or isomer (220 *g mol*$^{-1}$)	[(3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid **($C_7H_6ClNO_5$)**	NR	O=C(O)COC1=C(Cl)C=C(O)C(O)=N1	
Chloromaleamic acid (150 *g mol*$^{-1}$)	(2Z)-2-amino-2-chloro-4-oxo-2-butenoic acid **($C_4H_4ClNO_3$)**	NR	NC(/C(Cl)=C([H])\C(O)=O)=O	
Fumaric acid (116 *g mol*$^{-1}$)	(2E)-But-2-enedioic acid **($C_4H_4O_4$)**	110-17-8	O=C(O)C=CC(=O)O	
Chlorofumaric amide (150 *g mol*$^{-1}$)	(2Z)-4-amino-2-chloro-4-oxo-2-butenoic acid **($C_4H_4ClNO_3$)**	NR	O=C(O)/C(Cl)=C(C(N)=O)\[H]	
Fumaric amide (115 *g mol*$^{-1}$)	(2E)-4-amino-4-oxobutenoic acid **($C_4H_5NO_3$)**	NR	O=C(O)/C(Cl)=C(C(N)=O)\[H]	
Succinamic acid (117 *g mol*$^{-1}$)	4-Amino-4-oxobutanoic acid **($C_4H_7NO_3$)**	638-32-4	NC(=O)CCC(O)=O	
Succinic acid (118 *g mol*$^{-1}$)	Butanedioic acid **($C_4H_6O_4$)**	110-15-6	O=C(O)CCC(=O)O	

Acronym (M Weight)	IUPAC Name (Formula)	CAS No	SMILES Code	Structure
Carbon dioxide (*44 g mol*$^{-1}$)	Carbon dioxide **(CO_2)**	NR	C(=O)=O	

Table A-5. The ROCKS Table for Triclopyr (ACID) and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	Maximum %AR (day)		Final %AR (SL)
PARENT					
Triclopyr (Triclopyr Acid)	835.2240 Aqueous photolysis	49992401	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
Maleamic acid (Unk 1)	835.2240 Aqueous photolysis	49992401	pH 7	**10.3%** (0.5 d)	5.9% (30 d)
[(3-Chloro,5,6-dihydroxy-2-pyrindinyl)oxy]acetic acid or isomer (Unk 4)	835.2240 Aqueous photolysis	49992401	pH 7	**29.4%** (1 d)	ND (30 d)
Mixture of Chloromaleamic acid, Fumaric acid, and Chlorofumaric amide (Unk 6)	835.2240 Aqueous photolysis	49992401	pH 7	**27.8%** (6 d)	**26.5%** (30 d)
	835.2240 Aqueous photolysis	49992401	pH 7		
	835.2240 Aqueous photolysis	49992401	pH 7		
Carbon dioxide	835.2240 Aqueous photolysis	49992401	pH 7	**60.2%** (30 d)	**60.2%** (30 d)
MAJOR (>10%) TRANSFORMATION PRODUCTS					
TMP	835.2240 Aqueous photolysis	49992401	pH 7	0.8% (0.25 d)	ND (30 d)
Fumaric amide (Unk 2)	835.2240 Aqueous photolysis	49992401	pH 7	8.4% (14 d)	7.8% (30 d)
Mixture of succinamic acid and succinic acid (Unk 3)	835.2240 Aqueous photolysis	49992401	pH 7	8.8% (1 d)	2.1% (30 d)
	835.2240 Aqueous photolysis	49992401	pH 7		

Triclopyr (ACID) and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
PARENT					
Triclopyr	835.4100 Aerobic soil metabolism	49992402	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
TCP	835.4100 Aerobic soil metabolism	49992402	Silt loam	**34.5%** (14 d)	4.4% (120 d)
			Sandy clay loam	**19.4%** (59 d)	3.2% (120 d)
			Sandy loam	**27.8%** (59 d)	**19.0%** (120 d)
			Clay loam	**24.2%** (30 d)	1.7% (120 d)
Carbon dioxide	835.4100	49992402	Silt loam	**58.2%** (120 d)	**58.2%** (120 d)

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
	Aerobic soil metabolism		Sandy clay loam	**57.7%** (120 d)	**57.7%** (120 d)
			Sandy loam	**51.1%** (120 d)	**51.1%** (120 d)
			Clay loam	**53.2%** (120 d)	**53.2%** (120 d)
Unextractable residues	835.4100 Aerobic soil metabolism	49992402	Silt loam	**17.8%** (59 d)	**16.4%** (120 d)
			Sandy clay loam	**23.9%** (120 d)	**23.9%** (120 d)
			Sandy loam	**17.6%** (120 d)	**17.6%** (120 d)
			Clay loam	**26.6%** (59 d)	**23.0%** (120 d)
MINOR (<10%) TRANSFORMATION PRODUCTS					
TMP	835.4100 Aerobic soil metabolism	49992402	Silt loam	2.8% (30 d)	0.5% (120 d)
			Sandy clay loam	0.6% (14 d)	0.3% (120 d)
			Sandy loam	4.8% (120 d)	4.8% (120 d)
			Clay loam	4.4% (30 d)	1.2% (120 d)
MTCP	835.4100 Aerobic soil metabolism	49992402	Silt loam	5.6% (59 d)	4.9% (120 d)
			Sandy clay loam	0.4% (59 d)	0.1% (120 d)
			Sandy loam	4.4% (120 d)	4.4% (120 d)
			Clay loam	3.7% (90 d)	1.2% (120 d)
3,5 DCMP	835.4100 Aerobic soil metabolism	49992402	Silt loam	1.2% (120 d)	1.2% (120 d)
			Sandy clay loam	1.4% (120 d)	1.4% (120 d)
			Sandy loam	0.2% (90 d)	ND (120 d)
			Clay loam	1.3% (59 d)	0.9% (120 d)
5,6 DCMP	835.4100 Aerobic soil metabolism	49992402	Silt loam	0.3% (120 d)	0.3% (120 d)
			Sandy clay loam	0.4% (120 d)	0.4% (120 d)
			Sandy loam	0.4% (120 d)	0.4% (120 d)
			Clay loam	0.8% (90, 120 d)	0.8% (120 d)

Triclopyr (ACID) and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
PARENT					
Triclopyr (Triclopyr Acid)	835.4200 Anaerobic soil metabolism	49992403	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
TCP (3,5,6-TCP)	835.4200 Anaerobic soil metabolism	49992403	Clay	**54.0%** (152 d)	**54.0%** (152 d)
			Silt loam	**40.4%** (99 d)	**27.3%** (131 d)
			Sandy loam	**43.4%** (90 d)	**17.9%** (152 d)
			Clay loam	**32.8%** (19 d)	**12.5%** (132 d)
3,6-DCP	835.4200 Anaerobic soil metabolism	49992403	Silt loam	**10.6%** (131 d)	**10.6%** (131 d)
			Sandy loam	**31.8%** (152 d)	**31.8%** (152 d)
			Clay loam	**21.4%** (132 d)	**21.4%** (132 d)
Carbon dioxide	835.4200 Anaerobic soil metabolism	49992403	Clay	4.4% (90 d)	4.0% (152 d)
			Silt loam	**20.4%** (131 d)	**20.4%** (131 d)
			Sandy loam	**19.4%** (61 d)	**17.8%** (152 d)
			Clay loam	7.3% (72 d)	6.5% (132 d)
Unextractable residues	835.4200 Anaerobic soil metabolism	49992403	Silt loam	**21.5%** (131 d)	**21.5%** (131 d)
			Sandy loam	**14.3%** (120 d)	**13.3%** (152 d)
			Clay loam	**32.2%** (103, 132 d)	**32.2%** (132 d)
MINOR (<10%) TRANSFORMATION PRODUCTS					
TMP (X163004)	835.4200 Anaerobic soil metabolism	49992403	Clay	4.4% (37 d)	ND (152 d)
			Silt loam	8.1% (16 d)	1.7% (131 d)
			Sandy loam	6.4% (37 d)	1.2% (152 d)
			Clay loam	5.0% (19 d)	ND (132 d)
[(3,6-Dichloropyridin-2-yl)oxy]acetic acid (X124085) OR [(5,6-Dichloropyridin-2-yl)oxy]acetic acid	835.4200 Anaerobic soil metabolism	49992403	Silt loam	3.9% (69 d)	3.3% (131 d)
			Sandy loam	1.8% (30, 37 d)	ND (152 d)
			Clay loam	2.5% (72 d)	2.1% (132 d)
X79402	835.4200 Anaerobic soil metabolism	49992403	Sandy loam	0.7% (90 d)	ND (152 d)

Triclopyr BEE and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
PARENT					
Triclopyr Butoxyethyl Ester (Triclopyr BEE)	835.4400 Anaerobic aquatic metabolism	00151967	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
Triclopyr	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	**100.5%** (1 d)	**75.3%** (365 d)
			Virginia Water: sandy loam	**98.1%** (1 d)	**86.5%** (365 d)
TCP	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	**26.0%** (365 d)	**26.0%** (365 d)
			Virginia Water: sandy loam	**42.7%** (201 d)	**22.0%** (365 d)
MINOR (<10%) TRANSFORMATION PRODUCTS					
Carbon dioxide	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	0.05% (14 d)	0.0% (365 d)
			Virginia Water: sandy loam	0.01% (14, 20 d)	0.0% (365 d)

Triclopyr BEE and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
PARENT					
Triclopyr Butoxyethyl Ester (Triclopyr BEE)	835.4300 Aerobic aquatic metabolism	49992404	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
Triclopyr	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	**98.4%** (7 d)	**11.0%** (106 d)
			Water: Sand	**89.7%** (7 d)	5.3% (106 d)
TCP	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	**33.4%** (59 d)	**18.7%** (106 d)
			Water: Sand	**23.7%** (106 d)	**23.7%** (106 d)
3,6-DCP (3,6-Dichloro-2-pyridinol)	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	**52.4%** (106 d)	**52.4%** (106 d)
			Water: Sand	**33.7%** (59 d)	**30.0%** (106 d)
5-CLP & 6-CLP (5- & 6-Chloro-2-pyridinol)	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	**25.5%** (59 d)	**20.6%** (106 d)
			Water: Sand	1.2% (106 d)	1.2% (106 d)
Unextractable residues	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	**13.0%** (106 d)	**13.0%** (106 d)
			Water: Sand	**11.2%** (106 d)	**11.2%** (106 d)
MINOR (<10%) TRANSFORMATION PRODUCTS					
TMP	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	2.08% (0.02 d)	0.04% (106 d)
			Water: Sand	1.87% (0.02 d)	0.04% (106 d)
Carbon dioxide	835.4300 Aerobic aquatic metabolism	49992404	Water: Loam	0.5% (106 d)	0.5% (106 d)
			Water: Sand	1.6% (106 d)	1.6% (106 d)

Triclopyr BEE and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Study Type	MRID	System	Maximum %AR	Final %AR (SL)
PARENT					
Triclopyr Butoxyethyl Ester (Triclopyr BEE)	835.4400 Anaerobic aquatic metabolism	00151967	PRT		
MAJOR (>10%) TRANSFORMATION PRODUCTS					
Triclopyr	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	**100.5%** (1 d)	**75.3%** (365 d)
			Virginia Water: sandy loam	**98.1%** (1 d)	**86.5%** (365 d)
TCP	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	**26.0%** (365 d)	**26.0%** (365 d)
			Virginia Water: sandy loam	**42.7%** (201 d)	**22.0%** (365 d)
MINOR (<10%) TRANSFORMATION PRODUCTS					
Carbon dioxide	835.4400 Anaerobic aquatic metabolism	00151967	Georgia Water: sandy loam	0.05% (14 d)	0.0% (365 d)

[A]**AR**= Applied radioactivity; **PRT**= Parent; **SL**= Study length; **ND**= Not detected; **NA**= Not applicable

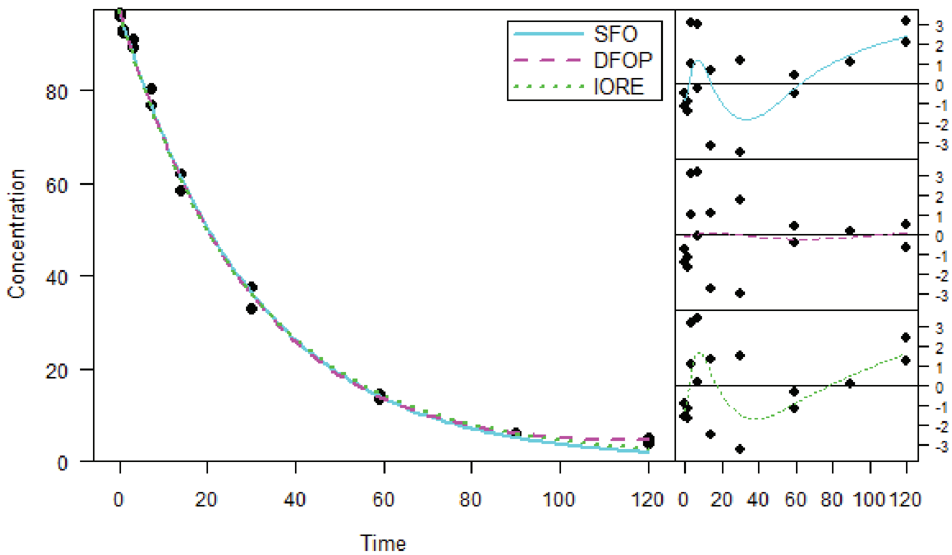
APPENDIX B. Calculations of Half-lives for the Residue of Concern; Calculations of Exposure EECs for TCP Degradate Using the Formation and Decline (F/D) Approach; and Examples for Aquatic Modeling Inputs and Outputs

I. Calculations of half-lives for the Residue of Concern (ROC)

Aerobic soil

Aerobic metabolism of Triclopyr ROC in silt loam soil

Days	% AR
0	96.0
0	96.7
1	93.1
1	92.6
3	91.2
3	89.1
7	80.3
7	77.0
14	62.1
14	58.3
30	32.9
30	37.6
59	13.6
59	14.5
90	6.20
90	6.20
120	5.10
120	4.00

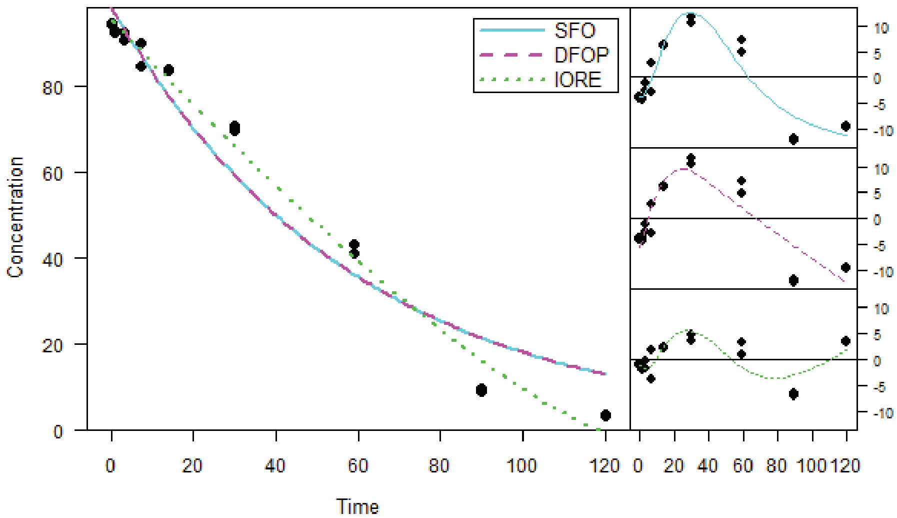


	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	21.2	70.3	2.2	97.1	k= 0.0327
DFOP	20.8	71.1	1.8	97.4	f= 0.999, k_0= 0.0335, k_1= -0.0272
IORE	20.7	73.2	2.1	97.6	N= 1.08, k= 0.0242

S_C	69.8
S_{SFO}	65.9
Slow $t_{1/2}$	-25.5
$t_{R\ IORE}$	22

Aerobic metabolism of Triclopyr ROC in sandy clay loam soil

Days	% AR
0	94.3
0	94.6
1	92.3
1	92.8
3	92.3
3	90.8
7	84.6
7	90.1
14	84.0
14	83.6
30	69.6
30	70.8
59	41.0
59	43.4
90	9.80
90	9.10
120	3.60
120	3.20

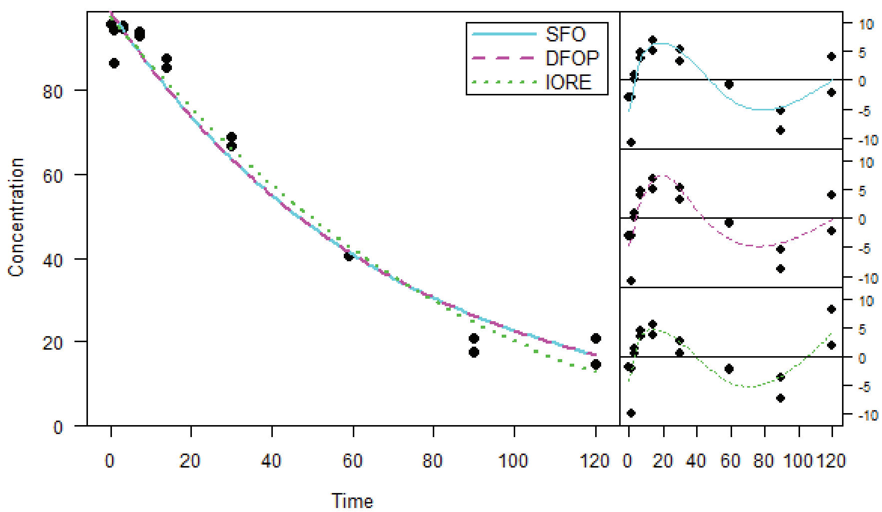


	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	41	136	9	98.3	k = 0.0169
DFOP	41	136	10	98.3	f = 0.821, k_0 = 0.0169, k_1 = 0.0169
IORE	50.2	100	4.2	95.5	N = 0.219, k = 0.375

S_C	234
S_{SFO}	951
Slow $t_1/_2$	41
$t_{R\ IORE}$	30.1

Aerobic metabolism of Triclopyr ROC in sandy loam soil

Days	% AR
0	95.7
0	95.7
1	94.2
1	86.4
3	95.4
3	94.6
7	94.0
7	93.0
14	85.5
14	87.4
30	66.7
30	68.8
59	40.7
59	40.5
90	17.5
90	21.0
120	14.7
120	21.0

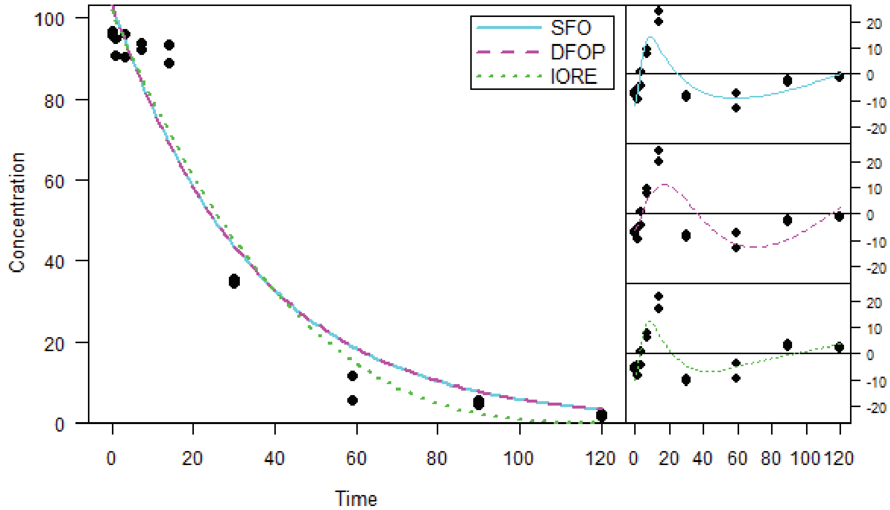


	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	47.2	157	5.4	98.8	k = 0.0147
DFOP	47.2	157	6.1	98.8	f = 0.524, k_0 = 0.0147, k_1 = 0.0147
IORE	50.8	131	5	97.5	N = 0.651, k = 0.06

S_C	400
S_{SFO}	429
Slow $t_1/_2$	47.2
$t_{R\ IORE}$	39.3

Aerobic metabolism of Triclopyr ROC in clay loam soil

Days	% AR
0	95.7
0	96.6
1	90.9
1	94.8
3	95.8
3	90.4
7	93.9
7	92.2
14	88.7
14	93.2
30	35.5
30	34.6
59	11.6
59	5.80
90	4.60
90	5.80
120	1.60
120	2.30



	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	24.1	80.1	14	103	k = 0.0287
DFOP	24.1	80.1	15	103	f = 0.867, k_0 = 0.0287, k_1 = 0.0287
IORE	26.3	67.3	13	102	N = 0.645, k = 0.121

S_C	1.59e+03
S_{SFO}	1.75e+03
Slow $t_{1/2}$	24.1
$t_{R\ IORE}$	20.2

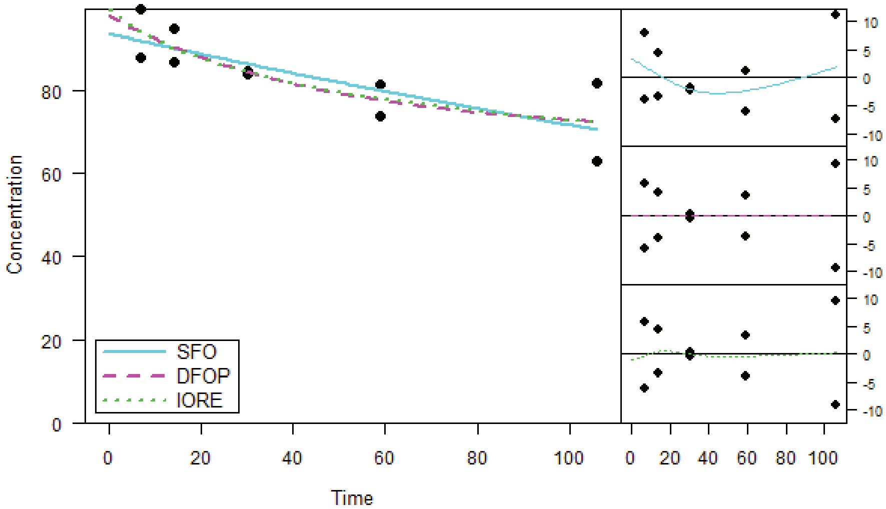
The 90 percent upper confidence bound on the mean of 4 values

(21.2; 41; 47.2 and 24.1 d @ 20 ºC) Or (14.9; 29; 33.4 and 17 @ 25 ºC) = **31 days** @ 25 ºC

Aerobic Aquatic

Triclopyr ROC in aerobic water:loam sediment

Days	%AR
7	99.6
7	87.9
14	86.6
14	94.6
30	83.9
30	84.6
59	73.9
59	81.2
106	63.0
106	81.7

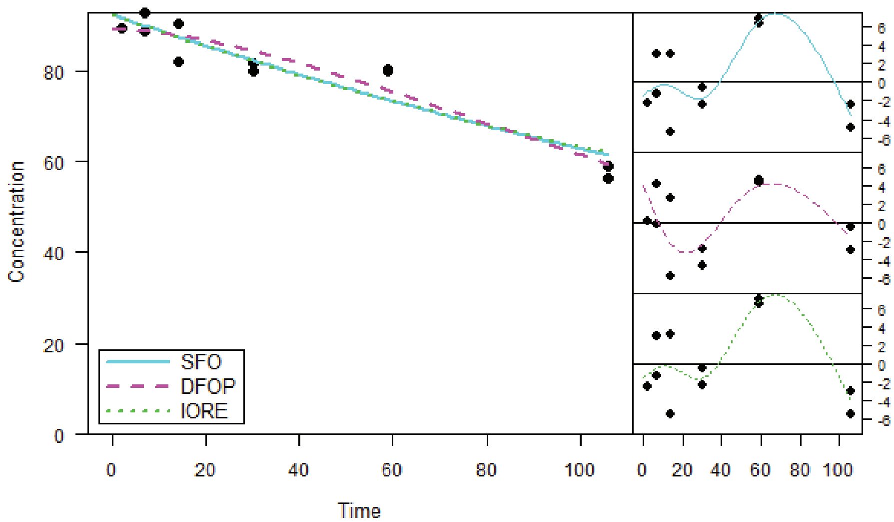


	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	259	861	1.8	93.5	k = 0.00267
DFOP	2617	13959	0.13	97.8	f = 0.275, k_0 = 0.0223, k_1 = 0.000142
IORE	1213	26280601	0.34	99.4	N = 7.19, k = 4.06e-15

