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**Australian Pesticides and
Veterinary Medicines Authority**



Chlorpyrifos
Final Review Technical Report
September 2024

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Preface

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is an independent statutory authority that administers the National Registration Scheme for Agricultural and Veterinary Chemicals. The APVMA evaluates, registers and regulates agricultural and veterinary (agvet) chemicals up to the point of sale. The states and territories are responsible for control of use. Its statutory powers are provided in the Agricultural and Veterinary Chemicals Code (the Agvet Code), which is scheduled to the *Agricultural and Veterinary Chemicals Code Act 1994*.

The APVMA has legislated powers to reconsider the approval of an active constituent, registration of a chemical product or approval of a label at any time after it has been registered. The reconsideration process is outlined in sections 29 to 34 of Part 2, Division 4 of the Agvet Code. The Code provides for the suspension and cancellation of approvals and registrations if it appears to the APVMA that the criteria for approval or registration are not, or are no longer, satisfied (s 41 and s 44 of Part 2, Division 5).

A reconsideration may be initiated when new research or evidence has raised concerns about the use or safety of a particular chemical, a product containing that chemical, or its label. The scope of each reconsideration can cover a range of areas including human health (toxicology, public health, work health and safety), the environment (environmental fate and ecotoxicology), residues and trade, chemistry, efficacy or target crop or animal safety. However, the scope of each reconsideration is determined on a case-by-case basis reflecting the specific issues raised by the new research or evidence.

The reconsideration process includes a call for data from a variety of sources, a scientific evaluation of that data and, following public consultation, a regulatory decision about the ongoing use of the chemical or product. The data required by the APVMA must be generated according to scientific principles. The APVMA conducts scientific and evidence-based risk analysis with respect to the matters of concern by analysing all the relevant information and data available.

About this document

This Technical Report is intended to provide an overview of the assessments that have been conducted by the APVMA and of the specialist advice received from its advisory agencies. It has been deliberately presented in a manner that is likely to be informative to the widest possible audience, thereby encouraging public comment.

This document contains a summary of the assessment reports generated in the course of the chemical review of an active ingredient, including the registered product and approved labels. The document provides a summary of the APVMA's assessment, which may include details of:

- the toxicology of both the active constituent and product
- the residues and trade assessment
- occupational exposure aspects
- environmental fate, toxicity, potential exposure and hazard
- efficacy and target crop or animal safety.

Introduction

Chlorpyrifos is a broad spectrum, non-systemic organophosphate insecticide approved for use in a wide range of agricultural, horticultural, commercial and veterinary situations. The APVMA commenced a reconsideration of chlorpyrifos active constituent approvals, product registrations and associated label approvals under Part 2, Division 4 of the Agvet Code in 1996. Chlorpyrifos was nominated for reconsideration in 1994 due to possible risks associated with work health and safety, residues in food and to the environment.

The APVMA published interim component assessment reports ([chemistry](#), [toxicology](#), [occupational health and safety](#), [environment](#) and [residues, trade and efficacy](#)) in 2000. As a result, several regulatory measures were implemented, including cancellation of home use products containing more than 50 g/L chlorpyrifos together with label amendments with updated directions for use, first aid instructions and safety directions, and environmental warning statements for domestic and agricultural products.

The APVMA published additional interim component assessment reports (including [residues and trade](#), [toxicology](#), [a toxicology update](#), [environment](#) and [residential exposure](#)) in 2009, 2017 and 2019. As a result of the assessment outcomes, the APVMA cancelled all home garden and domestic uses of chlorpyrifos in 2019, as well as the registrations for products with only those uses on the label. More information is available in the [Special Gazette of 24 June 2019](#).

The remaining components of reconsideration of chlorpyrifos active constituent approvals, product registrations and associated label approvals (hereafter referred to the chlorpyrifos chemical review) specifically relate to the use of chlorpyrifos in agricultural, horticultural, commercial and veterinary situations.

Purpose of review

The scope of the chlorpyrifos chemical review includes the following aspects of active constituent approvals, product registrations and label approvals for chlorpyrifos:

- Worker health and safety:
 - Risks to professional workers arising from exposure during handling and application.
 - Risks to professional workers who re-enter treated areas or re-handle treated material.
 - Determination of appropriate personal protective clothing and engineering control requirements.
 - Establishment of appropriate first aid instructions and safety directions for chlorpyrifos products.
- Residues and trade:
 - Residues in treated food and animal feeds arising from application in accordance with label instructions.
 - Establishment of appropriate maximum residue limits (MRLs) for supported uses of chlorpyrifos.
 - Determination of dietary exposure resulting from the consumption of produce treated with chlorpyrifos.
 - Risks to international trade resulting from the use of chlorpyrifos on major export commodities.

- Environment
 - Risks to terrestrial vertebrates, aquatic species, bees, other non-target arthropods, soil organisms and terrestrial plants resulting from application in accordance with label instructions.

The APVMA has also considered information pertaining to the chemistry (minimum active purity and impurities of toxicological concern) and toxicology (health-based guidance values and poison scheduling).

In addition to the above assessments, chlorpyrifos labels were reviewed for consistency with current APVMA policies and guidelines, including the [Agricultural Labelling Code](#), [Veterinary Labelling Code](#) and [APVMA Spray Drift Policy July 2019](#).

Mode of action, product claims and use patterns

Chlorpyrifos is a broad spectrum, non-systemic organophosphate insecticide with contact, stomach and respiratory action. Chlorpyrifos acts through the inhibition of acetyl cholinesterase (AChE), an enzyme that is important for the transmission of nerve signals.

Products containing chlorpyrifos are used extensively in Australian agriculture to control a variety of insect pests in field crops, fruits, vegetables, turf, ornamentals, and pastures. It is also used for the control of termites and other pests in commercial establishments and in certain public spaces.

Agricultural application is mainly by ground application using boom spray onto foliage or as a soil-based application, aerial application (e.g. banana, cotton), drenching (e.g. the base of fruit trees), baiting and seed dressing. Termite control is as a pre-construction soil application (for which it is listed as a Restricted Chemical Product under Schedule 4 of the Agvet Code Regulations) or as post-construction application through soil injection and barrier sprays.

International regulatory status

Chlorpyrifos has recently been considered by international regulators, including the United States Environmental Protection Agency (US EPA), the European Commission, Health Canada's Pest Management Regulatory Agency (PMRA) and the Codex Alimentarius Commission (which is the joint Food and Agriculture Organization and the World Health Organization's food standards program).

United States

On August 2021, the US EPA made a decision to end the use of chlorpyrifos on food crops by revoking all tolerances for residues of chlorpyrifos on food commodities as of 28 February 2022. This ruling was revoked on 28 December 2023 and all tolerances for residues of chlorpyrifos on food commodities were reinstated¹. The non-food uses of chlorpyrifos were not impacted by these decisions, such as for pest control in

¹ United States Environmental Protection Agency (<https://www.epa.gov/ingredients-used-pesticide-products/chlorpyrifos>)

commercial establishments, industrial sites, non-food plantations and turfgrass. The use of chlorpyrifos in both food and non-food situations are currently permitted.

European Union

As of 10 January 2020, the approval of chlorpyrifos was not renewed in the European Union (EU). Member States were to withdraw authorisations for plant protection products containing chlorpyrifos as an active substance by 16 February 2020, with a grace period not extending beyond 16 April 2020. Further, in 2020 the EU also replaced their maximum residues limits (MRLs) for chlorpyrifos with a default value of 0.01 mg/kg (the level of quantification).

Canada

The PMRA made the decision to cancel most uses of chlorpyrifos ([RVD2020-14](#)) on 10 December 2020 and decided to cancel all remaining uses of chlorpyrifos on 13 May 2021, with the decision reissued ([REV2021-04](#)) on 21 December 2021. Sales by the registrant were cancelled immediately, with sales by retailers cancelled as of 10 December 2022 and use of chlorpyrifos products allowed until 10 December 2023.

Codex Alimentarius Commission

The Codex Alimentarius Commission (Codex) is responsible for establishing Codex Maximum Residue Limits (CXLs) for pesticides. Codex CXLs are primarily intended to facilitate international trade and accommodate differences in Good Agricultural Practice (GAP) employed by various countries. The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 ([REP22/PR53](#)) agreed to revoke all Codex MRLs as a public health concern was expressed and data requested by the Joint Meeting on Pesticide Residues to complete its risk assessment was not available.

Public consultation

The APVMA published the draft Chlorpyrifos Review Technical Report on 12 December 2023, in conjunction with the Chlorpyrifos Proposed Regulatory Decision, and conducted a 3 month [public consultation](#). The [submissions received](#) by the APVMA in this public consultation are available on the APVMA website, where the APVMA received permission to publish the submission.

This final Chlorpyrifos Review Technical Report includes a summary of the APVMA's chemistry, toxicology, worker health and safety, residues and trade, environment, efficacy and target safety and spray drift assessments, which have been amended based on the consideration of the submissions received in the public consultation. A summary of the submissions received, where the APVMA received permission to publish, and the APVMA's response to the matters raised in these submissions is listed in [Appendix A](#) of this report.

This final Chlorpyrifos Review Technical Report only includes assessment summaries for chlorpyrifos active constituent approvals, chemical product registrations and label approvals that were placed under review and remain approved or registered. Chlorpyrifos active constituent approvals, chemical product registrations and label approvals were not considered in this final report if they were not formally placed under reconsideration

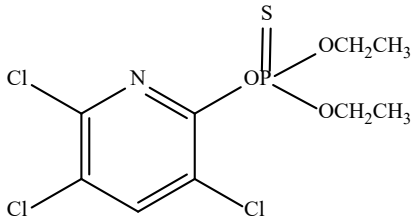
through issuance of a notice of reconsideration under section 32 of the Agvet Code, if they are no longer approved or registered due to cancellation or if they are no longer registered due to the registration ending without being renewed.

Chemistry

Active constituents

Details on the nomenclature and structure of the active constituent chlorpyrifos are listed in Table 1 below.

Table 1: Nomenclature and structural formula of the active constituent chlorpyrifos²

Parameter	Nomenclature and structure
Common name (ISO)	Chlorpyrifos
IUPAC name	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate
CAS registry number	2921-88-2
Molecular formula:	C ₉ H ₁₁ Cl ₃ NO ₃ PS
Molecular weight:	350.6 gmol ⁻¹
Structural formula:	

Technical chlorpyrifos takes the form of colourless crystals with a mild mercaptan odour at room temperature and normal atmospheric pressure. It is slightly volatile, and has very low solubility in water, while being highly soluble in most polar organic solvents and aromatic hydrocarbon solvents. Chlorpyrifos undergoes aqueous photolysis fairly rapidly, with a half-life of 30 days estimated under summer sunlight at 40 °C. It is hydrolysed with half-life of 72 days at pH 5 and pH 7 at 25 °C and is more rapidly hydrolysed at alkaline pH (16 days at pH 9 and 25 °C). Further details of the physicochemical properties are tabulated below (Table 2).

Table 2: Key physicochemical properties of the active constituent chlorpyrifos^{3,4}

Parameter	Physicochemical property
Appearance:	Technical active constituent: colourless crystals with a mild mercaptan odour

²The Pesticide Manual, British Crop Production Council, 18th edition, 2016.

³JMPR Periodic Review Evaluation for Chlorpyrifos, Joint Meeting on Pesticide Residues, FAO/WHO, 2000 (fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/Evaluation00/1CONTENTS.pdf) and references therein.

⁴FAO Specifications for Chlorpyrifos, FAO 2020 (fao.org/3/ca8091en/ca8091en.pdf)

Parameter	Physicochemical property
Melting point:	42–43.5 °C
Boiling point:	>400 °C
Specific gravity:	1.44 (20 °C)
Stability:	Stable for at least 2 years storage under normal conditions
Solubility in water:	~1.4 mg/L (25 °C)
Organic solvent solubility (g/kg, 25 °C):	Acetone: 6,500 Benzene: 7,900 Chloroform: 6,300 Carbon disulfide: 5,900 Diethyl ether: 5,100 Xylene: ,5000 Iso-octanol: 790 Methanol: 450
Octanol/water partition coefficient (Log K _{ow}):	4.7
Vapour pressure:	2.7 mPa (25 °C)
Henry's law constant:	0.676 Pa.m ³ mol ⁻¹
Hydrolysis:	Rate of hydrolysis is independent of pH below pH 7, with a half-life of 72 days at 25 °C in sterile buffered water. Hydrolysis is more rapid at alkaline pH, with a half-life of 16 days at pH 9.
Aqueous photolysis:	Photolysis of chlorpyrifos is fairly rapid, with 3,5,6-trichloro-2-pyridinol (TCP) as the main product. The average aqueous photolysis half-life of chlorpyrifos under midsummer conditions at 40 °C is about 30 days. TCP has a predicted photolysis half-life of 15 minutes based on a quantum yield study.

There are currently 23 active constituent approvals for chlorpyrifos, which are listed in Table 3 below.

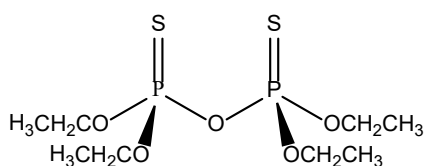
Table 3: Current active approvals for chlorpyrifos

Approval number	Approval holder
44005	ADAMA Australia Pty Ltd
46888	Gharda Australia Pty Ltd
47155	Sumitomo Chemical Australia Pty Ltd
48521	FMC Australasia Pty Ltd
50886	Imtrade Australia Pty Ltd

Approval number	Approval holder
55457	Agrogill Chemicals Pty Ltd
58019	Coromandel Australia Pty Ltd
60079	Agrogill Chemicals Pty Ltd
62025	Huilong Agrochemicals Australia Pty Ltd
64006	Netmatrix Crop Care Limited
65331	Nutrien Ag Solutions Limited
65346	Imtrade Australia Pty Ltd
65403	Sinon Australia Pty Ltd
67013	Sharda Worldwide Exports Pvt Ltd
67331	Agroshine Australia Pty Ltd
70330	Zhejiang Hengdian Imp. & Exp. Co Ltd
70430	Sabakem Pty Ltd
80115	Aimco Kr Australia Pty Ltd
81656	Sanonda (Australia) Pty Ltd
82263	Nutrien Ag Solutions Limited
83860	Crystal Crop Protection (Australia) Pty Ltd
86105	Krishi Rasayan Exports Pvt Ltd
87692	Lianyungang Liben Crop Science Co Ltd

The chlorpyrifos standard in the [Agricultural and Veterinary Chemicals Code \(Agricultural Active Constituents\) Standards 2022](#) (Agricultural Active Constituents Standard 2022) specifies a minimum purity of 940 g/kg for the technical active constituent, with a maximum of 3 g/kg for the toxicologically significant impurity *O,O,O',O'*-tetraethyl dithiopyrophosphate (*S,S*-TEPP).

Figure 1: Structure of *O,O,O',O'*-tetraethyl dithiopyrophosphate (*S,S*-TEPP)



The [Food and Agriculture Organization of the United Nations \(FAO\)](#) specification for chlorpyrifos technical active constituent specifies a minimum purity of 970 g/kg, with a maximum of 3 g/kg for O,O,O',O'-tetraethyl dithiopyrophosphate (FAO 2020). The minimum purity requirement for chlorpyrifos in this FAO full specification (i.e. 970 g/kg chlorpyrifos) is significantly higher than the minimum purity requirement in the prior 1984 FAO tentative specification (i.e. 940 ± 20 g/kg chlorpyrifos). Based on the available information, the APVMA is proposing to increase the minimum purity for the chlorpyrifos technical active constituent in the Agricultural Active Constituents Standard 2022 to 970 g/kg to align with the updated internationally accepted FAO full specification.

Formulated products

There are currently 52 registered chemical products containing chlorpyrifos as the active constituent, which are listed in Table 4 below. These products are formulated as emulsifiable concentrates (EC), water-dispersible granules (WG), wettable powders (WP) and granular formulations (GR). Chlorpyrifos is the only active constituent in most of these registered products. There are 2 EC products that also contain the active constituent bifenthrin.

Table 4: Current registered products containing chlorpyrifos

Registration number	Product name	Holder	Formulation type
42284	David Grays Chlorpyrifos 500	David Gray & Co Pty Limited	EC – emulsifiable concentrate
45486	Strike-Out 500 EC Insecticide	ADAMA Australia Pty Limited	EC – emulsifiable concentrate
49666	Barmac Chlorpyrifos G Granular Insecticide	Amgrow Pty Ltd	GR – granular formulation
49869	4Farmers Chlorpyrifos 500 Insecticide	4 Farmers Australia Pty Ltd	EC – emulsifiable concentrate
50387	Titan Chlorpyrifos 500 Termiticide and Insecticide	Titan Ag Pty Ltd	EC – emulsifiable concentrate
50416	Suscon Green Soil Insecticide	Nufarm Australia Limited	GR – granular formulation
50452	Titan Chlorpyrifos PC 450 Insecticide	Titan Ag Pty Ltd	EC – emulsifiable concentrate
51190	Imtrade Chlorpyrifos 500 Insecticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
51875	Pidgeon's Pest Controller 500 Termiticide and Insecticide	Pooma Fertilizers Pty Ltd	EC – emulsifiable concentrate
53428	Generifos 500EC Insecticide	Grow Choice Pty Limited	EC – emulsifiable concentrate

Registration number	Product name	Holder	Formulation type
55213	Kenso Agcare Kensban 500 Insecticide	Kenso Corporation (M) Sdn. Bhd.	EC – emulsifiable concentrate
55755	Surefire Fortune 500 Multi-Purpose Insecticide and Termiticide	PCT Holdings Pty Ltd	EC – emulsifiable concentrate
55897	Conquest Chlorpyrifos 500 Insecticide	Conquest Crop Protection Pty Ltd	EC – emulsifiable concentrate
60188	Genfarm Chlorpyrifos 500 Insecticide	Nutrien Ag Solutions Limited	EC – emulsifiable concentrate
60611	Huilong Chlorpyrifos 500 EC Insecticide	Huilong Agrochemicals Australia Pty Ltd	EC – emulsifiable concentrate
61071	Strike-Out 500 WP Insecticide	ADAMA Australia Pty Limited	WP – wettable powder
62672	Sabero Chlorpyrifos 500EC Insecticide	Coromandel Australia Pty Ltd	EC – emulsifiable concentrate
63086	Chemicide 500 Insecticide	Hextar Chemicals Pty Ltd	EC – emulsifiable concentrate
63145	AW Cuft 500 Insecticide and Termiticide	Agri West Pty Limited	EC – emulsifiable concentrate
64319	Farmalinx Chlorpos 500 EC Insecticide	Farmalinx Pty Ltd	EC – emulsifiable concentrate
65160	Apparent Dingo 500 Insecticide	Titan Ag Pty Ltd	EC – emulsifiable concentrate
65556	Rainbow Chlorpyrifos 500 Insecticide	Shandong Rainbow International Co Ltd	EC – emulsifiable concentrate
66354	Ozcrop Chlorpyrifos 500 EC Insecticide	Oz Crop Pty Ltd	EC – emulsifiable concentrate
67451	Sabakem Chlorpyrifos 500EC Insecticide	Sabakem Pty Ltd	EC – emulsifiable concentrate
67887	Spalding Chlorpyrifos 500 Insecticide	DGL Environmental Pty Ltd	EC – emulsifiable concentrate
67984	Ezycrop Chlorpyrifos 500 Insecticide	Ezycrop Pty Ltd	EC – emulsifiable concentrate
68467	Chlorban 500 EC Insecticide	UPL Australia Pty Ltd	EC – emulsifiable concentrate

Registration number	Product name	Holder	Formulation type
68574	Accensi Micro-Lo Pre-Construction/Post-Construction Termiticide and Insecticide	Accensi Pty Ltd	EC – emulsifiable concentrate
68575	Accensi Pre-Construction/Post-Construction Termiticide and Insecticide	Accensi Pty Ltd	EC – emulsifiable concentrate
68745	AC Chop 500 Insecticide and Termiticide	Axichem Pty Ltd	EC – emulsifiable concentrate
68781	Pyrinex Super Insecticide/Miticide	ADAMA Australia Pty Ltd	EC – emulsifiable concentrate
69048	Smart Chlorpyrifos 500 Insecticide	Crop Smart Pty Ltd	EC – emulsifiable concentrate
69671	Agrocn Chlorpyrifos 500 EC Insecticide and Termiticide	Shanghai Agrochina Chemical Co. Ltd.	EC – emulsifiable concentrate
69776	Accensi Chlorpyrifos 500 Insecticide	Accensi Pty Ltd	EC – emulsifiable concentrate
70410	Pyrigran Insecticide	Sulphur Mills Australia Pty Limited	WG – water dispersible granule
81735	ACP Chlorpyrifos 500 Insecticide	Australis Crop Protection Pty Ltd	EC – emulsifiable concentrate
83386	Sharda Chlorpyrifos 500 Insecticide	Sharda Cropchem Espana S.L	EC – emulsifiable concentrate
83426	Echem Chlorpyrifos 500 Insecticide	Echem (Aust) Pty Ltd	EC – emulsifiable concentrate
86189	Sinon Chlorpyrifos 500 Insecticide	Sinon Australia Pty Ltd	EC – emulsifiable concentrate
86612	Arysta Lifescience Chlorpyrifos 500 EC Insecticide	Arysta Lifescience Australia Pty Ltd	EC – emulsifiable concentrate
87086	Guangxin Chlorpyrifos 500 EC Insecticide	Anhui Guangxin Agrochemical Co Ltd	EC – emulsifiable concentrate
88651	Task 500 EC Insecticide	Hemani Industries Limited	EC – emulsifiable concentrate
89019	Kelpie Chlor-P 500 Insecticide & Termiticide	Sinochem International Australia Pty. Ltd.	EC – emulsifiable concentrate
89312	Delfos 5G Insecticide	Industrial Quimica Key, S.A.	GR – granular formulation

Registration number	Product name	Holder	Formulation type
89696	Clip Insecticide	Sharda Cropchem Espana S.L	EC – emulsifiable concentrate
90204	Cropsure Sureban 500EC Insecticide	Cropsure Pty Ltd	EC – emulsifiable concentrate
90395	Cropsure Sureban 750WG Insecticide	Cropsure Pty Ltd	WG – water dispersible granule
91024	APS Chlorpyrifos 500 EC Insecticide	Agricultural Product Services Pty Ltd	EC – emulsifiable concentrate
91672	Imtrade Outperform 630 Veriphy EC Insecticide/Miticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
91691	Imtrade Outplay 700 Veriphy EC Insecticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
92193	Eurochem Chlorpyrifos 750 WG Insecticide	Eurochem Pty Ltd	WG – water dispersible granule

There are currently no standards for chlorpyrifos end use products established by the APVMA. The [FAO specification for chlorpyrifos](#) includes specifications for EC and ultra-low volume (UL) chlorpyrifos products (FAO 2020). It is noted that these specifications include a limit for the toxicologically significant impurity O,O,O',O'-tetraethyl dithiopyrophosphate at a maximum of 0.3% of the active content, which is the same as the active constituent chlorpyrifos. This impurity has not been observed to increase in formulated products during storage. The APVMA therefore remains satisfied of the impurity content of the products listed in Table 4, and is not proposing to establish a standard for end use chlorpyrifos products.