S_C	416
S_{SFO}	337
Slow $t_{1/2}$	4.88e+03
$t_{R\ IORE}$	7.91e+06

Triclopyr ROC in aerobic water:sand sediment

Days	%AR
2	89.2
7	88.5
7	92.8
14	81.9
14	90.4
30	79.7
30	81.5
59	79.9
59	80.3
106	56.4
106	58.9



	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	180	598	3.3	92.2	k = 0.00385
DFOP	153	378	3.4	89.1	f = -0.847, k_0 = 0.0161, k_1 = 0.00765
IORE	192	839	3.8	92.3	N = 1.32, k = 0.000963

S_C	250
S_{SFO}	180
Slow $t_{1/2}$	90.6
$t_{R\ IORE}$	253

The 90 percent upper confidence bound on the mean of two values (259 & 180 d @ 20 °C or (183.1 & 127.3 d @ 25 °C) = **241 days** @ 25 °C

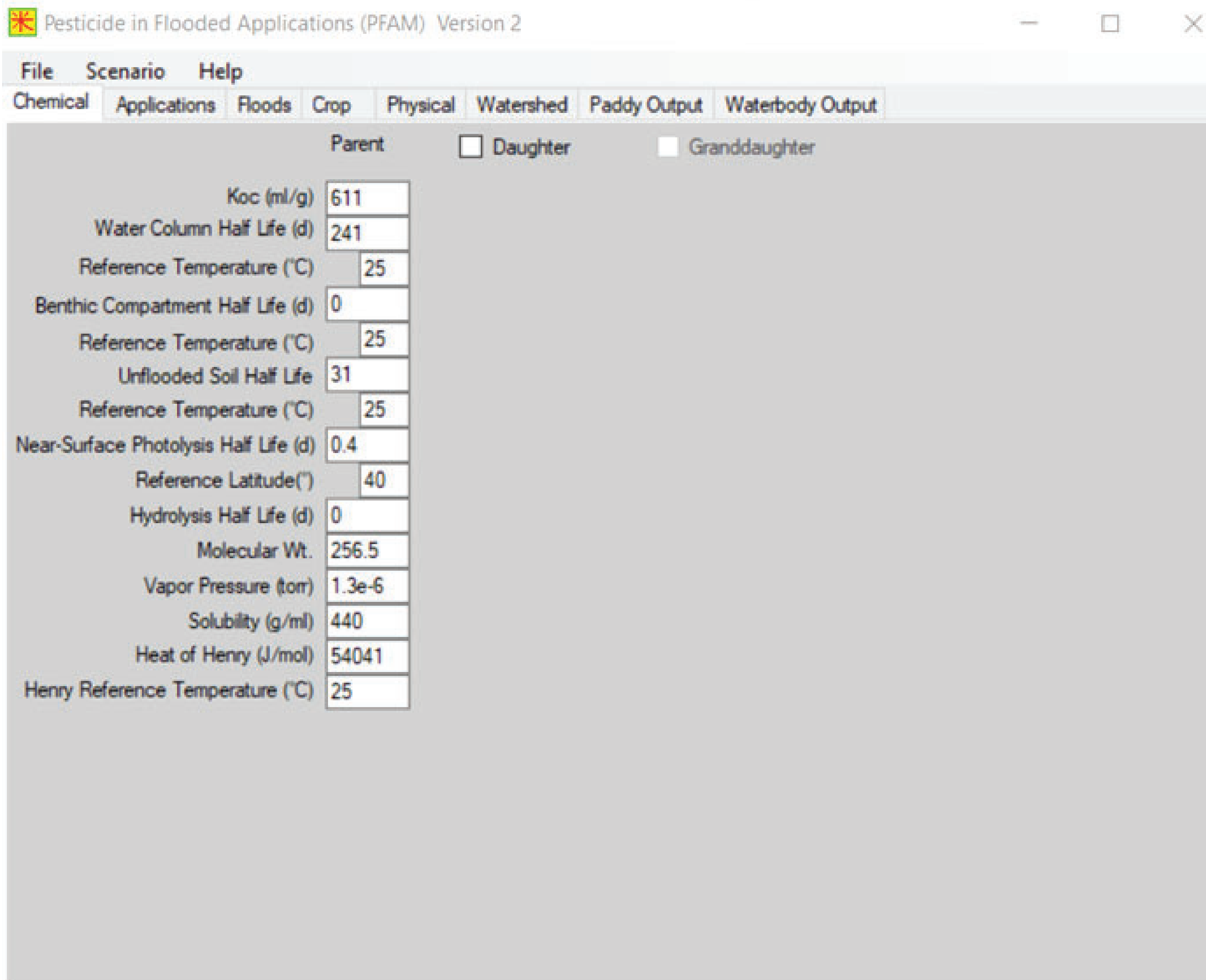
II. Examples for Aquatic Modeling Inputs and Outputs

Use on Rice

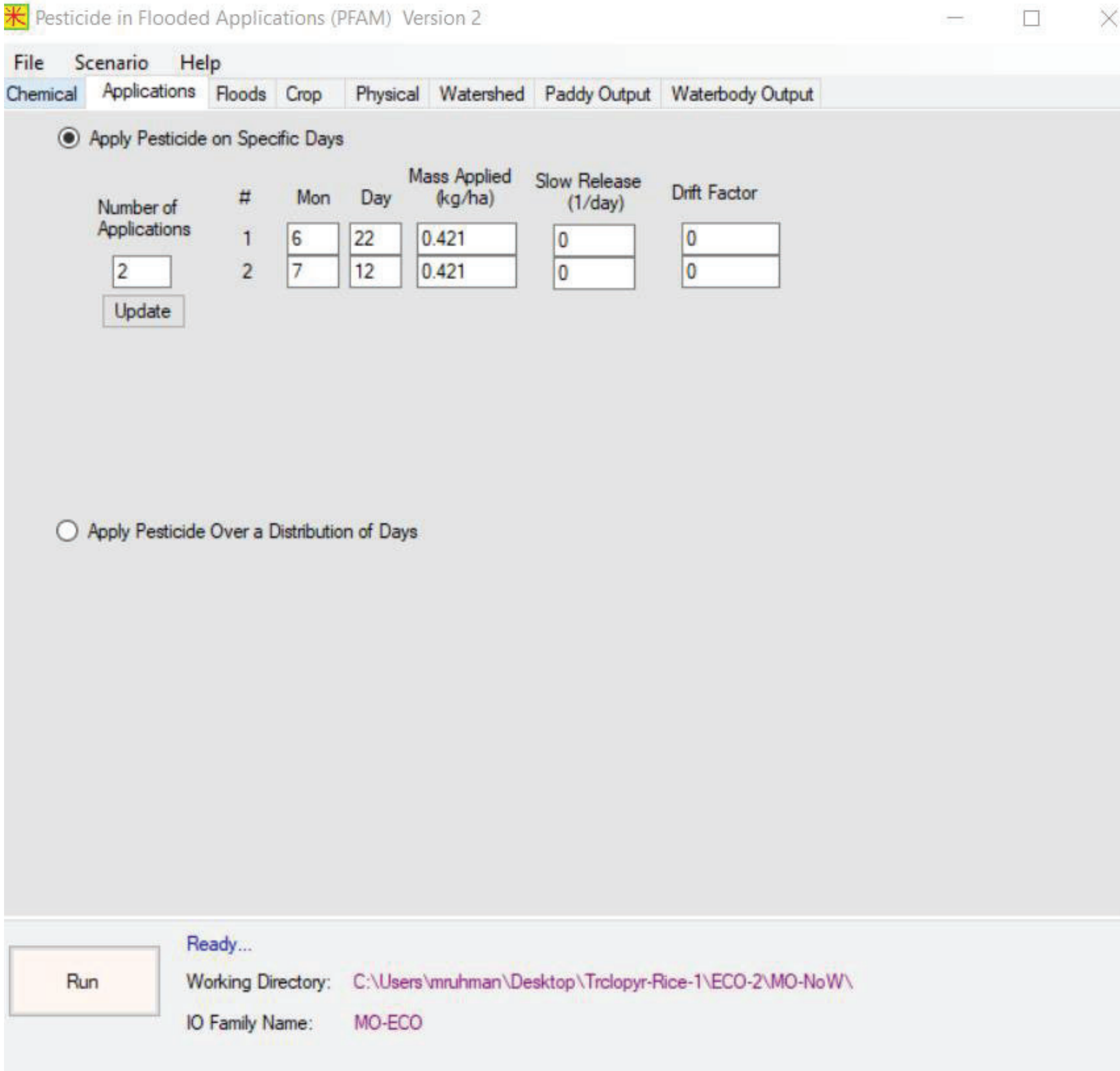
Scenario: ECO MO noWinter

Inputs

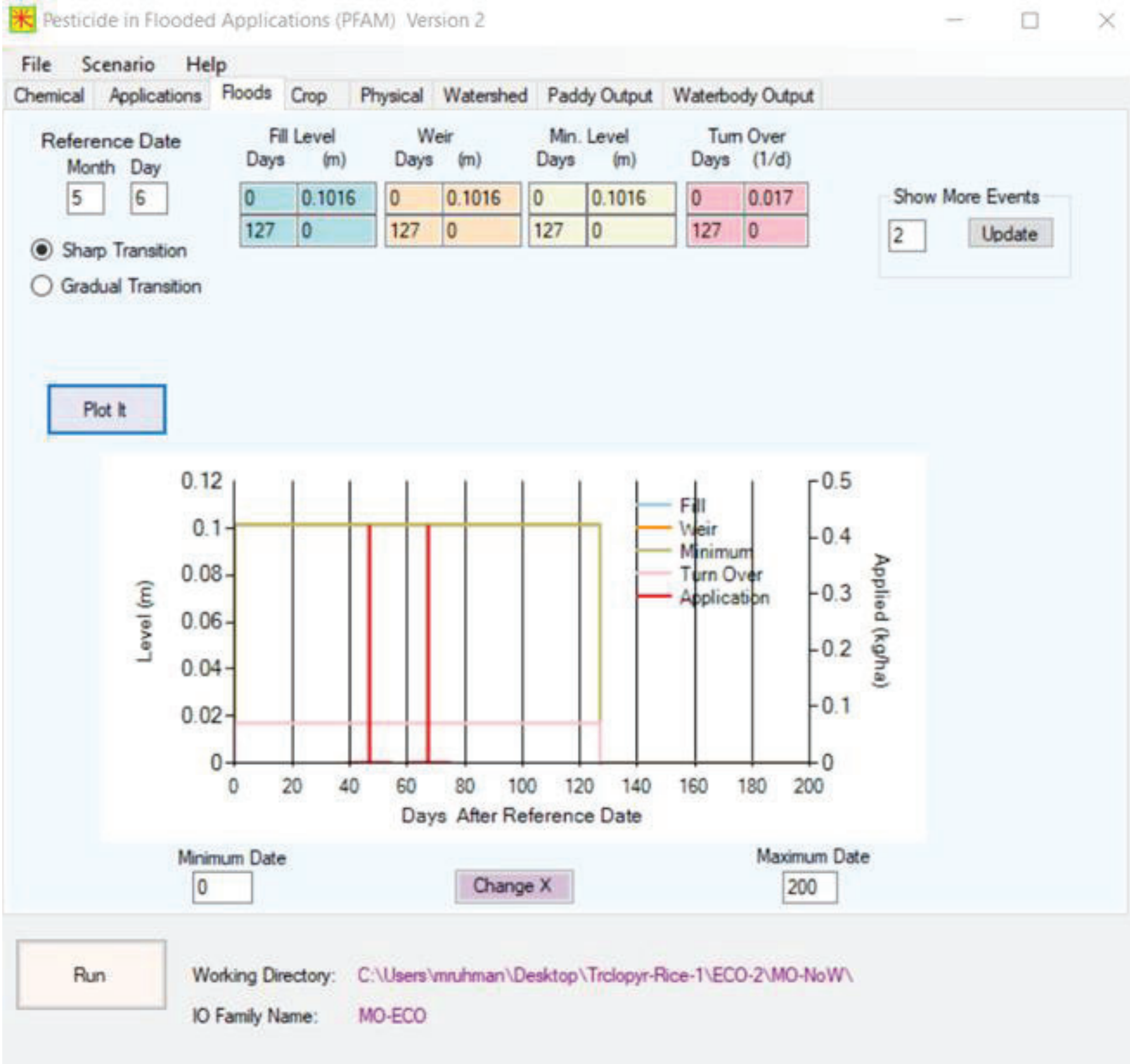
Chemical (ROC)



Applications



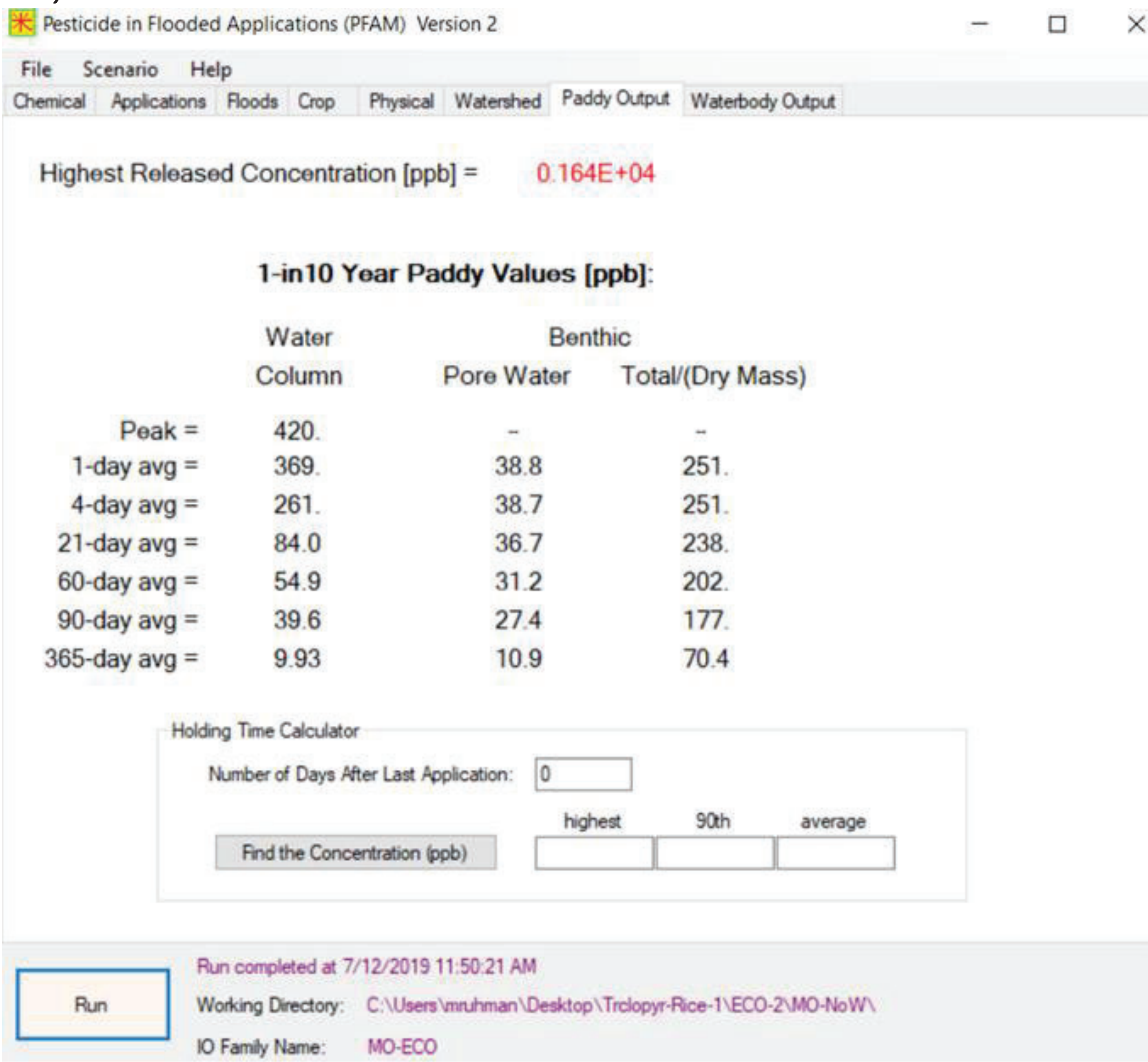
Floods



Pesticide in Flooded Applications (PFAM) Version 2
File
Scenario
Help
Chemical
Applications
Floods
Crop
Physical
Watershed
Paddy Output
Waterbody Output
Reference Date
Month
Day
5
6
Fill Level
Days (m)
0 0.1016
127 0
Weir
Days (m)
0 0.1016
127 0
Min. Level
Days (m)
0 0.1016
127 0
Turn Over
Days (1/d)
0 0.017
127 0
Show More Events
2
Update
Sharp Transition
Gradual Transition
Plot It
Level (m)
Applied (kg/ha)
Days After Reference Date
Fill
Weir
Minimum
Turn Over
Application
Minimum Date
0
Change X
Maximum Date
200
Run
Working Directory: C:\Users\mruhman\Desktop\Trclopyr-Rice-1\ECO-2\MO-NoW\
IO Family Name: MO-ECO

Output

Paddy Concentrations



Pesticide in Flooded Applications (PFAM) Version 2

File Scenario Help

Chemical | Applications | Floods | Crop | Physical | Watershed | Paddy Output | Waterbody Output

Highest Released Concentration [ppb] = 0.164E+04

1-in10 Year Paddy Values [ppb]:

	Water Column	Benthic Pore Water	Benthic Total/(Dry Mass)
Peak =	420.	--	--
1-day avg =	369.	38.8	251.
4-day avg =	261.	38.7	251.
21-day avg =	84.0	36.7	238.
60-day avg =	54.9	31.2	202.
90-day avg =	39.6	27.4	177.
365-day avg =	9.93	10.9	70.4

Holding Time Calculator

Number of Days After Last Application: 0

Find the Concentration (ppb) | highest | 90th | average

Run

Run completed at 7/12/2019 11:50:21 AM

Working Directory: C:\Users\mruhman\Desktop\Trclopyr-Rice-1\ECO-2\MO-NoW\

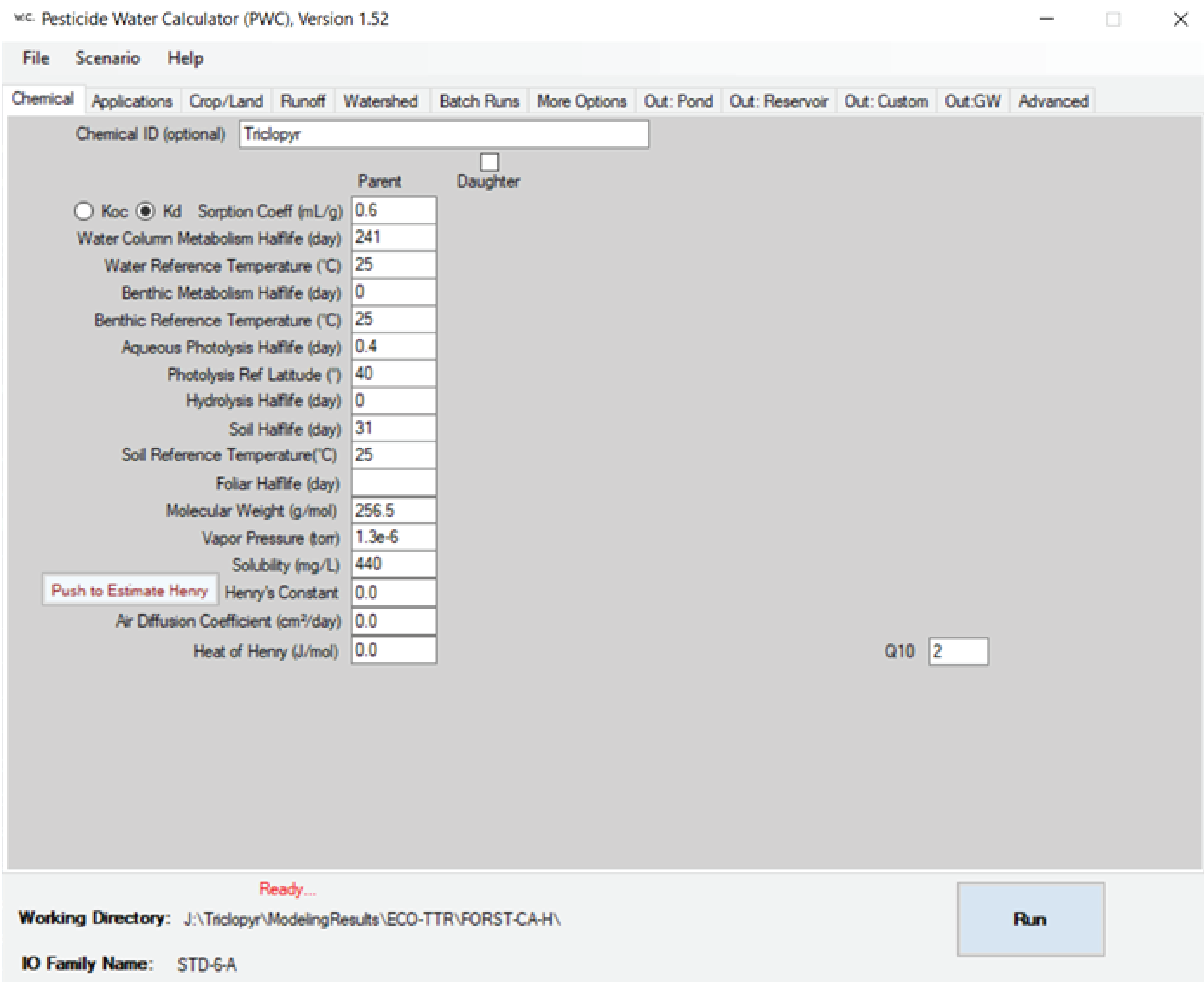
IO Family Name: MO-ECO

Use on Forestry (ACID, TEA and COLN represented by ROC)

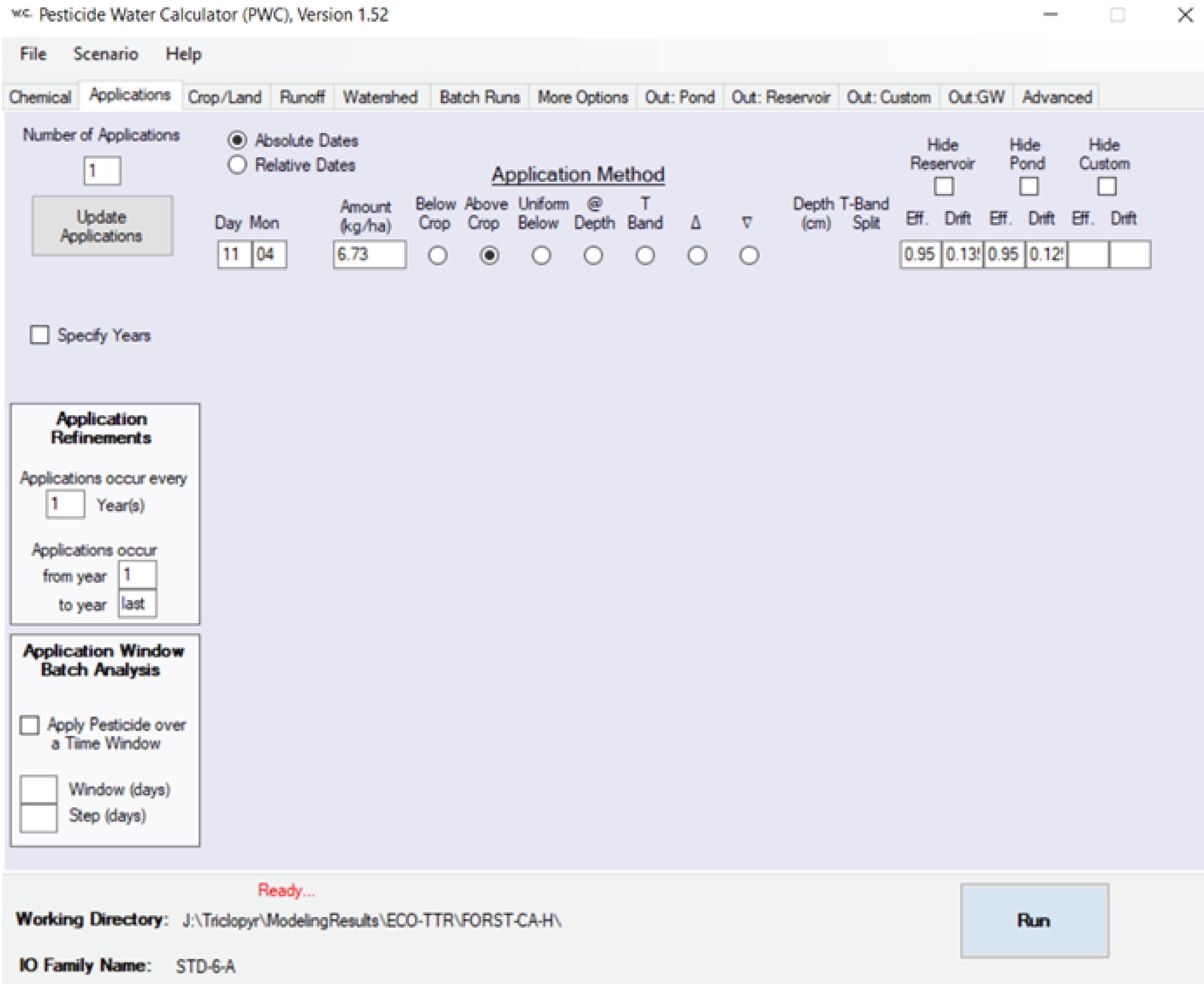
Scenario: CAForestryRLF (6 lbs. a.e./A= 6.73 kg/ha; 11-Apr; A)

Inputs

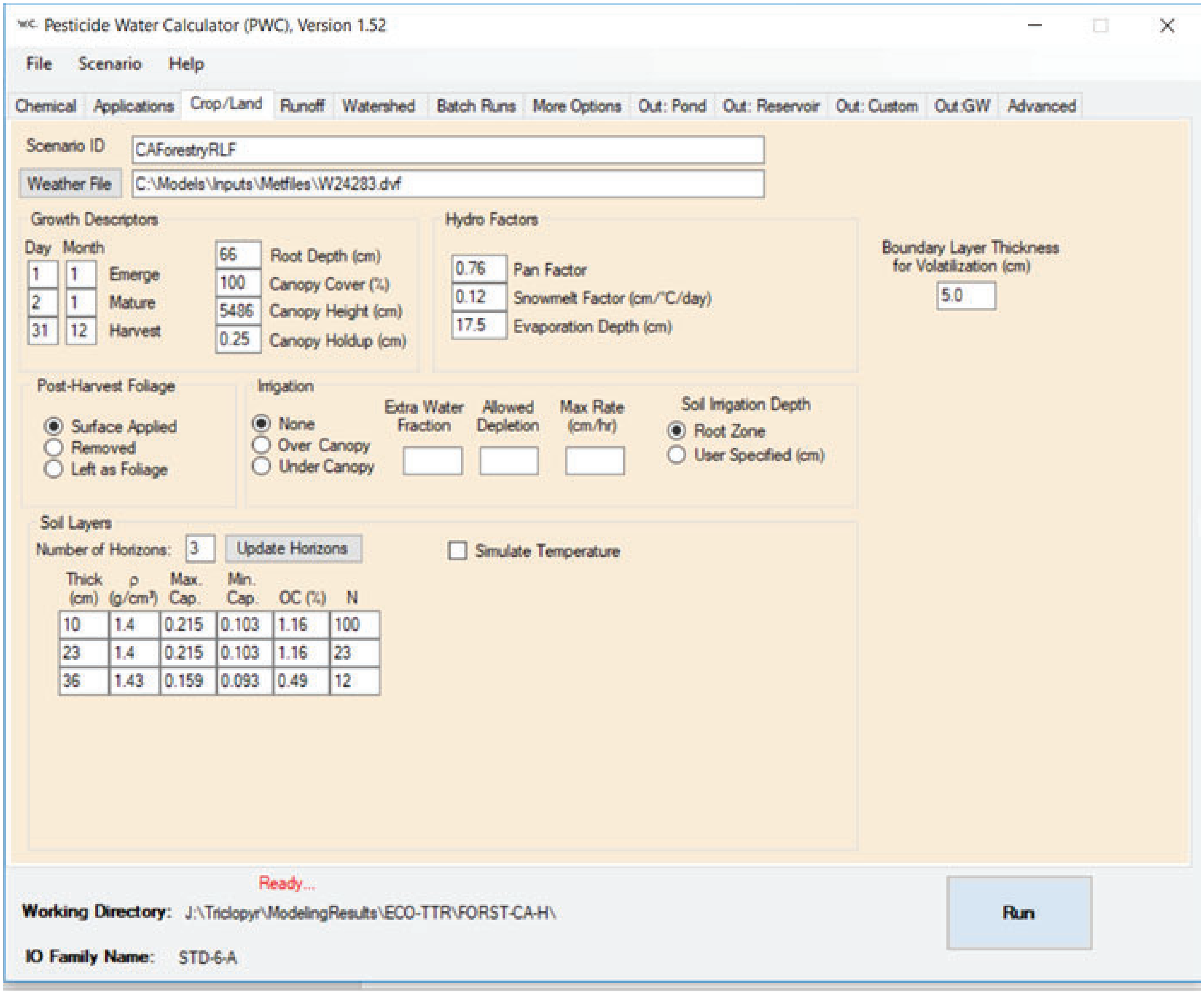
Chemical



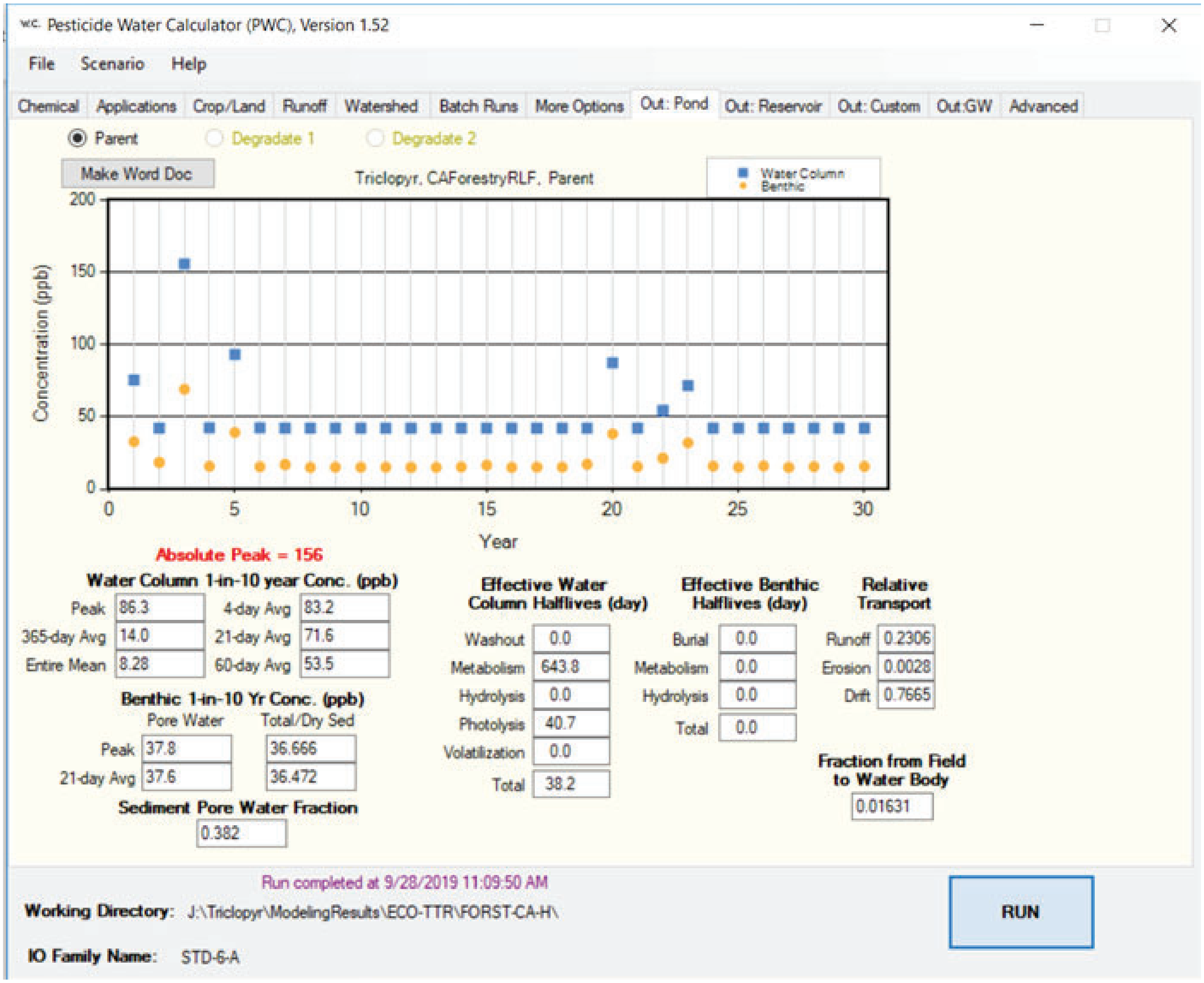
Applications



Crop-Land


Pesticide Water Calculator (PWC), Version 1.52
File
Scenario
Help
Chemical
Applications
Crop/Land
Runoff
Watershed
Batch Runs
More Options
Out: Pond
Out: Reservoir
Out: Custom
Out:GW
Advanced
Scenario ID
CAForestryRLF
Weather File
C:\Models\Inputs\Metfiles\W24283.dvf
Growth Descriptors
Day Month
1 1 Emerge
2 1 Mature
31 12 Harvest
66 Root Depth (cm)
100 Canopy Cover (%)
5486 Canopy Height (cm)
0.25 Canopy Holdup (cm)
Hydro Factors
0.76 Pan Factor
0.12 Snowmelt Factor (cm/°C/day)
17.5 Evaporation Depth (cm)
Boundary Layer Thickness for Volatilization (cm)
5.0
Post-Harvest Foliage
Surface Applied
Removed
Left as Foliage
Irrigation
None
Over Canopy
Under Canopy
Extra Water Fraction
Allowed Depletion
Max Rate (cm/hr)
Soil Irrigation Depth
Root Zone
User Specified (cm)
Soil Layers
Number of Horizons: 3
Update Horizons
Simulate Temperature
Thick (cm) ρ (g/cm³) Max. Cap. Min. Cap. OC (%) N
10 1.4 0.215 0.103 1.16 100
23 1.4 0.215 0.103 1.16 23
36 1.43 0.159 0.093 0.49 12
Ready...
Working Directory: J:\Triclopyr\ModelingResults\ECO-TTR\FORST-CA-H\
IO Family Name: STD-6-A
Run

Output



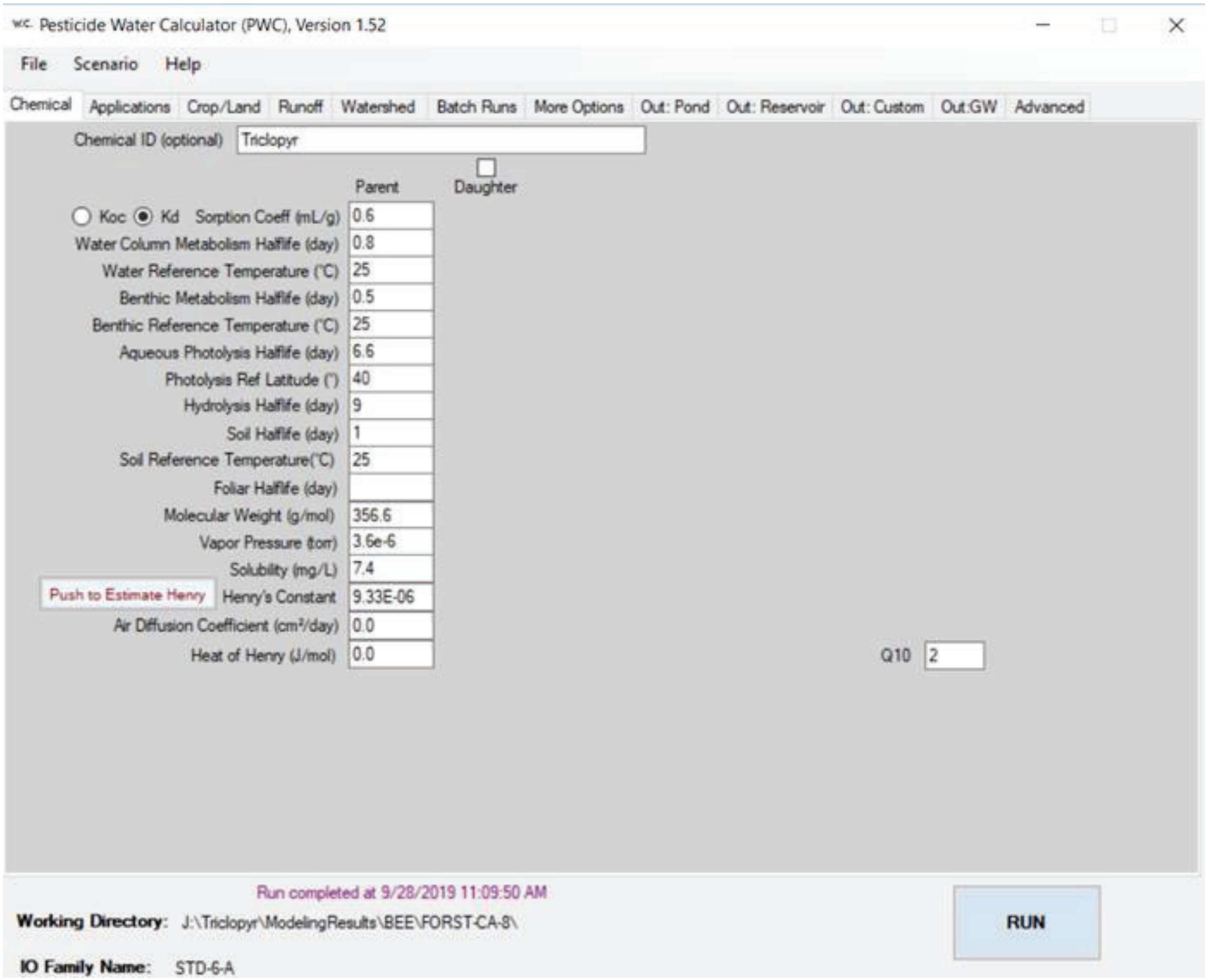
1-day EEC= 85.5 ppb (from out file)

Use on Forestry (BEE)

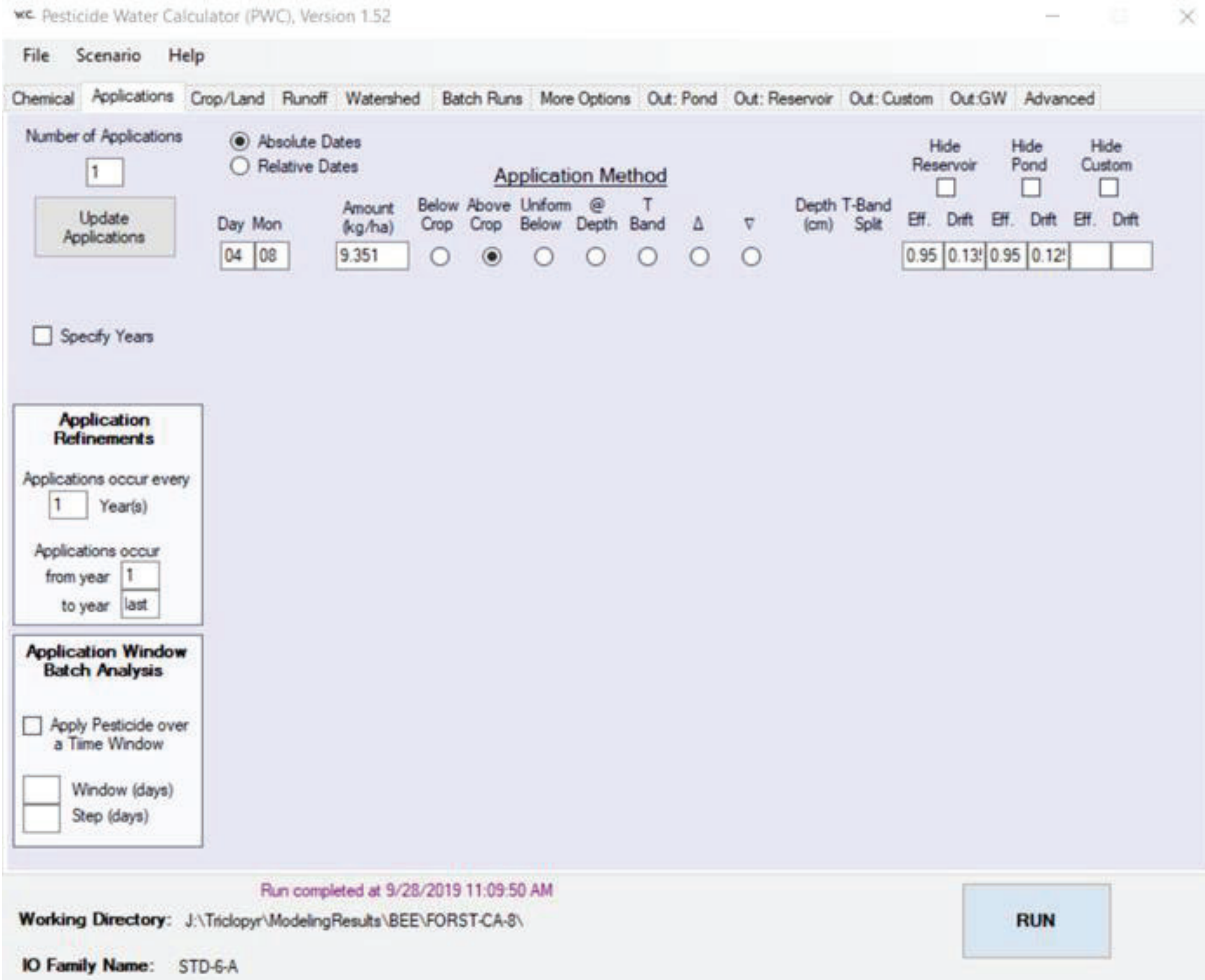
Scenario: CAForestryRLF (6 lbs. a.i./A= 9.35 kg /a.i/ha; 11-Apr; A)= a.i= BEE

Inputs

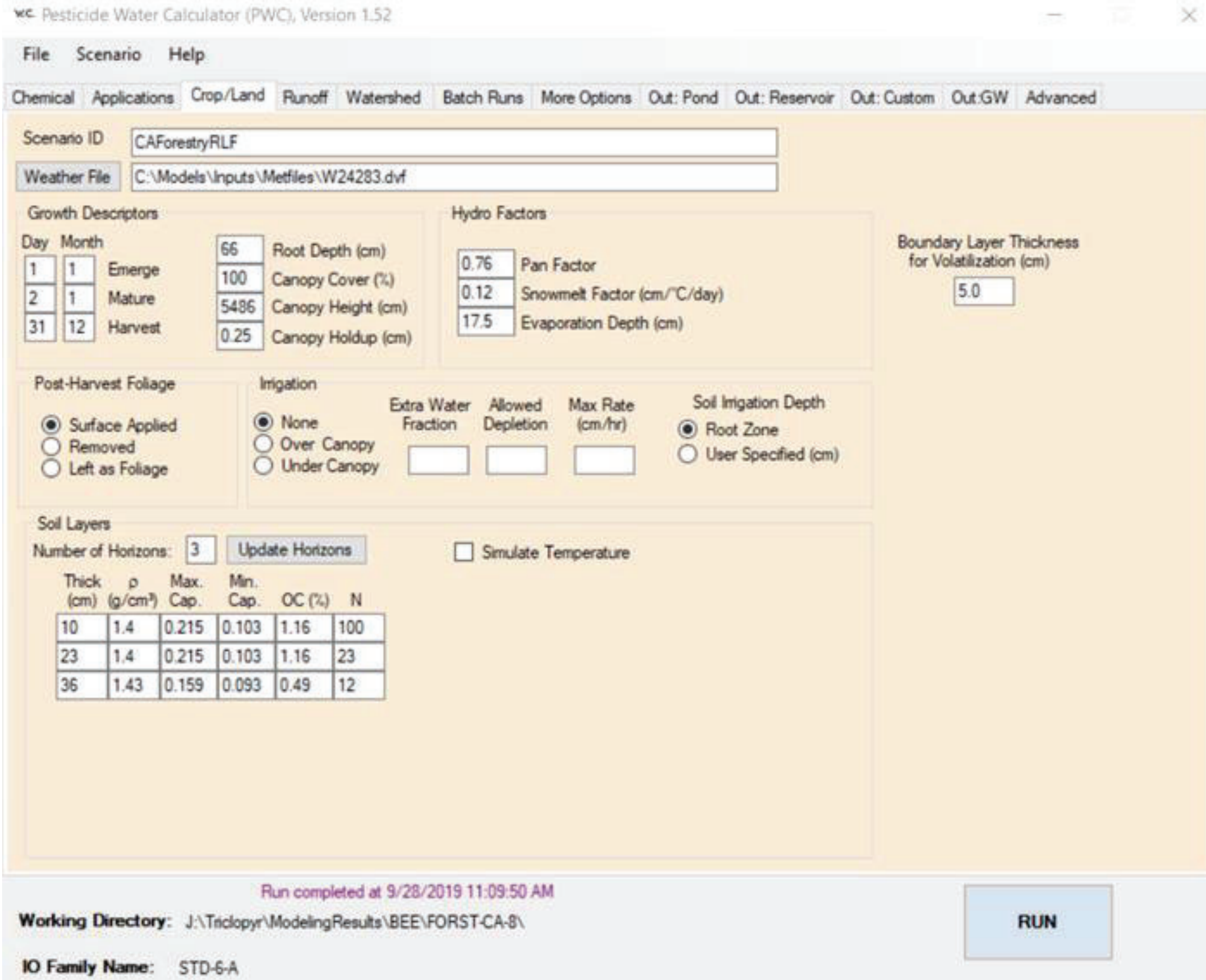
Chemical



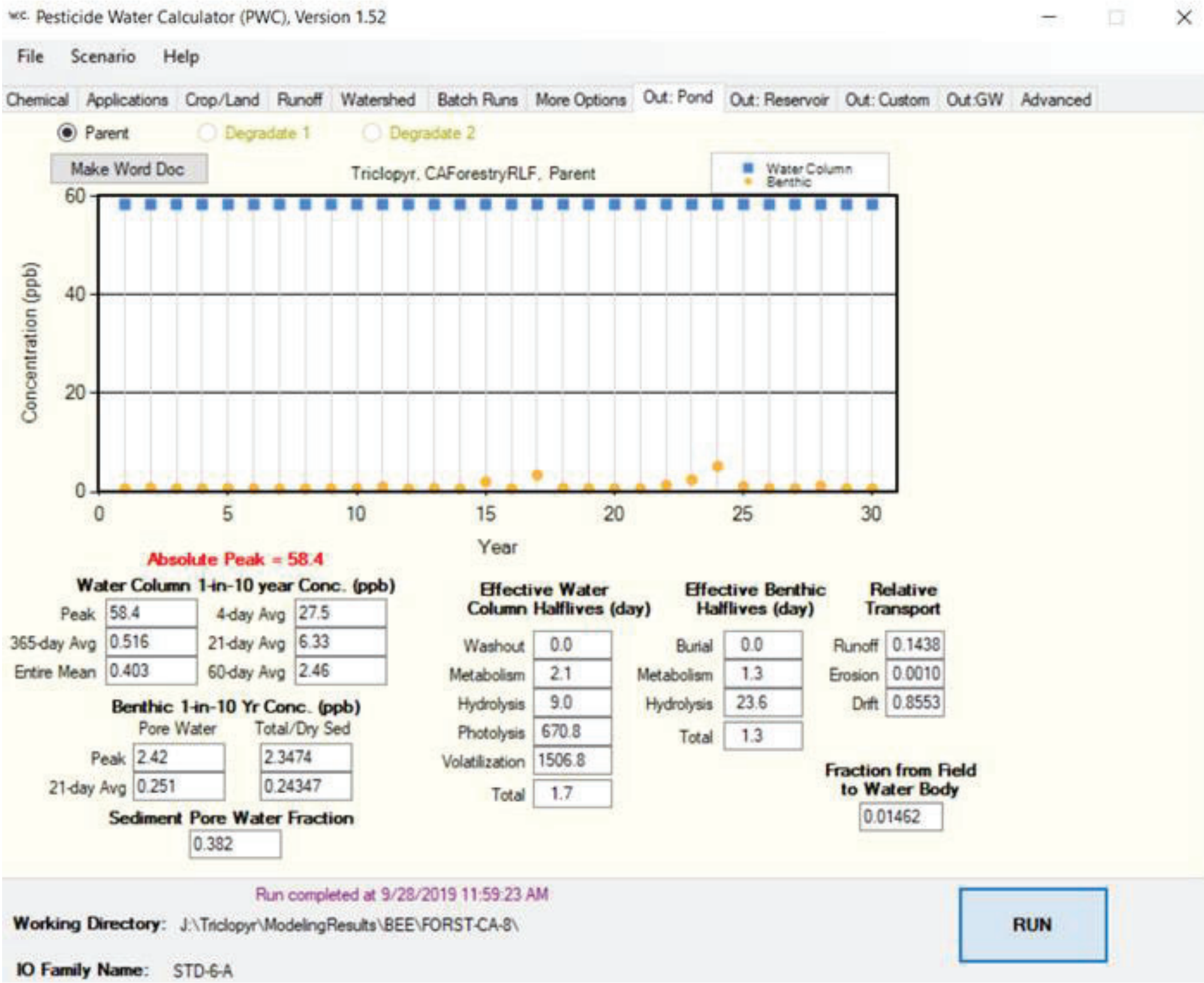
__Applications__



Crop/Land


Pesticide Water Calculator (PWC), Version 1.52
File
Scenario
Help
Chemical
Applications
Crop/Land
Runoff
Watershed
Batch Runs
More Options
Out: Pond
Out: Reservoir
Out: Custom
Out:GW
Advanced
Scenario ID
CAForestryRLF
Weather File
C:\Models\Inputs\Metfiles\W24283.dvf
Growth Descriptors
Day Month
1 1 Emerge
2 1 Mature
31 12 Harvest
66 Root Depth (cm)
100 Canopy Cover (%)
5486 Canopy Height (cm)
0.25 Canopy Holdup (cm)
Hydro Factors
0.76 Pan Factor
0.12 Snowmelt Factor (cm/°C/day)
17.5 Evaporation Depth (cm)
Boundary Layer Thickness for Volatilization (cm)
5.0
Post-Harvest Foliage
Surface Applied
Removed
Left as Foliage
Irrigation
None
Over Canopy
Under Canopy
Extra Water Fraction
Allowed Depletion
Max Rate (cm/hr)
Soil Irrigation Depth
Root Zone
User Specified (cm)
Soil Layers
Number of Horizons: 3
Update Horizons
Simulate Temperature
Thick (cm) ρ (g/cm³) Max. Cap. Min. Cap. OC (%) N
10 1.4 0.215 0.103 1.16 100
23 1.4 0.215 0.103 1.16 23
36 1.43 0.159 0.093 0.49 12
Run completed at 9/28/2019 11:09:50 AM
Working Directory: J:\Triclopyr\ModelingResults\BEE\FORST-CA-8\
IO Family Name: STD-6-A
RUN

Output



1-day EEC= 47.3 ppb (from out file)

III. Calculations of Exposure EECs for TCP Degradate Using the Formation and Decline (F/D) Approach

The EECs for the TCP degradate, forming from applications of triclopyr ACID and BEE, were estimated according to the formation and decline method guiding principles presented in Attachment 2 for Methods for Assessing Aquatic Exposure to Residue(s) of Concern, EFED division Director Memo dated June 20, 2019. The exercise requires the following:

(1) Identification of chemical species and degradation pathway associated with the formation of TCP from ACIC and from BEE
(2) Preparation of fate and transport data for TCP and all the chemical species associated with its formation;
(3) Identification of all fate processes involved in TCP formation (i.e., water column metabolism, benthic metabolism, photolysis, hydrolysis, soil metabolism and foliar degradation represented by aerobic/ anaerobic aquatic metabolism, aqueous photolysis, hydrolysis, aerobic soil metabolism and foliar degradation, respectively);
(4) Collection of data for each of the fate processes identified in 3 above (from submitted fate studies) in order to calculate the Molar Formation/Decline Ratio (MFDR) for each of the identified fate process (Note: depending on the number of submitted fate studies, multiple MFDR may result for some of the fate processes;
(5) Calculation of MFDR(s) for the fate processes involved in formation of TCP; and
(6) Collection of input parameters required for execution of special PWC runs.