The proposed changes to the Agricultural Active Constituents Standard 2022 discussed in the [Active constituents](#) section above may result in minor formulation updates for registered products in Table 4 that have previously used a source of chlorpyrifos active constituent with a purity less than 970 g/kg (but greater than or equal to 940 g/kg). These formulation updates may include requiring a slightly lower amount of technical active as a result of a higher purity to give the product label claim, along with consequent minor adjustments to levels of other ingredients such as solvents or carriers.

Chemistry recommendations

Proposed amendment to the Agricultural and Veterinary Chemicals Code (Agricultural Active Constituents) Standards 2022 for chlorpyrifos

The current chlorpyrifos standard in the Agricultural Active Constituents Standards 2022 states the material shall consist of chlorpyrifos together with related manufacturing impurities and shall be a white to amber solid, with a mild mercaptan type (sulphur) odour, free from visible extraneous matter and added modifying agents and the minimum purity specified is 940 g/kg.

The current standard indicates the following acceptable levels of toxicological impurities:

- O,O,O',O'-tetraethyl dithiopyrophosphate (S,S-TEPP): 3 g/kg maximum

It is recommended the Agricultural Active Constituents Standards 2022 for chlorpyrifos active constituent be amended, to increase the minimum purity specified from 940 g/kg to 970 g/kg as shown in Table 5.

Table 5: Proposed compositional requirements for chlorpyrifos active constituents

Column A	Column B	Column C	Column D
Identification of the active constituent	Description	Minimum purity	Maximum impurity levels
Common Name: Chlorpyrifos Chemical Name: O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate CAS Number: 2921-88-2	The material shall consist of chlorpyrifos together with related manufacturing impurities and shall be a white to amber solid, with a mild mercaptan type (sulphur) odour, free from visible extraneous matter and added modifying agents.	970 g/kg minimum	O,O,O',O'-tetraethyl dithiopyrophosphate (S,S-TEPP): 3 g/kg maximum

Toxicology

Previous assessments

An [updated toxicology assessment](#) was published by the APVMA in 2019 (APVMA 2019a), supplementing the [toxicology assessment report](#) published in 2017 (APVMA 2017). The scope of this 2019 updated toxicology assessment was to:

- evaluate the recent emergent published literature regarding the hypothesised adverse effects of low dose (doses below the threshold for inhibition of blood cholinesterases) chlorpyrifos treatment in vivo
- re-evaluate the regulatory studies supporting the current APVMA health-based guidance values for chlorpyrifos
- propose new APVMA health-based guidance values for chlorpyrifos.

The APVMA has reviewed the outcomes of the 2019 toxicology assessment, and the conclusion remains unchanged.

Health-based guidance values

The proposed new health-based guidance values for chlorpyrifos were established by the APVMA in June 2019. This included an [acceptable daily intake](#) of 0.001 mg/kg bw/day and an [acute reference dose](#) of 0.03 mg/kg bw/day.

Acceptable daily intake

The acceptable daily intake (ADI) for chlorpyrifos was established based on a series of studies in young and adult rats performed by DOW 2010[a] and Marty et al 2012. The no-observed-effect-level (NOEL) for inhibition of blood cholinesterases (erythrocyte cholinesterase as well as plasma cholinesterases) for rats from post-natal day 11 of age to adulthood was 0.1 mg/kg bw/day (consistently five-fold lower than the threshold for inhibition of brain cholinesterases in this species). This point of departure is supported by the following toxicological thresholds in other studies that have been evaluated by the agency (see Table 6).

Table 6: Toxicological thresholds in other studies

Reference	Study type	No observed adverse effect level (NOAEL)	Comments
Szabo et al 1988	13 week repeat daily oral (dietary) dose toxicity study in F344 rats	0.1 mg/kg bw/day based on inhibition of brain and erythrocyte cholinesterases at higher doses	Plasma and erythrocyte cholinesterase activities were decreased at doses ≥ 1 mg/kg bw/ day, and the activity of brain acetylcholinesterase was decreased at 5 and 15 mg/kg bw/day

Reference	Study type	No observed adverse effect level (NOAEL)	Comments
Young and Grandjean 1988	2 year repeat daily oral (dietary) carcinogenicity study (OECD Test Guideline No. 451) in F344 rats	0.1 mg/kg bw/day based on inhibition of erythrocyte and plasma cholinesterases at higher doses	NOEL for inhibition of brain cholinesterase was 1 mg/kg bw/day based on consistent, statistically significant ($p < 0.05$) inhibition at 10 mg/kg bw/day
Breslin et al 1991	2 generation reproductive toxicity study in SD rats	0.1 mg/kg bw/d based on inhibition of blood cholinesterases at higher doses	NOAEL for inhibition of brain cholinesterase and maternal toxicity was 1 mg/kg bw/day. The NOAEL for developmental effects was 1 mg/kg bw/day, and the NOAEL for effects on fertility and reproductive effects was 5 mg/kg bw/day

The ADI of 0.001 mg/kg bw/day is based on the NOEL of 0.1 mg/kg bw/day for inhibition of blood cholinesterases (blood acetyl- and butyrylcholinesterases) in rats in a repeat oral dose study, with a total intra- and inter-species uncertainty factor of 100 applied.

Acute reference dose

The acute reference dose (ARfD) for chlorpyrifos was established based on the human acute, single dose NOEL for inhibition of plasma cholinesterase of 1 mg/kg bw derived from Kisicki et al 1999. This point of departure is supported by the NOEL of 0.5 mg/kg bw for inhibition of blood cholinesterases in rats (Marty et al 2012).

The APVMA applied a ten-fold intra-species uncertainty factor for calculating the ARfD. Since the point of departure was determined in humans, an inter-species uncertainty factor is not required. However, because of the statistical power limitations (small n compared with modern human clinical trial standards) and other concerns associated with the Kisicki et al 1999 study, the APVMA applied an additional uncertainty factor of 3 to account for any remaining uncertainties. The total uncertainty factor applied is thus 10×3 .

The ARfD for chlorpyrifos was therefore calculated as follows:

$$1/(10 \times 3) = 0.03 \text{ mg/kg bw/day}$$

Poison Scheduling

The Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) classifies chlorpyrifos as Schedule 6, with a cut-off to Schedule 5 when used in preparations at concentrations of 5% or less, when in aqueous preparations containing 20% or less of microencapsulated chlorpyrifos, or in controlled release granular formulations containing 10% or less of chlorpyrifos. Potting or soil mixes containing 100 g/m³ or less of chlorpyrifos are exempt from poisons scheduling.

There are no proposed changes to the poisoning scheduling of chlorpyrifos.

Worker health and safety

Previous assessments

In 2000, an [interim occupational health and safety \(OHS\) assessment](#) for chlorpyrifos was conducted by the Office of Chemical Safety within the Australian Government Department of Health (OCS) and an interim OHS report was published by the APVMA comprising exposure and risk assessments for chlorpyrifos (APVMA 2000d). A Margin of Exposure (MOE) approach was used that involved a calculation of the ratio between estimated exposure and a relevant NOAEL as established in the interim toxicology report. As an outcome of the assessment, several risk management outcomes were implemented.

The APVMA has substantially changed its approach to exposure assessment since the publication of its interim OHS assessment on chlorpyrifos in 2000. Further, as discussed in the [Toxicology](#) section, the human health-based guidance values for chlorpyrifos were lowered in 2019. This necessitated a re-evaluation of exposures and risk characterisations associated with the uses of chlorpyrifos.

In 2019, a [supplementary residential exposure assessment and risk characterisation report](#) was published by the APVMA (APVMA 2019b). The residential (non-professional) uses of chlorpyrifos were not supported due to concerns regarding uncontrolled human health risks associated with mixing, loading and applying chlorpyrifos and/or uncontrolled risks to children associated with re-entry into treated areas. Therefore, all home garden and domestic uses of chlorpyrifos were cancelled.

Worker exposure assessment

The scope of this updated exposure assessment and risk characterisations includes professional workers who mix, load and apply chlorpyrifos and professional workers who re-enter chlorpyrifos treated areas or re-handle chlorpyrifos treated material (e.g. turf). The APVMA's risk assessment for worker health and safety has been revised upon consideration of the submissions received in response to public consultation on the Proposed Regulatory Decisions for the chlorpyrifos reconsideration. These revisions included:

- refinement of the work rate assumption for broadacre crops (decrease from 600 ha/day to 500 ha/day)
- consideration of whether occupational exposure risks can be mitigated using engineering controls during mixing and loading.

For exposure during mixing, loading and application, the current assessment has utilised the US EPA Office of Pesticide Programs Occupational Handler Exposure Calculator (US EPA 2020a). For exposure associated with re-entry into pesticide treated area, the current assessment has utilised the US EPA Occupational Pesticide Re-entry Exposure Calculator (US EPA 2020b). The following assumptions have been used in the exposure modelling (see Table 7).

Table 7: Assumptions used in modelling exposure for professional use of chlorpyrifos

Parameter	Value
Point of Departure for risk assessment	0.1 mg/kg bw/day
Acceptable margin of exposure (MOE)	100*
Body weight (adult)	80 kg
Body weight (child)	1 to 2 y: 11 kg 2 to 3 y: 15 kg
Dermal absorption factor	3% for concentrate and granule (0.03) 10% for spray dilution (0.1)
Inhalation absorption factor	100%
Airblast foliar application (orchard/vineyard)	30 ha/day
Groundboom field application (most crops)	50 ha/day
Groundboom application to commercial turf farms	30 ha/day
Groundboom field application (cotton)	400 ha/day
Groundboom field application (broadacre uses)	500 ha/day
Backpack application (mixer, loader, applicator)	10x15L refills = 150 L/day
Manually pressurised hand wand application	150 L/day
Mechanically pressurised handgun application	Strip or patch low on tree/vine (50–100 mL/tree) = 400 L/day Spot treatment foliar = 1,000 L/day Broadcast foliar = 4,000 L/day

* As a NOAEL from an animal study was used to estimate risks, an acceptable MOE ≥ 100 was considered acceptable. This value is based on a 10-fold uncertainty factor (UF) for intra-species and 10-fold UF for inter-species differences.

The exposure assessments and risk characterisations for professional use of chlorpyrifos also rely upon a further series of reasonable assumptions, notably that professional users:

- are trained in accurate mixing, loading and application methods
- are trained in, and are competent and experienced users of, personal protective equipment and relevant application techniques and equipment
- have a high level of compliance with label directions, including label-specified application rates and the use of personal protective equipment specified on product labels
- wear long-sleeved shirt, long pants, shoes and socks or an equivalent single layer of clothing when using chlorpyrifos, in addition to any personal protective equipment specified on product labels.

The exposure assessments and risk characterisations also assume that there are no concurrent co-exposures to other anticholinesterase products (the effects of which are likely to be at least additive to those of chlorpyrifos due to their common mode of action).

Ground-based application

The outcomes for the exposure risk assessments for the professional use of chlorpyrifos in agricultural situations using ground-based application equipment are set out in Table 8 and Table 9. Modelling for ground-based application assumed that all steps in the use of chlorpyrifos products are performed by a single operator (i.e. a single operator mixes, loads and applies the pesticide) and that there was only one type of use or activity performed per operator per day. Modelling for re-entry activities (8-hour days) assessed worker exposure via dermal exposure, as inhalation exposure under these circumstances were regarded as negligible. It is noted that the calculated re-entry intervals are not required when crops are treated at the bare soil or pre-emergent stage.

Modelling for the use of a 100 g/kg granular product to be admixed with potting medium was undertaken using a reverse exposure approach. It was assumed that treating potting medium with the granular product could be achieved by mechanical means with very little operator exposure, e.g., if the potting medium and granular product were combined in a cement mixer-type vessel. Therefore, the calculation to determine the quantity of treated potting medium that could be handled in a single day was based on unit exposures for hand dispersal of a granular product and assumed that a high level of PPE was worn by individuals handling the treated potting medium (i.e., double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator). The label rate for that use is 50–100 g ac/m³ of potting medium. Using the above assumptions, a single operator would exceed acceptable risk levels from handling less than one cubic meter of treated potting medium.

The post-application exposure for turf treated in commercial turf farms was considered separately, and included potential exposure from transplanted turf, assuming that it would be harvested and laid in a variety of different situations (such as sports fields, rights of way and commercial or residential settings). Further modelling in turf was also performed to determine whether exposure to children from newly planted lawns using recently sprayed commercial turf would pose a significant post-application risk. It was concluded using highly conservative inputs that post-application exposure to adult workers handling treated turf was negligible when harvesting and re-planting on day one post chlorpyrifos treatment, and that the risks to children from newly planted lawns using recently sprayed commercial turf were acceptable.

Table 8: Chlorpyrifos uses that are supported based on this worker exposure assessment

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
Fruit and vegetables					
Apples, pears	250 g ac/ha	Airblast	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves. EngC (A): Closed cab application equipment.	Dormant period: Not required.
	250 g ac/ha	Backpack	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Scouting – Day 7
Avocado	500 g ac/ha (25 g ac/100 L, spot spray)	Mechanically pressurised handgun	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Scouting, hand pruning – Day 8; Hand harvesting – Day 16
Beetroot, capsicum, carrots, green beans, peas, radishes, stalk and stem vegetables (asparagus, celery, rhubarb), turnips	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13; Hand harvesting – Day 7
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Hand harvesting – Day 11
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Hand harvesting – Day 12.
Cassava	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Hand harvesting – Day 11

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
Citrus fruit, pome fruit	250 g ac/ha	Airblast	EC	PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves EngC (A): Closed cab application equipment	Scouting, hand pruning, training – Day 1; Hand harvesting – Day 10; Thinning fruit – Day 19
Cole crops (brassica crops)	70 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Scouting, hand harvesting, hand weeding – Day 8.
	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Scouting, hand harvesting, hand weeding – Day 15; Irrigation (hand set) – Day 8; Hand weeding (smaller plants) – Day 5
	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Scouting, hand harvesting, hand weeding – Day 20; Irrigation (hand set) – Day 13; Hand weeding (smaller plants) – Day 10
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator. EngC (A): Closed cab application equipment.	Scouting, hand harvesting, hand weeding – Day 23; Irrigation (hand set) – Day 16; Hand weeding (smaller plants) – Day 13
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Scouting, hand harvesting, hand weeding – Day 25; Irrigation (hand set) – Day 17; Hand weeding (smaller plants) – Day 14

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	450 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Scouting, hand harvesting, hand weeding – Day 26; Irrigation (hand set) – Day 18; Hand weeding (smaller plants) – Day 15; Scouting, thinning (smaller plants) – Day 1.
Cucurbit vegetables	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13; Harvesting, training and turning – Day 1
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Harvesting, training and turning – Day 4
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Harvesting, and training and turning – Day 5
Eggplant	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13; Hand harvesting – Day 1
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Hand harvesting – Day 4

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Hand harvesting – Day 5
Ginger	450 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 18
			WP	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves and full facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 18
Grapes (grape vines)	250 g ac/ha	Airblast	EC WG WP	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves EngC (A): Closed cab application equipment	Dormant period: Not required Seasonal period (not practical): Girdling – 30 days; Tying and training, leaf pulling, harvesting – Day 28; Irrigation (hand set) – Day 13; Scouting, hand weeding, hand pruning, bird control, propagating, trellis repair – Day 3
Leafy crucifers (including chou moullier, kale, mustard, rape), lettuce, silver beet)	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 8; Hand harvesting – Day 2.

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Hand harvesting – Day 12.
Macrocarpa hedges	250 g ac/ha	Airblast	WP WG	PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 13; Scouting, shaping – Day 1.
Onions, shallots	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Hand weeding (full foliage) – Day 20; Irrigation (hand set) – Day 13; Hand weeding (minimal foliage), scouting – Day 10
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Hand weeding (full foliage) – Day 23; Irrigation (hand set) – Day 16; Hand weeding (minimal foliage), scouting – Day 13
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Hand weeding (full foliage) – Day 25; Irrigation (hand set) – Day 17; Hand weeding (minimal foliage), scouting – Day 14
Parsnip	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Day 17 – Irrigation (hand set); Day 12 – Hand harvesting

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
Potato, sweet potato	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13.
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17
Swede, turnip	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 8; Hand harvesting – Day 2
Stone fruits	250 g ac/ha	Airblast	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves EngC (A): Closed cab application equipment	Dormant period: Not required
	0.0125–0.025 g ac/tree	Mechanically pressurised handgun application (strip or patch low on tree/vine)	WG	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not required
Tomatoes	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13; Hand harvesting, tying and training – Day 7

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Hand harvesting, tying and training – Day 11
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Hand harvesting, tying and training – Day 12
Field crops and pasture					
Barley, canola (rapeseed), wheat ⁵	200 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Scouting – Day 5
	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Scouting – Day 12
Canola (rapeseed), cereals ⁵	35 g ac/ha, 70 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not required
Cereals (including sorghum) ⁵	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Scouting – Day 2; Scouting (sorghum) – not required
	175 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Scouting – Day 4; Scouting (sorghum) – not required

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Scouting – Day 7; Scouting (sorghum) – not required
	280 g ac/ha	Groundboom	EC	PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves EngC (A): Closed cab application equipment	Scouting – Day 8; Scouting (sorghum) – not required
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Scouting – Day 11; Scouting (sorghum) – not required
Field peas, broad beans (faba beans), chickpeas, lupins ⁵	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 8; Scouting – Day 2
Field peas, lupins ⁵	200 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 10; Scouting – Day 5
Lucerne, lucerne seed crops, subterranean clover, clover	200 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Irrigation (hand set) – Day 10; Scouting – Day 5
Lucerne, subterranean clover, clover	400 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 17; Scouting – Day 12

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
Pasture and forage crops	35 g ac/ha, 70 g ac/ha	Groundboom	EC	PPE(M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not required
	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator ³	Irrigation (hand set) – Day 13; Scouting – Day 7
	280 g ac/ha	Groundboom	EC	PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 14; Scouting – Day 8
Pasture and forage crops, lucerne, lucerne seed crops	175 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 9; Scouting – Day 4
	350 g ac/ha	Groundboom	EC	PE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16; Scouting – Day 11
Pasture and forage crops, lucerne, lucerne seed crops, clover seed crops, medics	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 8; Scouting – Day 2
Oilseeds (excluding cotton)	150 g ac/ha	Groundboom	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Irrigation (hand set) – Day 8; Scouting – Day 2; Scouting (peanut and sunflower) – not required

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	250 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Irrigation (hand set) – Day 13; Scouting – Day 7; Scouting (peanut and sunflower) – not required
	350 g ac/ha	Groundboom	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Irrigation (hand set) – Day 16 (forage crop only); Scouting – Day 11; Scouting (peanut and sunflower) – not required
Rice	35 g ac/ha, 70 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not required
Sugarcane	175 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Day 4 – Scouting
	350 g ac/ha	Groundboom	EC	PE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator EngC (A): Closed cab application equipment	Day 11 – Scouting
Miscellaneous uses					
Agricultural, commercial and industrial areas (not publicly accessible)	4.5 g ac/L water to 5 g ac/L water (outdoor use)	Manually pressurised handwand	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves, half facepiece respirator	Not applicable
Container plants (commercial cultivation)	5 g ac/L water	Manually pressurised handwand	WG WP	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not applicable

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
Hides/skins	1 g ac/L water	Manually pressurised handwand	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not applicable
Potted ornamentals (commercial cultivation)	0.1–0.2 g ac/L water	Manually pressurised handwand	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not applicable
Termiticide – chemical soil barrier around buildings (reticulated or AS Series 3660 systems)	50 g ac/m ²	Mechanically pressurised handgun	EC	PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not applicable
Termiticide – nest or colony	5 g ac/L water	Manually pressurised handwand (spot spray)	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not applicable
Turf (commercial turf that is not publicly accessible)	1,000 g ac/ha	Rotary spreader	GR	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves.	Not required
	0.015 g ac/mound	Backpack (spot spray)	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not required
	10 g ac/20 L water/ha ⁴	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not required
	350 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not required

Crop	Rate	Application	Formulation Type ¹	Mitigation for mixing/loading and application (MOE ≥ 100) ²	Re-entry interval
	450 g ac/ha	Groundboom	EC	PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator	Not required
Vegetation (not publicly accessible)	14 g ac/ha to 54 g ac/ha	Manually pressurized handwand	EC	PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves	Not applicable

1 EC = emulsifiable concentrate; WG = water dispersible granule; WP = wettable powder

2 PPE = personal protective equipment; M/L = mixing/loading; A = application; EngC = engineering controls

3 Use patterns would also be supported with use of cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves for mixing/loading and use of closed cab application equipment.

4 Product labels are inconsistent with the application rate. Some specify this as a per hectare rate, others only specify the concentration. MOE was calculated based on this being a per hectare rate, using groundboom application equipment.