<u>Chemical species and degradation pathway associated with the formation of TCP from ACID and BEE</u>

Based on data presented in the fate and transport summary (section 5 of this document), TCP is a major degradate of the ACID and BEE. The chemical species associated with TCP formation are: Triclopyr ACID and BEE.

Fate and transport data for TCP and all the chemical species associated with its formation

Table B-1 includes a summary of fate and transport data for TCP. Additionally, fate and transport parameters required for PWC modeling following the F/D approach, are summarized in Table B-2; that is fate and transport parameters for the ACID, BEE and TCP.

Table B-1 Summary of Environmental Degradation Data forTCP[1].

Study	System Details	Representative Half-life[2] Or Kd value*	Source/ Study Classification
K_d (mL/g) [1]	Sandy soil: pH 7.0 and O.C 0.22%	0.53	MRID 42493901, Chlorpyriphos study
	Sandy loam soil: pH 7.8and O.C 2.54%	0.6	
	Silt loam: pH 7.1 and O.C 0.31%	1.69	
	Clay loam: pH 6.9 and O.C 2.08%	1.95	
Aerobic Soil Metabolism (days)	MO: Boone Silt loam, 25°C	34.1 (SFO)	MRID 499924-02[N] (A)
	TX: Raymondville Sandy clay loam, 25°C	20.4 (SFO)	

Study	System Details	Representative Half-life[2] Or Kd value*	Source/ Study Classification
	ND: MSL-PF Sandy loam, 25°C	22.9 (SFO)	
	CA: Tehama Clay loam, 25°C	70.3 (SFO)	
Anaerobic Soil Metabolism (days)	WY: LAD-SCL-PF Clay, 25°C	Stable	MRID 499924-03 [N] (A)
	UK: Brierlow Silt Loam, 25°C	52.2 (SFO)	
	UK: Longwood Sandy Loam, 25°C	29.4 (SFO)	
	UK: South Witham Clay, 25°C	70.4 (SFO)	
Aerobic Aquatic Metabolism[3] (days)	Italy loam sediment: Water, 25°C	Stable	MRID 499924-04 [N] (S)
	French Sand Sediment: Water, 25°C		
Anaerobic Aquatic Metabolism[4] (days)	GA Sandy Loam, 25°C	271 (SFO)	MRID 001519-67 [N] (S)
	VA Sandy loam, 25°C	Stable	

[1] **General Notes:** Studies submitted since the Problem Formulation was completed are designated with an [N] in association with the MRID number; **Studies classification:** A= Acceptable, S= Supplemental; N/A= Not applicable

[2] **Half-lives:** SFO=single first order; DFOP=double first order in parallel; DFOP slow DT_{50}=slow rate half-life of the DFOP fit

[4] The test substance is the 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester (BEE) form of triclopyr. BEE was a transient species transforming relatively quickly into the 3,5,6-trichloro-2-pyridinyloxyacetic acid (ACID) form of triclopyr. ACID maximums reached 98 & 90% in seven days. Therefore, starting from the 7-day time interval, the study can be considered to represent the fate of the ACID form of triclopyr in an aerobic aquatic system

[5] The test substance is the BEE form of triclopyr. BEE transformed completely into the ACID form of triclopyr. ACID maximums reached 101 & 98% in one-day. Therefore, the study can be considered to represent the fate of the ACID form of triclopyr in an aerobic aquatic system

Table B-2. Aquatic Modeling Input Parameters for Chemical Tabs of BEE, the ACID and TCP.

Parameter (units)	ACID & BEE Values[1]		TCP Value(s)	
	ACID	BEE	TCP	Comments and Referenced MRID
K_d (mL/g)	0.6	0.6	1.2	Average (n= 4); Chlorpyriphos study[2]
Water Column Metabolism t ½ (days) @ 25°C	29.1	0.8	Stable	MRID 00151967
Benthic Metabolism t ½ (days) @ 25°C	1,531	0.5	Stable	MRID 49992404
Aqueous Photolysis t ½ (days)@ pH 5; 40°N	0.4	6.6	0.4	Assumed to equal parent noting that this low value is expected because reported absorption spectra in MRID 001547-16 shows two high absorption peaks in the visible light (wave length between 200-400 nm)
Hydrolysis Half-life @ pH 7 (days)	Stable	9	Stable	Assume to be the same as parent
Soil Half-life (days) at 25°C	20	1.0	55.8	Represents the 90 percent upper confidence bound on the mean (n=4); MRID 499924-02
Molecular Weight (g/mol)	256.5	356.6	198	Chemical profile; MRID 42493901
VP (Torr) at 25°C	1.3×10^{-6}	3.6×10^{-6}	1.3×10^{-6}	Assume to be the same as ACID
Solubility in Water (mg/L)	440	7.4	170	Chemical profile
Heat of Henry (J/mol) @ 25°C	54,041	37,892	54,041	Same as triclopyr ACID from EPIWEB 4.1

[1] **Value(s) for the ACID and BEE** are those presented in the Aquatic Exposure Assessment, Modeling (Section 8.11 of this document)

[2] Kd value was Kd value was used in modeling to match that used for the ACID noting that CV value for Koc was slightly lower than that for Kd (56 versus 61%).1999 Chlorpyrifos RED; Memo from EFED (Barrett, Michael R.) to HED (Steve Knizer), both of OPP/EPA, dated November 20, 1998

Fate processes involved in TCP formation from the ACID and BEE

Based on the fate and transport data, the following processes are identified:

(a) From the ACID: The processes involved are water column metabolism, benthic metabolism and soil metabolism noting that photolysis, hydrolysis and foliar degradation processes are not involved; and
(b) From BEE: The processes involved in transformation of BEE to the ACID are water column metabolism, benthic metabolism, hydrolysis and soil metabolism noting that photolysis and foliar degradation processes are not involved. Furthermore, the processes involved in transformation of the ACID to TCP are those stated in (a), above.

<u>Collection of data for each of the fate processes (from submitted fate studies)</u>
This data is needed to calculate the Molar Formation/Decline Ratio (MFDR) for each of the identified fate process

<u>ACID to TCP data</u>
(1) Water column metabolism data (Source: aerobic aquatic study, MRID 49992404)

Water: loam sediment from Italy			Water: sand sediment from France		
Day	**ACID**	**TCP**	**Day**	**ACID**	**TCP**
2	85.1	0.0	2	88.8	0.3
2	85.5	0.9	7	80.4	7.8
7	98.4	0.9	7	89.7	3.1
7	86.0	1.7	7	87.9	3.1
7	90.8	2.6	14	62.1	19.0
14	80.0	5.7	14	78.2	11.9
14	88.7	5.1	30	57.9	19.7
30	58.6	20.8	30	60.7	19.3
30	57.5	23.1	59	31.8	18.2
59	24.0	14.1	59	33.4	13.2
59	36.6	33.4	106	2.9	22.3
106	11.0	4.8	106	5.3	23.7
106	10.1	18.7			

(2) Benthic metabolism data (Source: anaerobic aquatic study, MRID 00151967)

System 1: Flooded Cecil sandy loam soil			System 2: Flooded Norfolk sandy loam soil		
Day	**ACID**	**TCP**	**Day**	**ACID**	**TCP**
0	99.0	0.04	0	96.4	0
1	100.5	0.4	1	98.1	0.2
7	91.2	1.8	7	89.9	2.9
14	77.1	4.0	14	93.7	2.8
20	76.3	4.1	20	91.1	4.6
60	94.1	6.1	60	95.2	7.0
100	88.3	15.2	100	90.6	10.2

System 1: Flooded Cecil sandy loam soil			System 2: Flooded Norfolk sandy loam soil		
201	74.8	25.9	201	86.6	14.0
365	75.3	25.7	365	86.5	15.3
365	74.7	26.0	365	79.4	22.0

(3) Aerobic soil data (Source: aerobic soil study, MRID 49992404)

Soil 1: Aerobic Boone silt loam soil, MO			Soil 2: Aerobic Raymondville sandy clay loam soil, TX			Soil 3: Aerobic MSL-PF sandy loam soil, ND			Soil 4: Aerobic Tehama clay loam soil, CA		
Day	**ACID**	**TCP**	**Day**	**ACID**	**TCP**	**Day**	**ACID**	**TCP**	**Day**	**ACID**	**TCP**
0	95.1	0.9	0	93.7	0.6	0	94.6	1.1	0	95.1	0.6
0	96.0	0.7	0	93.9	0.7	0	94.8	0.9	0	96.0	0.6
1	87.6	5.5	1	91.0	1.3	1	91.4	2.8	1	88.4	2.5
1	87.4	5.2	1	91.6	1.2	1	84.2	2.2	1	92.1	2.7
3	79.3	11.9	3	89.6	2.7	3	92.1	3.3	3	92.1	3.7
3	77.5	11.6	3	88.1	2.7	3	90.8	3.8	3	87.4	3.0
7	60.4	19.9	7	80.2	4.4	7	86.9	7.1	7	86.2	7.7
7	52.4	24.6	7	85.0	5.1	7	84.8	8.2	7	81.7	10.5
14	27.6	34.5	14	75.7	8.3	14	70.8	14.7	14	82.1	6.6
14	27.1	31.2	14	74.4	9.2	14	74.7	12.7	14	91.1	2.1
30	5.9	27.0	30	50.6	19.0	30	43.9	22.8	30	13.6	21.9
30	7.1	30.5	30	52.3	18.5	30	47.7	21.1	30	10.4	24.2
59	0.8	12.8	59	22.6	18.4	59	12.9	27.8	59	1.2	10.4
59	1.0	13.5	59	24.0	19.4	59	13.8	26.7	59	1.4	4.4
90	0.0	6.2	90	3.0	6.8	90	0.9	16.6	90	0.9	3.7
90	1.0	5.2	90	1.3	7.8	90	3.3	17.7	90	0.9	4.9
120	0.7	4.4	120	0.4	3.2	120	1.6	13.1	120	0.2	1.4
120	0.3	3.7	120	0.4	2.8	120	2.0	19.0	120	0.6	1.7

BEE to ACID data

Based on examination of the transformation process of BEE to the ACID, it can be assumed that nearly 100% of BEE transforms into the ACID (1 to 1 transformation) in all processes involved (water column metabolism, benthic metabolism, hydrolysis and soil metabolism). For example, BEE hydrolyze in aqueous systems and transforms in aerobic soil systems and aerobic/anaerobic aquatic systems into the ACID only within <day.

Calculation of the Formation and Decline ratios (FDR) for all fate processes involved in formation ACID from BEE and formation of TCP from the ACID

As stated earlier, FDR is considered to equal 1 all processers involved in transformation of BEE to the ACID. Therefore, what is left is calculation of FDRs for transformation of the ACID to TCP. As stated earlier, FDRs are to be calculated for the following processes water column metabolism, benthic metabolism and soil metabolism from fate data collected in the previous step. For this a ***Solver Tool*** is used. The Tool calculates the formation rate of TCP from ACID along with the decline rate of the ACID simultaneously. Inputs for the tool are the fate data for chosen process and outputs include the formation rate of TCP from ACID and the decline rate of the ACID for each fate process (designated as ***K1fa*** and ***Kp***, respectively; **Table B-3**). Additionally, the output includes graphs representing the formation and decline data (Figures B-2 and B-3)

Table B-3. Formation/Decline Values for the Various Transformation Processes Producing the Degradate TCP.

Study (MRID)	System	K1fa (TCP Formation Rate)	Kp (Acid Decline Rate	Formation/Decline Ratio (FDR)[1]	Molecular Formation/ Decline Ratio (MFDR)[2]
Decline of ACID and Formation of TCP					
Aerobic Soil	USA Boone silt loam soil, Missouri (20°C, pH 4.7)	0.050093373	0.083599303	0.59921	**0.46255**
	Raymondville sandy clay loam soil, TX (20°C, pH 7.6)	0.012816393	0.024026057	0.53344	**0.41178**
	MSL-PF Sandy loam soil, ND (20°C, pH 6.2)	0.013908826	0.027348302	0.50858	**0.39259**
	Tehama clay loam soil, CA (20°C, pH 6.4)	0.014250641	0.038564986	0.36952	**0.28525**
Anaerobic Aquatic	Flooded Cecil sandy loam soil	1	1	1	**0.74600**
	Flooded Norfolk sandy loam soil	1	1	1	**0.74600**
Aerobic Aquatic	Water: loam sediment from Italy	0.009996	0.018495	0.540469	**0.41720**
	Water: loam sediment from France	0.007895	0.019697	0.400827	**0.30941**
Decline of BEE and Formation of ACID					
Aerobic Soil	MS Loamy soil (pH 8; O.C= 0.5%) and GA Sandy loam soil (MRID 472938-01)	1	1	1	**0.71929**
Hydrolysis	Sterile buffered solutions @ pH 7	1	1	1	**0.71929**
Anaerobic Aquatic	Flooded Cecil sandy loam and Norfolk sandy loam soils	1	1	1	**0.71929**
Aerobic Aquatic	Water: loam sediment from Italy and Water: loam sediment from France	1	1	1	**0.71929**

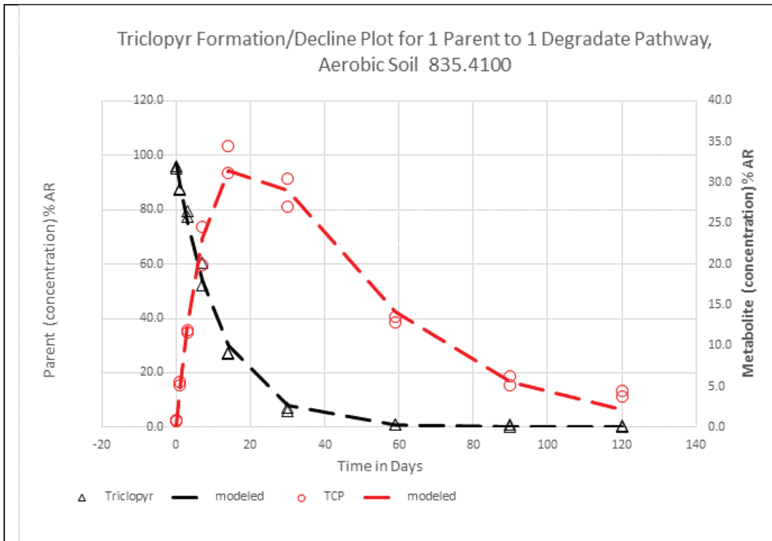
Equation for calculating FDR = $\frac{k1fa \text{ (metabolite A formation)}}{Kp \text{ (parent P decline)}}$

Equation for calculating MFDR = $\frac{FDR \times \text{M.Wt. metabolite}}{\text{M.Wt. parent}}$

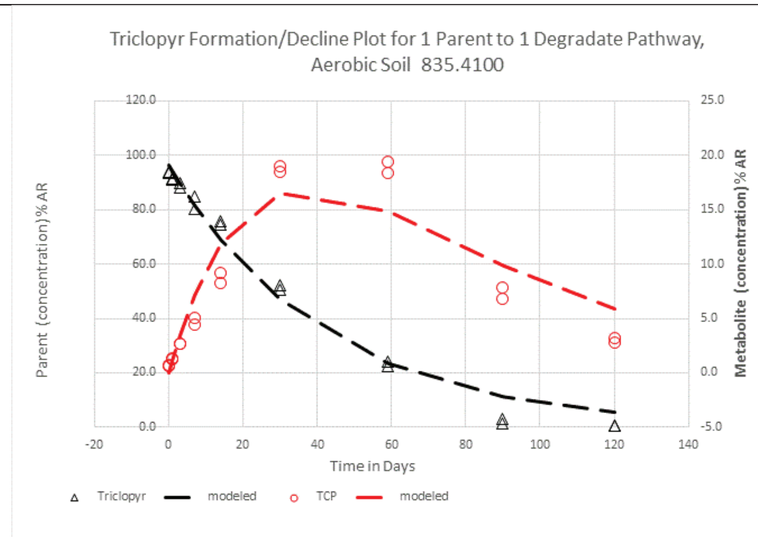
M. Wt.= Molecular weight g mol^{-1}= ACID: 256.5; **TCP:** 198; BEE: 356.6

Example MO soil: FDR= $\frac{0.050093373}{0.083599303} = 0.59921$

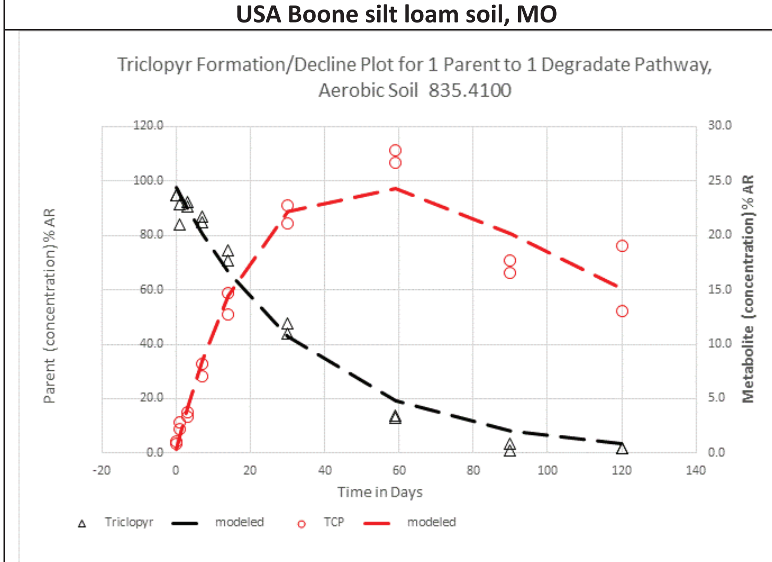
MFDR= $\frac{0.59921 \times 198}{256.5} = 0.46255$



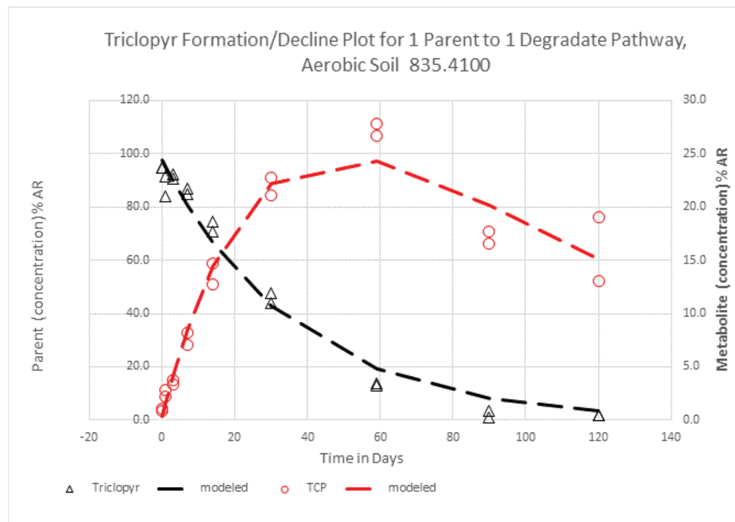
USA Boone silt loam soil, MO



Raymondville sandy clay loam soil, TX

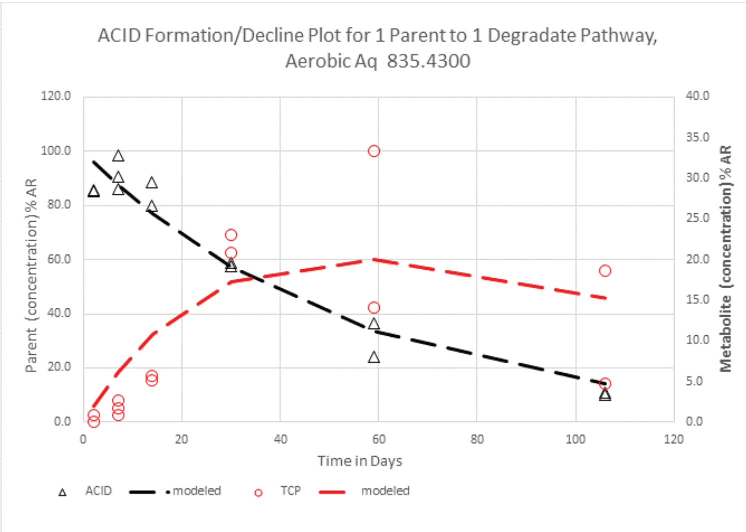


MSL-PF Sandy loam soil, ND

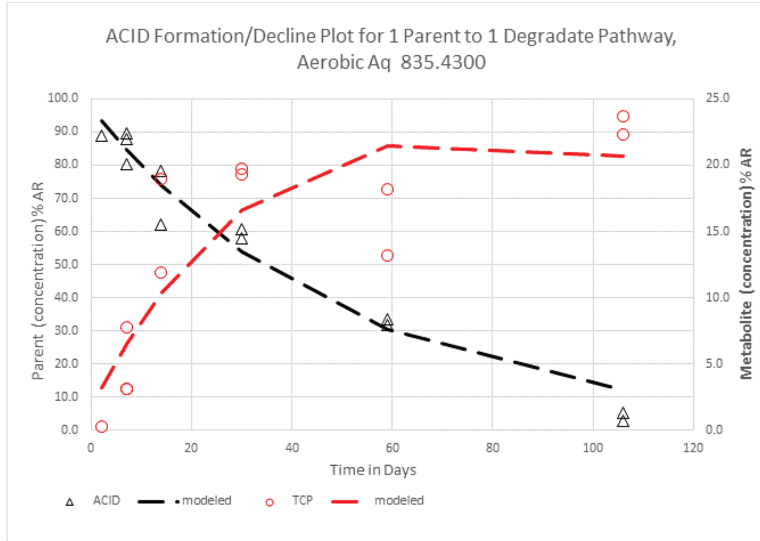


Tehama clay loam soil, CA

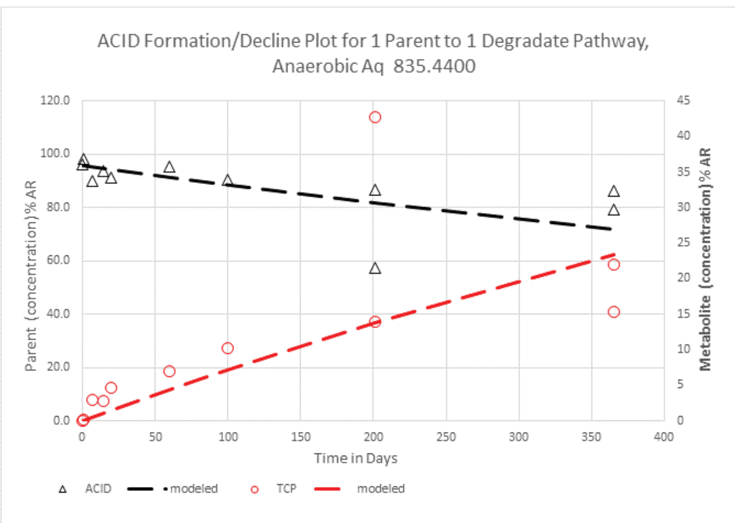
Figure B-1 Graphs Representing the Formation and Decline Data for Four Aerobic Soil Systems.