5 Use not considered practical with the required work rate restriction of 50 ha/day.

Table 9: Chlorpyrifos uses that are not supported based on this worker exposure assessment and where engineering controls are required to minimize operator exposure during mixing and loading

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Fruit and vegetables				
Apples, avocado, banana, pears, stone fruits	1,000 g ac/ha	Airblast	EC WP	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Apples, banana, grapes (grape vines), kiwifruit, pears, stone fruits	500 g ac/ha	Airblast	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
	500 g ac/ha	Airblast	WG WP	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Avocado	500 – 1,000 g ac/ha + 500 g ac/ha dichlorvos	Airblast	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	1,000 g ac/ha	Mechanically pressurised handgun (spot spray)	EC	MOE < 100 with maximum PPE for mixing/loading and application

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Banana	500 to 900 g ac/100 L water or 2.5 to 3.5 g ac/stool	Mechanically pressurised handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
	250 g ac/100 L water	Mechanically pressurised handgun	WG WP	MOE < 100 with maximum PPE for mixing/loading and application
	250 g ac/4 kg sand	Hand dispersal	WG WP	MOE < 100 with maximum PPE for mixing/loading and application
	75–100 g ac/ha	Mechanically pressurised handgun (spot spray)	EC	MOE < 100 with maximum PPE for mixing/loading and application
	5 g ac/5 L	Backpack	WP	MOE < 100 with maximum PPE for mixing/loading and application
Beetroot, carrot, cereals, onions, radish, shallots and turnips	250 g ac/ha/10 kg seed	Seed treatment	WP	MOE < 100 with maximum PPE for mixing/loading and application
Cabbage, cauliflower	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	150 g ac/100 L water	Mechanically pressurised handgun (soil drench)	EC	MOE < 100 with maximum PPE for mixing/loading and application
Citrus fruits	1,000–2,000 g ac/ha	Airblast	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	1,000 g ac/100 L water	Airblast	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Custard apple	1,000–10,000 g ac/ha	Airblast	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Mango	1,000 g ac/ha, 2,000 g ac/ha	Airblast	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Pineapple	750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
	1,500 g ac/ha, 2,500 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Potatoes	1,500 g ac/ha– 3,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Strawberries, vegetables (various)	50 g ac/ha	Broadcast bait	EC	Inadequate information included on product labels to assess exposure from mixing, loading and application
Tomatoes	2,500 g ac/ha, 1,500 g ac/ha, 1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	750 g ac/ha, 500 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Various (Queensland fruit fly control)	0.1–0.2 g ac/tree or 30–60 g ac/ha	Mechanically pressurised handgun (strip or patch low on tree/vine)	EC WG WP	MOE < 100 with maximum PPE for mixing/loading and application
Vegetables (various)	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	500–750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Field crops and pasture				
Cereals	250 g ac/125 kg seed, 125–250 g ac/210 kg seed, 40–60 g ac/100 kg seed	Seed treatment	WP	MOE < 100 with maximum PPE for mixing/loading and application
Cereals, pastures and forage crops	150–350 g ac/ha	Mister	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Cereals, oilseeds (including canola), pastures and forage crops, sorghum	450–750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Cereals, oilseeds	125 g/310 kg seed	Seed treatment	EC	MOE < 100 with maximum PPE for mixing/loading and application
Coffee beans	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Cotton	70 – 130 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
	150 – 1,500 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Cotton, lucerne, maize, pulses, sorghum, sunflower	50 g ac/ha	Broadcast bait application	EC	Inadequate information included on product labels to assess exposure from mixing, loading and application
Cotton, lucerne, maize, sorghum, sunflower	100 g ac/ha	Broadcast bait application	EC	Inadequate information included on product labels to assess exposure from mixing, loading and application
Field crops (broadacre use, various including cereals, canola and pulses)	35 – 100 g ac/ha	Groundboom (broadacre use)	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
	> 100 g ac/ha	Groundboom (broadacre use)	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Hops	800 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Maize	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Maize, safflower, sunflower	750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Rice	750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Tobacco	1500 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
Sugarcane	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	450–750 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Miscellaneous uses				
Agricultural, commercial and industrial areas (not publicly accessible)	4.5 g ac/L water to 5 g ac/L water	Backpack or mechanically pressurised handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
	2.5 g ac/L water to 5 g ac/L water (indoor use)	Manually pressurized handwand	EC	MOE < 100 with maximum PPE for mixing/loading and application
Commercial and industrial areas (not publicly accessible)	1 g ac/10 m ²	Hand dispersal	GR	MOE < 100 with maximum PPE for loading and application
Duboisia	450 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
Grapevine rootlings	8000 g ac/ha	Hand dispersal	GR	MOE < 100 with maximum PPE for loading and application
Ornamental nursery plants	250 to 500 g ac/m ³ potting medium	Hand dispersal	GR	Not practical due to restricted volume of potting-medium that may be handled while maintaining acceptable risks to applicators (<1 cubic meter)
Outdoor areas (not publicly accessible)	1 g ac/10 m ²	Hand dispersal	GR	MOE < 100 with maximum PPE for loading and application
Polluted water impoundments	1 g ac/10,000 L water or 10 g ac/100 m ³	Backpack or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
Tasmanian blue gum	1,500 g ac/ha	Hand dispersal	GR	MOE < 100 with maximum PPE for loading and application

Crop	Rate	Application	Formulation Type	Mixing, loading, application outcome ¹
Termiticide – chemical soil barrier around and under buildings	50 g ac/m ² or 100 g ac/m ² (horizontal barrier)	Soil injection or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
	1000 g ac/m ³ or 2000 g ac/m ³ (vertical barrier)	Soil injection or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
Termiticide – chemical soil barrier around poles	10 g ac/L water	Soil injection or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
Turf (commercial turf that is not publicly accessible)	2,000 g ac/ha, 3,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	2,000 g ac/ha	Rotary spreader	GR	MOE < 100 with maximum PPE for loading and application
	1,000 g ac/ha	Hand dispersal	GR	MOE < 100 with maximum PPE for loading and application
	1,000 g ac/ha	Groundboom	EC	MOE < 100 with maximum PPE for mixing/loading and closed cab application ²
	350 g ac/ha	Mister	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application
	12.5 g ac/ha, 50 g ac/ha	Broadcast bait application	EC	Inadequate information included on product labels to assess exposure from mixing, loading and application
Vegetation (not publicly accessible)	13–54 g ac/ha	Backpack or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application

1 Maximum PPE for EC products: Double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator. Maximum PPE for GR/WP/WG products: Double layer of clothing, elbow-length chemical resistant gloves and a full facepiece respirator. Maximum engineering controls for mixing/loading: closed mixing/loading systems (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank).

2 Operator exposure may be minimized during mixing and loading by using engineering controls (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank). This is considered in the [Ground-based application using closed mixing/loading systems](#) section below.

Ground-based application using closed mixing/loading systems

The outcomes for the risk assessments for the professional use of chlorpyrifos in agricultural situations using ground-based application equipment, with engineering controls to mitigate occupational exposure for mixing and loading activities, are set out in Table 10. This modelling also assumed that all steps in the use of chlorpyrifos products are performed by a single operator (i.e. a single operator mixes, loads and applies the pesticide) and that there was only one type of use or activity performed per operator per day. The engineering controls assessed are closed mixing and loading systems (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank).

Table 10: Worker exposure assessment outcomes for chlorpyrifos uses where engineering controls are required to minimize operator exposure during mixing and loading

Crop	Rate (g ac/ha)	Application	Work rate (ha/day)	PPE and Engineering Controls ¹	MOE (acceptable MOE ≥ 100)
Fruit and vegetables					
Apples, banana, grapes (grape vines), kiwifruit, pears, stone fruits	500	Airblast	30	Closed M/L. Closed cab application.	123
Pineapple, tomatoes, vegetables (various)	750	Groundboom	50	Closed M/L. Closed cab application.	109
Tomatoes, vegetables (various)	500	Groundboom	50	Closed M/L. Closed cab application.	164
Field crops and pasture					
Cereals, oilseeds (including canola), pastures and forage crops, sorghum, sugarcane	450	Groundboom	50	Closed M/L. Closed cab application.	180
	750	Groundboom	50	Closed M/L. Closed cab application.	109
Cotton	70	Groundboom	400	Closed M/L. Closed cab application.	88
				Closed M/L, gloves. Closed cab application.	193
	100	Groundboom	400	Closed M/L. Closed cab application.	61
				Closed M/L, gloves. Closed cab application.	136
	130	Groundboom	400	Closed M/L. Closed cab application.	65
				Closed M/L, gloves. Closed cab application.	104

Crop	Rate (g ac/ha)	Application	Work rate (ha/day)	PPE and Engineering Controls ¹	MOE (acceptable MOE ≥ 100)
Field crops (broadacre use, various including cereals, canola and pulses)	35	Groundboom (broadacre use)	500	Closed M/L. Closed cab application.	139
				Closed M/L, gloves. Closed cab application.	307
	70	Groundboom (broadacre use)	500	Closed M/L. Closed cab application.	69
				Closed M/L, gloves. Closed cab application.	152
	100	Groundboom (broadacre use)	500	Closed M/L. Closed cab application.	48
				Closed M/L, gloves. Closed cab application.	105
Maize, rice, safflower, sunflower	750	Groundboom	50	Closed M/L. Closed cab application.	109
Miscellaneous uses					
Duboisia	450	Groundboom	50	Closed M/L. Closed cab application.	180
Turf (commercial turf that is not publicly accessible)	1000	Groundboom	30	Closed M/L. Closed cab application.	135

¹ M/L = mixing/loading

Aerial application

Modelling for aerial application was undertaken using a reverse exposure approach. That is, for both the pilot and the mixer/loader, a calculation was undertaken to determine the quantity of product that could be applied (pilot) or handled during mixing/loading activities. For this reverse exposure assessment, it has been assumed that mixing and loading activities are performed by someone other than the pilot. As unit exposures differ for liquids and granular products, Table 11 presents the maximum quantities that can be handled with corresponding maximum areas treated based on representative use rates.

Table 11: Aerial application maximum acceptable quantities of chlorpyrifos handled/applied per day for mixer/loader activities and applicators (aerial fixed wing pilots)

Activity	Maximum quantity per day (liquid)	Maximum quantity per day (granule)	Representative application rate	Maximum area treated per day (liquid)	Maximum area treated per day (granule)
Pilot	168 kg	51.8 kg	150 g ac/ha	1120 ha	345 ha
			350 g ac/ha	480 ha	148 ha

Activity	Maximum quantity per day (liquid)	Maximum quantity per day (granule)	Representative application rate	Maximum area treated per day (liquid)	Maximum area treated per day (granule)
			500 g ac/ha	336 ha	103 ha
			750 g ac/ha	224 ha	69 ha
Mixer/loader ¹	26.7 kg	33.6 kg	150 g ac/ha	178 ha	224 ha
			350 g ac/ha	76 ha	96 ha
			500 g ac/ha	53 ha	67 ha
			750 g ac/ha	35 ha	44 ha
Mixer/loader ²	40 kg	139 kg	150 g ac/ha	266 ha	926 ha
			350 g ac/ha	114 ha	397 ha
			500 g ac/ha	80 ha	278 ha
			750 g ac/ha	53 ha	185 ha

1 Baseline PPE: Single layer of clothing and elbow-length chemical resistant gloves

2 Baseline PPE: Double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator

It is considered that aerial application of products containing chlorpyrifos would not be practical due to the restricted areas that may be treated while maintaining acceptable risks to the mixers/loaders and applicators. Even with the lowest application rates on representative product labels, the mixing and loading tasks may need to be divided by multiple individuals to possibly be considered suitable for application by aerial methods. It should also be noted that pilot exposure to granular formulations is higher than a mixer/loader wearing a double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator. The following restraint is therefore advised for all products containing chlorpyrifos:

DO NOT apply by aircraft.

Para-occupational exposure

The potential for para-occupational (or 'take-home') exposure to chlorpyrifos is considered negligible based on US data that that maximum concentration of chlorpyrifos in farmworker homes is 200 ng/g (Quirós-Alcalá et al. 2011), an assumed default bioavailability of 0.1, dust ingestion of 60 mg for adults and 100 mg for toddlers (based on the 95th percentile values in the Australian Exposure Factors Guide), and the ADI of 1,000 ng/kg bw/d (0.001 mg/kg bw/d). Further, good worker hygiene practices are expected for product users, re-entry workers and workers re-handling treated commodities/turf. Therefore, the para-occupational risks associated with use of chlorpyrifos-containing products, in accordance with label directions, is considered to be low.

First aid instructions and warning statements

The revised first aid instructions (FAI) and warning statements for chlorpyrifos products whose uses are supported, are listed in Table 12 and should be included in the relevant product labels.

Table 12: Chlorpyrifos first aid instructions and warning statements

Status	Substance	Concentration	First aid instruction	Warning statement
Existing entry	Chlorpyrifos	≤ 5%	a	Nil
Existing entry	Liquid hydrocarbons	> 25%	a, c	Nil
Amended entry	Chlorpyrifos	> 5%	a, m, s	31, 53
Amended entry	Chlorpyrifos (slow-release impregnated plastics)	Any	a	Nil

First aid instructions

First Aid instructions a, c, m and s should appear on labels for products that contain chlorpyrifos (over 5%) and liquid hydrocarbon (over 25%), as:

- If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.
- If swallowed, DO NOT induce vomiting.
- If swallowed, splashed on skin or in eyes, or inhaled, contact a Poisons Information Centre (Phone Australia 131126) or a doctor at once. Remove any contaminated clothing and wash skin thoroughly. Give atropine if instructed.
- If in eyes, hold eyes open, flood with water for at least 15 minutes and see a doctor.

First Aid instructions a, m and s should appear on labels for products that contain chlorpyrifos (over 5%), as:

- If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.
- If swallowed, splashed on skin or in eyes, or inhaled, contact a Poisons Information Centre (Phone Australia 131126) or a doctor at once. Remove any contaminated clothing and wash skin thoroughly. Give atropine if instructed.
- If in eyes, hold eyes open, flood with water for at least 15 minutes and see a doctor.

First Aid instruction a should appear on labels for products that contain chlorpyrifos (less than or equal to 5% or products formulated as a slow-release impregnated plastic), as:

- If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.

Warning statements

The following warning statements should be added to the FAI entry – chlorpyrifos > 5% in the FAISD Handbook, excluding when formulated as a slow-release impregnated plastic.

- 31 – Breathing vapour or spray mist is harmful and may cause an asthma-like reaction.
- 53 – WARNING – Contains [name of substance], excessive exposure to which may temporarily interfere with vision and the ability to safely operate machinery.

Safety directions

The revised the safety directions for chlorpyrifos products, based on the uses supported by the APVMA review, are listed in Table 13 to Table 17. The updated safety directions given below should be included on product labels.

Chlorpyrifos EC 500 g/L (or less)

Table 13: Safety directions for chlorpyrifos EC 500 g/L (or less)

Substance	Formulation	Statement Codes
Chlorpyrifos	EC 500 g/L or less in liquid hydrocarbon 520 g/L or less	120 130 131 132 133 180 190 161 162 164 210 211 220 222 223 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 350 360 361 364 365 366

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Product is poisonous if absorbed by skin contact, inhaled or swallowed	120 130 131 132 133
Repeated exposure may cause allergic disorders	180
Repeated minor exposure may have a cumulative poisoning effect	190
Will irritate eyes and skin	161 162 164
Precautions	
Avoid contact with eyes and skin	210 211
Do not inhale vapour or spray mist	220 222 223
Mixing or using	
When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. If clothing becomes contaminated with product or wet with spray, remove clothing immediately. If product on	279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343

Safety directions	Code
skin, immediately wash area with soap and water. If product in eyes, wash it out immediately with water.	
After use	
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.	350
After each day's use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing.	360 361 364 365 366

Chlorpyrifos EC 600 g/L (or less) with bifenthrin 30 g/L (or less)

Table 14: Safety directions for chlorpyrifos EC 700 g/L (or less)

Substance	Formulation	Statement codes
Chlorpyrifos	EC 600 g/L or less with bifenthrin 30 g/L or less	120 130 132 133 161 162 160 164 190 203 210 211 220 222 223 276 279 280 281 290 292d 294c 297 300 279 282 290 292b 350 360 361 363 364 366

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Product is poisonous if inhaled or swallowed	120 130 132 133
Will irritate the eyes	161 162
May irritate the skin	160 164
Repeated minor exposure may have a cumulative poisoning effect	190
Facial skin contact may cause temporary facial numbness	203
Precautions	
Avoid contact with eyes and skin	210 211
Do not inhale vapour or spray mist	220 222 223
Mixing or using	
When using together with other products, consult their safety directions	276
When opening the container and preparing the spray, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, elbow-length chemical resistant gloves, goggles and half facepiece respirator. When using the prepared spray wear cotton overalls, over normal clothing, buttoned to the neck and wrist.	279 280 281 290 292d 294c 297 300 279 282 290 292c

Safety directions	Code
After use	
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water	350
After each day's use, wash gloves, goggles, respirator, and if rubber wash with detergent and warm water, and contaminated clothing	360 361 363 364 366

Chlorpyrifos EC 700 g/L (or less)

Table 15: Safety directions for chlorpyrifos EC 700 g/L (or less)

Substance	Formulation	Statement codes
Chlorpyrifos	EC 700 g/L or less in phenyl methyl ketone 500 g/L or less	120 130 131 132 133 190 161 162 164 210 211 220 222 223 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 350 360 361 364 365 366

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Product is poisonous if absorbed by skin contact, inhaled or swallowed	120 130 131 132 133
Repeated minor exposure may have a cumulative poisoning effect	190
Will irritate eyes and skin	161 162 164
Precautions	
Avoid contact with eyes and skin	210 211
Do not inhale vapour or spray mist	220 222 223
Mixing or using	
When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. If clothing becomes contaminated with product or wet with spray, remove clothing immediately. If product on skin, immediately wash area with soap and water. If product in eyes, wash it out immediately with water.	279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343
After use	
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.	350
After each day's use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing.	360 361 364 365 366

Chlorpyrifos WP 500 g/kg (or less)

Table 16: Safety directions for chlorpyrifos WP 500 g/kg (or less)

Substance	Formulation	Statement codes
Chlorpyrifos	WP 500 g/kg or less	120 130 131 132 133 190 161 162 164 210 211 220 221 223 279 280 281 282 290 291b 294c 299 298a 300 303 350 360 361 363 364 366

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Product is poisonous if absorbed by skin contact, inhaled or swallowed	120 130 131 132 133
Repeated minor exposure may have a cumulative poisoning effect	190
Will irritate eyes and skin	161 162 164
Precautions	
Avoid contact with eyes and skin	210 211
Do not inhale vapour or spray mist	220 221 223
Mixing or using	
When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge.	279 280 281 282 290 291b 294c 299 298a 300 303
After use	
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.	350
After each day's use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing.	360 361 364 365 366

Chlorpyrifos WG 750 g/kg (or less)

Table 17: Safety directions for chlorpyrifos WG 750 g/kg (or less)

Substance	Formulation	Statement codes
Chlorpyrifos	WG 750 g/kg or less	129 133 190 161 162 210 162 279 280 281 282 290 291b 294 299 298a 300 303 350 360 361 365 364 366

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Harmful if swallowed	129 133
Repeated minor exposure may have a cumulative poisoning effect	190
Will irritate eyes	161 162
Precautions	
Avoid contact with eyes	210 162
Mixing or using	
When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length PVC gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge.	279 280 281 282 290 291b 294 299 298a 300 303
After use	
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.	350
After each day's use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing.	360 361 365 364 366

Worker health and safety recommendations

The following uses of chlorpyrifos are not supported based on potential risks identified in the worker health and safety assessment:

- Aerial application to all crops
- Airblast application to fruits and vegetables at rates that exceed 500 g ac/ha
- Groundboom application to cotton crops at rates that exceed 750 g ac/ha
- Groundboom application to all broadacre field crops (including cereals, canola and pulses) at rates that exceed 100 g ac/ha
- Groundboom application to vegetables, field crops and duboisia at rates that exceed 750 g ac/ha
- Mister application to cereals, pastures and forage crops
- Mechanically pressurised handgun application to avocado crops at rates that exceed 500 g ac/ha and for the control of Queensland fruit fly in various crops
- Backpack or mechanically pressurised handgun application to agricultural, commercial and industrial areas, polluted water impounds and vegetation
- Manually pressurised handwand application to indoor agricultural, commercial and industrial areas

- Soil injection or mechanically pressurized handgun application for termiticide chemical soil barriers around and under buildings (excluding use of reticulated or AS Series 3660 systems) and around poles
- Application to turf at rates that exceed 1,000 g ac/ha
- Application of granular formulated products
- Seed dressings
- Insect baits

The following uses of chlorpyrifos are not supported based on potential risks identified in the worker health and safety assessment, unless operator exposure is minimised during mixing and loading using engineering controls (closed mixing and loading systems):

- Airblast application to fruits and vegetables at application rates greater than 250 g ac/ha, up to 500 g ac/ha
- Groundboom application to cotton crops at application rates up to 130 g ac/ha
- Groundboom application to all broadacre field crops (including cereals, canola and pulses) at application rates up to 100 g ac/ha
- Groundboom application to vegetables, field crops and duboisia at application rates greater than 400 g ac/ha, up to 750 g ac/ha
- Groundboom application to turf at an application rate of 1,000 g ac/ha

While a number of chlorpyrifos use patterns could be supported from a worker health and safety perspective (see Table 8 and Table 10), many of these uses were not supported in the contemporary residues and trade assessments and environment assessments. The first aid instructions, warning statements and safety directions recommended in this report are reflective of uses supported by all assessment areas. The relevant first aid instructions and warning statement listed in Table 12 and the relevant safety directions listed in Table 13 to Table 17 should be included on all product labels.

The following restraints should also be included on all labels to mitigate the identified potential risks to product users:

- DO NOT apply by aircraft
- DO NOT apply using equipment carried on the back of the user
- DO NOT apply using mechanically pressurized hand wand sprayer

Further, use of chlorpyrifos in brassica crops at a maximum rate of 70 g ac/ha, and the use of chlorpyrifos on forage crops, clover seed crops, lucerne, lucerne seed crops and medics at a maximum rate of 130 g ac/ha, has been supported all risk assessments with certain risk mitigation measures. The following re-entry period should be included on labels of products that are approved for use in forage crops, clover seed crops, lucerne, lucerne seed crops and/or medics at a maximum rate of 130 g ac/ha to mitigate the identified potential risks to professional workers who re-enter chlorpyrifos treated areas.

- DO NOT enter treated crops for 2 days after treatment for scouting or for 8 days after treatment for irrigation (hand set). When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent

clothing) and chemical resistant gloves. Clothing must be washed after each day's use. These re-entry intervals do not apply if crops are treated pre-emergence or product is applied to soil at seed planting.

The following re-entry period should be included on labels of products that are approved for use in brassica crops at a maximum rate of 70 g ac/ha and in forage crops, clover seed crops, lucerne and/or medics at a maximum rate of 130 g ac/ha to mitigate the identified potential risks to professional workers who re-enter chlorpyrifos treated areas.

- DO NOT enter treated brassica crops for 8 days after treatment for scouting, hand harvesting or hand weeding. DO NOT enter treated forage crops, lucerne crops, clover seed crops or medics for 2 days after treatment for scouting or for 8 days after treatment for irrigation (hand set). When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be washed after each day's use. These re-entry intervals do not apply if crops are treated pre-emergence or product is applied to soil at seed planting.

Environment

Previous assessments

In 2000, an [interim environmental risk assessment](#) for chlorpyrifos on the environmental fate and effects was published by the APVMA (2000c). As an outcome, various risk management recommendations were implemented to reduce environmental risks including label warnings for environmental protection and establishment of buffer zones for various use patterns.

In 2019, a [supplementary environment assessment report](#) was published by the APVMA (2019c), which provided recommendations to address the environmental risks of home garden, domestic and certain agricultural uses. For spray applications, the assessment determined that single application rates above 850 g ac/ha were not acceptable to birds and the possibility of avian mortality was likely under field conditions. Therefore, certain home garden/urban use products with usage rates >850 g ac/ha were cancelled. The 850 g ac/ha threshold also applied for the protection of birds in agricultural situations.

Current assessment

This environment assessment considers the environmental risks of the remaining registered uses of chlorpyrifos; however, many that are not supported based on human health or on other grounds have not been reconsidered in the interest of efficiency. The APVMA's risk assessment for worker health and safety was revised upon consideration of the submissions received in response to public consultation on the Proposed Regulatory Decisions for the chlorpyrifos reconsideration. This included refinement of the work rate assumption for broadacre crops and consideration of whether occupational exposure risks can be mitigated using engineering controls during mixing and loading. Therefore, the environmental exposure risks of additional chlorpyrifos uses have been considered in this revised assessment compared to in the environment assessment summarised in the draft [Chlorpyrifos Review Technical Report](#), including uses on cereal, canola, cotton and pulse crops.

This environment risk assessment has been further revised upon consideration of the submissions received in response to public consultation on the Proposed Regulatory Decisions for the chlorpyrifos reconsideration. These revisions are discussed in detail in the [Risks to non-target species](#) section and include:

- Terrestrial vertebrates – revision of parameters for the wild mammal and food chain (secondary exposure) assessments, and consideration of full rate ranges and additional relevant uses
- Aquatic species – revision of some assessment parameters for the runoff risk assessment and reassessment of certain use patterns that were supported by the terrestrial vertebrates assessments
- Bees – determination of the maximum rate at which pollinator restraints are not required for relevant uses

The environmental risk assessment scenarios considered in this environment assessment are summarised in Table 18. Chlorpyrifos is primarily applied as a broadcast foliar spray to crops and other plants for control of various insect pests, but it can also be applied as a dry granular formulation, seed treatment, or bait. It is also registered for control of mosquito larvae in polluted water impounds and as a termiticide. Environmental risks were determined according to the methodology outlined in the [APVMA Risk Assessment Manual –](#)

[Environment](#). The chlorpyrifos uses that have not been considered in this updated environment assessment are listed Table 19.

Table 18: Environmental risk assessment scenarios

Category	Situation	Risk assessment scenario
Fruit and vegetables	Apples, avocado, pears, stone fruits	30 to 1000 g ac/ha
	Avocado (spot spray)	500 g ac/ha
	Bananas	500 to 1000 g ac/ha
	Citrus	30 to 2000 g ac/ha
	Custard apple	1000 to 10,000 g ac/ha
	Ginger	350 to 450 g ac/ha
	Grain baits in stone fruit	200 mg ac/kg grain bait
	Grain baits in strawberries, vegetables	50 mg ac/kg grain bait
	Grapevines, kiwifruit	65 to 500 g ac/ha
	Mango (spot or foliar spray)	1000 g ac/ha
	Loquats	30 to 60 g ac/ha
	Passionfruit	60 g ac/ha
	Pome fruits	30 to 250 g ac/ha
	Tomatoes	250 to 2500 g ac/ha
	Vegetables (band spray)	350 to 1000 g ac/ha
	Vegetables (broadcast spray)	70 to 3000 g ac/ha
Vegetable seeds	25000 mg ac/kg seed	
Field crops and pasture	Barley, wheat	70 to 400 g ac/ha

Category	Situation	Risk assessment scenario
	Broad beans, chickpeas, clover seed crops, improved annual pastures, established perennial pastures, oats, rye, triticale	70 to 150 g ac/ha
	Canola, cereals, forage crops, pastures	35 to 750 g ac/ha
	Canola seeds	400 mg ac/kg seed
	Cereal seeds	2000 mg ac/kg seed
	Clover, subterranean clover, clover	100 to 400 g ac/ha
	Cotton	70 to 750 g ac/ha
	Field peas, lupins	70 to 200 g ac/ha
	Grain baits in cotton, lucerne, maize, pulses, sorghum, sunflower	200 mg ac/kg grain bait
	Lucerne, oilseeds (excluding canola & cotton)	70 to 450 g ac/ha
	Lucerne seed crops	100 to 350 g ac/ha
	Medics	100 to 175 g ac/ha
	Rice	30 to 750 g ac/ha
	Sorghum (excluding sugar drip or alpha sorghum)	175 to 750 g ac/ha
	Sugarcane	175 to 1000 g ac/ha
Miscellaneous uses	Hides/skins, chemical soil barrier under buildings, treatment of termite nest or colony (in wall cavities), control of funnel ant in turf (commercial)	Negligible exposure of the environment
	Agricultural, commercial and industrial areas (not publicly accessible)	1000 to 5000 g ac/ha
	Control of Argentine ants in container plants in soil or other growing media (commercial)	Handheld sprayer: 5000 g ac/ha

Category	Situation	Risk assessment scenario
	Control of scarab beetle larvae in potted ornamentals (commercial)	Soil drench: 4000 g ac/ha
	Chemical soil barrier around buildings (not publicly accessible); chemical soil barrier around poles	1000 kg ac/ha
	Duboisia	450 g ac/ha
	Grapevine rootlings	8000 g ac/ha
	Macrocarpa hedges	250 g ac/ha
	Polluted water impoundments	1 g ac/10,000 L
	Turf (commercial)	250 to 3000 g ac/ha
	Grain baits in turf	200 mg ac/kg grain bait
	Ant nests and trails	Surface granules: 1000 g ac/ha
	Control of mosquito adults in vegetation (light to medium, not publically accessible)	29 to 32 g ac/ha
	Control of mosquito adults in vegetation (medium to heavy, not publically accessible)	52 to 54 g ac/ha

Table 19: Chlorpyrifos uses that were not reconsidered in this environment assessment

Crop/host	Pest	Rate	Rationale
Fruit and vegetables			
Banana	Banana scab moth	5 g ac/5 L (knapsack)	Not supported – safety (worker exposure) concerns
	Cluster caterpillars	75 to 100 g ac/ha (spot spray)	
	Banana weevil borer	250 to 900 g ac/100 L water or 2.5 to 3.5 g ac/stool or 250 g ac/4 kg sand	
Cabbage, cauliflower, tomatoes	African black beetle	150 g ac/100 L water (drench at 100 mL/plant)	Not supported – safety (worker exposure) concerns

Crop/host	Pest	Rate	Rationale
Field crops and pasture			
Cotton	Wireworm, false wireworm, sugarcane wireworm	2.5 to 7.5 g ac/100 m row	Not supported – safety (worker exposure) concerns
Hops	Common armyworm, southern armyworm, light brown apple moth	800 g ac/ha	Not supported – safety (worker exposure) concerns
Maize	Wireworm, false wireworm, sugarcane wireworm	2.5 to 7.5 g ac/100 m row	Not supported – safety (worker exposure) and trade concerns
Safflower, sunflower	Wireworm, false wireworm	2.5 to 7.5 g ac/100 m row	Not supported – safety (worker exposure) concerns
Sorghum (excluding sugar drip or alpha sorghum)	Wireworm, false wireworm	2.5 to 7.5 g ac/100 m row	Not supported – safety (worker exposure) and trade concerns
Tobacco	Wireworm, false wireworm, cutworm	1500 g ac/ha (pre-plant, soil incorporated)	Not supported – safety (worker exposure) concerns
Miscellaneous uses			
Ornamental nursery plants	Sciarid fly, shore fly	250 g ac/m ³ potting medium	Not supported – safety (worker exposure) concerns
	Pruinose scarab, Argentine scarab, fiddler beetle, opaline cockchafer, black vine weevil	375 to 500 g ac/m ³ potting medium	
Tasmanian blue gum	African black beetle	1500 g ac/ha (1.5 g ac/seedling at 1000 seedlings/ha)	Not supported – safety (worker exposure) concerns
Vegetation (light, not publicly accessible)	Mosquito larvae	13 to 15 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation
Vegetation (medium, not publicly accessible)	Mosquito larvae	29 to 32 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation
Vegetation (heavy, not publicly accessible)	Mosquito larvae	52 to 54 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation

Fate and behaviour in the environment

The fate and behaviour of chlorpyrifos in the environment have been described in the previous APVMA 2000c and 2019c assessments. A full listing of endpoints is provided in Appendix C.

Chlorpyrifos is non-persistent in soil under field conditions (geomean DT₅₀ 28 days) and is slightly mobile (geomean K_{oc} 3572 mL/g). In aquatic systems, chlorpyrifos is moderately persistent (geomean DT₅₀ 42 days) with up to 54% partitioning to sediment. It is not expected to undergo long-range transport through the air based on rapid reaction with hydroxyl radicals.

Lu et al. (2014) reports persistence and dissipation of chlorpyrifos in brassicas, lettuce, celery, asparagus lettuce (celtuce), eggplant and pepper. The application rate in the studies was 970 g ac/ha, and measured DT₅₀ values were 5.8, 3.9, 5.4, 3.9, 2.6 and 3.0 days, respectively. The geometric mean of these half-lives is 4.0 days.

Insect DT₅₀ values were also determined for both ground-dwelling species (DT₅₀ 4.0 days) and foliage-dwelling species (DT₅₀ 3.1 days) based on residue data available from an avian field study where citrus was treated with 2400 g ac/ha. The geometric mean of these half-lives is 3.5 days.

Regression analysis of the adsorption data indicate that sorption of chlorpyrifos increases as the organic carbon increased ($K_d = 42 * \%OC + 25$). There are measured data available for total organic carbon in agricultural soils around Australia and these are published by [Soil Quality Pty Ltd](#). While not all agricultural regions are represented, the data allow for a relatively good assessment of differences in organic carbon levels in different regions of States and some different agricultural uses (for example, dryland and horticulture). The fraction of contribution of different soil organic carbon levels in different regions has been assessed to determine appropriate levels for different cropping types in different parts of the country. These are applied broadly in the runoff assessment here to differentiate between levels of organic carbon that may be found between states in dryland cropping and horticulture. The results will have a strong influence on the runoff assessment. Based on that analysis, the organic carbon levels in the top 10 cm soil have been adopted for the different states, and the corresponding K_d values from the above relationship derived for use in the runoff assessment (Table 21).

Table 20: Key regulatory endpoints for exposure assessment

Compartment	Value	Reference
Foliage and other dietary items	DT ₅₀ 4.0 d	Lu et al. 2014
Insects	DT ₅₀ 3.5 d	Wilkens et al. 2008a
Soil	DT ₅₀ 28 d 1% OC: K _d 67 mL/g 2% OC: K _d 108 mL/g	Fontaine et al. 1987, Old 2002b, Old 2002c, Old 2002d Damon & Heim 2001
Water	DT ₅₀ 42 d	Abu 2015b, Kang 2015

Compartment	Value	Reference
Sediment	DT ₅₀ 42 d	Abu 2015b, Kang 2015
	5% OC: K _p 236 mL/g	Damon & Heim 2001
Air	DT ₅₀ 1.4 h	Simon 2001

Table 21: Summary of % organic carbon and corresponding K_d for runoff assessments

State	Horticulture		Dryland	
	% organic carbon	K _d (mL/g)	% organic carbon	K _d (mL/g)
Western Australia	2.0	108	1.0	67
South Australia	1.5	88	1.3	77
Victoria	2.0	108	1.0	67
Tasmania	4.0	194	4.0	194
New South Wales	2.0	108	1.5	88
Queensland	2.0	108	1.0	67

Effects on non-target species

The effects of chlorpyrifos on non-target species have been described in the previous APVMA 2000c and 2019c assessments. A full listing of endpoints is provided in Appendix C.

Chlorpyrifos has high toxicity to mammals (LD₅₀ 97 mg ac/kg bw/d, *Rattus norvegicus*) and birds (geomean LD₅₀ 32 mg ac/kg bw/d, 14 species). Therefore, the following hazard statement is advised for chlorpyrifos product labels (followed by an appropriate risk management statement).⁵

Toxic to birds and wild mammals.

The major metabolites TMP, TCP, and DCP have low toxicity to mammals; TCP has low toxicity to birds.

Following long-term dietary exposure to chlorpyrifos, neonatal effects were observed in mammals at doses at low as 5.0 mg ac/kg bw/d (NOEL 1.0 mg ac/kg bw/d, *Rattus norvegicus*), and significant impairment of avian

⁵ Not required for hides/skins situations

reproductive success was observed at concentrations as low as 125 ppm (NOEL 2.9 mg ac/kg bw/d, *Anas platyrhynchos*).

Chlorpyrifos has high toxicity to fish (lowest LC₅₀ 0.010 mg ac/L, *Leuciscus idus*), aquatic invertebrates (lowest LC₅₀ 0.000045 mg ac/L, *Mysidopsis bahia*), and moderate toxicity to algae (lowest E_rC₅₀ 1.0 mg ac/L, *Pseudokirchneriella subcapitata*). Therefore, the following protection statement is advised for chlorpyrifos product labels.

Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.

The major metabolites TMP, TCP and DCP are less toxic than the parent substance to aquatic species.

Following long-term exposure to chlorpyrifos, increased mortality was observed in fish in the early life stages at concentrations as low as 0.00078 mg ac/L (lowest NOEC 0.00038 mg ac/L, *Menidia peninsulae*), and reduced growth and survival of aquatic invertebrates was observed at concentrations as low as 0.000010 mg ac/L (lowest NOEC 0.0000046 mg ac/L, *Mysidopsis bahia*).

As described by APVMA (2019c) and based on higher tier (microcosm/mesocosm) data, the consistent finding was a NOEC value of 0.10 µg ac/L for the most sensitive aquatic species. This value was set as the RAL for protection of aquatic species for both runoff and spray drift assessments.

Available data show concern for bioconcentration of chlorpyrifos in aquatic species with BCF values of 1,374 in fish (Murphy & Luteske 1986) and 430–680 in bivalves (Hansen et al. 1992, Thacker et al. 1992).

Three studies on aquatic vertebrates are available to assess the potential for endocrine disruption (Coady et al. 2012, 2015; Currie et al. 2011); however, it was not possible to discern whether adverse effects were observed due to endocrine disruption or other mode of action.

Chlorpyrifos has high toxicity to adult bees by contact exposure (geomean LD₅₀ 0.075 µg ac/bee, *Apis mellifera*) and oral exposure (geomean LD₅₀ 0.21 µg ac/bee, *Apis mellifera*), and high toxicity to bee larvae (LD₅₀ 0.021 µg ac/bee, *Apis mellifera*). A representative EC formulation is approximately equivalent in toxicity to the technical substance. Tunnel tests in flowering *Phacelia tanaetifolia* at an application rate of 1000 g ac/ha indicate residues impact the foraging activity of bees for at least 14 days after application. The following hazard statement is advised for chlorpyrifos product labels (followed by an appropriate risk management statement).⁶

Highly toxic to bees.

For the spray drift assessment for the protection of pollinators, the RAL is 12 g ac/ha based on the geomean contact LD₅₀ 0.075 µg ac/bee and a conversion factor of LOC 0.4/ExpE 2.4 × 1000 as per the [APVMA's Spray drift risk assessment manual](#) (SDRAM).

There are no contemporary laboratory data on the toxicity of chlorpyrifos to predatory and parasitic arthropods. Available extended laboratory data on a representative EC formulation show complete mortality

⁶ Not required for hides/skins situations

of the ladybird beetle *Coccinella septempunctata* at rates as low as 180 g ac/ha (Thomas & Phadke 1991), and complete inhibition of parasitisation capacity of rove beetle *Aleochara bilineata* at 960 g ac/ha (Moreth 1992). Field studies at 960 g ac/ha in pome fruit and 720 g ac/ha in grassland demonstrate a high initial toxicity to arthropod populations, but most species recovered within 23 days in pome fruit and within one year in grassland. Based on the available data, chlorpyrifos products are not considered to be compatible with integrated pest management programs utilising beneficial arthropods. Therefore, the following protection statement is advised for chlorpyrifos agricultural product labels.⁷

Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.

Chlorpyrifos and a representative EC formulation are moderately toxic to soil macro-organisms such as earthworms (geomean LC_{50corr} 130 and 76 mg ac/kg dry soil, respectively). Following long-term exposure, reduced reproduction was observed at concentrations as low as 27 mg ac/kg dry soil (NOEC_{corr} 6.4 mg ac/kg dry soil). Chlorpyrifos does not affect soil processes such as nitrogen transformation at exaggerated soil concentrations (lowest NOEC 6.4 mg ac/kg dry soil). Although the minor soil metabolites TMP and DCP are more toxic than the parent substance to soil macro-organisms, they are formed in small quantities and the assessment of chlorpyrifos is considered to address their risks.

The toxicity of 4 major chlorpyrifos formulation to non-target terrestrial plants has been tested following pre-emergent and post-emergent exposure. All ER₂₅ values are >2,400 g ac/ha.

Based on the available data, the regulatory acceptable levels for the environmental risk assessment are summarised in Table 22.

Table 22: Regulatory acceptable levels for non-target species

Group	Exposure	Endpoint	AF	RAL	Reference
Mammals	Acute	LD ₅₀ 97 mg ac/kg bw	10	9.7 mg ac/kg bw	Henck & Kociba 1980
	Chronic	NOEL 1.0 mg ac/kg bw/d	1	1.0 mg ac/kg bw/d	Breslin et al. 1991
Birds	Acute	LD ₅₀ 32 mg ac/kg bw	10	3.2 mg ac/kg bw	Bull & Cameron 2013, Gallagher et al. 1996, Hudson et al. 1972, 1984, Lloyd et al. 1989a, 1989b, Miyazaki & Hodgson 1972, Rodgers 1996, Schafer & Brunton 1971, 1979, Sharma 2008a, Sherman et al. 1967, Smith 1987, Stevenson 1963, Yogeesh 2014
	Chronic	NOEL 2.9 mg ac/kg bw/d	1	2.9 mg ac/kg bw/d	Lloyd et al. 1990

⁷ Not required for hides/skins, mosquito larvae control, crawling insect control (including ant nests and trails) or termiticides

Group	Exposure	Endpoint	AF	RAL	Reference
Aquatic species	Acute/chronic	NOEC 0.00010 mg ac/L	1	0.00010 mg ac/L	Daam 2008, Giddings 1993, 2011, López-Mancisidor 2015, López-Mancisidor et al. 2008, van den Brink et al. 1996, van Wijngaarden et al. 2005
Adult bees	Acute contact	LD ₅₀ 0.075 µg ac/bee	2.5	0.030 µg ac/bee	Bell 1994, Suresh 2015
	Acute oral	LD ₅₀ 0.21 µg ac/bee	2.5	0.084 µg ac/bee	Bell 1994, Sharma 2008b, Suresh 2015
Bee larvae	Acute oral	LD ₅₀ 0.021 µg ac/bee	2.5	0.0084 µg ac/bee	Odemer 2015
Soil macro-organisms	Acute	LC _{50corr} 76 mg ac/kg ds	10	7.6 mg ac/kg ds	Johnson 1993, Candolfi 1995
	Chronic	NOEC _{corr} 6.4 mg ac/kg ds	1	6.4 mg ac/kg ds	Hayward 2002
Soil micro-organisms	Chronic	NOEC 6.4 mg ac/kg ds	1	6.4 mg ac/kg ds	Baloch & Hund 1990, Baloch & Todt 1990
Terrestrial plants	Pre-emergent	ER ₂₅ >2400 g ac/ha	2	1200 g ac/ha	Paterson & Toft 2007a
	Post-emergent	ER ₂₅ >2400 g ac/ha	2	1200 g ac/ha	Paterson & Toft 2007b

Risks to non-target species

Terrestrial vertebrates

In the supplementary environment assessment report published in 2019, acute exposure of birds represented the highest risk to terrestrial vertebrates, and any mitigation measures in this area were considered protective of chronic exposure and native mammals (acute and chronic). An upper application rate of 850 g ac/ha was supported for protection of birds following direct dietary exposure of potentially oversprayed food items.

In light of new assessment methodology practiced since the previous assessment was published, risks to terrestrial vertebrates have been reconsidered. The assessment determined that acute risks to birds are still significantly higher than long term risks to birds. Therefore, the previous approach of applying an acute risk index to determine the maximum allowable rate for avian exposure is still accepted. However, the risks to mammals from long-term exposure have been determined to be significantly higher than previously assessed.

After consideration of the submissions received in response to public consultation on the chlorpyrifos Proposed Regulatory Decision, the wild mammals assessment was updated as follows:

- The number of use patterns considered increased based on worker exposure outcomes (Table 18)
- Maximum acceptable application rates have been calculated for each application timing
- The primary exposure assessment was revised to consider a PT 1.0 (formerly PT 0.5), given the critical endpoint is based on neonatal effects that may result from short-term exposure at a critical life stage.