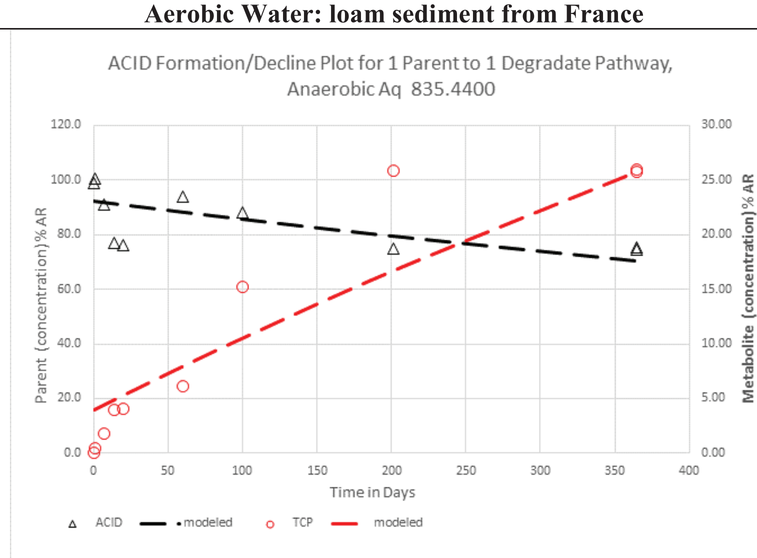
Aerobic Water: loam sediment from Italy



Aerobic Water: loam sediment from France



Flooded Cecil sandy loam soil



Flooded Norfolk sandy loam soil

Figure B-2 Graphs Representing the Formation and Decline Data for Aerobic/Anaerobic Aquatic Systems (Two Systems Each).

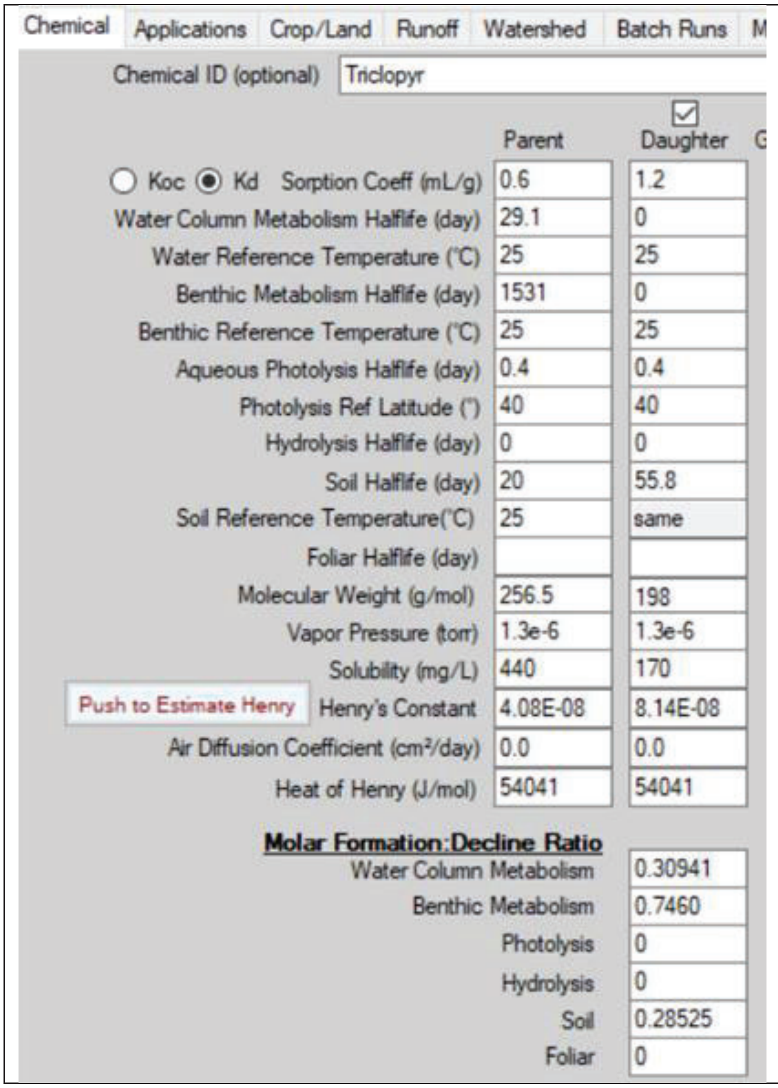
Collection of input parameters required for execution of special PWC runs

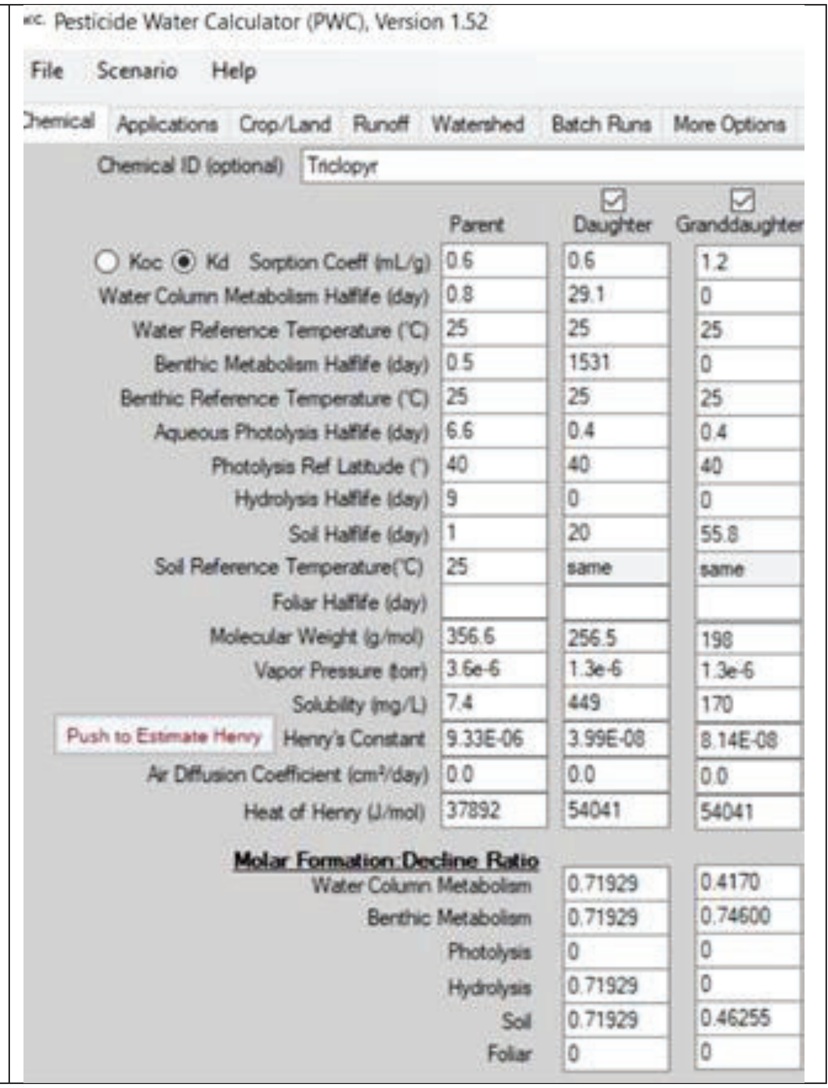
Two transformation pathways are recognized for the required calculations of concentrations for each individual stressor present in these pathways, namely:

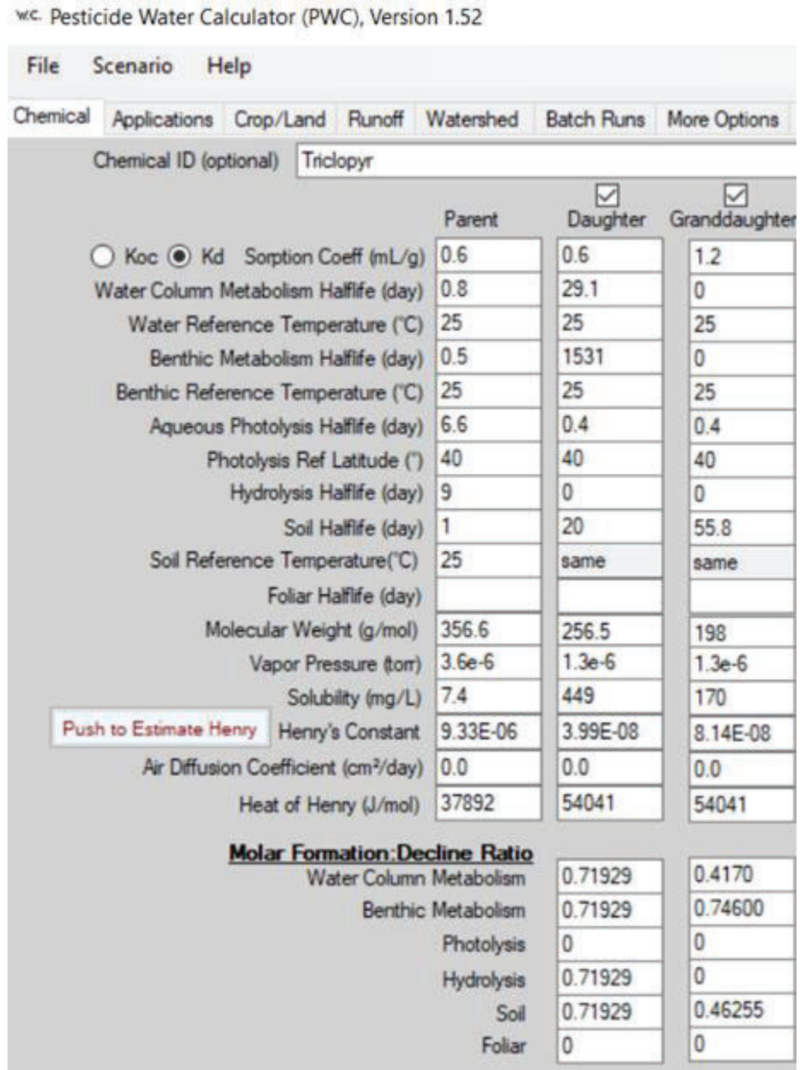
For the first pathway: ACID (referred to in PWC as parent) → TCP (referred to in PWC as Daughter); and

For the second pathway: BEE (referred to in PWC as parent) → ACID (referred to in PWC as daughter) → TCP (referred to in PWC as Granddaughter)

One PWC run is needed for the first pathway with its associated inputs and another separate PWC run with its associated inputs (**Figure B-3**).


Chemical
Applications
Crop/Land
Runoff
Watershed
Batch Runs
M
Chemical ID (optional)
Triclopyr
Parent
Daughter
Koc
Kd
Sorption Coeff (mL/g)
0.6
1.2
Water Column Metabolism Halflife (day)
29.1
0
Water Reference Temperature (°C)
25
25
Benthic Metabolism Halflife (day)
1531
0
Benthic Reference Temperature (°C)
25
25
Aqueous Photolysis Halflife (day)
0.4
0.4
Photolysis Ref Latitude (°)
40
40
Hydrolysis Halflife (day)
0
0
Soil Halflife (day)
20
55.8
Soil Reference Temperature(°C)
25
same
Foliar Halflife (day)
Molecular Weight (g/mol)
256.5
198
Vapor Pressure (torr)
1.3e-6
1.3e-6
Solubility (mg/L)
440
170
Push to Estimate Henry
Henry's Constant
4.08E-08
8.14E-08
Air Diffusion Coefficient (cm²/day)
0.0
0.0
Heat of Henry (J/mol)
54041
54041
Molar Formation:Decline Ratio
Water Column Metabolism
0.30941
Benthic Metabolism
0.7460
Photolysis
0
Hydrolysis
0
Soil
0.28525
Foliar
0


Pesticide Water Calculator (PWC), Version 1.52
File
Scenario
Help
Chemical
Applications
Crop/Land
Runoff
Watershed
Batch Runs
More Options
Chemical ID (optional)
Triclopyr
Parent
Daughter
Granddaughter
Koc
Kd
Sorption Coeff (mL/g)
0.6
0.6
1.2
Water Column Metabolism Halflife (day)
0.8
29.1
0
Water Reference Temperature (°C)
25
25
25
Benthic Metabolism Halflife (day)
0.5
1531
0
Benthic Reference Temperature (°C)
25
25
25
Aqueous Photolysis Halflife (day)
6.6
0.4
0.4
Photolysis Ref Latitude (°)
40
40
40
Hydrolysis Halflife (day)
9
0
0
Soil Halflife (day)
1
20
55.8
Soil Reference Temperature(°C)
25
same
same
Foliar Halflife (day)
Molecular Weight (g/mol)
356.6
256.5
198
Vapor Pressure (torr)
3.6e-6
1.3e-6
1.3e-6
Solubility (mg/L)
7.4
449
170
Push to Estimate Henry
Henry's Constant
9.33E-06
3.99E-08
8.14E-08
Air Diffusion Coefficient (cm²/day)
0.0
0.0
0.0
Heat of Henry (J/mol)
37892
54041
54041
Molar Formation:Decline Ratio
Water Column Metabolism
0.71929
0.4170
Benthic Metabolism
0.71929
0.74600
Photolysis
0
0
Hydrolysis
0.71929
0
Soil
0.71929
0.46255
Foliar
0
0



Inputs for the first PWC run: ACID → TCP	Input for the second PWC run: BEE → ACID → TCP

Figure B-3 Chemical Input Parameters for the F/D runs; all other parameters needed for the run is the same as those used for the ROC runs.

Output from the first run calculates exposure EECs for the ACID and TCP separately (**Table B-4**) while output for the second run calculates exposure EECs for BEE, the ACID and TCP (**Table B-5**). It is noted that outputs from the ROC runs are also included in **Table B-4**.

Table B-4. Range of Surface and Pore Waters Estimated Environmental Concentrations (EECs) for the ROC; ACID; and TCP Representing the Use of ACID, TEA and COLN Forms of Triclopyr (Estimated Using PWC version 1.52 and PFAM).

Use Site	Range	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	Chemical Species[2]	1-in-10-year Mean EECs				
				Water Column (µg/L)			Pore-Water (µg/L)	
				1-day	21-day	60-day	1-day	21-day
Aquatic Weed Control	Min	Applied @ 400 ppb	ROC (acid equivalent= a.e.)	396	343	255	152	151
			ACID	384	308	200	116	117
			TCP (Low MFDR)	20.1	20.2	18.6	13.3	12.1
			TCP (High MFDR)	27.6	27.7	25.5	18.1	16.6
		Applied @ 2,500 ppb	ROC (a.e.)	2,480	2,140	1,590	949	943
			ACID	2,400	1,930	1,250	723	730
			TCP (Low MFDR)	125	126	116	83.0	75.5
			TCP (High MFDR)	173	173	159	113	104
	Max	Applied @ 5,000 ppb	ROC (a.e.)	4,950	4,290	3,180	1,900	1,890
			ACID	4,810	3,850	2,500	1,450	1,460
			TCP (Low MFDR)	251	253	233	166	151
			TCP (High MFDR)	346	347	319	226	208
Citrus (FL)	Min	FLcitrusSTD (6; 3-Sep; G)	ROC (a.e.)	67	53.6	37.3	22.4	22.2
			ACID	23.9	15.3	8.19	4.97	4.90
			TCP (Low MFDR)	1.81	1.77	1.58	1.10	1.11
			TCP (High MFDR)	2.44	2.39	2.13	1.47	1.48
	Max	FLcitrusSTD (6; 26-May; G)	ROC (a.e.)	297	242	164	99	98.2
			ACID	281	194	104	66.9	65.9
			TCP (Low MFDR)	21.2	20.9	18.8	13.2	13.2
			TCP (High MFDR)	28.6	28.2	25.3	17.7	17.6
Forestry	Min	CAForestryRLF (6; 4-Aug; A)	ROC (a.e.)	46	39.0	29.9	25	24.6
			ACID	42.3	32.8	23.7	19.0	18.9
			TCP (Low MFDR)	2.73	2.70	2.56	2.09	2.12
			TCP (High MFDR)	3.78	3.73	3.53	2.85	2.88
	Max	CAForestryRLF (6; 11-Apr; A)	ROC (a.e.)	86	71.6	53.5	38	37.6
			ACID	82.9	65.0	45.5	32.8	32.5
			TCP (Low MFDR)	3.22	3.19	3.05	2.37	2.36
			TCP (High MFDR)	4.35	4.32	4.12	3.17	3.16
Grass: Range/ Pasture/ Non-crop Lands	Min	CArangelandhayRLF (9; 4-Apr; A)	ROC (a.e.)	99	84.1	62.7	38	37.5
			ACID	92.8	77.1	52.3	31.1	30.8
			TCP (Low MFDR)	5.58	4.78	4.36	3.52	3.51
			TCP (High MFDR)	8.80	7.53	5.97	4.82	4.81
	Max	RangeBSS (9; 15-May; A)	ROC (a.e.)	403	336.0	232.0	138	137.0
			ACID	384	284	157	96.4	95.1
			TCP (Low MFDR)	27.0	26.7	24.4	17.5	17.4
			TCP (High MFDR)	36.6	36.2	33.1	23.5	23.4
Grass: Meadow	Min	MeadowBSS (9; 13-Aug; A)	ROC (a.e.)	132	106.0	75.1	71	76.0
			ACID	113	72.6	48.0	29.9	29.5
			TCP (Low MFDR)	16.3	15.5	13.4	11.8	11.7
			TCP (High MFDR)	25.0	23.4	18.5	15.9	15.8
	Max	MeadowBSS (9; 15-May; A)	ROC (a.e.)	346	289.0	200.0	118	117.0
			ACID	332	245	136	82.8	81.6
			TCP (Lowest MFDR)	22.9	22.6	20.7	14.8	14.8

Use Site	Range	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	Chemical Species[2]	1-in-10-year Mean EECs: Water Column (µg/L) 1-day	Water Column (µg/L) 21-day	Water Column (µg/L) 60-day	Pore-Water (µg/L) 1-day	Pore-Water (µg/L) 21-day
			TCP (Highest MFDR)	30.9	30.5	27.9	19.9	19.7
Orchards (CA)	Min	CAcitrus_WirrigSTD (6; 6-Apr; G)	ROC (a.e.)	21	17.7	12.5	8	7.9
Orchards (CA)	Min	CAcitrus_WirrigSTD (6; 6-Apr; G)	ACID	20.9	15.7	9.67	5.72	5.65
Orchards (CA)	Min	CAcitrus_WirrigSTD (6; 6-Apr; G)	TCP (Lowest MFDR)	1.10	1.09	1.01	0.754	0.750
Orchards (CA)	Min	CAcitrus_WirrigSTD (6; 6-Apr; G)	TCP (Highest MFDR)	1.48	1.47	1.36	1.01	1.00
Orchards (CA)	Max	CAalmond_WirrigSTD (6; 11-May; G)	ROC (a.e.)	29	25.4	18.5	11	11.0
Orchards (CA)	Max	CAalmond_WirrigSTD (6; 11-May; G)	ACID	29	22.7	13.9	8.30	8.20
Orchards (CA)	Max	CAalmond_WirrigSTD (6; 11-May; G)	TCP (Lowest MFDR)	1.90	1.88	1.76	1.30	1.30
Orchards (CA)	Max	CAalmond_WirrigSTD (6; 11-May; G)	TCP (Highest MFDR)	2.59	2.57	2.40	1.76	1.75
Premises	Min	CAresidentialRLF/ CAImperviousRLF (9; 1-May; G)	ROC (a.e.)[3]	12	10.1	7.5	5	4.5
Premises	Max	ResidentialBSS/ ImperviousBSS (9; 21-May; G)	ROC (a.e.)[3]	32	26.1	18.5	12	11.9
Rice	Min	1st Scenario	ECO MS noWinter: ROC (a.e.)[3]	254	67.5	31.2	97	84.7
Rice		2nd Scenario	ECO MS noWinter: ROC (a.e.)[3]	256	72.5	47.9	33	31.5
Rice		Ratoon Rice	Ratoon Rice, TX: ROC (a.e.)[3]	334	60.1	32.5	25	22.8
Rice		1st Scenario	ECO MO noWinter: ROC (a.e.)[3]	366	78.2	36.1	99	88.9
Rice	Max	2nd Scenario	ECO MO noWinter: ROC (a.e.)[3]	369	84.0	54.9	39	36.7
Rights-of-Way	Min	CArightofwayRLF_V2/CAImperviousRLF (9; 21-May; A)	ROC (a.e.)[3]	17	14.9	11.4	7	7.0
Rights-of-Way	Max	RightOfWayBSS/ ImperviousBSS (9; 1-May; A)	ROC (a.e.)	259	214	147.5	89	88.7
Rights-of-Way	Max	RightOfWayBSS/ ImperviousBSS (9; 1-May; A)	ACID	184	131	80.9	50	45.9
Rights-of-Way	Max	RightOfWayBSS/ ImperviousBSS (9; 1-May; A)	TCP (Lowest MFDR)	Not Calculated				
Rights-of-Way	Max	RightOfWayBSS/ ImperviousBSS (9; 1-May; A)	TCP (Highest MFDR)	23.9	23.6	21.9		
Turf	Min	CATurfRLF (4; 16-Apr; A)	ROC (a.e.)	15	12.6	11.1	9	8.8
Turf	Min	CATurfRLF (4; 16-Apr; A)	ACID	12.1	9.29	8.12	6.51	6.45
Turf	Min	CATurfRLF (4; 16-Apr; A)	TCP (Lowest MFDR)	1.09	1.08	1.01	0.832	0.829
Turf	Min	CATurfRLF (4; 16-Apr; A)	TCP (Highest MFDR)	1.48	1.46	1.36	1.11	1.11
Turf	Max	TurfBSS (4; 11-Apr; A)	ROC (a.e.)	23	18.2	15.0	11	10.9
Turf	Max	TurfBSS (4; 11-Apr; A)	ACID	18.3	12.8	9.97	6.76	6.67
Turf	Max	TurfBSS (4; 11-Apr; A)	TCP (Lowest MFDR)	2.13	2.09	1.90	1.54	1.53
Turf	Max	TurfBSS (4; 11-Apr; A)	TCP (Highest MFDR)	2.87	2.82	2.57	2.06	2.05
Christmas Trees	Min	ORXmasTreeSTD (6; 16-May; G)	ROC (a.e.)	21	17.5	13.1	8	7.8
Christmas Trees	Min	ORXmasTreeSTD (6; 16-May; G)	ACID	20.6	16.2	10.6	6.24	6.18
Christmas Trees	Min	ORXmasTreeSTD (6; 16-May; G)	TCP (Lowest MFDR)	1.28	1.20	1.07	0.856	0.853
Christmas Trees	Min	ORXmasTreeSTD (6; 16-May; G)	TCP (Highest MFDR)	1.81	1.68	1.48	1.17	1.17
Christmas Trees	Max	ORXmasTreeSTD (6; 24-Aug; G)	ROC (a.e.)	24	20.8	16.2	10	10.7
Christmas Trees	Max	ORXmasTreeSTD (6; 24-Aug; G)	ACID	21.7	17.9	11.8	6.94	6.88

Use Site	Range	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	Chemical Species[2]	1-in-10-year Mean EECs				
				Water Column (µg/L)			Pore-Water (µg/L)	
				1-day	21-day	60-day	1-day	21-day
			TCP (Lowest MFDR)	1.85	1.78	1.61	1.33	1.40
			TCP (Highest MFDR)	2.27	2.24	2.06	1.76	1.83