The summary of outcomes for the wild mammal assessments are set out in Table 23, with risk assessment conclusions presented for the full rate ranges and application timing ranges where applicable. The revised assessment concluded acceptable risks of one foliar application (applied in a strip or patch low in the tree, avoiding fruit) up to 45 g a/ha for the control of Queensland fruit fly in fruit trees. In addition, acceptable risks of one application up to 130 g ac/ha could be concluded for the control of mites, aphids or Lucerne flea in certain field crops, with restrictions on the application timing depending on the situation. Acceptable risks to wild mammals could not be concluded for any of the remaining use situations. The details of the wild mammal assessment are provided in Appendix D.

Application rates for potted ornamentals, termite protection and for crawling insect control are considerably higher; however, direct dietary exposure of contaminated food items is considered negligible following spot application or application in protected environments. Therefore, direct dietary exposure risks to terrestrial vertebrates are acceptable for these use patterns. For the granular products to be sprinkled lightly around ant nests and trails, the following restraints are required.

DO NOT use in areas easily accessible to birds and wild mammals. To protect birds and wild mammals, remove spillages.

One product (50416) is applied as granules for use in grapevine rootlings. The granular acute assessment for birds ingesting granules with or as grit follows EFSA (2009) and is reported in Table 24. The risk is unacceptable and while it is a screening level assessment, no further refinement can be undertaken with the available data. The incorporation by using a hand rake or like implement is not applicable for reducing exposure because the incorporation depth is only 2–4 cm and there is no information on incorporation efficiency. Up to 99% incorporation efficiency would be required for exposure to be reduced to acceptable levels. This is not considered likely. For example, even with drilling seeds, Northern Zone (2021) reports incorporation efficiencies of around 90% for standard and precision drilling of wheat and canola, respectively in headland areas and these would be expected to be more efficient than shallow incorporation using a hand rake.

For seed dressings and insect baits, the screening level assessments assume that birds feed entirely on readily available, freshly treated seeds or grain baits. An additional assessment assumes that small omnivorous birds consume newly emerged crop shoots from treated seeds. Acceptable risks could not be concluded at the lowest treatment rates of 400 mg ac/kg seed (Table 25) or 50 mg ac/kg bait (Table 26). There are no field studies available to address avian risks in these use situations. There are a number of factors that can be considered to refine the assessments; however, it is noted that these uses are not supported from a worker safety perspective. Therefore, the avian risk assessment for seed dressings and insect baits have not been refined any further.

The log Pow 4.9 for chlorpyrifos indicates a potential for bioaccumulation. As bioaccumulation processes are often slow, a chronic assessment is appropriate. The food chain assessment for fish-eating species for terrestrial crop situations assumes that the RAL for aquatic species is not exceeded on the basis that only use situations with acceptable risks to aquatic species will be approved. Provided water concentrations do not exceed the aquatic RAL, any accumulated residues in fish will not reach levels harmful to predators.

After consideration of the submissions received in response to public consultation on the chlorpyrifos Proposed Regulatory Decision, the food chain assessment for fish-eating species has been expanded to include registered uses of chlorpyrifos in rice. In these situations, accumulated residues in fish and benthic invertebrates may be of concern to species feeding in rice fields (such as water rats and bitterns). A water depth of 15 cm was assumed. In addition, a 21 day time-weighted average PEC_{water} was determined based on the water DT₅₀ 42 days (geomean of 2 water/sediment system DT₅₀ values derived for modelling). The resulting TWA factor is 0.85. A maximum seasonal rate of 9.0 g ac/ha was determined to be acceptable to fish-eating species in rice situations (Table 27). This maximum seasonal rate is considerably lower than the lowest registered rate of 30 g ac/ha; therefore, continued use of chlorpyrifos in rice is not supported.

The food chain assessment for earthworm-eating species is not specific to the actual cropping situation, rather it depends on the application rates, frequency and timing. There are a range of application practices considered for field uses of chlorpyrifos. In the draft Chlorpyrifos Review Technical Report, a maximum acceptable threshold of 76 g ac/ha for earthworm-eating mammalian species across a 10- hectare area was determined, assuming chronic exposure to the peak concentration of chlorpyrifos in the top 5 cm soil after the last application in the season. After consideration of the submissions received in response to public consultation on the chlorpyrifos Proposed Regulatory Decision, the food chain assessment for earthworm-eating species has been revised to consider smaller foraging areas and dissipation and leaching of chlorpyrifos in the soil as follows:

- Earthworm-eating species in Australia include bandicoots, antechinus, rat kangaroos, and echidnas. The home ranges for small species such as antechinus and rat kangaroos are very small, and therefore the assessment no longer considers exposure across a 10-hectare area
- Chlorpyrifos leached to soil depths ranging from 15 to 20 cm in the field soil dissipation studies (Fontaine et al. 1987; Old 2002a, 2002b, 2002c). Therefore, the PEC_{soil} was refined by assuming a 15-cm soil depth. This also corresponds to a more realistic zone for earthworms in the soil
- In order to consider the dissipation of chlorpyrifos in soil, a 21-day time-weighted average PEC_{soil} was determined based on the soil DT₅₀ 28 days (geomean of six field soil DT₅₀ values derived for modelling). The resulting TWA factor is 0.78

For terrestrial crops, the revised food chain (secondary exposure) assessment for earthworm-eating species determined a maximum acceptable seasonal soil exposure rate of 270 g ac/ha (Table 27). Therefore, there are no concerns identified at the application rates supported by the primary exposure assessment for terrestrial crops (up to 255 g ac/ha).

These findings are consistent with the assessment by the Persistent Organic Pollutants Review Committee (POPRC) for chlorpyrifos showing that chlorpyrifos has been found in biota at different trophic levels in remote regions, in apex predators and in human breast milk, which is a concern for offspring. It was

considered there was sufficient evidence that chlorpyrifos meets the Stockholm Convention criterion on bioaccumulation (Appendix F).

Table 23: Chlorpyrifos – Summary of risk assessment outcomes for wild mammals

Category	Situation	Rate (g ac/ha)	Assessment outcome
Fruit and vegetables	Apples, pears, stone fruits	30 to 1000	Acceptable risk at BBCH \geq 40 up to 45 g ac/ha. Not supported at BBCH <40 or ground/trunk directed
	Avocado (foliar spray)	30 to 1000	Acceptable risk up to 45 g ac/ha as foliar spray. Ground/trunk directed not supported
	Avocado (spot spray)	500	Not supported
	Bananas	500 to 1000	Not supported
	Citrus	30 to 2000	Acceptable risk up to 45 g ac/ha as foliar spray Ground/trunk directed not supported
	Custard apple	1000 to 10,000	Not supported
	Ginger	350 to 450	Not supported
	Grapevines, kiwifruit	65 to 500	Not supported
	Mango (spot or foliar spray)	1000	Not supported
	Loquats	30 to 60	Acceptable risk up to 45 g ac/ha as foliar spray Ground/trunk directed not supported
	Passionfruit	60	Not supported
	Pome fruits	30 to 250	Acceptable risk at BBCH \geq 40 up to 45 g ac/ha Not supported at BBCH <40 or ground/trunk directed
	Tomatoes	250 to 2500	Not supported
	Vegetables (band spray)	350 to 1000	Not supported
	Vegetables (broadcast spray)	70 to 3000	Acceptable risk at BBCH <40 at 70 g ac/ha Not supported at higher rate or BBCH \geq 40

Category	Situation	Rate (g ac/ha)	Assessment outcome
Field crops and pasture	Barley, wheat	70 to 400	Acceptable risk at BBCH 30-39 up to 255 g ac/ha Not supported at BBCH <30 or ≥40
	Broad beans, chickpeas	70 to 150	Acceptable risk at BBCH 10-39 at 70 g ac/ha Not supported at higher rate or BBCH ≥40
	Canola (rapeseed)	35 to 750	Acceptable risk at: BBCH <40 up to 70 g ac/ha BBCH ≥40 up to 55 g ac/ha
	Cereals	70 to 750	Acceptable risk at BBCH 30-39 up to 255 g ac/ha Not supported at BBCH <30 or ≥40
	Clover, subterranean clover, clover	100 to 400	Acceptable risk at BBCH 10-19 up to 130 g ac/ha Not supported at BBCH ≥20
	Clover seed crops	70 to 150	Acceptable risk at: BBCH 10-19 up to 130 g ac/ha BBCH 20-39 at 70 g ac/ha Not supported at BBCH ≥40
	Cotton	70 to 750	Acceptable risk at BBCH 10-39 up to 130 g ac/ha Not supported at higher rate or BBCH ≥40
	Improved annual pastures, established perennial pastures	70 to 150	Not supported
	Field peas, lupins	70 to 200	Acceptable risk at BBCH 10-39 at 70 g ac/ha Not supported at higher rate or BBCH ≥40
	Forage crops	35 to 750	Acceptable risk at: BBCH 10-19 up to 130 g ac/ha BBCH 20-39 up to 70 g ac/ha Not supported at BBCH ≥40
	Lucerne	70 to 450	Acceptable risk at: BBCH 10-19 up to 130 g ac/ha BBCH 20-39 at 70 g ac/ha Not supported at BBCH ≥40
	Lucerne seed crops	100 to 350	Acceptable risk at BBCH 10-19 up to 130 g ac/ha Not supported at BBCH ≥20

Category	Situation	Rate (g ac/ha)	Assessment outcome
	Pastures	35 to 750	Not supported
	Medics	100 to 175	Acceptable risk at BBCH 10-20 up to 130 g ac/ha Not supported at BBCH \geq 20
	Oats, rye, triticale	70 to 150	Acceptable risk at BBCH 30-39 Not supported at BBCH $<$ 30 or \geq 40
	Oilseeds (excluding canola & cotton)	70 to 450	Acceptable risk at BBCH $<$ 40 at 70 g ac/ha Not supported at BBCH \geq 40
	Rice	30 to 750	Not supported
	Sorghum (excluding sugar drip or alpha sorghum)	175 to 750	Acceptable risk at BBCH 30-39 up to 255 g ac/ha Not supported at BBCH $<$ 30 or \geq 40
	Sugarcane	175 to 1000	Not supported
Miscellaneous uses	Crawling insect control	5000	Acceptable risk - negligible exposure
	Duboisia	450	Not supported
	Macrocarpa hedges	250	Not supported
	Potted ornamentals	5000	Acceptable risk - negligible exposure
	Termite protection	100000	Acceptable risk - negligible exposure
	Turf (commercial)	250 to 3000	Not supported

Maximum seasonal supported rate considers both dietary exposure scenario (see Appendix C) and food chain assessment scenario (seasonal catchment exposure rates from Table B1 in Appendix D were compared to maximum acceptable of 76 g ac/ha).

Table 24: Screening level assessment of acute risks to birds ingesting granules with/as grit (grapevine rootlings)

Parameter		Small bird	Large bird
Application rate	(kg granules/ha)	80	80

Parameter		Small bird	Large bird
Active constituent content	(mg ac/kg granules)	100,000	100,000
Granular density	(granules/kg)	1,500,000	1,500,000
Gloading	(mg ac/granule)	0.067	0.067
Gsurface	(granules/m ²)	12,000	12,000
SPsurface	(no. soil particles/m ²)	15,200	71
DgritI	(grit/kg bw/d)	651	2,453
DgritD	(mg ac/kg bw/d)	19	163
RAL	(mg ac/kg bw/d)	3.2	3.2
RQ	(unitless)	6.0	51

Assessment method according to EFSA (2009)

Application rate based on 20 g/vine for product no. 50416 and assumes 4000 vines/ha

Gloading = active constituent content (mg acs/kg granules)/granular density (granules/kg)

Gsurface = number of granules on soil surface per m² = application rate (kg granules/ha) * granular density (granules/kg) /10000

SPsurface = number of soil particles from EFSA (2009)

DgritI = daily grit intake from EFSA (2009)

RAL = regulatory acceptable level (from Table 22)

DgritD = daily grit dose (mg ac/kg bw/d) = DgritI * (Gsurface/(SPsurface + Gsurface)) * Gloading

RQ = risk quotient = DgritD/RAL, where acceptable RQ ≤ 1

Table 25: Screening level assessment of acute risks of seed treatments to birds at lowest treatment rate of 400 mg ac/kg seed

Food item	Indicator species	Shortcut value	NAR (mg ac/kg seed)	DDD (mg ac/kg bw)	RAL (mg ac/kg bw)	RQ
Treated seed	Small granivorous bird	0.30	400	120	3.2	38
Newly emerged shoots	Small omnivorous bird	0.50	400	40	3.2	13

Shortcut values (FIR/bw) from EFSA (2009) for avian exposure to small seeds and newly emerged shoots

NAR = nominal application rate (lowest registered rate)

Consumption of treated seed DDD = daily dietary dose (mg/kg bw/d) = shortcut value * NAR (mg/kg)

Consumption of newly emerged shoots DDD = daily dietary dose (mg/kg bw/d) = shortcut value * NAR (mg/kg)/5

RAL = regulatory acceptable level (Table 22)

RQ = risk quotient = DDD/RAD, where acceptable RQ ≤1

Table 26: Assessment of acute risks of insect baits to birds at lowest treatment rate of 50 mg ac/kg bait

Focal group	Indicator species	BW (g)	DEE (kJ/d)	FIR (g/d)	DDD (mg ac/kg bw)	RAL (mg ac/kg bw)	RQ
Omnivorous birds	Lark (P)	23	90	8.1	18	3.2	5.5
	Pipit	26	97	8.8	17	3.2	5.3
	Magpie (P)	300	509	46	7.7	3.2	2.4
	Raven (P)	530	747	68	6.4	3.2	2.0
	Gull	288	305	27	4.7	3.2	1.5
	Duck	823	616	54	3.3	3.2	1.0
	Bustard	4500	1919	167	1.9	3.2	0.58
Granivorous birds	Finch (P)	12	58	5.2	22	3.2	6.8
	Dove	33	72	6.2	9.3	3.2	2.9
	Quail	105	155	15	7.2	3.2	2.3
	Parrot	90	140	12	6.8	3.2	2.1
	Pigeon	207	245	21	5.1	3.2	1.6

BW = body weight

DEE = daily energy expenditure (calculated using DEE equation for passerine (P) or non-passerine birds, EFSA 2009 p269)

FIR = $DEE / (FE * (1 - MC/100) * (AE/100))$, where:

FE = food energy of 18 kJ/g dw for cereals on average (Table 3 in Appendix G in EFSA 2009)

MC = moisture content of 15% for cereals on average (Table 3 in Appendix G in EFSA 2009)

AE = assimilation efficiency (Table 2 in Appendix L of EFSA 2009), which is:

72% for passerines on artificial diet (lark, pipit, magpie, raven, finch)

74% for Charadriiformes and Anseriformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (gull, duck)

67% for Galliformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (quail)

76% for Columbiformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (dove, pigeon)

75% default for remaining species (bustard, parrot)

DDD = daily dietary exposure = $FIR / BW * PEC$, where:

PEC = predicted environmental concentration = concentration of the active constituent in the bait = 50 mg ac/kg food

RAL = regulatory acceptable level (Table 22)

RQ = risk quotient = DDD/RAL, where acceptable RQ ≤ 1

Table 27: Food chain assessment in terrestrial vertebrates (maximum acceptable threshold)

Exposure	Indicator species	Group	Shortcut value	Max acceptable (g/ha)	PEC _{media} (mg/kg or mg/L)	PEC _{food} (mg/kg)	DDD (mg/kg/d)	RAL (mg/kg/d)	RQ
Chronic	Earthworm-eating species	Mammals	1.28	290	0.094	0.81	1.0	1.0	1.0
		Birds	1.05	965	0.33	2.9	3.0	2.9	1.0
	Fish-eating species (rice situations)	Mammals	0.142	9.0	0.0051	7.0	1.0	1.0	1.0
		Birds	0.159	24	0.014	19	3.0	2.9	1.0

Shortcut values from EFSA (2009)

PEC_{media} = predicted environmental concentration in:

soil (mg/kg) = (maximum acceptable seasonal rate to achieve RQ 1.0) / (15 cm soil depth) / 150 * (TWAfactor 0.78)

water (mg/L) = (maximum acceptable seasonal rate to achieve RQ 1.0) / (15 cm water depth) / 100 * (TWAfactor 0.85)

PEC_{food} = predicted environmental concentration in:

earthworm (mg/kg) = PEC_{soil} * BCF_{earthworm}, where BCF_{earthworm} is 8.8 based on $[0.84 + 0.012 * 10^{(\log Kow \text{ of } 4.9)}] / Kf \text{ } 108 \text{ (for } 2\% \text{ OC)}$

fish (mg/kg) = PEC_{water} * BCF_{fish} 1374 (Murphy & Luteske 1986)

DDD = daily dietary dose (mg/kg bw/d) = shortcut value * PEC_{food}

RAL = regulatory acceptable level (from Table 22)

RQ = risk quotient = PEC / RAL, where acceptable RQ ≤ 1

Aquatic species

After consideration of the submissions received in response to public consultation on the chlorpyrifos Proposed Regulatory Decision, this aquatic species assessment was revised as follows:

- The number of use patterns considered increased based on worker exposure outcomes (Table 18)
- The foliar interception parameters for avocado, citrus and loquats were corrected
- The fraction field treated (FFT) parameters for container plants and potted ornamentals were corrected
- The fraction catchment treated (FCT) parameters for fruit, vegetables, field crops, container plants and potted ornamentals were corrected

For treatment of polluted water impoundment, the application rate is predicted to result in water concentrations that exceed the aquatic endpoint. The application rate of 2 mL/10000 L, or 20 mL/100 m³ water results in a water concentration of 100 µg ac/L, which is 3 orders of magnitude higher than the aquatic endpoint (risk quotient = 1,000). However, the actual aquatic risk is dependent on the purpose of the water impoundment (including dams or those found in urban areas such as ditches, sewage ponds and drains).

Therefore, it is recommended that existing environmental protection statements on labels be expanded to include directions to limit use for control of mosquito larvae to temporary pools, as opposed to permanent water bodies, which are more likely to contain sensitive aquatic species. The following restraint is therefore required for any products used to control mosquito larvae in polluted water impoundments.

DO NOT use on permanent water bodies for control of mosquito larvae.

Runoff risks to aquatic species for most uses reconsidered are acceptable, with the exception of external perimeter treatment for termite protection (Table 28). For uses where runoff assessment parameters were corrected after consideration of public consultation responses, runoff risks to aquatic species have been reconsidered only for the scenarios supported by the terrestrial vertebrate assessments. The corrections to the foliar interception (avocado, citrus, loquats), FFT (container plants, potted ornamentals), or FCT (fruit, vegetables, field crops, container plants, potted ornamentals) parameters resulted in no changes to the conclusion of acceptable runoff risks. The details of the runoff assessments are provided in Appendix E.

The following runoff restraint is required for relevant supported chlorpyrifos uses.

DO NOT apply if heavy rains or storms are forecast within 3 days.

DO NOT irrigate to the point of field runoff for at least 3 days after application.

A further scenario for termite control is treatment of termite nests or colonies. If such treatment is protected from runoff losses, this use is supportable. However, outdoor treatments including in trees are not supported due to a general lack of information required to support exposure calculations.

Table 28: Chlorpyrifos – Summary of runoff risk assessment outcomes for agricultural uses

Category	Situation	Rate (g ac/ha)	Number	Interval (d)	Conclusion
Fruit and vegetables	Apples, pears, pome fruits, stone fruits	45	1	–	Acceptable risk
	Avocado, citrus, loquats	45	1	–	Acceptable risk
	Brussels sprouts, chard (silver beet), cole (brassica) crops (including broccoli, cabbage, cauliflower), leafy crucifers (including chou moulrier, kale, mustard, rape), lettuce, swede, turnips	70	1	–	Acceptable risk
Field crops & pasture	Barley, cereals, oats, rye, sorghum, triticale, wheat	255	1	–	Acceptable risk
	Broad beans, chickpeas, field peas, lupins	70	1	–	Acceptable risk
	Canola (rapeseed), oilseeds (excluding canola and cotton)	70	1	–	Acceptable risk

Category	Situation	Rate (g ac/ha)	Number	Interval (d)	Conclusion
	Clover, clover seed crops, cotton, forage crops, lucerne, lucerne seed crops, medics, subterranean clover	130	1	–	Acceptable risk
Miscellaneous uses	Container plants (Argentine ants), Tasmanian blue gum planting hole soil	5,000	1	–	Acceptable risk
	Potted ornamentals (beetle larvae)	4,000	1	–	Acceptable risk
	External perimeter treatment for control of crawling insects around large buildings	5,000	1	–	Acceptable risk
	Control of adult mosquitos in vegetation	54	4	7	Acceptable risk
	Commercial turf (farms)	500	2	7	Acceptable risk
	External perimeter treatment (horizontal or vertical) around large buildings for termite protection	1,000,000 or 500,000	1	–	Not supported
	New and existing poles for termite protection	1,000,000	1	–	Acceptable risk

Bees

Exposure of bees is expected to be negligible for soil drenches, granular products, termite protection and crawling insect control. Therefore, risks to bees are acceptable for these use patterns and pollinator restraints are not required.

Risks to bees foraging in other treated areas are assessed using a tiered approach. The number of use patterns to be considered in this environmental risk assessment increased after consideration of the submissions received in response to public consultation on the chlorpyrifos reconsideration Proposed Regulatory Decision (Table 18), impacting the rates for chlorpyrifos uses in other treated areas to be reconsidered. Risks to bees have not been reassessed; rather, the maximum rate at which pollinator restraints are not required was determined (Table 29).

A screening level risk assessment assumes the worst-case scenario of a direct overspray of blooming plants that are frequented by bees in order to identify those substances and associated uses that do not pose a risk. Exposure of pollinators foraging from oversprayed blooming plants was determined to be acceptable at rates up to 0.7 g ac/ha. Given the lowest application rate is 30 g ac/ha, pollinator restraints are required for all spray applications of chlorpyrifos where exposure of pollinators is possible. No higher tier information is available to inform an acceptable aging period for foliar residues. The following protection statement is advised for spray applications of chlorpyrifos and is to be included on relevant product labels.

Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.