[1] ***PWC Scenario (1st Application Date; Yearly Rate; Application Type):*** Scenario (Yearly application rate in lbs. a.e/A/Year; 1st application date in the window; Ground (if A= Aerial). **Example**: FLcitrusSTD (6; 3-Sep; G) = FL citrus scenario with an application rate of 6 lbs. a.e/A/Year applied on September 3 using ground equipment

[2] **ROC** (acid equivalent= a.e.) = Total concentrations in µg/L of **ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** in acid equivalent; **ACID=** Triclopyr acid concentrations in µg/L; **TCP** (Lowest MFDR)= TCP degradate concentrations in µg/L based on the lowest Molecular formation and decline ratio obtained from varied soil and aquatic systems; **TCP** (Highest MFDR)= TCP degradate concentrations in µg/L based on the highest Molecular formation and decline ratio obtained from varied soil and aquatic systems[33]

[3] **ROC (a.e.)** = Concentrations of the residue of concern in µg/L of **ACID + TCP + 3,6 DCP + 5-CLP + 6-CLP** in acid equivalent were only estimated and due to the **low ROC** concentrations, no values were estimated for the **ACID or TCP**

Table B-5. Maximum Surface and Pore Waters Estimated Environmental Concentrations (EECs) for the BEE; ACID; and TCP Representing the Use of BEE Form of Triclopyr (Estimated Using PWC version 1.52)

Use Site	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	*Chemical Species*[2]	1-in-10-year Mean EECs				
			Water Column (µg/L)			Pore-Water (µg/L)	
			1-day	21-day	60-day	1-day	21-day
Citrus (FL)	FLcitrusSTD (8.342; 26-May; G)	BEE	140	11.30	3.94	5.4	0.33
		ACID	193	142	76.6	49.9	49.2
		TCP (Lowest MFDR)	15.2	15.0	13.5	9.52	9.47
		TCP (Highest MFDR)	20.5	20.2	18.2	12.7	12.6
Forestry	CAForestryRLF (8.342; 4-Aug; A)	BEE	47	6.33	2.46	2.4	0.25
		ACID	25.9	22.6	16.7	14.2	14.2
		TCP (Low MFDR)	1.89	1.87	1.78	1.48	1.49
		TCP (High MFDR)	2.61	2.57	2.44	2.00	2.02
Grass: Range/ Pasture/Non-Crop Lands	RangeBSS (12.512; 15-May; A)	BEE	267	28.00	9.79	3.2	0.48
		ACID	259	201	113	72.4	71.4
		TCP (Low MFDR)	19.4	19.1	17.5	12.6	12.5
		TCP (High MFDR)	26.2	25.9	23.7	16.8	16.7
Grass: Meadow	MeadowBSS (12.512; 15-May; A)	BEE (acid Equivalent)	264	27.50	9.64	2.8	0.43
		ACID	223	172	97.2	62.2	61.3
		TCP (Low MFDR)	16.5	16.3	14.9	10.7	10.6
		TCP (High MFDR)	22.3	22.0	20.1	14.3	14.2
Premises	ResidentialBSS/ImperviousBSS (12.512; 21-May; G)	BEE[3]	10	0.90	0.30	0.1	0.13
Right-of-Way	RightOfWayBSS/ImperviousBSS (12.512; 21-May; A)	BEE[3]	57	6.64	2.41	0.8	0.12
Turf	TurfBSS (5.561; 11-Apr; A)	BEE	9.3	1.50	0.97	0.12	0.03
		ACID	11.9	9.18	7.14	5.09	5.02
		TCP (Low MFDR)	1.53	1.51	1.38	1.11	1.11

[33] Estimated according to the formation and decline method guiding principles presented in Attachment 2 for Methods for Assessing Aquatic Exposure to Residue(s) of Concern, EFED division Director Memo dated June 20, 2019

Use Site	PWC Scenario (1st Application Date; Yearly Rate; Application Type)[1]	*Chemical Species*[2]	1-in-10-year Mean EECs				
			Water Column (µg/L)			Pore-Water (µg/L)	
			1-day	21-day	60-day	1-day	21-day
		TCP (High MFDR)	2.06	2.03	1.86	1.49	1.48
Christmas Trees	ORXmasTreeSTD (8.342; 24-Aug; G)	BEE	22	2.32	0.81	0.24	0.05
		ACID	16.2	12.9	8.54	5.21	5.17
		TCP (Low MFDR)	1.30	1.27	1.12	0.95	0.99
		TCP (High MFDR)	1.88	1.82	1.57	1.31	1.38

[1] ***PWC Scenario (1st Application Date; Yearly Rate; Application Type):*** Scenario (Yearly application rate in lbs. a.e/A/Year; 1st application date in the window; Ground (if A= Aerial). **Example**: FLcitrusSTD (6; 3-Sep; G) = FL citrus scenario with an application rate of 6 lbs. a.e/A/Year applied on September 3 using ground equipment

[2] **BEE** = Concentrations in µg/L of BEE; **ACID=** Triclopyr acid concentrations in µg/L; **TCP** (Lowest MFDR)= TCP degradate concentrations in µg/L based on the lowest Molecular formation and decline ratio obtained from varied soil and aquatic systems; **TCP** (Highest MFDR)= TCP degradate concentrations in µg/L based on the highest Molecular formation and decline ratio obtained from varied soil and aquatic systems[34]

[3] **BEE** = Concentrations in µg/L of BEE were only estimated and due to the **low BEE** concentrations, no values were estimated for the **ACID or TCP.**

[34] Estimated according to the formation and decline method guiding principles presented in Attachment 2 for Methods for Assessing Aquatic Exposure to Residue(s) of Concern, EFED division Director Memo dated June 20, 2019

APPENDIX C. Ecological Incident Summary for Triclopyr Active Ingredients

Table C-1. Triclopyr Acid, TEA, BEE Incidents from the Incident Data System (IDS)

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
Triclopyr Acid Plant Incidents		
I003147-001	Triclopyr	1996 Agricultural Area-Company response to FIFRA REGS compliance. Registered Use. Agricultural area-plant damage.
I012786-005	Triclopyr Adsorption	Scotts Chemical reported a 2001 complaint that Garlon D 12 damaged 10 ornamental trees. The symptom was listed simply as "phytotoxicity." Undetermined.
I014404-018	Triclopyr Adsorption or drift	The Annual Report 1991 from the State of Washington included a 1990 incident in Yakima County in which the complainant alleges that an application of triclopyr damaged poplar trees and other ornamentals in her yard. It is not clear whether this was a direct application or as the result of spray drift of the pesticide. Undetermined.
I020459-019	Triclopyr Drift	A 2000 case that involved alleged drift of triclopyr sprayed in a vacant field that was across the street from neighboring property in Clark County, WA. There was damaged to unknown plants on the property. Residue analysis were positive for triclopyr. The owner of the lot, and the unlicensed applicator who made the application, accepted full responsibility for the plant damage. From the Washington State Department of Agriculture 2002 PIRT Report.
I020627-032	Triclopyr Drift	2001 incident involve drift of triclopyr from a Right of Way application that damaged pear trees. The WSDA concluded that there was evidence of drift. Damage was estimated at $6,750. From The Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report in 2003
I024272-364	Triclopyr Direct	In June of 2012 in Dukes County, MA it was alleged a ground application of the product Max Poison IVY & Tough Brush Killer (a.i. triclopyr) adversely affected the customer's Kiwi plants.
Multi active Plant Incidents which include Triclopyr acid		
I020459-016	Triclopyr, Dicamba, and MCPA Possible Drift	The Washington State Department of Agriculture reported in the 2002 PIRT Report a 2000 case that involved commercial application of herbicides sprayed on broadleaf weeds in turf that damaged numerous broad leaf ornamental plants.
I013883-026	Triclopyr / 2,4-D Drift	1997 in Kitsap County, WA. Cypress trees dying along a fence line. Residue found in plants. Neighbor had used the product. Site of application not given. Incident is from the 1998 Annual Report from the Washington State Department of Health Pesticide Incident Reporting and Tracking Review Panel.
I014409-009	Triclopyr/ 2,4-/ Glyphosate Drift	This 1992 incident in King County, WA. was reported in the Washington State Dept. of Health Annual Report 1993, Pesticide Incident Reporting Review Panel, April 1994, prepared by the Washington State Department of Agriculture. Alleged that glyphosate, 2,4-D and triclopyr drifted into a garden. The drift/over spray was confirmed by lab. results. No analysis and State sent a warning letter. Accidental misuse.
I014404-019	Triclopyr and 2,4-D Drift	The Annual Report 1991 from the State of Washington included a 1990 incident in Spokane County in which shrubs in a yard were dying. The State Extension Office suspected herbicide drift of 2,4-D and triclopyr from an application made along a fence line in the vicinity. Individual was charged with a violation of label and state law.

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
I015748-035	Triclopyr and Propanil (STAM) at 2 pts/acre Direct to Crop	Dow reported a 2004 incident in Dewitt, AR, in which Grandstand (0.66 pt/acre) damaged 80 acres of a 160-acre crop of rice. Dow admitted that the rice showed signs of injury. A number of authorities in the field felt that Grandstand could not be related to the injury. Rice production in AR and LA has been diminished by a disease that has not been identified, but the thinking is that Grandstand amplifies the symptoms. Yield losses have been around 50%. Registered Use.
I015921-002	Picloram, Triclopyr and Tebuthiuron Drift	Dow reported a multi-year incident in Cleveland, OK, in which the plaintiff suffered damage to real property including the deaths of hundreds of trees of desirable variety as the result of conduct in January 2001 and June/July, 2002, and over spraying in December, 2003 and spring of 2004. Products that were sprayed included Spike 20P(tebuthiuron), Remedy (triclopyr), and Grazon™ P+D Herbicide (Picloram). In addition to the deaths of the trees, the plaintiff alleges that the contamination of the land and water resources have diminished the property's use for deer hunting and fishing. Legality Undetermined.
I016962-005	Triclopyr, 13 oz/acre Cyhalofop-butyl 13oz/acre Direct to Rice	In 2004 a California farmer claimed that the used Clincher CA (cyhalofop-butyl) and Grandstand CA (triclopyr) aerial application resulted in yield loss on 560 acres of rice. Apparently, the same incident (same date, same town, and same pesticides) was reported in three different claims (I016962-005, -006, and -007) by different people. The three incidents were combined into I016962-005 and the acreage of the three reported areas affected were summed.
I020459-015	Triclopyr (116001)/ 2,4-D Drift	In 2002 the Washington State Department of Agriculture reported a case that involved alleged drift of a spray application of the herbicides 2,4-D and triclopyr to property next door in Clark County, WA. Tree limbs that were hanging over the property line were damaged. Accidental exposure.
I020627-017	Triclopyr and 2,4-D Drift	A 2001 case that involve alleged drift of a commercial application of herbicides sprayed on blackberries in adjacent property that damaged plants in a residential yard in Kitsap County, WA. Triclopyr and 2,4-D were sprayed. The report did not describe the types of plants effected or the type of damage, but it did say that the herbicides were verified as the cause by symptoms and residue analysis. Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report 2003
I020627-018	Triclopyr and 2,4-D Drift	Incident involved a 2001 application of herbicides on weeds in a blackberry field in Gray Harbor County, WA that drifted to neighboring property and damaged shrubs and trees. The herbicides applied were triclopyr and 2.4-D. The report stated that the damage was probably due to volatilization. From the Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report 2003
I020627-021	Triclopyr and 2,4-D Drift	2001 incident involved alleged drift of triclopyr and 2,4-D from an application on blackberries in Cowlitz County, WA that damaged plants on neighboring property. The application was made contrary to the label. From the Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report in 2003.
I020998-014	Triclopyr, Glyphosate and 2,4-D Drift	2002 incident involved pesticide application in Clark County, WA. that drifted to neighboring yard and garden and caused plant damage. From the Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report 2002

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
I020998-015	Triclopyr, Glyphosate Drift	2002 Incident involves drift from application of herbicides on weeds that caused damage to vineyard in Skamania County. From the Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report in 2002
I020998-043	Triclopyr and 2,4-D Drift	This 2002 incident in Washington state involved pesticide application sprayed on weeds on property line that drifted to neighboring property and caused plant damage. Incident from The Office of Environmental Health and Safety, Washington State Department of Agriculture Annual report 2002
I021457-013	2,4-D and Triclopyr (detected) Drift	On 06/13/2006 Washington State Department of Health, Division of Environmental Health documented a pesticide related incident involving herbicide 2, 4-D that was sprayed onto a grass field and drifted onto a neighbor's property damaging plants. 2, 4-D and triclopyr were detected in the residue.
I024123-001	Triclopyr and Glyphosate Direct Injection intentional misuse	In West Australia in June of 2012 it was reported that five river red gums were poisoned in West Beach and Woodville. Arborists' tests have found traces of (a.i. glyphosate and triclopyr) in the trees' leaves. These trees are dying because someone drilled holes in their trunks and filled them with the herbicide glyphosate. Intentional misuse.
I029622-004	Triclopyr and Aminopyralid Drift	On December 19, 2016 it was reported that a small garden in Felding, Manawatu, New Zealand was damaged. Aminopyralid and Triclopyr were contained in product used, Tordon™ PastureBoss. Garden was adjacent to a neighbor's lawn that was sprayed with product.
Triclopyr TEA Product Plant Incidents		
I002507-001	Triclopyr TEA Drift	Year – N.R. Reportedly, a fence line was treated with **Garlon-3** (Triclopyr) a herbicide with a backpack sprayer. Allegedly, a neighboring cotton field experienced patches of injury caused by the drifting effect at the time of spraying the fence line.
I003377-027	Triclopyr TEA Drift	In 1993 a California pest control operator applied a pesticide to a railroad right-of-way by ground application. Owners of grapevines adjacent to the railroad noted damage to their crops; preliminary estimates of monetary damage were placed at $6,000,000. The pesticide operator (Asplundh) agreed to plead guilty to 2 misdemeanors (lack of supervision, and failure to evaluate surrounding conditions). A total of $10,000 was imposed in fines ($5,000 paid and $5,000 suspended). Triclopyr was detected as a residue on the plants. Misuse.
I004846-001	Triclopyr TEA Direct to Rice	In 1997 in Texas, Grandstand R applied to a rice field, allegedly caused twisting and knotting up in the rice.
I006846-001	Triclopyr TEA Direct to Rice	In 1998 in Arkansas a rice crop demonstrated yield loss, when grown on a field that had been treated with the pesticide.
I006846-002	Triclopyr TEA Direct to Rice	In 1998 in Arkansas a Rice crop demonstrated yield loss, when grown on a field that had been treated with the a Triclopyr TEA product.
I006846-003	Triclopyr TEA Direct to Rice	In 1998 in Arkansas a rice crop demonstrated yield loss, when grown on a field that had been treated with the Triclopyr TEA product.
I007340-707	Triclopyr TEA Direct Contact	From Aggregate report. Under 6(a)2 Solaris reported that ornamentals were alleged to have been damaged in New Jersey on May 27, 1998, as the result of using Ortho Brush-B-Gon.
I007875-001	Triclopyr TEA	In 1991 in Oregon, Wisconsin, garden and ornamental plants of homes bordering 55 treated acres allegedly were injured by drift (physical) and drift of Crossbow

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
	Drift	Herbicide due to volatilization. The incident was being investigated by the Wisconsin Dept. of AG Trade and Consumer Protection, for spraying effected under conditions that were too windy.
I008003-001	Triclopyr TEA-Grandstand Direct to Rice	In a 1998 6(a)2 report. Grower alleged that 58 acres of rice in Eunice, LA, were damaged by Grandstand at 1 pt/acre by ground. Description: "Oversprayed portions of the field exhibited severe root fish-hooking and dead tellers. Grower took the acreage to yield and compared this yield with other acreage that was treated with other products. He noted a 11.4 barrel deficiency in this treated rice compared to the untreated."
I008188-001	Triclopyr TEA Direct to Rice	Dow AgroSciences reported that 125 acres of rice were alleged to have been damaged by Grandstand in Biggs, CA. 8 days after July 8, 1998 application. Rice 49 days old when applied. Rice showed symptoms of root twisting and color change. Variety M-202. After application was made temperatures exceeded 100 degrees F."
I008188-002	Triclopyr TEA Direct to Rice	Dow AgroSciences reported that 82 acres of rice in Biggs, CA, were alleged to have been damaged by Grandstand on November 3, 1998. There was a decreased yield.
I008188-003	Triclopyr TEA Direct to Rice	Dow AgroSciences reported a November 1998 complaint alleging that 202 acres of rice in Chico, CA, were damaged by Grandstand. The description in the reports states: "Color change noticed on 8/26/98. Rice was 47 days old at application. Variety L-204. Yield at 69 dry. Average 72 dry for all M fields."
I008571-027	Triclopyr TEA Direct to turf	In 1999 in Boynton Beach, FL, nearly 5 acres of lawn were sprayed with Brush-B-Gon from a 24 oz bottle with sprayer to control weeds. The label specifically states against this. At the recommendation of a local store, the customer now has alleged property damage from use on his entire St. Augustine lawn and wants compensation.
I008639-001	Triclopyr TEA Direct to Rice	In 1998 106 acres of rice in Bastrop, LA, allegedly endured 100% crop injury after pesticide application at planting time. Decreased yield was the salient crop injury demonstrated.
I008884-001	Triclopyr TEA Direct to Rice	Dow AgroSciences reported a 1999 incident in which Grandstand was allegedly aerially applied to a rice field in McGehee, AK, but drifted onto a nearby tree plantation area where it destroyed 95.6 acres of cottonwood and 27.9 acres of oak trees.
I009262-093	Triclopyr TEA Direct to turf	As part of its August 1999 report of pesticide incidents, Scotts Co. included a complaint from a resident of Ladysmith, WI, who claimed that the parts of her lawn that she treated with Weed-B-Gon Chick, Clover were burned.
I009262-094	Triclopyr TEA Direct to turf	August 1999 incident report, Scotts Co. included a complaint from a resident of Orland Park, IL, who alleged that Weed-B-Gon Chick Killer damaged his lawn. The temperature was in the low 80s and he sprayed a 10 x 12 area with a solution of 4 oz/20 gallons.
I009513-001	Triclopyr TEA Direct to Rice	Gueydan, LA in May 1999. Dow Agrosciences reported a claim made that GRANDSTAND at 1 pt/acre adversely affected 120 acres of rice. Triclopyr is the active ingredient of the product and it caused fish-hooking on roots, aborted tillers, and reduced stand.
I009513-002	Triclopyr TEA Direct to Rice	1999 in Texas 6(a)2 report: Dow AgroSciences reported the claim that GRANDSTAND damaged 150 acres of rice in Katy, TX. Rice is twisted at the roots and tillers are falling off.

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
I009513-003	Triclopyr TEA Direct to Rice	11/02/1999 6(a)2 report: Dow AgroSciences reported a complaint alleging that GRANDSTAND had damaged all 153 acres of rice in Gridley, CA. An inspector reported that there was visible tip burn and damage to the rice tillers.
I012366-048	Triclopyr TEA Direct to Rice	Dow Chemical reported a 2000 complaint from Princeton, CA, that GRANDSTAND HERBICIDE damaged 90.3 acres of rice. The description in the Dow report reads: "Application made at 10 oz for the control of redstem - noticed tip burn 10 days after application."
I010927-035	Triclopyr TEA Direct to Rice	Dow reported a 1999 complaint from Biggs, CA, that Grandstand damaged all 156.9 acres of rice plants in Butte County, CA. The Dow report is as follows: "Looked at field on 7/13/99. Notice tip burn and overlap areas from application. Yellowing and white spots on the rice and in severely damaged areas. Burned down tillers and also necrotic spots on leaf. Looked at field again on 7/23/99. Small buffer strip on the east side.
I010927-036	Triclopyr TEA Direct to Rice	Dow reported a 1999 complaint from Princeton in Colusa County CA, that Grandstand damaged a 213-acre crop of rice. The Dow report states: "Noticed burn on rice shortly after application. Looked at crop on 7/21/99. Noticeable burn and some overlap areas. Application made during hot weather, with hot surfactant."
I010927-037	Triclopyr TEA Direct to Rice	Dow reported a 1999 complaint from Willows in Glenn County, CA, that Grandstand herbicide damaged all 52 acres of a rice crop at 10 oz ai/acre. The aerial application was made during very hot weather, on May 28. The field was inspected on August 4 and on December 23 when there had been a low yield and the plants were then dead.
I010927-038	Triclopyr TEA Direct to Rice	Dow reported a 2000 complaint from Princeton in Colusa County, CA that aerial application of Grandstand damaged all 145 acres of a rice crop. The report of the problem by Dow said: "Alleged crop injury and non-performance due to Grandstand. Application made late at 45 days after planting. Application made against label 2 applications 20 days apart. Application made only 15 days apart."
I010927-039	Triclopyr TEA Direct to Rice	In 2000 Dow reported a complaint from Woodland in Yolo County, CA, that aerial application of Grandstand at 6 oz ai/acre damaged all 132 acres of a rice crop. Dow's report of the incident follows: "Application of Grandstand took place late in the season resulting in damage to the rice. Yield by grower allegedly reduced. Variety m-204."
I016962-008	Triclopyr TEA Direct to Rice	A farming business in Texas sued Helena Chemical Company alleging that the Grandstand herbicide (triclopyr) they sold them caused "various damage" to their rice crop in 2003.
I024071-185	Triclopyr TEA Drift	In Trumbull County OH, during the spring of 2012 it was alleged that an application of the product Max Poison Ivy & Tough Brush Killer Conc (a,i. triclopyr) to poison ivy killed a dogwood and an unknown tree.
Multi Active Plant Incidents including Triclopyr TEA products		
I006871-001	Triclopyr TEA and Picloram mixture Runoff	From a 6(a)(2) report. In Ohio a mixture of Garlon™ 3A (Triclopyr) and Tordon (Picloram) was applied to an electric power line right-of-way. A 1.5 inches of rain occurred the next evening moving product into an adjacent soybeans field which resulted in cupped leaves and absent plants. No other data, name of county or the location was reported.
I009969-006	Triclopyr TEA and Azoxystrobin	Dow Chemical reported a 1999 complaint from Yuba City, CA, that GRANDSTAND™ applied at 14 oz/acre had damaged 142 acres of rice. Dow inspector's report: 7/23/99 noted a 3 inch height difference. Visual symptoms of

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
	Direct to Rice	rice tip burn, aerial roots, crooked neck on roots. Quadris™ application made 7/21/99. Stemrot. Stated 3-4 inches of water in rice during application. Panicle and head cut in rice-some roughseed through."
I023044-034	Triclopyr TEA, Sulfometuron, and Glyphosate Drift	On May 11, 2011 in San Luis Obispo County, CA a pesticide company applied the products Garlon 3A (a.i. triclopyr), Roundup (a.i. glyphosate), and Oust (a.i. sulfometuron methyl) to a PG&E substation adjacent to a nursery. The nursery alleged about 2,800 plants were damaged due to the herbicide applications. The California Department of Pesticides suspects pesticide application violations. Waiting for lab results.
I012701-001	Triclopyr TEA and Clopyralid In Compost	In 2002 a DuPont reported a problem concerning the Columbus, OH, Compost Facility which conducted a bioassay to investigate the toxicity of their compost to tomato seedlings. The seedlings showed stunted growth and splitting of terminal leaves. There had been similar problems with composts in other areas.
I016962-043	Triclopyr TEA and Propanil Direct to Rice	In 2005 a grower in Sunflower County, MS applied Stam M-4 at 1 gal/acre and Grandstand R at 0.67 pints/acre to rice, to control broadleaf weeds, and curly indigo. 70 out of the 405 treated rice field acres experienced injury in the form of tillers erupting from the stalk. This decreased the yield by 17.9 bushels/acre compared to the uninjured 335 acres of rice field.
I017837-003	Triclopyr TEA and 2,4-D Drift	In 2004 a Minnesota nursery grower filed a lawsuit against MN Valley power alleging Garlon 3A and DMA-4 herbicides applied to their right-of-way 100 feet from the property killed nursery trees and greenhouse annuals. Leaf tissue samples of tree showed .017 ppm of 2-4-D and no detectable triclopyr.
I020725-057	Aminopyralid TPA salt, Triclopyr TEA Drift	Ain 2009 a California grower reported tomato crop loss due to pesticide drift to the Yolo County Deputy Agricultural Commissioner office. The application of pesticide Milestone VM Plus at 6 pts /acre was conducted by the Department of Water Resources to the levee banks adjacent to the tomato field and 30 acres of tomato crops were destroyed. Samples of both soil and vegetation have been collected and sent to laboratory
I023832-026	Triclopyr TEA+Dicamba DMA Adsorption	During the winter of 2012 in Brazoria County, TX an application of the product Weed-B-Gon Max Weed Killer RS 32oz Disc 715490410 (a.i. dicamba, dimethylamine salt and triclopyr, triethylamine salt) allegedly damaged a tree.
I023931-075	Triclopyr TEA + MCPA DMA + Dicamba DMA Direct	During 2012 Greene County, TN a resident alleged an application of the product Weed B Gon Killer for Lawns Conc (a.i. dicamba dimethylamine salt, MCPA, dimethylamine salt and triclopyr, triethylamine salt) killed her lilies.
I024071-326	Triclopyr TEA + MCPA DMA + Dicamba DMA Direct	In St Louis county. MO in April 2012 it was alleged an application of the product Weed B Gon Weed Killer for Lawns (a.i. MCPA dimethylamine salt, triclopyr triethylamine salt and dicamba, dimethylamine salt) damaged some Hosta plants.
I024071-335	Triclopyr TEA + MCPA DEA + Dicamba Al Direct	In Sangamon County, MO in April 2012 it was alleged an application of the product Weed B Gon Max Weed Killer RS (a.i. MCPA diethanolamine salt, triclopyr triethylamine salt and dicamba aluminum salt) killed outdoor ornamental plants.
I024071-350	Triclopyr TEA, Dicamba DEA salt Drift to trees	In April, 2012 in Utah it was alleged an application of the product Weed B Gon Max Weed Killer RS (a.i. dicamba diethanolamine salt, triclopyr triethylamine salt) may have killed a dogwood, plum and cherry trees. Two days after the application the owner noticed the trees starting to wilt and looking like they may die.