Table 29: Chlorpyrifos - Maximum rate not requiring a pollinator restraint (0.7 g ac/ha)

Life stage	Exposure	Rate (g/ha)	Predicted total dose (µg/bee)	RAL (µg/bee)	RQ
Adults	Acute contact	0.7	0.0017	0.030	0.06
	Acute oral	0.7	0.020	0.084	0.24
Larvae	Acute oral	0.7	0.0085	0.0084	1.0

Predicted total dose calculated using USEPA BeeREX tool for adult worker bee foraging for nectar and larval drone within the hive

RAL = regulatory acceptable level (from Table 22)

RQ = risk quotient = PEC / RAL, where acceptable RQ ≤ 1

Other non-target arthropods

Based on available data, chlorpyrifos products are not considered to be compatible with integrated pest management programs utilising beneficial arthropods. Therefore, the following protection statement is advised for use of chlorpyrifos in crops and is to be included on relevant product labels.

Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.

Soil organisms

Risks to soil organisms are assessed using a tiered approach. A screening level risk assessment assumes the worst-case scenario of a direct overspray of soil without interception in order to identify those substances and associated uses that do not pose a risk to soil organisms. Acceptable risks of chlorpyrifos to soil organisms could be concluded at the screening level up to 5000 g ac/ha (surface spray in potted ornamentals). Use in grapevine rootlings is not supported. No protection statements are required for soil organisms on chlorpyrifos product labels with the supported uses.

Table 30: Screening level assessment of risks to soil organisms

Group	Exposure	Rate (g/ha)	PEC (mg/kg dry soil)	RAL (mg/kg dry soil)	RQ
Grapevine rootlings					
Macro-organisms	Acute	8000	11	7.6	1.4

Group	Exposure	Rate (g/ha)	PEC (mg/kg dry soil)	RAL (mg/kg dry soil)	RQ
	Chronic	8000	11	6.4	1.7
Micro-organisms	Chronic	8000	11	6.4	1.7
Potted ornamentals (surface spray)					
Macro-organisms	Acute	5000	6.7	7.6	0.88
	Chronic	5000	6.7	6.4	1.0
Micro-organisms	Chronic	5000	6.7	6.4	1.0

PEC = predicted environmental concentration in top 5-cm soil (mg ac/kg dry soil) = rate (g ac/ha)/750

RAL = regulatory acceptable level (from Table 22)

RQ = risk quotient = PEC/RAL, where acceptable RQ ≤ 1

Terrestrial plants

Chlorpyrifos is not toxic to non-target terrestrial plants and buffer zones are not required for the protection of vegetation areas.

Environment recommendations

Uses supported from the viewpoint of environmental safety are listed in Table 31 with the required protection statements and restraints. Uses that are not supported from the viewpoint of environmental safety are listed in Table 32.

Table 31 Supported uses from the viewpoint of environmental safety

Crop/host	Pest	Rate	Protection statements and restraints
Fruit and vegetables			
Apples, pears, avocado, citrus, loquats, pome fruits, stone fruits	Queensland fruit fly	One foliar spray at 30 - 45 g ac/ha	<p>DO NOT direct spray to trunk.</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p>

Crop/host	Pest	Rate	Protection statements and restraints
			<p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Cole (brassica) crops (including broccoli, brussels sprouts, cabbage, cauliflower)	Redlegged earth mite, blue oat mite	70 g ac/ha	<p>DO NOT apply once growth of harvestable vegetative parts begins (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p>
Chard (silver beat), leafy crucifers (including chou moullier, kale, mustard, rape), lettuce, swede, turnips	Redlegged earth mite, blue oat mite	70 g ac/ha	<p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Field crops and pasture			
Barley, wheat	Redlegged earth mite, blue oat mite	70 - 200 g ac/ha	<p>DO NOT apply before end of tillering (BBCH <30) or once booting begins (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p>
	Pasture looper, lucerne flea	100 - 200 g ac/ha	

Crop/host	Pest	Rate	Protection statements and restraints
	Pasture webworm	200 g ac/ha	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.
Cereals	Pasture webworm	150 g ac/ha (post-emergence)	DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.
	Australian plague locust	175 - 255 g ac/ha	Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.
	Wingless grasshopper	250 g ac/ha	Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.
	Migratory locust	175 g ac/ha	
	Redlegged earth mite, blue oat mite	35 - 70 g ac/ha	Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.
	Lucerne flea	35 g ac/ha	
Oats, rye, triticale	Redlegged earth mite, blue oat mite	70 - 150 g ac/ha	
Sorghum (excluding sugar drip or alpha sorghum)	Corn aphid, sorghum midge	250 g ac/ha	
	Australian plague locust, migratory locust	175 g ac/ha	
Broad beans, canola (rapeseed), chickpeas, field peas, lupins, oilseeds (excluding canola and cotton)	Redlegged earth mite, blue oat mite	70 g ac/ha	<p>DO NOT apply after stem elongation (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p>

Crop/host	Pest	Rate	Protection statements and restraints
Canola (rapeseed)	Lucerne flea	35 - 70 g ac/ha	<p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p> <p>DO NOT exceed (55 g ac/ha) after stem elongation (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Clover, subterranean clover	Redlegged earth mite, pasture looper, lucerne flea	100 - 130 g ac/ha	<p>DO NOT apply once side shoots start to appear (BBCH \geq20).</p> <p>DO NOT apply more than once per year.</p>
Lucerne, medics, forage crops	Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 - 130 g ac/ha	<p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p>
Lucerne seed crops	Bluegreen aphid, spotted alfalfa aphid, pea aphid, lucerne flea	100 - 130 g ac/ha	<p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or</p>

Crop/host	Pest	Rate	Protection statements and restraints
Cotton	Redlegged earth mite, blue oat mite	70 - 130 g ac/ha	<p>weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Cotton	Redlegged earth mite, blue oat mite	70 - 130 g ac/ha	<p>DO NOT apply after canopy closure (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Forage crops	Redlegged earth mite, blue oat mite, pea aphid	35 - 70 g ac/ha	<p>DO NOT apply after stem elongation or rosette growth senescence (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p>
Forage crops	Lucerne flea	35 g ac/ha	<p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are</p>

Crop/host	Pest	Rate	Protection statements and restraints
			<p>actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Lucerne, clover seed crops	Redlegged earth mite, blue oat mite	70 to 130 g ac/ha	<p>DO NOT exceed (70 g ac/ha) once side shoots start to appear (BBCH \geq20).</p> <p>DO NOT apply after stem elongation or rosette growth senescence (BBCH \geq40).</p> <p>DO NOT apply more than once per year.</p> <p>Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p>
Miscellaneous uses			
Agricultural, commercial, and industrial areas (not publicly accessible)	Ants (including Argentine ants), fleas, cockroaches, spiders, silverfish	4.5 to 5.0 g ac/L water	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.
Commercial and industrial areas (not publicly accessible)	Argentine ants	10 g ac/100 m ²	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.

Crop/host	Pest	Rate	Protection statements and restraints
Outdoor areas (not publicly accessible)	Ants (including Argentine ants)	1 g ac/10 m ²	Toxic to birds and wild mammals. DO NOT use in areas easily accessible to birds and wild mammals. To protect birds and wild mammals, remove spillages. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effect on bees
Chemical soil barrier under buildings (not publicly accessible)	Termites	50 - 100 g ac/m ² (horizontal barrier) 1000 - 2000 g ac/m ³ (vertical barrier)	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. To avoid runoff, the moisture membrane must be installed immediately after treatment.
Chemical soil barrier around poles	Termites	10 g ac/L water	
Treatment of termite nest or colony (in wall cavities)	Termites	5 g ac/L water	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.
Hides/skins	Hide beetles	1 g ac/L water (min. 15 ga c/skin)	
Container plants in soil or other growing media (commercial)	Argentine ants	5 g ac/L water	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT plant out if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after planting out. Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.
Potted ornamentals (commercial)	Scarab beetle larvae	0.1 - 0.2 g ac/L water	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT plant out if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after planting out.
Polluted water impoundments (temporary water pools)	Mosquito larvae	1 g ac/10,000 L water or 10 g ac/100 m ³	DO NOT use on permanent water bodies for control of mosquito larvae.

Crop/host	Pest	Rate	Protection statements and restraints
Turf (commercial)	Funnel ant	2.5 g ac/5L water or	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. Highly toxic to bees. However, the use of this product as directed is not expected to have an adverse effect on bees.

Table 32: Uses not supported from the viewpoint of environmental safety

Crop/host	Pest	Rate	Assessment outcome
Fruit and vegetables			
Apples, pears	Woolly aphid, mealybug, apple dimpling bug, San José scale	50 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Light brown apple moth, wingless grasshopper	25 g ac/100 L water	
	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	
Avocado	Fiorina scale, latania scale	50 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle	25 or 50 g ac/100 L water (spot spray)	
	Avocado leafroller, ivy leafroller	25 or 50 g ac/100 L water	
	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	
Bananas	Banana scab moth, banana flower thrips, caterpillars, lepidopterous caterpillars	500 to 1000 g ac/ha	Unacceptable risk to terrestrial vertebrates
Beetroot	Earwigs, cutworms	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets	250 g ac/10 kg seed	
Capsicum, eggplant, sweet potato, stalk and stem vegetables (including asparagus, celery and rhubarb)	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	

Crop/host	Pest	Rate	Assessment outcome
Carrots	Light brown apple moth	250 to 350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Cutworm	350 g ac/ha	
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets	250 g ac/10 kg seed	
Cabbage, cauliflower	African black beetle	1000 g ac/ha	Unacceptable risk to terrestrial vertebrates
Cassava	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
Chard (silver beet), lettuce	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Redlegged earth mite, blue oat mite	70 g ac/ha at BBCH \geq 40 150 g ac/ha at any time	
Citrus fruits	California red scale (citrus red scale)	25 to 50 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Citrus rust thrips, citrus leaf eating weevil, citrus mealy bug, fruit eating weevil, fullers rose weevil, purple scale, white louse scale	50 g ac/100 L water	
	Ants	100 g ac/100 L water	
	Wingless grasshopper	25 g ac/100 L water	
	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	
Cole (brassica) crops (including broccoli, brussels sprouts, cabbage, cauliflower)	Cabbage moth, cabbage white butterfly, cabbage aphid, cluster caterpillar, cabbage cluster caterpillar, butterflies, Helicoverpa spp. (including corn earworm, native budworm)	750 to 1000 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Cutworm	350 g ac/ha	
	Vegetable weevil	400 to 500 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	African black beetle	350 to 450 g ac/ha	
	Redlegged earth mite, blue oat mite	70 g ac/ha at BBCH \geq 40 150 g ac/ha at any time	

Crop/host	Pest	Rate	Assessment outcome
Cucumbers, cucurbit vegetables or cucurbits (excluding cucumbers)	Ants, mealybugs	500 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Cutworm	350 g ac/ha	
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper, white flies	250 g ac/ha	
Custard apple	Ants	100 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
Ginger	African black beetle, cutworm	350 to 450 g ac/ha	Unacceptable risk to terrestrial vertebrates
Grapes (grapevines)	Light brown apple moth, grapevine moth	25 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Grapevine scale	25 or 50 g ac/100 L water	
	Mealybug, tuber mealybug	50 g ac/100 L water	
Green beans, peas	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper, white flies	250 g ac/ha	
Kiwifruit	Common and southern armyworms, light brown apple moth, scale insects	25 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
Leafy crucifers (including chou moullier, kale, mustard, rape)	Vegetable weevil	400 to 500 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Redlegged earth mite, blue oat mite	70 g ac/ha at BBCH \geq 40; 150 g ac/ha at any time	
Loquats	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	Unacceptable risk to terrestrial vertebrates
Onions, radish, shallots	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets	250 g ac/10 kg seed	
Mango	Green tree ant	100 g ac/100 L water (spot spray)	Unacceptable risk to terrestrial vertebrates
	Common mango scale	50 g ac/100 L water	

Crop/host	Pest	Rate	Assessment outcome
Parsnip	Vegetable weevil	400 g ac/ha	Unacceptable risk to terrestrial vertebrates
Passionfruit	Queensland fruit fly	60 g ac/ha	Unacceptable risk to terrestrial vertebrates
Pineapple	White grubs	2500 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Pineapple scale	1500 g ac/ha	
	Pineapple mealybug, ants	750 or 1500 g ac/ha	
Pome fruits	Winged grasshopper	25 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	
Potatoes	Wireworm	3000 g ac/ha	Unacceptable risk to terrestrial vertebrates
	African black beetle, white fringed weevil	450 to 3000 g ac/ha	
	Cutworm	350 g ac/ha	
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
Swede	Vegetable weevil	350 to 500 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Redlegged earth mite, blue oat mite	70 g ac/ha at BBCH \geq 40; 150 g ac/ha at any time	
Stone fruits	European earwig, San José scale	50 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
	Light brown apple moth	25 g ac/100 L water	
	European earwig	100 g ac/ha (with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)	
	Queensland fruit fly	Trunk directed at 30-60 g ac/ha; foliar spray at 45-60 g ac/ha	
Strawberry	Field cricket, mole cricket	50 g ac/ha (in 10 kg brain bait)	Unacceptable risk to terrestrial vertebrates
Tomatoes	False wireworm, wireworm	2500 g ac/ha	Unacceptable risk to terrestrial vertebrates
	White flies	1500 g ac/ha	
	African black beetle	1000 g ac/ha	
	Silverleaf whitefly, green vegetable bug, Helicoverpa	750 to 1500 g ac/ha	

Crop/host	Pest	Rate	Assessment outcome
	spp. (including tomato grub, native budworm)		
	Green peach aphid	500 g ac/ha	
	Cutworm	350 g ac/ha	
	Vegetable weevil	400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
Turnip	Cutworm	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Vegetable weevil	350 to 500 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Redlegged earth mite, blue oat mite	70 g ac/ha at BBCH \geq 40; 150 g ac/ha at any time	
	Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets	250 g ac/10 kg seed	
Vegetables (various)	Field cricket, mole cricket	50 g ac/ha (in 10 kg brain bait)	Unacceptable risk to terrestrial vertebrates
Field crops and pasture			
Barley, wheat	Bryobia mite	400 g ac/ha	Unacceptable risk to terrestrial vertebrates
Broad beans, chickpeas	Redlegged earth mite, blue oat mite	150 g ac/ha	Unacceptable risk to terrestrial vertebrates
Canola (rapeseed)	False wireworm, wireworms	500 to 750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Balaustium mite, Bryobia mite	400 g ac/ha	
	Cutworm	350 to 450 g ac/ha	
	Vegetable weevil	200 to 400 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Redlegged earth mite, blue oat mite	150 to 200 g ac/ha	
	Pasture webworm	200 g ac/ha	
	Pasture looper, lucerne flea	100 to 200 g ac/ha	
	False wireworms	125 g ac/310 kg seed	
Cereals	Spur throated locust	625 to 750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Blackheaded pasture cockchafer	450 g ac/ha	
	Southern armyworm, common armyworm, cutworm	350 to 450 g ac/ha	

Crop/host	Pest	Rate	Assessment outcome
	Pasture webworm	150 g ac/ha (pre-plant) or 350 g ac/ha	
	Australian plague locust	>255 to 280 g ac/ha	
	Black soil scarab, wheat root scarab	250 g ac/125 kg seed or 250 g ac/10 kg seed	
	Spine-tailed weevil	125 g ac/210 kg seed	
	False wireworms, wireworms	125 g ac/310 kg seed	
	Cereal curculio	125 g ac/210 kg seed or 60 g ac/100 kg seed	
	Spotted vegetable weevil	125 g ac/210 kg seed	
	Seed harvesting ants	40 g ac/100 kg seed	
Clover, subterraneous clover	Bryobia mite	400 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Blue oat mite, pasture webworm	200 g ac/ha	
	Redlegged earth mite, pasture looper, lucerne flea	>130 to 200 g ac/ha	
Clover seed crops	Redlegged earth mite, blue oat mite	>130 to 150 g ac/ha	Unacceptable risk to terrestrial vertebrates
Coffee beans (non-bearing)	Mealybugs	1000 g ac/ha (butt and soil treatment applied at 100 g ac/100 L water using 1000 L water/ha)	Unacceptable risk to terrestrial vertebrates
Cotton	Spur throated locusts	625 to 750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Cotton flea beetle, red shouldered leaf beetle	450 to 750 g ac/ha	
	Mites	300 to 750 g ac/ha	
	Pink spotted bollworm moth	500 g ac/ha	
	Cutworm, southern armyworm, common armyworm	350 to 450 g ca/ha	
	Wingless grasshopper	250 g ac/ha	
	Cotton aphid	150 to 200 g ac/ha	
	Migratory locusts	175 g ac/ha	
	Springtails	150 g ac/ha	
	Redlegged earth mite, blue oat mite	>130 to 150 g ac/ha	
	False wireworms	125 g ac/310 kg seed	

Crop/host	Pest	Rate	Assessment outcome
Cotton, lucerne, maize, sorghum, sunflower	False wireworms, brown field cricket, cockroaches	50 g ac/ha (with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)	Unacceptable risk to terrestrial vertebrates
	Earwigs	100 g ac/ha (with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)	
Field peas, lupins	Redlegged earth mite, blue oat mite	>70 to 200 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Brown pasture looper, lucerne flea	100 to 200 g ac/ha	
	Pasture webworm	200 g ac/ha	
Forage crops	Corbie, winter corbie	450 to 750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Spur throated locust	625 to 750 g ac/ha	
	Blackheaded pasture cockchafer, cutworms, underground grass grub	450 g ac/ha	
	Armyworm	350 to 450 g ac/ha	
	Cutworms, lawn armyworm, sod webworm, brown pasture looper	350 g ac/ha	
	Pasture webworm	150 to 350 g ac/ha	
	Australian plague locust	175 to 280 g ac/ha	
	Wingless grasshopper	250 g ac/ha	
	Migratory locust, sitonia weevil	175 g ac/ha	
Improved annual pastures, established perennial pastures, lucerne pastures	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha	Unacceptable risk to terrestrial vertebrates
Lucerne	Cutworms	350 to 450 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Bryobia mite	400 g ac/ha	
	Webspinner, caterpillar	350 g ac/ha	
	Lucerne leafroller	150 to 200 g ac/ha	
	Pasture webworm	200 g ac/ha	
	Redlegged earth mite, blue oat mite, pasture looper, lucerne flea	>130 to 200 g ac/ha	
	Stone weevil	175 g ac/ha	

Crop/host	Pest	Rate	Assessment outcome
	Bluegreen aphid, spotted alfalfa aphid, pea aphid	>130 to 150 g ac/ha	
Lucerne seed crops	Webspinner caterpillar	350 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Lucerne leafroller	150 to 200 g ac/ha	
	Sitona weevil	175 g ac/ha	
	Bluegreen aphid, spotted alfalfa aphid, pea aphid, lucerne flea	>130 to 150 g ac/ha	
Maize	African black beetle	10 g ac/100 m row	Unacceptable risk to terrestrial vertebrates
Medics	Bluegreen aphid, spotted alfalfa, pea aphid	>130 to 150 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Stone weevil	175 g ac/ha	
Oilseeds (excluding canola and cotton)	Cutworms	350 to 450 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Wingless grasshopper	250 g ac/ha	
	Redlegged earth mite, blue oat mite	>70 to 150 g ac/ha	
	False wireworms	125 g ac/310 kg seed	
Pulses (cowpea, chickpea, mung bean, pigeon pea, navy bean, and soybean)	False wireworms, wireworms, brown field cricket, cockroaches	50 g ac/ha (with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)	Unacceptable risk to terrestrial vertebrates
Rice	Brown plant hopper	750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Bloodworm	30 or 75 g ac/ha	
Sorghum (excluding sugar drip or alpha sorghum)	Spur throated locust	625 to 750 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Armyworms, cutworm	350 to 450 g ac/ha	
Sugarcane	Symphylids	1000 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Sugarcane wireworm, African black beetle, beetle	750 g ac/ha	
	Spur throated locust	625 to 750 g ac/ha	
	Southern armyworm, common armyworm	350 to 450 g ac/ha	
	Australian plague locust	175 g ac/ha	

Crop/host	Pest	Rate	Assessment outcome
Miscellaneous uses			
Chemical soil barrier around buildings (not publicly accessible)	Termites	50 g ac/m ² or 100 g ac/m ² (horizontal barrier)	Unacceptable risk to aquatic species
		1000 g ac/m ³ or 2000 g ac/m ³ (vertical barrier)	
Chemical soil barrier around buildings (reticulated or AS Series 3660 systems)	Termites	50 g ac/m ² (horizontal barrier)	Unacceptable risk to aquatic species
Treatment of termite nest or colony (outdoor)	Termites	5 g ac/L water	Unacceptable risk to aquatic species
Duboisia	Cutworms	450 g ac/ha	Unacceptable risk to terrestrial vertebrates
Grapevine rootlings	African black beetle	8000 g ac/ha (2 g ac/vine at 4000 vines/ha)	Unacceptable risk to terrestrial vertebrates and soil organisms
Macrocarpa hedges	Dimpling bug	25 g ac/100 L water	Unacceptable risk to terrestrial vertebrates
Turf (commercial)	African black beetle	3000 g ac/ha	Unacceptable risk to terrestrial vertebrates
	Argentine stem weevil	2000 g ac/ha	
	Funnel ant, crickets	1000 g ac/ha	
	Blackheaded pasture cockchafer, underground grass grub, winter corbie	450 g ac/ha	
	Brown pasture looper, pasture webworm, lawn armyworm, sod webworm	350 g ac/ha	
	Crickets	10 g ac/20 L water 12.5 g ac/ha (applied in 2.5 kg bran bait) 50 g ac/ha (with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)	
Polluted water impoundments (permanent water pools)	Mosquito larvae	1 g ac/10,000 L water or 10 g ac/100 m ³	Unacceptable risk to non-target aquatic species

Crop/host	Pest	Rate	Assessment outcome
Vegetation (light to medium, not publicly accessible)	Mosquito adults	29 to 32 g ac/ha	Unacceptable risk to terrestrial vertebrates
Vegetation (medium to heavy, not publicly accessible)	Mosquito adults	52 to 54 g ac/ha	Unacceptable risk to terrestrial vertebrates

Residues and trade

Previous assessments

In 2000, an [interim agricultural assessment for chlorpyrifos](#) was published by the APVMA, which included a residues and trade assessment (APVMA 2000a). The 2000 interim review report found that additional residues data were required to affirm proposed MRL recommendations for Australian food and animal feed commodities. As a result, several risk management measures were implemented including amendments to label information, withholding periods (WHPs) and MRLs including the establishment of temporary MRLs pending the submission of further data.

In 2009, the APVMA published a [preliminary review findings](#) report (APVMA 2009). Additional residues data were assessed in this report and formed the basis of recommendations, including amendments to WHPs and certain use patterns, addition of export intervals, cancellation of certain crops and use patterns, and amendments to the APVMA MRL standard (Tables 1 and 4) for chlorpyrifos.

As discussed in the [Toxicology](#) section, the human health-based guidance values for chlorpyrifos were lowered in 2019. This necessitated a re-evaluation of the consumer safety assessment considering these revised health-based guidance values. Further, since the preliminary review findings report (APVMA 2009) consultation, many international MRLs for chlorpyrifos have been reduced or removed. Codex have revoked all MRLs for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at *0.01 mg/kg where the "*" denotes that the MRL is set at or about the limit of analytical quantitation. Due to the changes in international MRLs for chlorpyrifos, a contemporary trade risk assessment is also warranted.

Residues in food and animal feeds

No additional data was received in the preliminary review findings report (APVMA 2009) public consultation, though comments received in relation to some crops have been considered. This included requests to consider support for some chlorpyrifos uses in brassica vegetables, bulb vegetables, custard apple, lettuce, oilseeds, root and tuber vegetables, and tomatoes, where some uses are now supported with clarified withholding periods, application timing restrictions or other critical comments. A summary of the residues assessment outcomes for various crop groupings are shown in Table 33 and Table 34.

The approved uses of chlorpyrifos on shallots (equivalent directions to use on bulb onions) and coffee beans have also been considered, as these use patterns were not directly considered in the preliminary review findings report (APVMA 2009). The chlorpyrifos uses on cucumber could not be extended into all cucurbits, as residue data addressing the 7-day WHP is only available for cucumber. However, upon consideration of the submissions received in response to the consultation on the chlorpyrifos Proposed Regulatory Decision, it was determined that this data could be extrapolated to zucchinis as they are both members of the same crop group, for which cucumber is the representative crop. Residues data for asparagus and celery could not be extrapolated to other members of the stalk and stem vegetables, except rhubarb, as artichoke globe is a representative crop for this crop group and data for that crop is not available. Consideration of potential extension of uses beyond those uses that are currently on chlorpyrifos product labels are out of scope for this residues assessment.

The use of chlorpyrifos on capsicum, eggplant, cucumber and other cucurbits, legume vegetables (garden peas, green beans), leafy vegetables and tomatoes in protected cropping situations is not supported due to insufficient relevant data.

The consideration of MRLs that result from chlorpyrifos uses in food producing situations that are supported by the worker health and safety and environment risk assessments, in addition to being supported in the outcomes summarised in Table 33 and Table 34, are discussed in the [Consideration of overall risk assessment outcomes for chlorpyrifos](#) section below.

Table 33: Summary of residue assessment outcomes for horticultural crops

Parameter	Assessment outcome
Avocado	
Uses supported by Residues	Leafrollers, hairy caterpillar, scales, light brown apple moth, red shouldered leaf beetle and Queensland fruit fly
Uses not supported by Residues	None
MRL ¹	0.5 mg/ka
WHP	7 days
Other label statement/restriction	Nil
Banana	
Uses supported by Residues	Bell treatment, foliar treatment and soil/butt treatment
Uses not supported by Residues	Any treatment after the exposure of fingers
MRL ¹	0.5 mg/kg
WHP	Not required when used as directed.
Other label statement/restriction	For bell treatment, foliar treatment, soil/butt treatment and bag dust: DO NOT apply after the exposure of fingers
Brassica vegetables	
Uses supported by Residues	Mites, cutworms, crickets (bran baits), vegetable weevil, African black beetle, wingless grasshopper
Uses not supported by Residues	Butterflies, moths, caterpillars, aphids, budworm and corn earworm
MRL ¹	0.05 mg/kg
WHP	Not required when used as directed

Parameter	Assessment outcome
Other label statement/restriction	<p>Critical comments for African black beetle², cutworms, mites and vegetable weevil and wingless grasshoppers² (application rate up to 450 g ac/ha) – DO NOT apply after 14 days of transplanting.</p> <p>Critical comments for African black beetle (cabbage and cauliflower application rate 1 kg ac/ha) – Restrict to single application within 7 days of transplanting.</p> <p>To align with the nomenclature of Codex commodity classification and APVMA crop group guidance, the term ‘cole vegetables’ should be changed to ‘Brassica vegetables’ on product labels.</p>
Bulb vegetables (onions and shallots)	
Uses supported by Residues	Bulb onion and shallot: Cutworms, crickets (bran baits), wingless grasshopper and vegetable weevil; Bulb onion only: Seed dressing uses – cutworms, earwigs, false wireworms, field crickets, harvester ants and mole crickets.
Uses not supported by Residues	None
MRL ¹	0.05 mg/kg (bulb onion and shallot)
WHP	Not required when used as directed
Other label statement/restriction	<p>Critical comments for cutworm, wingless grasshopper² and vegetable weevil – Apply when pests appear at or prior to planting or transplanting. Spraying should cover the soil out to at least 20 cm on both sides of row crop. Repeat once if required within 14 days of planting or transplanting. DO NOT apply more than 2 sprays.</p> <p>To align with the nomenclature of Codex commodity classification and APVMA crop group guidance and to prevent confusion with other type of onions such as spring onions, the term ‘onions’ should be changed to ‘bulb onion’ on product labels.</p>
Capsicum, eggplant	
Uses supported by Residues	Cutworm, grasshopper, weevil, crickets (bran baits)
Uses not supported by Residues	None
MRL ¹	Eggplant – 0.2 mg/kg, sweet pepper (capsicum) – 1 mg/kg
WHP	Eggplant – 3 days, sweet peppers (capsicum) – 4 days
Other label statement/restriction	DO NOT use in protected-cropping situations
Citrus fruits	
Uses supported by Residues	Scale, grasshoppers, thrips, mealybug, ants, Queensland fruit fly and weevils
Uses not supported by Residues	None
MRL ¹	1 mg/kg for citrus and 5 mg/kg for citrus pulp (dry)

Parameter	Assessment outcome
WHP	14 days or Nil for butt and soil treatment
Other label statement/restriction	Nil
Coffee	
Uses supported by Residues	Mealybugs
Uses not supported by Residues	None
MRL ¹	0.05 mg/kg
WHP	Not required when used as directed
Other label statement/restriction	Nil
Cucumber and other cucurbits	
Uses supported by Residues	Cucumber and zucchini: use at 750g ac/ha or less: Whiteflies, ants, mealybug, cutworm, wingless grasshopper, weevils, cricket (bran baits)
Uses not supported by Residues	Any use on cucurbits other than cucumber and zucchini (e.g. melons, pumpkins, gourds, chokos, marrows and squashes). Cucumber: Any use above 750g ac/ha.
MRL ¹	1 mg/kg
WHP	7 days
Other label statement/restriction	DO NOT use in protected-cropping situations.
Custard apple	
Uses supported by Residues	Ants
Uses not supported by Residues	None
MRL ¹	0.05 mg/kg
WHP	14 days
Other label statement/restriction	Critical comments: Prune tree skirt off ground at end of each season. Do not contact fruit with spray
Grapes	
Uses supported by Residues	Light brown apple moth, grapevine moth, mealybug, tuber mealybug, grapevine scale
Uses not supported by Residues	None
MRL ¹	1 mg/kg
WHP	14 days (foliar), Not Required when used as directed (dormant period)

Parameter	Assessment outcome
Other label statement/restriction	Nil
Ginger, root	
Uses supported by Residues	Cutworm, African black beetle
Uses not supported by Residues	None
MRL ¹	*0.02 mg/kg
WHP	Not required when used as directed
Other label statement/restriction	Nil
Hops	
Uses supported by Residues	Common armyworm, southern armyworm and light brown apple moth
Uses not supported by Residues	None
MRL ¹	0.05 mg/kg
WHP	Not required when used as directed
Other label statement/restriction	DO NOT apply after flowering. DO NOT graze or cut treated areas for stock food.
Kiwifruit	
Uses supported by Residues	Common armyworm, southern armyworms, scale insects, light brown apple moth
Uses not supported by Residues	None
MRL ¹	2 mg/kg
WHP	14 days
Other label statement/restriction	Critical statement for armyworms and light brown apple moth – DO NOT apply post-bloom. Critical statement for scale insects – DO NOT apply during blossom period. DO NOT use on edible peel kiwifruit varieties.
Leafy vegetables	
Uses supported by Residues	Lettuce, chard (silver beet): Cutworms, redlegged earth mite, blue oat mite, crickets (bran baits) and wingless grasshopper; Lettuce: vegetable weevil
Uses not supported by Residues	Chard (Silver beet): Vegetable weevil All uses on leafy crucifers including chou moullier, kale, mustard, rape
MRL ¹	Lettuce head – 1 mg/kg; lettuce leaf – 5 mg/kg and chard (silver beet) – 4 mg/kg

Parameter	Assessment outcome
WHP	14 days
Other label statement/restriction	DO NOT use in protected-cropping situations
Legume vegetables (garden peas, green beans)	
Uses supported by Residues	Cutworms, wingless grasshopper, vegetable weevil and crickets (bran baits)
Uses not supported by Residues	None
MRL ¹	Legume vegetables – 1 mg/kg, legume animal feeds (except pulses) – 30 mg/kg
WHP	Harvest (legume vegetables) – 7 days, legume animal feeds – 28 days
Other label statement/restriction	DO NOT use in protected-cropping situations
Mango	
Uses supported by Residues	Scale
Uses not supported by Residues	None
MRL ¹	1 mg/kg
WHP	21 days
Other label statement/restriction	Nil
Passionfruit	
Uses supported by Residues	Queensland fruit fly
Uses not supported by Residues	None
MRL ¹	*0.05 mg/kg
WHP	14 days
Other label statement/restriction	Critical comment: Avoid contact with the fruit
Pineapple	
Uses supported by Residues	Mealybug, ants and white grub
Uses not supported by Residues	None
MRL ¹	0.5 mg/kg
WHP	Nil
Other label statement/restriction	Nil

Parameter	Assessment outcome
Pome fruits	
Uses supported by Residues	Apples, pears: Light brown apple moth, San José scale (application in dormant period); Pome fruits (all): Queensland fruit fly, wingless grasshopper
Uses not supported by Residues	Foliar uses involving application at 50 g ac/100L which includes: Apples, pears: San José scale (application not in dormant period), woolly aphid, mealybug; Apples: Apple Dimpling bug
MRL ¹	0.7 mg/kg for pome fruit and 7 mg/kg for apple pomace (dry)
WHP	14 days or Not Required when used as directed for dormancy spray
Other label statement/restriction	Nil
Root and tuber vegetables	
Uses supported by Residues	All root and tuber vegetables: Cutworm, crickets (bran baits), wingless grasshopper (barrier spray); Seed dressing (beetroot, carrot, radish, turnip): Cutworm, earwig, false wireworm, crickets, harvester ants and mole crickets; Cassava; cutworm; Potato: Vegetable weevil and soil applications – African black beetle, white fringed weevil and wireworm
Uses not supported by Residues	Light brown apple moth, earwig (band spray), redlegged earth mite and blue oat mite, wingless grasshopper (foliar), vegetable weevil (except potato)
MRL ¹	0.05 mg/kg
WHP	Not required when used as directed
Other label statement/restriction	Critical comments for wingless grasshopper: DO NOT use on crops. Apply only as a barrier across the line of advance when grasshoppers are invading the crops. Critical comments for cutworm (root and tuber vegetables, except potato): DO NOT apply 14 days after seedling emergence Critical comments for vegetable weevil (potato): DO NOT apply after the seedling growth stage. (Note – This should replace the current statement “one spray should be sufficient if applied at the seedling stage”.)
Stalk and stem vegetables (asparagus, celery, rhubarb)	
Uses supported by Residues	Asparagus, celery and rhubarb: Crickets (bran baits), cutworm, wingless grasshopper and vegetable weevil
Uses not supported by Residues	Foliar application on wingless grasshopper and vegetable weevil All uses on stalk and stem vegetables except for asparagus, celery and rhubarb
MRL ¹	0.05 mg/kg for asparagus, celery and rhubarb
WHP	Not required when used as directed

Parameter	Assessment outcome
Other label statement/restriction	<p>Critical comments for cutworms, wingless grasshopper and vegetable weevil: Asparagus: Apply as a post-plant spray, up to 30 days before spear emergence. Do not spray the spears. Once harvest is complete, further applications are permissible, if required, up to 30 days before the next year's spears emerge. Celery: Apply no later than 14 days after transplanting. For seedbeds, treatment can be at any time, up to the point of transplant lift. For field-seeded crops, DO NOT apply after the plants reach the minimum size of a transplant, approximately 8 weeks after seeding. Rhubarb²: Apply no later than 14 days after crown transplant.</p> <p>Asparagus, celery, rhubarb: Remove critical comment "repeat as required".</p> <p>The term 'stalk and stem vegetables (including asparagus, celery and rhubarb)' should be changed to 'asparagus, celery and rhubarb'</p>
Strawberry	
Uses supported by Residues	Field cricket, mole cricket
Uses not supported by Residues	None
MRL ¹	0.05 mg/kg
WHP	Not required when used as directed
Other label statement/restriction	Nil
Stone fruits	
Uses supported by Residues	Stone fruits (except peaches): European earwig (cracked-grain baits), San José scale, light brown apple moth and Queensland fruit fly. Peaches: European earwig (cracked-grain baits), light brown apple moth. Queensland fruit fly and San José scale (application in the dormant period only)
Uses not supported by Residues	Peaches: European earwig (foliar use), San José scale (application outside of dormant period)
MRL ¹	Stone fruits (except peaches) – 1 mg/kg; Peaches – 0.05 mg/kg
WHP	Stone fruits (except peaches, foliar) – 14 days. Stone fruits (dormant period) – Not required when used as directed. Peaches – Not Required when used as directed.
Other label statement/restriction	Peaches: Critical comment for Queensland fruit fly – Avoid contact with fruit
Tomato	
Uses supported by Residues	Processing tomatoes: Tomato grubs, budworm, green vegetable bug, green peach aphids, whitefly, silverleaf whitefly, cutworm, wingless grasshopper, vegetable weevil, wireworm, false wireworm, African black beetle, crickets (bran baits); Fresh tomatoes: Uses up to 14 days after seeding/transplanting, crickets (bran baits, whole crop-life)
Uses not supported by Residues	None
MRL ¹	Tomato – 1 mg/kg, tomato pomace – 10 mg/kg

Parameter	Assessment outcome
WHP	3 days (processing tomatoes), Not Required when used as directed (fresh tomatoes)
Other label statement/restriction	DO NOT use in protected-cropping situations For uses other than baits, the following restraint applies to fresh tomatoes: DO NOT apply later than 14 days after sowing or transplanting

1 These MRL recommendations are reflective of the residue safety assessment outcomes only. Recommended amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 are discussed in the below [Residues and trade recommendations](#).

2 Use is not considered practical with the required application timing restrictions based on pest activity in relevant crop growth stages.

Table 34: Summary of residue assessment outcomes for field crops and pasture

Parameter	Assessment Outcome
Cereals	
Uses supported by Residues	Cereals: Armyworm, webworm, cutworms, locusts, redlegged earth mite, blue oat mite, fleas, grasshoppers, black-headed cockchafer and Seed dressing uses – curculio, seed harvesting ants, wireworms, false wireworms, black soil scarab, wheat root scarab, spine-tailed weevil, spotted vegetable weevil; Rice: Bloodworm, brown planthopper; Maize and sorghum: Wireworm, false wireworm, earwigs, cockroach and field cricket; Maize: African black beetle; Sorghum: Aphids, midges
Uses not supported by Residues	None
MRL ¹	Cereals (except rice and sorghum) grains – 2 mg/kg, rice – 0.5 mg/kg, sorghum – 1 mg/kg, wheat bran (unprocessed) – 5 mg/kg Cereal forage – 20 mg/kg, straw and fodder (dry) of cereal grains [except sorghum] – 10 mg/kg, sorghum fodder and straw (dry) – 20 mg/kg
WHP	Harvest and grazing – 14 days for all cereals except rice (10 days for harvest and grazing) and sorghum (7 days for harvest and grazing)
Other label statement/restriction	Nil
Cotton	
Uses supported by Residues	Armyworm, mites, cutworms, native budworm, cotton bollworm, locust, wingless grasshopper, earworm, cotton flea beetle, leaf beetle, springtail, aphids, brown field cricket, cockroaches, earwigs, wireworm and false wireworm
Uses not supported by Residues	None
MRL ¹	MRL recommendations for oilseed apply for cotton seed, i.e. 0.05 mg/kg, forage – 30 mg/kg, straw – 20 mg/kg
WHP	Harvest and grazing – 28 days

Parameter	Assessment Outcome
Other label statement/restriction	Nil
Oilseeds (except cotton)	
Uses supported by Residues	Canola, linseed, peanut, safflower, sunflower: Cutworms, redlegged earth mite, blue oat mite, wingless grasshopper; Canola, safflower, sunflower: Wireworm and false wireworm; Canola: Lucerne flea, vegetable weevil, balaustium mite, brown pasture looper, bryobia mite, pasture webworm; Sunflower: Cockroaches, earwigs and field crickets; Seed dressing in oilseeds – False wireworm
Uses not supported by Residues	None
MRL ¹	Oilseeds – 0.05 mg/kg, oilseed forage – 30 mg/kg, oilseed straw – 20 mg/kg
WHP	Harvest – Not required when used as directed (oilseeds, except cotton and peanuts), 14 days (peanuts). Grazing (except cotton) – 14 days
Other label statement/restriction	Critical comment for wingless grasshopper and cutworm – DO NOT apply to canola, linseed, safflower or sunflower later than the 10 leaf stage
Pastures and forage crops	
Uses supported by Residues	Legume animal feeds (except pulses): Armyworm, locusts, mites, earwigs, lucerne flea, cutworms, caterpillars, cockchafer, leaf roller, aphids, sitonia weevil, webworms, budworm; Grass pastures: Armyworms, cutworms, locusts, mites, lucerne flea, wingless grasshopper, webworms, cockchafer, grass grubs, loopers, corbies, sitonia weevil
Uses not supported by Residues	None
MRL ¹	Legume animal feeds (except pulses) and grass pastures – 30 mg/kg
WHP	Harvest and grazing – 28 days (legume animal feeds, except pulses) and 14 days (grass pastures)
Other label statement/restriction	Nil
Pulses	
Uses supported by Residues	All pulses: Redlegged earth mite and blue oat mite; Cowpeas, mung beans, navy beans, pigeon peas, chickpeas: Wireworms and false wireworm; Cowpeas: Brown field cricket; Soya bean: Cutworms, false wireworm, wingless grasshopper, cockroaches, crickets
Uses not supported by Residues	Armyworm, locusts, underground grass grub, looper, webworm
MRL ¹	Pulse (dry) [except Soya bean (dry)] – 0.1 mg/kg, soya bean (dry) – 0.05 mg/kg, pulse forage – 5 mg/kg, pulse straw and fodder – 0.5 mg/kg
WHP	Harvest – Not required when used as directed (pulses, except soya bean), 28 days (soya bean) Grazing – 28 days (all pulses)
Other label statement/restriction	Nil

Parameter	Assessment Outcome
Sugar cane	
Uses supported by Residues	Any foliar treatment, within 3 months following planting/ratooning
Uses not supported by Residues	Any foliar treatment applied later than 3 months after planting/ratooning
MRL ¹	Sugar cane – *0.01 mg/kg, Sugar cane fodder – 4 mg/kg
WHP	Harvest – Not required when used as directed, grazing – 14 days
Other label statement/restriction	DO NOT apply later than 3 months after planting or ratooning

¹ The MRL recommendations are reflective of the residue safety assessment outcomes only. Recommended amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 are discussed in the below [Residues and trade recommendations](#).

Animal transfer studies and animal commodity MRLs

Livestock transfer studies were previously in the [2000 chlorpyrifos residues assessment](#) (APVMA 2000a) and were also considered by the Joint Meeting on Pesticide Residues (JMPR) in 2000 (JMPR 2000). There were data for cattle, pigs, and poultry which were detailed in the preliminary review findings report (APVMA 2009). No new studies have been submitted.

Currently the temporary MRLs in animal commodities are 0.1 mg/kg in mammalian edible offal, *0.01 mg/kg in eggs, 0.5 mg/kg in mammalian fat, 0.2 mg/kg in milk fat, 0.1 mg/kg in poultry fat and poultry offal. Where the '*' denotes that the MRL is set at or about the limit of analytical quantitation.

Based on the residues safety assessment outcomes and livestock feed burden associated with currently approved uses, it was recommended that the:

- eggs MRL should be *0.01 mg/kg
- poultry meat [in the fat] MRL should be 0.1 mg/kg
- poultry offal MRL should be *0.01 mg/kg
- meat (mammalian)[in the fat] MRL should be 2 mg/kg
- mammalian edible offal MRL should be 0.02 mg/kg
- whole milk MRL should be 0.02 mg/kg
- milk fat MRL should be 0.5 mg/kg.

The animal commodity MRLs that stem from chlorpyrifos uses that were supported by the worker health and safety and environment risk assessments are discussed below in the [Consideration of overall risk assessment outcomes for chlorpyrifos](#) section below.

Dietary exposure

An updated dietary exposure assessment has been undertaken based on the residue assessment outcomes, the revised ADI of 0.001 mg/kg bw/day and the revised ARfD of 0.03 mg/kg bw/day. The chronic and acute dietary exposures of chlorpyrifos were acceptable for use patterns supported from a residues safety perspective (Table 33 and Table 34).