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
I024071-364	Triclopyr TEA, MCPA DMA, and Dicamba DMA Direct	In Dupage County, Illinois during April 2012 it was alleged an application of the product Weed B Gon Max Weed Killer RS (a.i. MCPA, triclopyr & dicamba) killed three hydrangea bushes
I024179-104	Triclopyr TEA, MCPA DMA, and Dicamba DMA Direct	In May 2012 in Paulding County, GA it was alleged an application of the product Weed-B-Gon Weed Killer for Lawn (a.i. dicamba, dimethylamine salt; MCPA, dimethylamine salt and triclopyr, triethylamine salt) damaged a customer's tree.
I024179-177	Triclopyr TEA, MCPA DMA, and Dicamba DMA Adsorption	In May 2012 in Hennepin County, MN it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. MCPA, dimethylamine salt; triclopyr, triethylamine salt and dicamba dimethylamine salt) killed an oak tree.
I024179-217	Triclopyr TEA, MCPA DMA, and Dicamba DMA Direct	In May 2012 in Middlesex County, MA it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. dicamba, dimethylamine salt; MCPA, dimethylamine salt and triclopyr, triethylamine salt) damaged a bed of black eye susan plants causing the flowers to wilt.
I024179-243	Triclopyr TEA, MCPA DMA, and Dicamba DMA Direct	In May, 2012 in Paulding County, GA it was alleged an application of the product Weed B Gon Weed Killer for Lawn (a.i. MCPA , dimethylamine salt; triclopyr, triethylamine salt and dicamba, dimethylamine salt) killed a 50 ft tree with a 4 foot diameter.
I024179-257	Triclopyr TEA, MCPA DMA, and Dicamba DMA Adsorption	In Laramie County Wyoming a 2012 application of the product Weed B Gon Max Weed Killer Conc (a.i. MCPA, dimethylamine salt; triclopyr, triethylamine salt, dicamba and dimethylamine salt) was reported to have damaged trees turning leaves yellow and then black.
I024179-313	Triclopyr TEA, MCPA DMA, and Dicamba DMA Adsorption	In May, 2012 in Fayette County, KY it was alleged an application of the product Weed B Gon Weed Killer for Lawn Conc (a.i. MCPA, dimethylamine salt; triclopyr, triethylamine salt and dicamba, dimethylamine salt) killed a plum tree.
I024272-164	Triclopyr TEA, MCPA DMA, and Dicamba DMA Adsorption	During the spring of 2012 in Monroe County, NY it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. MCPA, dimethylamine salt, triclopyr, triethylamine salt and dicamba, dimethylamine salt) killed a customer's bushes
I024272-170	Triclopyr TEA, MCPA DMA, and Dicamba DMA Drift	In June of 2012 Montgomery County, MO it was alleged an application of the product Weed B Gon Max Weed killer (a.i. MCPA, dimethylamine salt, triclopyr, triethylamine salt and dicamba, dimethylamine salt) blew onto zinnia and bean plants resulting in their death.
I024272-178	Triclopyr TEA, MCPA DMA, and Dicamba DMA Direct to lawn	During June of 2012 in Cuyahoga County, OH it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. MCPA, dimethylamine salt, triclopyr and triethylamine salt and dicamba, dimethylamine salt) killed some flowers.
I024272-320	Triclopyr TEA, MCPA DMA, and Dicamba DMA Adsorption	During June of 2012 in Suffolk County, NY it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. MCPA dimethylamine salt, triclopyr triethylamine salt and dicamba, dimethylamine salt) around some hostas and hydrangeas killed the plants
I024272-339	Triclopyr TEA, MCPA DMA, and Dicamba DMA	During June of 2012 in Renesselaer County, NY it was alleged an application of the product Weed B Gon Max Weed Killer (a.i. MCPA dimethylamine salt, triclopyr, triethylamine salt and dicamba dimethylamine salt) killed 3 shrubs.

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
	Adsorption	
I029601-007	Triclopyr TEA, Dicamba DMA, and MCPA DMA salt Adsorption	In winter of 2016 tree damage was reported in El Rio, Texas from use of Weed B Gon Max Ready Spray (Registration Number 228-424-239). Homeowner reported one dead ornamental tree from use of herbicide containing Triclopyr and Dicamba active ingredients.
I031341-160	Triclopyr TEA mixture Direct	In 2018 in Downers Grove, Illinois a homeowner sprayed Weed-B-Gon on privet hedges, roses and hibiscus plants and 3 weeks later 45% of the plants were wilted
Triclopyr BEE Product Plant Incidents		
I003581-001	Triclopyr BEE Drift	It was reported that pastureland, adjacent to a vineyard, was treated with Garlon 4. Some of the aerially-applied Garlon drifted onto the vineyard and resulted in brown or dead leaves, decreased growth, and several dead vines.
I004712-001	Triclopyr BEE Drift	The County treated a right-of-way near a 10-acre site of plants which allegedly showed growth regulatory type injury in 0.92 acres after pesticide treatment.
I004721-001	Triclopyr BEE Drift	The Power & Light Company treated a right-of-way with pesticide near a planted field. Allegedly, the crop showed signs of growth regulatory type injury.
I005004-001	Triclopyr BEE Drift	Dow Elanco 6(a)2 report. Garlon 4(Triclopyr) aerial drift contaminated an adjacent pond thus, causing damage to some aquatic vegetation. No other details were reported.
I005082-001	Triclopyr BEE (Turflon ester) Direct-Unintentional	6(a)(2). A owner of a rose tree nursery had a malfunction on his spray rig. A valve shutting off the tank containing Turflon ester did not completely close when he switched to a tank containing Triforine and Mavrik. The operator proceeded with the treatment and two days later he noted damage to roses.
I005413-001	Triclopyr BEE Drift	A California roadside median was treated with Garlon 4 (triclopyr) on a relatively windy day and the spray injured several wine grape fields that were adjacent. Dow Agrosciences reported that the litigation has been voluntarily dismissed with prejudice, no other details were given
I007834-039	Triclopyr -BEE Garlon Drift	Aggregate report: On April 23, 1998, personnel of the CA Dept. of Transportation applied Garlon on weeds alongside Highway 111, in Coachella, CA. This application was made adjacent to grape vineyards. On April 24, the vineyard owner notified the Riverside County Agricultural Commissioner's Office that the pesticide had drifted onto his vineyards. On May 27 the Southern Regional Office was notified by the grower that the crop loss was estimated at $500,000. Misuse accidental
I008077-001	Triclopyr BEE Drift	Alleged damage to a vineyard occurred in ST. Helena, CA over a period of three years: April 1994, 1995, and 1996 from drift of pesticide applied to an adjacent horse pasture. The injury consisted of damage to vines, severe stunting, death of shoot tips and entire shoots which resulted in low fruit, shot berries, withering and dead clusters and loss of crop yield (grapes) and budding grape plants. 13.99 use site acres affected two different owners (1) with 8.02 acres; (2) with 5.97 acres.
I013645-010	Triclopyr BEE (Garlon 4) Drift	In 1998 the CA Department of Pesticide Regulation reported an incident in Coachella that resulted in severe damage to two grape vineyards. Personnel of the CA Department of Transportation applied GARLON 4 alongside Highway 111 on April 23, 1998. The next day, the Riverside County Agricultural Commission

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
		Office was notified of pesticide damage to two vineyards; it was alleged that the damage sustained was $1,000,000. Soil and foliage samples were then collected, and the analyses established that GARLON 4 had drifted onto the vineyards and was responsible for the damage that had been sustained. On May 26 a Violation Notice was issued to Cal Trans for its use of a pesticide in conflict with its registered labeling, and on Dec. 30 an assessment of $1,000 was levied for violating FAC, Section 12973.
I025619-019	Triclopyr BEE Drift	In 2013 in San Luis Obispo County, California an application of Garlon 4 (a.i. triclopyr) allegedly drifted onto a vineyard damaging several hundred grapevines. The grapevine tissue tested positive for triclopyr from ranges of 120 ppb to 1,200 ppb. The inspector also suspects glyphosate was in the tank due to the "witches broom" symptoms on the vines. No testing for glyphosate was performed.
Multi-active Incidents which include Triclopyr BEE products		
I001944-001	Triclopyr BEE and Picloram mixture Drift	DowElanco 6(a)2 report: A pest control operator applied Garlon 4 and Tordon K on a right-of-way in Oklahoma on a day when the wind speed was between 10 and 16.1 mph. The homeowner of property adjacent to the right-of-way alleged that 332 oak, 44 walnut, 234 grafted walnut, 50 hickory, 30 hickory grafted to pecan, 30 sassafras, 12 redbud, 5 dogwood, 3 black cherry, 1 Chinese chestnut, 3 apple, 3 pear, 5 sycamore, and 1 ornamental pear were damaged. Also, damage was claimed to have occurred to numerous vegetable plantings and to animals. The State Dept. of Agriculture investigated and concluded there was no herbicidal effect to the trees.
I010927-014	Triclopyr BEE (Remedy) and Glyphosate Aerial Drift	Dow reported a 1999 complaint from Carson County, TX, involving triclopyr damaged an entire 300 acre field of soybeans. The problem was that the operator of a flying service applied Remedy to mesquite trees in Armstrong County, TX, then flushed the chemical out of the plane before filling the sprayer, through a rubber hose, with Round Up. When he sprayed 300 acres of soybeans, they all died. Plastic tubing should have been used to transfer the chemical because Remedy penetrates the inner lining of rubber hosing.
I011622-003	Triclopyr BEE (Garlon) and Remedy Drift	Dow submitted report in June 15, 2001, that reported the judgment made by a court concerning a prior damage claim. The case was made by a tomato farmer in California that Garlon was sprayed by the State of California Department of Water Resources, and this spraying damaged 300 acres of tomato plants which were adjacent. The result was the cupping and curling of the plants, and the Court's finding was in favor of the tomato farmer. Garlon and Remedy are registered for a number of uses but they do not include tomatoes.
I012209-003 I012209-012 - update	Triclopyr BEE and Glyphosate/Aceto chlor(Roundup Pro) Drift	An August 2001 report from the CA Dept. of Pesticide Regulation stated that the owner of a grape vineyard in Kenwood in Sonoma County called the Sonoma County Agricultural Commissioner's office to report a crop loss and symptoms of herbicide exposure in his 8 acre vineyard. An investigation was made and it was found that on May 24-25, 2001, the owner of a winery in Glen Ellen applied GARLON 4 and ROUNDUP PRO on his property to control blackberries. Samples were taken from the vineyard and found positive. It was found that some of the pesticides had drifted onto the grape vines causing damage valued at $84,380. A Notice of Violation was filed and a fine of $675 was levied. The action was closed on May 21, 2002
I016940-015	Garlon 4 and Glyphosate-	In 2004 the CA Dept. of Pesticide Regulation reported through EPA Region 9 that there were several applications of Garlon herbicide made by State Park employees

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
	isopropylammonium (Roundup) Drift	in Napa County to control weeds. The herbicide drifted on to a grape vineyard, olive trees and ornamental plants. The vineyard was 8.63 acres valued at $148,170.00. The grapes were refused at the winery because it had been contaminated with a pesticide that was not approved for use on grapes.
I021421-001	Triclopyr BEE and 2,4-D, BEE (Crossbow Herbicide) Drift	In Nov. 2009 a report submitted to N.C. Dept. of Agriculture & Consumer Services Pesticide Board documents that a landscaping company in Sylva, (Jackson County, N.C.) agreed to pay $1,000 for using pesticide Crossbow Specialty Herbicide, inconsistent with label instructions. The pesticide damaged grapevines and its label states it shouldn't come into direct contact with grapes.
I025974-014	Triclopyr BEE, Picloram P Salt, and Aminopyralid TIPA salt Direct to grasses	In spring of 2016 in Jackson County, TX, the products Garlon 4 Ultra Herbicide (a.i. Triclopyr, butoxyethyl ester), Tordon K Herbicide (a.i. picloram, potassium salt) and Milestone VM Herbicide (a.i. aminopyralid, triisopropanolamine salt) were applied to a right-of-way. The exposure occurred in a field/pasture to five bulls that were allowed into an adjacent pasture after the application. Two of the bulls died and the others displayed malaise.
Pollinator Incidents which include Triclopyr Products		
I028969-001	Triclopyr BEE and Impel Direct	On Jan. 20 to Feb. 1, 2016 a spoil island (Travatine Island) in Pinellas County, FL was treated with Garlon 4 and Impel Red (oil dispersant). Bees started walking away from the hives in a disoriented manner, unable to fly. No wing or other observed deformities are reported. Loss of six of eleven hives reported.
I031717-001	Triclopyr (116001) and Glyphosate (detected in honey?)	Based on a 2018 phone conversation with EPA , a beekeeper in Pinellas County, Florida reporting loss of 9 of 12 colonies due to application of triclopyr herbicide application by the county for invasive plant control. Beekeeper claimed presence of RoundU™p (glyphosate)in honey and feels this contributes to the chronic bee loss. FDACS investigated the losses and did not find triclopyr or other pesticides residues in the collected samples and also indicated that FDACs believes her colonies are Africanized and in poor health.
I029045-011	Triclopyr BEE, Imazapyr IPA, Glyphosate IPA Drift possible	From April 1 to June 30, 2016 a bee keeper reported a continuing loss of bees in Ridge Spring, SC. A local utility had used products containing triclopyr (Boulder and Alligare), glyphosate (Glyphosate 4 Plus), Imazapyr (Alligare) in right of ways near his property. None of these herbicides are considered acutely toxic to bees.
I030739-001	Triclopyr BEE (Garlon 4 Ultra) Direct ingestion	IN 2018 a Florida beekeeper reporting a loss of bees in February 2018 related to Garlon 4 Ultra (active ingredient Triclopyr BEE) that the county applied near St Petersburg, FL. Product is rated as nearly non-toxic to bees but caller reported the bees gather pollen that has the active ingredient in it and then the bees starve to death. Caller reported problems related to the herbicide on four separate occasions. Caller lost 7 of 12 hives in one instance, three of her twelve hives in s second, nine out of twelve in a different instance. Triclopyr acid, a breakdown product of Triclopyr BEE has been shown to display low oral toxicity to adults. Acute and chronic larval dietary studies are still being reviewed for the Triclopyr acid by the Agency.
I030739-002	Triclopyr BEE (Garlon 4) Drift to hives	This record is similar in content to an NPIC report in incident I02969-00001. It relates to 2017 bee kill reported by beekeeper near St. Petersburg Florida regarding application of Garlon 4 (Triclopyr BEE) herbicide by County seven times over 2-weeks to control non-native plants. Caller noticed multiple instances of bee kill in significant numbers and various behavior impairment behavior of bees. According to current studies evaluated by the Agency this active ingredient is nearly non-toxic to adult honeybees from direct contact.

Incident Number	Product and /or Additional Active Ingredients involved/ Cause	Year/State/Use Site Species affected Magnitude/Other Notes- Legality- Certainty Index
I029211-003	Triclopyr TEA Milestone (Aminopyralid TPA) salt, and Streamline Drift	In 2016, an Illinois beekeeper had noticed problems with 2 hives in a state park of 4000 acres within range of her bee hives. Herbicides were sprayed along park roads and under power lines near her home. The bee hives at her home are 15 miles from the state bee yard where the bee keeper first noticed some-thing wrong with her bees. She had a mild chemical exposure on her home hives. The one damage hive was isolated, and the bees were put on all new equipment. Milestone, Garlon3A and Streamline were used for vegetation control.
I029211-004	Triclopyr TEA and Aminopyralid TPA salt- Drift	In 2016 was reported by an Illinois beekeeper reported that honey bees were effected in hives located within a state park where herbicide spraying was conducted along roads and utility right of ways. This report has multiple individual reports within it. Milestone and Garlon 3 A had been used in the park.
I029211-005	Triclopyr TEA, Aminocyclopyr, and Metsulfuron and Aminopyralid herbicides and been used in the area Possible Drift	Addendum to Incident 029186 001 more bee kills were reported in Murphysboro, Illinois as well. returned to the bee yard from the park half to 1/4 of the bees in the bee yard remained alive. But by the next day they were all dead. The beekeeper checked the hives 2 miles away and they looked good. Then next day two hives were found dead in the other bee yard. The other hives exposed showed bees acting drunk and disoriented. Due to the weakened hives, and loss of adult foragers, small hive beetles have moved in to the weak hives. Another beekeeper who had 70 hives was now down to 30 hives. No lab results were given.
I029385-006	Triclopyr TEA (Pro-Health and Fumaglin-B, Kem-Tek Supershock, Kem-Tek Power 99, and Phos-Free) Undetermined	On 24 May 2016 it was reported to Indiana authorities that 4 of his bee hives were found dead of possible poisoning. Less than a hundred dead frozen bees were taken for analysis, which may be insufficient for testing due to low quantity. The complainant's residence is surrounded by densely populated area with a mix of residential, industrial, school, and golf course properties which were neatly groomed and it is highly likely there were many pesticides products used by the various property owners. Pro-Health and Fumaglin-B, Kem-Tek Supershock, Kem-Tek Power 99, and Phos-Free were used by the beekeeper to treat hives placed in the area. None of these listed actives known to have been used in the area are considered toxic to bees.
Aquatic Incidents which include Triclopyr Products		
I000925-001	Triclopyr and 2,4-D mixed	In 1993 a fish kill was reported in area below a railroad crossing and above a low retention dam on Blueston River near Bluefield in Mercer County, WV from possible drift. Mixed species- 23,000 fish died.
I008883-001	Triclopyr TEA and Propanil	In 1999 Dow AgroSciences reported an allegation that 45,000 pounds of catfish had been destroyed in a catfish farm in St. Martinsville, LA, by triclopyr. An adjacent rice field had been sprayed with Grandstand R at the rate of 3.0 lbs/gallon, and with Stam M-4 (Propanil), a product not made by Dow. The manager of the catfish farm contends that the spray drift of Grandstand R had killed the fish as the consequence of oxygen starvation. There were no analyses made to support the allegation which is presumed to have been based on the herbicidal action of Grandstand R (triclopyr) that might kill the plankton in the fish pond.

APPENDIX D. Summary of Summitted Ecological Effects Studies

Newly Submitted Studies

MRID 49992406: *Lifecycle Chronic Toxicity for Daphnia magna exposed to Triclopyr BEE.*
Significantly increased parental mortality was observed during the 21-day study at the ≥ 520 ug a.i./L. Live offspring production and successful birth rate were negatively impacted at the 1600 and 5100 ug ai/L levels ($p<0.05$). Additionally, survival of offspring was negatively impacted at the highest dose, 5100 ug ai/L ($p<0.05$). There was no effect on time to first brood. The most sensitive endpoint from this study was parental survival, resulting in an overall NOAEC and LOAEC of 170 ug ai/L and 520 ug ai/L, respectively. Study was considered supplemental as no growth parameters were measured, but reproduction and survival data were considered valid.

MRID 50673901: *Lifecycle Chronic Toxicity for Mysid exposed to Triclopyr BEE.*
The 28-day chronic toxicity of Triclopyr butoxyethyl ester (BEE) to mysids (*Americamysis bahia*) was studied under flow-through conditions. Mysids were exposed to nominal concentrations of 0 (negative and solvent control), 19, 38, 75, 150, and 300 µg ai/L. The time-weighted average (TWA) concentrations based on analytical measurements were <6.25 (<LOQ, controls), 10.9, 20.4, 38.7, 86.9, and 153 µg ai/L. No significant treatment-related effects were observed for pre- or post-pairing first generation or second generation survival, as well as time to first brood. Female and male length and dry weight and numbers of offspring/female were significantly affected by the test material. The most sensitive endpoints were female and male dry weight, resulting in a NOAEC and LOAEC of 10.9 and 20.4 µg ai/L, respectively.

MRID 49992407: *Early Lifestage Testing with TCP on Rainbow trout.*
The 91-day chronic toxicity of 3,5,6-trichloro-2-pyridinol (TCP) to the early life-stage of the rainbow trout *(Oncorhynchus mykiss)* was studied under flow-through conditions. Fertilized eggs/embryos (200/level, 3 hours old) were exposed to TCP at nominal concentrations of 0 (negative control), 0 (solvent control), 58.3, 97.2, 162, 270, 450, and 750 µg ai/L. The mean-measured concentrations <20 (<LOQ, controls), 58.6, 106, 178, 278, 479, and 825 µg ai/L, respectively. The LOAEC for swim-up time was determined to be 825 ug ai/L where a 4% change was noted. The most sensitive NOAEC was determined by the Agency to be 178 µg ai/L, based on significant reductions in weight and length at 278 ug ai/L. No significant treatment-related differences were observed for hatching success, days-to-mean hatch, post-hatch survival, or percent normal at hatch and termination.

MRID 49992409: *Acute Oral Toxicity Testing with Honeybee exposed to Triclopyr Acid.*
A limit test was conducted with triclopyr acid using 30 bees tested at a nominal concentration of 100 ug ai/bee. The actual intake was 99 µg ai/bee. At 48 hours, mortality was 0% in the negative control and treatment group. Dimethoate was used as the positive control. No abnormal effects or other sublethal effects were observed in the Triclopyr control or treatment group.

MRID 50673902: *Chronic Repeat Dose Toxicity to Honeybee Larvae exposed to Triclopyr acid*
Larval and pupal mortality and adult emergence of honey bees were significantly affected in this 22-day experiment. Day 15 mortality NOAEL and LOAEL are determined to be 0.58 and 1.5 ug ai/larvae/day, respectively. The 22-day NOAEC for % emergence of surviving larvae slightly higher and determined to be 38.4 mg ai/kg diet.

MRID 50673903: *Chronic Oral Toxicity to Adult Honey bee exposed to Triclopyr acid.*
After 10 days oral exposure of adult honey bees, mortality averaged 3% in the negative and solvent controls, as compared to mortality averaging 10, 13, 0, 0, and 37% in the measured 150, 255, 490, 973, and 2091 mg ai/kg diet groups, respectively. Mortality in the positive control (Dimethoate technical) was at 100% at ten days. Behavioral abnormalities were not reported. The NOAEC was 973 mg ai/kg diet, respectively. This corresponds to a NOAEL of 22.3 µg ai/bee/day. Food consumption was adversely affected at a lower concentration than mortality, resulting in a NOAEC of 490 mg ai/kg diet. This value corresponds to a NOAEL of 14.3 µg ai/bee/day.

All Submitted Studies

Tables D-1 and **D-2** identify ecological effects studies by MRID that offer data for each guideline requirement as well as study classifications

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
850.1010 **Acute FW Invertebrate**	40346504 Water flea, *Daphnia magna*	99.5% Technical acid	Acceptable EC_{50}= 132.9 ppm[1]
	00151959 Water flea, *Daphnia magna*	44.9 % TEA	Acceptable EC_{50}=1496 ppm
	00159956 Water flea, *Daphnia magna*	64.7 % TEA	Acceptable EC_{50} = 775 ppm
	00151963 Water flea, *Daphnia magna*	96.4 % Technical BEE	Supplemental EC_{50} = 1.7 ppm
	00151965 Water flea, *Daphnia magna*	96.4 % Technical BEE	Acceptable EC50=12 ppm
	43442603 Water flea, *Daphnia magna*	62.3% Garlon 4 TEP	Acceptable EC_{50} = 0.35 ppm
	41205408 Water flea, *Daphnia magna*	TCP Degradate	**Report ES-83L 1978**
	41829005 Water flea, *Daphnia magna*	99.9 % TCP Degradate	Acceptable EC_{50} = 10.4 ppm

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
850.1025 **Acute estuarine mollusc**	42646101 Oyster spat, *Crassostrea virginica*	46% TEA	Acceptable Formulated EC_{50}=58 ppm
	00062623 40346606 Oyster spat, *Crassostrea virginica*	43.8 % TEA	Acceptable Larvae EC_{50} = 55.7 ppm Spat EC_{50}=58 PPM
	41971602 Oyster spat, *Crassostrea virginica*	96.1 % BEE technical	Acceptable EC_{50} = 0.46 ppm
	41969903 Oyster spat, *Crassostrea virginica*	62.9 % Garlon 4	Acceptable EC_{50} =0.32 ppm
	42245903 Oyster spat, *Crassostrea virginica*	99.9% TCP Degradate	Acceptable EC_{50} = 9.3 ppm
850.1035 **Acute Estuarine /Marine Crustacea**	00062623 40346406 Pink shrimp, *Penaeus duorarum*	43.8 % TEA	Supplemental LC = 895 ppm
	00062623 40346406 Fiddler crab, *Uca pugilator*	43.8 % TEA	Supplemental EC_{50} > 1000 ppm
	42646102 Grass shrimp, *Palaemonetes pugio*	46 % TEA	Acceptable LC_{50} = 327 ppm
	41971601 Grass shrimp, *Palaemonetes pugio*	96.1 % BEE technical	Acceptable LC_{50} = 2.48 ppm
	41969902 Grass shrimp, *Palaemonetes pugio*	62.4 % Garlon 4	Acceptable LC_{50} = 1.7 ppm
	42245902 Grass shrimp, *Palaemonetes pugio*	99.9% TCP Degradate	Acceptable EC_{50} = 83 ppm
850.1075 **Freshwater Fish Acute**	00049637 Rainbow trout, *Oncorhynchus mykiss* and Bluegill sunfish, *Lepomis macrochirus*	Technical acid	Acceptable LC_{50} = 148 ppm –Bluegill And 117 ppm for Rainbow trout
	40098001 Rainbow trout, *Oncorhynchus mykiss* and Bluegill sunfish, *Lepomis macrochirus*	43.5 % acid formulation	Supplemental LC_{50} > 100 ppm both species

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
	00151956 Fathead minnow, *Pimephales promelas;* Rainbow trout, *Oncorhynchus mykiss* and Bluegill sunfish, *Lepomis macrochirus*	64.7 % TEA	Supplemental LC_{50}s = 891 ppm Bluegill, 947 [[m Fathead minnow, and 552 ppm Rainbow trout
	00151958 Fathead minnow, *Pimephales promelas*	44.9 % TEA	Supplemental LC_{50} = 279 ppm
	00062622 Bluegill sunfish, *Lepomis macrochirus*	47.8 % TEA	Acceptable LC_{50} = 240 ppm
	00151963 Fathead minnow, *Pimephales promelas*	BEE technical	Supplemental LC_{50} =2.4 ppm
	00151965 Fathead minnow, *Pimephales promelas*	BEE Technical	Supplemental LC_{50} = 2.31 ppm
	41736304 Coho salmon (fry and fingerling), *Oncorhynchus kisutch*	99 % BEE technical	Supplemental data Not conducted to guideline standards
	41971603 Rainbow trout, *Oncorhynchus mykiss*	62.9 % Garlon 4	Supplemental LC_{50} < 2.7 ppm
	41971604 Bluegill sunfish, *Lepomis macrochirus*	62.9 % Garlon 4	Supplemental LC_{50} = 1.3 ppm
	42884501 Rainbow trout, *Oncorhynchus mykiss*	97 % BEE technical	Acceptable LC_{50} =0.65 ppm
	42917901 Bluegill sunfish, *Lepomis macrochirus*	97 % BEE technical	Acceptable LC_{50} = 0.36 ppm
	43442601 Bluegill sunfish, *Lepomis macrochirus*	62 % Garlon 4	Acceptable LC_{50} = 0.44 ppm
	43442602 Rainbow trout, *Oncorhynchus mykiss*	62 % Garlon 4	Acceptable LC_{50} = 0.98 ppm

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
	ACC 229783 Rainbow trout, *Oncorhynchus mykiss* and Bluegill sunfish, *Lepomis macrochirus*	42 % TEA and BEE formulation	Acceptable LC_{50} = 1.46 ppm for Bluegill and 1.29 ppm for Rainbow trout
	41205402 Rainbow trout, *Oncorhynchus mykiss* and Bluegill sunfish, *Lepomis macrochirus*	TCP Degradate	Supplemental information
	41829003 Bluegill sunfish, *Lepomis macrochirus*	99.9 % TCP Degradate	Acceptable LC_{50} = 12.5 ppm
	41829004 Rainbow trout, *Oncorhynchus mykiss*	99.9 % TCP Degradate	Acceptable LC_{50} = 12.6 ppm
	44585404 Pacific salmon-several species	Garlon 3A, Garlon 4, BEE, TCP and TMP Degradates	Open lit supplemental data
	00028766 Rainbow trout, *Oncorhynchus mykiss*, Bluegill sunfish, *Lepomis macrochirus* and Goldfish, *Carassius auratus*	TCP degradate	Not useable-incomplete
850.1075 Estuarine/ Marine Fish Acute	41633703 Inland silverside, *Menidia beryllina*	44.7 % TEA	Acceptable LC_{50} = 130 ppm
	41969901 Inland silverside, *Menidia beryllina*	62.9 % Garlon 4	Acceptable LC_{50} = 0.45 ppm
	42053901 Inland silverside, *Menidia beryllina*	96.1% BEE technical	Acceptable LC_{50} = 0.76 ppm
	42245901 Atlantic silverside, *Menidia menidia*	99.9 % TCP Degradate	Acceptable LC_{50} = 58.4 ppm
850.1400 **Fish Early Life Stage**	00151958 Fathead minnow, *Pimephales promelas*	44.9 % TEA	Acceptable LOAEC= 162 ppm NOAEC= 104 ppm
	43230201 Rainbow trout, *Oncorhynchus mykiss*	97% BEE Technical	Acceptable LOAEC = 0.048 ppm NOAEC = 0.026 ppm

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
	44997301 and 46033201 amended Rainbow trout, *Oncorhynchus mykiss*	99.7% TCP Degradate	Unacceptable
850.1300 **Freshwater Aquatic Invertebrate Chronic**	00151959 Waterflea, *Daphnia magna*	44.9 % TEA	Acceptable LOAEC= 149 ppm NOAEC= 80.7 ppm
	45861301 Waterflea, *Daphnia magna*	TCP Degradate	In review
	Waterflea, *Daphnia magna*	Triclopyr BEE	No data
850.1350 **Estuarine/** **Marine Invertebrate Lifecycle Toxicity**	50673901 *Americamysis bahia*	Triclopyr BEE 92.4%	Acceptable LOAEC=20.4 ug ai/L NOAEC=10.9
850.4400 **Aquatic Plant Vascular**	41633709 Duckweed, *Lemna gibba*	45 % TEA	Supplemental EC_{50} = 19.5 ppm
	41736302 Duckweed, *Lemna gibba*	45 % TEA Garlon 3	Acceptable EC_{50} = 24.4 ppm
	42719101 Duckweed, *Lemna gibba*	97 % BEE technical	Acceptable EC_{50} = 0.88 ppm
	43230310 Duckweed, *Lemna gibba*	Access BEE 9%/ Picloram IOE 4.7% mix	Acceptable EC_{50} = 99.8 ppm
	45312002 Duckweed, *Lemna gibba*	99.7 % TCP Degradate	AcceptableEC_{50} = 8.2 ppm
850.4500 **Aquatic Plant Non-Vascular**	41736303 Green algae, *Selenastrum capricornutum*	98.8% Technical acid	Supplemental EC_{50} = 32.5 ppm NOEC = 7.0 ppm
	41633705 Green algae, *Selenastrum capricornutum*	45 % TEA	Acceptable EC_{50} = 39.1 ppm
	41633704 Green algae, *Selenastrum capricornutum*	61.3 % BEE Garlon 4	Acceptable EC_{50} = 5.6 ppm
	42645901 Green algae, *Selenastrum capricornutum*	Access =Triclopyr BEE 9%/ Picloram IOE 4.7% mix	Supplemental EC_{50} = 4.86 ppm

Table D-1. Submitted Aquatic Ecological Effects Data for triclopyr Acid, TEA salt, BEE, and TCP.OSCSPP Guideline	Submitted Studies (MRID)	Test Material	Study Classification and Results
	45312001 Green algae, *Selenastrum capricornutum*	99% TCP Degradate	Acceptable EC_{50} = 2.9 ppm
	45312003 Bluegreen algae, *Anabaena flos-aquae*	99% TCP degradate	Acceptable EC_{50} = 2.0 ppm
	42721101 Bluegreen algae, *Anabaena flos-aquae*	97% Technical BEE	Supplemental EC_{50} = 1.97 ppm
	41633706 Bluegreen algae, *Anabaena flos-aquae*	45 %TEA	Acceptable EC_{50} = 5.9 ppm
	43230307 Bluegreen algae, *Anabaena flos-aquae*	Access = BEE 9% Picloram IOE 4.7%	Not Acceptable
	41633708 Freshwater diatom, *Navicula pelliculosa*	45 % TEA	Acceptable EC_{50} = 15.3 ppm
	42721102 Freshwater diatom, *Navicula pelliculosa*	97% Technical BEE	Supplemental 24 hr EC_{50} = 0.10 ppm
	43230301 Freshwater diatom, *Navicula pelliculosa*	Access =Triclopyr BEE 9%/Picloram IOE 4.7%	Not Acceptable
	41633707 Marine diatom, *Skeletonema costatum*	45 % TEA	Supplemental EC_{50} = 14.9 ppm
	42721103 Marine diatom, *Skeletonema costatum*	97% Technical BEE	Supplemental EC_{50} = 1.17 pp,
	43230304 Marine diatom, *Skeletonema costatum*	Access =Triclopyr BEE 9%/ Picloram IOE 4.7% mix	Not acceptable

[1]ppm = mg ai/L
* considered a data gap pending review of the submitted study.

Table D-2. Submitted Terrestrial Ecological Effects Data for Triclopyr Acid, TEA, BEE and TCP.

OSCPP Guideline	Submitted Studies (MRID)	Test Material	Study Classifications and results
850.2100 **Avian Oral Acute**	40346401 Mallard duck, *Anas platyrhynchos*	Technical acid	Acceptable LD_{50}=1698 Mg ai/Kg bw
	00134178 Mallard duck, *Anas platyrhynchos*	64.7 TEA	Supplemental LD_{50}=3175 Mg ai/Kg bw
	40346501 Mallard duck, *Anas platyrhynchos*	64.7 TEA	Acceptable LD_{50}=3176 Mg ai/Kg bw
	41902002 Bobwhite quail, *Colinus virginianus*	96.1 % BEE technical	Acceptable LD_{50}=735
	41902003 Bobwhite quail, *Colinus virginianus*	62.9 % Garlon 4	Acceptable LD_{50}=849.2
	41829001 Bobwhite quail, *Colinus virginianus*	TCP Degradate	Acceptable LD_{50} > 2000 mg ai/Kg
	00028759 Domestic chicken	TCP Degradate	Supplemental LD_{50} > 1000 Mg ai/Kg
	Passerine Species	Triclopyr Acid	No Data
850.2300 **Avian Acute Dietary**	00031249 Mallard duck, *Anas platyrhynchos*	99 % Technical acid	Acceptable LC_{50} >5620 ppm
	40346403 Bobwhite quail, *Colinus virginianus*	Technical acid	Acceptable LC_{50} = 2934 pm
	00049638 Coturnix quail, *Coturnix coturnix*	TEA technical	Supplemental LC_{50} = 3272 ppm
	40346502 Mallard duck, *Anas platyrhynchos*	64.7% TEA	Acceptable LC_{50} >10,000 ppm
	40346503 Bobwhite quail, *Colinus virginianus*	64.7 % TEA	Acceptable LC_{50} >10,000 ppm
	00134179 Mallard duck, *Anas platyrhynchos*	93 % BEE technical	Acceptable LC_{50} >10,000 ppm
	00134180 Bobwhite quail, *Colinus virginianus*	93 % BEE technical	Acceptable LC_{50}= 9026 ppm
	41905501 Bobwhite quail, *Colinus virginianus*	96.1% BEE technical	Acceptable LC_{50} =5401 ppm
	41905502 Mallard duck, *Anas platyrhynchos*	96.1 % BEE technical	Acceptable LC_{50}>5401 ppm
	41829002 Mallard duck, *Anas platyrhynchos*	TCP degradate	Supplemental LC_{50} > 5620 ppm
850.2300 **Avian Reproduction**	00031250 Mallard duck, *Anas platyrhynchos*	99% Technical acid	Acceptable LOAEL=200 ppm
	00031251 Bobwhite quail, *Colinus virginianus*	99% Technical acid	Supplemental LOAEL>500 ppm
850.3020 **OECD 213** **Honeybee Acute**	40356602 Honeybee, *Apis mellifera*	99.2% Technical acid	Acceptable >100 ug ai/bee
	41219109 Honeybee, *Apis mellifera*	97.7% Technical BEE	Acceptable > 100 ug ai/bee
	42625901 Honeybee, *Apis mellifera*	Access = triclopyr BEE 9% + Picloram EHE 4.7%	Acceptable >25 ug form./bee

OSCPP Guideline	Submitted Studies (MRID)	Test Material	Study Classifications and results
850.3030 Honeybee Residues on Foliage	N.A.	N.A.	No data
OECD 214 Honeybee Oral Acute	49992409 Honeybee, *Apis mellifera*	Triclopyr acid (99%)	Acceptable LD_{50}>99 ug ai/bee
OECD 245 Honeybee Chronic Oral Toxicity Test	50673803 Honeybee, *Apis mellifera*	Triclopyr acid (99.4%)	Acceptable LOAEL=33.4 NOAEL=22.3 ug ai/bee/day
OECD 239 Honeybee Larvae Chronic Toxicity	50673902 Honeybee, *Apis mellifera*	Triclopyr acid (99.4%)	Acceptable LOAEL = 1.5 NOAEL = 0.58 ug ai/larvae/day
850.3040, **Higher Tier Bee Studies ***	N.A.	N.A.	
850.4400 Terrestrial Plants Tier I or Tier II Seedling Emergence	41734301 Ten Species Tier I Seedling Emergence	63.7 % BEE	Acceptable EC25 < 9.0 lb ai/A all species
	41734301 Ten Species Tier I Seedling Emergence	45.2 % TEA	Acceptable EC25 < 8.0 lb ai/A all species
	41296501 Species Tier I Seedling Emergence	Access 9% Triclopyr BEE with 4.7% Picloram	Supplemental Drybean EC25 = 0.000004 lb ai/A
850.4550 Terrestrial Plants Tier I or Tier II Vegetative Vigor	41784401 Ten Species Tier I Vegetative Vigor	45.2 % TEA	Acceptable EC25<9.0 lb ai/A all species
	41734301 Ten Species Tier I Vegetative Vigor	63.7 % BEE	Acceptable EC25<8.0 lb ai/A all species
	41296501 Species Tier I Vegetative Vigor	Access 9% Triclopyr BEE with 4.7% Picloram	Supplemental Soybean EC25 = 0.0002 lb ai/A
	43129801 Ten Species Tier II Seedling Emergence	46.5 % TEA salt	Acceptable Corn EC25>0.333 lb ai/A
	43276601 Tier II Seedling Emergence	Access 9% Triclopyr BEE with 4.7% Picloram	Acceptable Lima bean EC25 0.00042 lb ai/A
	43650001 Ten Species Tier II Seedling Emergence	62.2% Garlon 4 Triclopyr BEE	Acceptable Alfalfa EC25=0.062 lb ai/A

OSCPP Guideline	Submitted Studies (MRID)	Test Material	Study Classifications and results
850.4150	43129801 Ten Species Tier II Vegetative Vigor	46.5 % TEA salt	Acceptable Sunflower EC25 = 0.0076 lb ai/A
	43650001 Ten Species Tier II Vegetative Vigor	62.2% Garlon 4 Triclopyr BEE	Acceptable Sunflower EC25 =0.0089 lb ai/A
Non-Guideline	ACC 235248 Tier III Veg vigor- foliar application-in field	Garlon 3A	Acceptable

APPENDIX E. Sample Runs for Terrestrial Models Used in this assessment

1. TREX Example Run Input and Output: Pasture/Range land use with Triclopyr ACID

Chemical Identity and Application Information	
Chemical Name:	Triclopyr Acid
Seed Treatment? (Check if yes)	☐ FALSE
Use:	hay or pasture, all or unspecified 22
Product name and form:	Garlon
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%
Application Rate (lb ai/acre)	9
Half-life (days):	35
Application Interval (days):	
Number of Applications:	1
Are you assessing applications with variable rates or intervals?	no

Endpoints			
Avian	Mallard duck	LD50 (mg/kg-bw)	1698.00
	Bobwhite quail	LC50 (mg/kg-diet)	2934.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	100.00
Mammals		LD50 (mg/kg-bw)	630.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	25.00
		NOAEC (mg/kg-diet)	500.00

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	882	2460	2.79	1128	1.28	1384	1.57	154	0.17	964	1.09	34	0.04
100	1122	1403	1.25	643	0.57	789	0.70	88	0.08	549	0.49	19	0.02
1000	1585	628	0.40	288	0.18	353	0.22	39	0.02	246	0.16	9	0.01

Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
LC50	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2934	2160	0.74	990	0.34	1215	0.41	135	0.05	846	0.29

Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
	EECs and RQs									
NOAEC (ppm)	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
100	2160	21.60	990	9.90	1215	12.15	135	1.35	846	8.46

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/ Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	1385	2059	1.49	944	0.68	1158	0.84	129	0.09	807	0.5825	29	0.0207
35	1120	1423	1.27	652	0.58	801	0.71	89	0.08	557	0.4976	20	0.0176
1000	485	330	0.68	151	0.31	186	0.38	21	0.04	129	0.2667	5	0.0095

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
	EECs and RQs									
NOAEC (ppm)	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
500	2160	4.32	990	1.98	1215	2.43	135	0.27	846	1.69

Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	55	2059	37.48	944	17.18	1158	21.08	129	2.34	807	14.68	29	0.52
35	44	1423	32.02	652	14.67	801	18.01	89	2.00	557	12.54	20	0.44
1000	19	330	17.16	151	7.87	186	9.65	21	1.07	129	6.72	5	0.24

II. BEE REX Example Model Run (4.0 lbs ai/A Triclopyr Acid)

Table 1. User inputs (related to exposure)

Description	Value
Application rate	1
Units of app rate	lb a.i./A
Application method	foliar spray
Are empirical residue data available?	no

Table 2. Toxicity data

Description	Value (µg a.i./bee)
Adult contact LD50	100 (>100)
Adult oral LD50	99 (>99)
Adult oral NOAEL	22.3
Larval LD50	4.3
Larval NOAEL	0.58

Table 3. Estimated concentrations in pollen and nectar

Application method	EECs (mg a.i./kg)	EECs (µg a.i./mg)
foliar spray	110	0.11
soil application	NA	NA
seed treatment	NA	NA
tree trunk	NA	NA

Table 4. Daily consumption of food, pesticide dose and resulting dietary RQs for all bees

Life stage	Caste or task in hive	Avg age (in days)	Jelly (mg/day)	Nectar (mg/day)	Pollen (mg/day)	Total dose (µg a.i./bee)	Acute RQ	Chronic RQ
Larval	Worker	1	1.9	0	0	0.002	#DIV/0!	0.004
		2	9.4	0	0	0.010	#DIV/0!	0.02
		3	19	0	0	0.021	#DIV/0!	0.04
		4	0	60	1.8	6.798	#DIV/0!	11.72
		5	0	120	3.6	13.596	#DIV/0!	23.44
	Drone	6+	0	130	3.6	14.696	#DIV/0!	25.34
	Queen	1	1.9	0	0	0.002	#DIV/0!	0.00
		2	9.4	0	0	0.010	#DIV/0!	0.02
		3	23	0	0	0.025	#DIV/0!	0.04
		4+	141	0	0	0.155	#DIV/0!	0.27

Adult	Worker (cell cleaning and capping)	0-10	0	60	6.65	7.33	0.07	0.51
	Worker (brood and queen tending, nurse bees)	6 to 17	0	140	9.6	16.46	0.17	1.15
	Worker (comb building, cleaning and food handling)	11 to 18	0	60	1.7	6.79	0.07	0.47
	Worker (foraging for pollen)	>18	0	43.5	0.041	4.79	0.05	0.33
	Worker (foraging for nectar)	>18	0	292	0.041	32.12	0.32	2.25
	Worker (maintenance of hive in winter)	0-90	0	29	2	3.41	0.03	0.24
	Drone	>10	0	235	0.0002	25.85	0.26	1.81
	Queen (laying 1500 eggs/day)	Entire lifestag e	525	0	0	0.58	0.006	0.040

III. TerrPlant Model Run: 6.0 lbs ai/A for Forestry Use

TerrPlant v. 1.2.2
Green values signify user inputs (Tables 1, 2 and 4).
Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	**Triclopyr TEA as acid**
PC code	**116001**
Use	**Forestry**
Application Method	**Aerial**
Application Form	**Spray**
Solubility in Water (ppm)	**440**

Table 2. Input parameters used to derive EECs.

Input Parameter	Symbol	Value	Units
Application Rate	A	6	lbs ai/A
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.05	none

Table 3. EECs for Triclopyr TEA as acid. Units in lbs ai/A.

Description	Equation	EEC
Runoff to dry areas	(A/I)*R	0.3
Runoff to semi-aquatic areas	(A/I)*R*10	3
Spray drift	**A*D**	**0.3**
Total for dry areas	**((A/I)*R)+(A*D)**	**0.6**
Total for semi-aquatic areas	**((A/I)*R*10)+(A*D)**	**3.3**

Table 4. Plant survival and growth data used for RQ derivation. Units are in lbs ai/A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC_{25}	NOAEC	EC_{25}	NOAEC
Monocot	0.33	0.333	0.166	0.111
Dicot	1	0.333	0.0076	0.0041

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Triclopyr TEA as acid through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	1.82	10.00	1.81
Monocot	listed	1.80	9.91	2.70
Dicot	non-listed	0.60	3.30	39.47
Dicot	listed	1.80	9.91	73.17

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

APPENDIX F. Endocrine Disruptor Screening Program (EDSP)

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of the Draft Ecological Risk Assessment for Registration Review, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), triclopyr ACID, TEA, COLN and BEE are subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013[1] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Triclopyr ACID, TEA, COLN and BEE are not on List 1. For further information on the status of the EDSP, the policies and procedures,

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[1] See http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074 for the final second list of chemicals.

the lists of chemicals, future lists, the test guidelines and Tier 1 screening battery, please visit our website[2].

[2] Available: http://www.epa.gov/endo/

APPENDIX G. Listed Species

In November 2013, the EPA, along with the Services and the United States Department of Agriculture (USDA), released a summary of their joint Interim Approaches for assessing risks to endangered and threatened (listed) species from pesticides. The Interim Approaches were developed jointly by the agencies in response to the National Academy of Sciences' (NAS) recommendations and reflect a common approach to risk assessment shared by the agencies as a way of addressing scientific differences between the EPA and the Services. The NAS report[1] outlines recommendations on specific scientific and technical issues related to the development of pesticide risk assessments that EPA and the Services must conduct in connection with their obligations under the ESA and FIFRA.

EPA received considerable public input on the Interim Approaches through stakeholder workshops and from the Pesticide Program Dialogue Committee (PPDC) and State-FIFRA Issues Research and Evaluation Group (SFIREG) meetings. As part of a phased, iterative process for developing the Interim Approaches, the agencies will also consider public comments on the Interim Approaches in connection with the development of upcoming Registration Review decisions. The details of the joint Interim Approaches are contained in the white paper *Interim Approaches for National-Level Pesticide Endangered Species Act (ESA) Assessments Based on the Recommendations of the National Academy of Sciences April 2013 Report (NRC, 2013)*[2], dated November 1, 2013.

Given that the agencies are continuing to develop and work toward implementation of the Interim Approaches to assess the potential risks of pesticides to listed species and their designated critical habitat, this ecological risk assessment for triclopyr ACID, TEA, COLN and BEE does not contain a complete ESA analysis that includes effects determinations for specific listed species or designated critical habitat. Although EPA has not yet completed effects determinations for specific species or habitats, this assessment assumed, for all taxa of non-target wildlife and plants, that listed species and designated critical habitats may be present in the vicinity of the application of triclopyr ACID, TEA, COLN and BEE. This assessment will allow EPA to focus its future evaluations on the types of species where the potential for effects exists once the scientific methods being developed by the agencies have been fully vetted. Once the agencies have fully developed and implemented the scientific methodology for evaluating risks for listed species and their designated critical habitats, these methods will be applied to subsequent analyses for triclopyr ACID, TEA, COLN and BEE as part of completing this registration review.

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[1] *Assessing Risks to Endangered and Threatened Species from Pesticides.* Available at http://www.nap.edu/catalog.php?record_id=18344

[2] Available at http://www2.epa.gov/endangered-species/assessing-pesticides-under-endangered-species-act#report