Chronic dietary exposure assessment

The chronic dietary exposure to chlorpyrifos is estimated by the National Estimated Daily Intake (NEDI) calculation encompassing all registered/temporary uses of chlorpyrifos and the mean daily dietary consumption data derived from the 2011–2012 National Nutritional and Physical Activity Survey. The NEDI calculation is made in accordance with World Health Organization (WHO) Guidelines and is a conservative estimate of dietary exposure to chemical residues in food. The chronic dietary exposure for uses in food-producing situations supported by all risk assessments in the draft Chlorpyrifos Review Technical Report was considered acceptable (APVMA 2023). The chronic dietary exposure for chlorpyrifos uses that are supported by all risk assessments in this final Chlorpyrifos Review Technical Report are discussed in the [Consideration of overall risk assessment outcomes for chlorpyrifos](#) section below.

Acute dietary exposure assessment

The acute dietary exposure to chlorpyrifos is estimated by the National Estimated Short-Term Intake (NESTI) calculation. The NESTI calculations are made in accordance with the deterministic method used by the JMPR with 97.5th percentile food consumption data derived primarily from the 2011–2012 National Nutritional and Physical Activity Survey. NESTI calculations are conservative estimates of short-term exposure (24-hour period) to chemical residues in food.

The following uses are not supported because of acute dietary exposure concerns for the 2–6 year cohort (consumption at >100% of the ARfD):

- Use on pome fruit (apples and pears) at an application rate of 750 g ac/ha (apples at 126% of the ARfD)
- Use on chard for control of vegetable weevil at 400 g ac/ha (104% of the ARfD)
- Use on cucumbers at an application rate of >750 g ac/ha (121% of the ARfD)
- Use on kiwifruit with edible peel (119% of the ARfD)

It is concluded that the acute dietary exposure of chlorpyrifos is acceptable for all uses supported in the residues safety assessment above. Excluding uses that are not supported due to acute dietary exposure concerns, the maximum estimated acute dietary exposure in the 2–6 years age group was 92% of the ARfD for leafy lettuce and in the 2+ age group was 57% of the ARfD for tomato juice.

The acute exposure of chlorpyrifos that stems from uses supported by all risk assessments is discussed in the [Consideration of overall risk assessment outcomes for chlorpyrifos](#) section below.

Trade assessment

Commodities considered to be major export commodities are defined in the APVMA's [Overseas trade \(Part 5B\) guidance](#). The presence of finite (measurable) residues of chlorpyrifos in major export commodities may pose a risk to Australian trade in situations where (i) no residue tolerance (import tolerance) is established in the importing country or (ii) where residues in Australian produce are likely to exceed a residue tolerance (import tolerance) established in the importing country.

Of the major export plant commodities, there are uses of chlorpyrifos in cereal grains, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit. Mammalian and poultry animal commodities which may be derived from livestock fed feeds produced from treated chlorpyrifos treated crops are also major export commodities. Sugar is a major export commodity; however, finite residues are not expected to occur in sugar cane treated with chlorpyrifos and the trade risk is therefore considered to be low.

Trade risk assessment for plant commodities

For cereal grains, sorghum, rice, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit, a comparison of the current and proposed Australian MRLs (based on the residues safety assessment outcomes) with Codex and international MRLs (current as of August 2024) is detailed below in Table 35.

Table 35: Comparison of proposed Australian and current international chlorpyrifos MRLs for plant commodities

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed in 2023) ¹	Codex ²	USA ³	EU ⁴	Japan ⁵	Korea ⁶	Taiwan ⁷
Cereal grains	T0.1	2	–	0.5 (wheat)	*0.01	0.5 (wheat and other cereal grains)	0.4 (wheat)	*0.02 (cereal grains)
Sorghum	T3	1	–	0.5	*0.01	0.5 (other cereal grains)	0.5	*0.02 (cereal grains)
Rice	T0.1	0.5	–	–	*0.01	–	–	*0.02 (cereal grains)
Oilseeds	T0.01 (0.05 for cotton seed)	0.05	–	0.2 (cotton seed and peanut) 0.1 (sunflower)	*0.01	0.3 (cotton seed)	–	0.5 (other cereals and crops)
Pulses	T0.05 (vegetables)	0.1	–	0.3 (soybean)	*0.01	0.3 (beans, dried)	–	0.1 (mung bean and small red beans)

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed in 2023) ¹	Codex ²	USA ³	EU ⁴	Japan ⁵	Korea ⁶	Taiwan ⁷
Citrus fruits	T0.5	1	–	1	*0.01	1	1	*0.01 (vegetables and fruits)
Grapes	T1	1	–	–	*0.01	0.5	–	*0.01 (vegetables and fruits)
Pome fruit	T0.5	0.7	–	0.01 (apple) 0.05 (pear)	*0.01	0.5 (apple) 0.3 (pear)	1	*0.01 (vegetables and fruits)
Stone fruit	T1	1 (except peaches which are 0.05)	–	1 (cherry) 0.05 (nectarine, peach and plum)	*0.01	1 (peach and nectarine) 0.5 (Japanese plum)	0.5 (peach) 0.2 (plum)	*0.01 (vegetables and fruits)

1 The Australia (proposed) MRL is reflective of the residue safety assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, including trade, and corresponding amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023, are in the [Residues and trade recommendations](#).

2 The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 agreed to revoke all Codex MRLs as a public health concern was expressed and it was unlikely that data to complete risk assessment would be available. Details on this decision can be found on the [FAO website](#).

3 All US tolerances for chlorpyrifos were revoked on 28 February 2022. On 28 December 2023 and all tolerances for residues of chlorpyrifos on food commodities were reinstated. Details on this decision can be found on the [USEPA website](#). Current tolerances can be found on the [Code of Federal Regulations website](#).

4 Chlorpyrifos has not been approved in the European Union since 16/01/2020. MRLs established in the EU for chlorpyrifos can be found on the [EU Pesticides Database](#).

5 Japanese MRLs for Chlorpyrifos can be found on the [Japan Food Chemistry Research Foundation website](#).

6 Republic of Korea MRLs for chlorpyrifos can be found [Food Safety Korea website](#)https://www.foodsafetykorea.go.kr/foodcode/02_01_01.jsp?pesticide_code=P00131&s_option=EN&s_type=2.

7 Taiwanese MRLs for chlorpyrifos can be found on the [Taiwan Ministry of Justice website](#).

For cereal grains, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit which are major export commodities, the currently approved uses of chlorpyrifos may result in residues above 0.01 mg/kg which is the limit of quantification of the assessed analytical method and is the default MRL set of all commodities in the European Union. Given that Codex have revoked all MRLs for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at *0.01 mg/kg, and that MRL appropriate coverage in Japan, Korea and Taiwan is lacking for most of the major export commodities, it is considered that there may be an undue risk to international trade associated with the current uses in cereal grains, canola, cotton, pulses, citrus, grapes, pome fruit and stone fruit with exception of applications made prior to crop emergence or the end of dormancy.

For cereals, canola, cotton and pulses, available residues data found that median residues in grain were below the LOQ for post-harvest intervals of 100 days or more when applied at rates of 675 g ac/ha for cereals and oilseeds and 450 g ac/ha for pulses. Based on this information and given that pre-emergent applications of chlorpyrifos, a non-systemic insecticide, will be made prior to crop emergence, finite residues are not likely in exported grain. Therefore, the risk to trade associated with pre-emergent uses of chlorpyrifos on cereals, canola, cotton and pulses is considered to be low. For the application of chlorpyrifos during dormancy to grapes, pome fruit and stone fruit, finite residues are not expected in harvested fruit, and therefore the risk to trade for applications made during dormancy is considered to be low.

The residues and trade considerations for specific low-rate uses of chlorpyrifos in major export commodities (i.e. cereals, canola, cotton and pulses), which are supported by the worker health and safety and environment risk assessments, are discussed below in the [Consideration of overall risk assessment outcomes for chlorpyrifos](#) section. It is noted that while pre-emergent uses of chlorpyrifos in these major export commodities were not considered to pose an undue risk to trade based on a range of factors discussed above, the establishment of MRLs is predicated on the highest potential residues that may result from the specific approved use patterns (i.e. the critical GAP) and the proportionality concept for adjusting crop field trial values can only be applied when the data is consistent with certain principles outlined in OECD guidance [OECD 2016]. If the APVMA does not have residues data from trials that is consistent with these principles, then the APVMA cannot conduct a robust assessment of the residues levels expected and an MRL cannot be established.

Trade risk assessment for animal commodities

For human food commodities derived from mammalian livestock and poultry, a comparison of the current and proposed Australian MRL (based on the residues safety assessment outcomes) with Codex and international MRLs (current of August 2024) is detailed below in Table 36.

Table 36: Comparison of proposed Australian and current international chlorpyrifos MRLs for animal commodities

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed in 2023) ¹	Codex ²	USA ³	EU ⁴	Japan ⁵	Korea ⁶	Taiwan ⁷
Mammalian meat [in the fat]	T0.5	2	–	0.3 (cattle fat) 0.2 (goat, hog and sheep fat) 0.05 (muscle)	*0.01	0.05 (0.01 for pig muscle and fat)	1 (cattle and sheep) 0.02 (pig)	–
Mammalian offal	T0.1	0.02	–	0.05	*0.01	0.01	0.01 (cattle, sheep and pig)	–

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed in 2023) ¹	Codex ²	USA ³	EU ⁴	Japan ⁵	Korea ⁶	Taiwan ⁷
Milk [in the fat]	T0.2	0.5 (whole milk 0.02)	–	0.25	*0.01	0.01	0.02	–
Poultry meat [in the fat]	T0.1	0.1	–	0.1 (fat and muscle)	*0.01	0.01	0.01	–
Poultry offal	T0.1	*0.01	–	0.1	*0.01	0.01	0.01	–
Eggs	T*0.01	*0.01	–	0.01	*0.01	0.01	0.01	–

1 The Australia (proposed) MRL is reflective of the residue safety assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, including trade, and corresponding amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023, are in the [Residues and trade recommendations](#).

2 The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 agreed to revoke all Codex MRLs as a public health concern was expressed and it was unlikely that data to complete risk assessment would be available. Details on this decision can be found on the [FAO website](#).

3 All US tolerances for chlorpyrifos were revoked on 28 February 2022. On 28 December 2023 and all tolerances for residues of chlorpyrifos on food commodities were reinstated. Details on this decision can be found on the [USEPA website](#). Current tolerances can be found on the [Code of Federal Regulations website](#).

4 Chlorpyrifos has not been approved in the European Union since 16/01/2020. MRLs established in the EU for chlorpyrifos can be found on the [EU Pesticides Database](#).

5 Japanese MRLs for Chlorpyrifos can be found on the [Japan Food Chemistry Research Foundation website](#).

6 Republic of Korea MRLs for chlorpyrifos can be found [Food Safety Korea website](#) https://www.foodsafetykorea.go.kr/foodcode/02_01_01.jsp?pesticide_code=P00131&s_option=EN&s_type=2.

7 Taiwanese MRLs for chlorpyrifos can be found on the [Taiwan Ministry of Justice website](#).

The preliminary review findings report (APVMA 2009) concluded that, to comply with the target MRL/tolerance of the most sensitive export destination for animal commodities (in this case, the EU's 0.01 mg/kg MRL), it is necessary to set the time required on clean feed (Export Slaughter Intervals, ESIs) for different animal species. The ESIs in the preliminary review findings report (APVMA 2009) that are applicable to each species are 56 days for grazing animals (e.g., cattle, sheep and goats) and 7 days for pigs.

Consideration of overall risk assessment outcomes for chlorpyrifos

The majority of chlorpyrifos uses in food-producing situations were not supported in the draft [Chlorpyrifos Review Technical Report](#). The APVMA's risk assessment for human and environmental exposure to chlorpyrifos was revised upon consideration of the submissions received in response to public consultation on the Proposed Regulatory Decisions for the chlorpyrifos reconsideration.

The majority of chlorpyrifos uses in food-producing situations are not supported in the revised risk assessments; however, certain additional uses in vegetables and field crops were supported with application rate and application timing restrictions. The use patterns that are supported in the worker health and safety and environment risk assessments are presented in Table 37 below. These uses are within the application rate and timing range indicated on labels considered under the reconsideration.

Table 37: Chlorpyrifos uses supported in the worker health and safety and environment assessments

Crop grouping	Crop use or situation	Pests	Supported use pattern		
			Application rate (g ac/ha)	Application timing	Multiple applications
Brassica vegetables	Brassica crops (broccoli, Brussels sprouts, cabbage, cauliflower)	Redlegged earth mite, blue oat mite	70	Within 14 days on transplanting	No - one per season only
Leafy vegetables	Chard (silver beet)	Redlegged earth mite, blue oat mite	70	BCCH < 40 only	No - one per season only
	Lettuce	Redlegged earth mite, blue oat mite	70	BCCH < 40 only	No - one per season only
Cereals	Cereals	Redlegged earth mite, blue oat mite, lucerne flea	35 – 70	BCCH 30 to 39	No - one per season only
Oilseeds	Canola	Redlegged earth mite, blue oat mite	70 – 100	Prior to seedling emergence	No - one per season only
		Redlegged earth mite, lucerne flea	70	BCCH < 40 only	No - one per season only
	Cotton	Redlegged earth mite, blue oat mite	70 – 130	Prior to seedling emergence	No - one per season only
	Oilseeds (other than canola and cotton)	Redlegged earth mite, blue oat mite	70	Prior to seedling emergence	No - one per season only
Pulses	Field peas, lupins, broad beans and chickpeas	Redlegged earth mite, blue oat mite	70 – 100	Prior to seedling emergence	No - one per season only
Forage crops	Clover seed crops	Redlegged earth mite, blue oat mite	70 – 130	Prior to seedling emergence	No - one per season only
		Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 – 130	BBCH < 20 only	No - one per season only
	Forage crops	Redlegged earth mite, blue oat mite	70	BCCH < 40 only	No - one per season only
		Redlegged earth mite, blue oat mite, pea aphid, lucerne flea	35	BCCH < 40 only	No - one per season only

Crop grouping	Crop use or situation	Pests	Supported use pattern		
			Application rate (g ac/ha)	Application timing	Multiple applications
Lucerne		Redlegged earth mite, blue oat mite	70 – 130	Prior to seedling emergence	No - one per season only
		Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 – 130	BBCH < 20 only	No - one per season only
Lucerne seed crops		Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 – 130	BBCH < 20 only	No - one per season only
		Lucerne flea	70 – 130	BBCH < 20 only	No - one per season only
Medics		Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 – 130	BBCH < 20 only	No - one per season only

The use patterns that are supported in the worker health and safety and environment risk assessments are discussed below with respect to residues and trade. It is important that the APVMA have confidence in the level of residues expected from these low-rate use patterns, as they are now considered to be the use patterns with the highest potential for chlorpyrifos residues in food producing situations and, if supported, would inform a number of relevant chlorpyrifos MRLs established by the APVMA. [OECD guidance](#) for crop field trials provides the following guidance on the use of proportionality [OECD 2016]:

29 (b) The proportionality concept can be applied to data from field trials conducted within a rate range of between 0.3x and 4x the GAP rate. This is only valid when quantifiable residues occur in the dataset. Where there are no quantifiable residues, i.e. values are less than the limit of quantitation, the residues may only be scaled down. It is unacceptable to scale up in this situation.

29 (d) Scaling is only acceptable if the application rate is the only deviation from critical GAP (cGAP). In agreement with JMPR practice, additional use of the $\pm 25\%$ rule for other parameters such as PHI is not acceptable. For additional uncertainties introduced, e.g. use of global residue data, these need to be considered on a case-by-case basis so that the overall uncertainty of the residue estimate is not increased.

If the APVMA is unable to establish MRLs for use patterns with the highest potential for chlorpyrifos residues in food producing situations, the use pattern cannot be supported.

Brassica vegetables

The use on brassica crops (broccoli, Brussels sprouts, cabbage, cauliflower) now supported in the environment risk assessment involves a single application at a maximum rate of 70 g ac/ha, made within 14 days of transplanting. The residues data that was considered relevant for brassica vegetables in the preliminary review findings report (APVMA 2009) include a trial for cabbage, Chinese cabbage, savoy cabbage, cauliflower and Brussels sprouts.

The limited available relevant data indicated that residues of chlorpyrifos in brassica vegetables at harvest after application at 70 g ac/ha within 14 days of transplanting should be <0.01 mg/kg (Anon 1986, 1990). An MRL for VB 0040 Brassica (cole or cabbage) vegetables, head cabbages, flowerhead brassicas at *0.01 mg/kg is considered appropriate. Therefore, this use is also supported from a residue and trade perspective.

Leafy vegetables

The uses on chard and lettuce now supported in the environment risk assessment involve a single application at a maximum rate of 70 g ac/ha, made prior to BBCH 40 (before harvestable vegetables parts begin). Residues data available for leafy vegetables include 9 trials for spinach and 4 trials for lettuce, which are summarised in the preliminary review findings report (APVMA 2009). However, residues data for the specific supported uses are not available, as none of these residues trials involve a last application at a timing of BBCH 40 and all residues trials involve multiple applications of chlorpyrifos, rather than a single application.

Due to the difference in the use patterns addressed in the leafy vegetables residue trials compared to the use pattern that can be supported from an environmental and worker health and safety perspective, and noting that all residues data from these trials showed finite residues at harvest, it is concluded that there is insufficient relevant residues data for a robust assessment of the level of chlorpyrifos residues expected in these leafy vegetable crops. Therefore, the specific uses on chard and lettuce cannot be supported at this time from a residues and trade perspective.

Cereals

The uses on cereals supported by work health and safety and environment risk assessments involve a single application at a maximum rate of 70 g ac/ha, made between BCCH 30 and 39. The post-emergent use of chlorpyrifos is considered to pose an undue risk to international trade. Therefore, these uses of chlorpyrifos on cereals are not supported from a residues and trade perspective.

Oilseeds

The use on oilseeds (other than canola and cotton) supported by work health and safety and environment risk assessments involves a single application at a maximum rate of 70 g ac/ga, made prior to seedling emergence. The uses on canola and cotton supported by work health and safety and environment risk assessments involve a single application at a maximum rate of 100 g ac/ha or 130 g ac/ha respectively, made prior to seedling emergence. With respect to residues, the pre-emergent uses will be discussed further below. The use of chlorpyrifos on canola at 70 g ac/ha and BBCH < 40 was also supported by the environment risk assessment; however, post-emergent uses on canola are considered to pose a risk to international trade and are not supported from a residues and trade perspective.

Oilseeds (except cotton and canola)

Residue trials for oilseeds that address all relevant food and feed commodities (seed, forage and fodder) involve foliar application at 675 g ai/ha, and these trials are summarised in the preliminary review findings report (APVMA 2009). The data indicates that chlorpyrifos residues should be <0.01 mg/kg in seed from the

specific oilseeds (except cotton and canola) use pattern, but that finite residues may be expected in oilseed forage and fodder.

It is important that the APVMA have confidence in the level of residues expected in forage and fodder from this specific use on oilseeds, as it would result in chlorpyrifos residues in animal feeds and may drive the maximum feeding level and MRLs required for mammalian animal commodities. The rate associated with this specific use pattern (70 g ac/ha) is 0.16× that addressed in the forage and fodder residue trials and the [OECD guidance](#) for crop field trials indicates that the proportionality concept can only be applied to data from field trials conducted within a rate range of between 0.3× and 4× the rate. The fact that the trials involved foliar applications to actively growing crops is another difference to the supported pre-emergent use pattern. It is therefore considered that proportionality cannot be applied to estimate residues expected from this specific use pattern from the available dataset with confidence.

Due to the difference in the use pattern addressed in the residue trials, with the use pattern that can be supported from an environmental and worker health and safety perspective, it is concluded that there is insufficient data for a robust assessment of the level of chlorpyrifos residues expected in oilseed forage and fodder. Therefore, this specific use on oilseeds (except canola and cotton) cannot be supported at this time from a residues and trade perspective.

Canola

Residue trials for canola that address all relevant food and feed commodities (seed, forage and fodder) involve foliar application at 450 or 675 g ai/ha. The maximum application rate supported by work health and safety and environment risk assessments associated with this specific use pattern (100 g ac/ha) is 0.15× or 0.22× the rate addressed in these residue trials. OECD guidance for crop field trials indicates that the proportionality concept can only be applied to data from field trials conducted within a rate range of between 0.3× and 4× the rate. Within this rate range, there is one canola trial that addresses residues in grain and straw at 2.5× the supported rate and a separate trial that addresses residues in forage at 1.5 and 3× the supported rate. However, the fact that the trials involved foliar applications to actively growing crops is another difference to the supported pre-emergent use pattern. It is therefore considered that proportionality cannot be applied to estimate residues expected from this specific use pattern from the available dataset with confidence, noting that finite residues were observed in grain in some samples from trials conducted with application at exaggerated rates.

Due to the difference in the use patterns addressed in the canola residue trials, with the use pattern that can be supported from an environmental and worker health and safety perspective, it is concluded that there is insufficient residues data for a robust assessment of the level of chlorpyrifos residues in canola grain. It is also considered that there are insufficient data for a robust assessment of the level of chlorpyrifos residues in canola forage and fodder, which is necessary to estimate the livestock dietary burden. Therefore, this specific use on canola cannot be supported at this time from a residues and trade perspective.

Cotton

Residue trials for cotton, including cotton fodder, are tabulated in the [interim agricultural assessment for chlorpyrifos](#) (APVMA 2000a). All available residues data was conducted at application rates outside the scalable range of between 0.3× and 4× the rate. Due to the difference in the use patterns addressed in the

cotton residue trials, with the use pattern supported by the environmental and worker health and safety risk assessments, it is concluded that there is insufficient residues data for a robust assessment of the level of chlorpyrifos residues in cotton seed. It is also considered that there are insufficient data for a robust assessment of the level of chlorpyrifos residues in cotton forage and fodder, which is necessary to estimate the livestock dietary burden. Therefore, this specific use on cotton cannot be supported at this time from a residues and trade perspective.

Pulses

The uses on field peas, lupins, broad beans and chickpeas supported by work health and safety and environment risk assessments involve a single application at a maximum rate of 100 g ac/ha, made prior to seedling emergence. Residues data for this specific use pattern is not available. There are a number of residues trials for pulses that address forage only conducted at 150 g ac/ha, which can be extrapolated to give the estimated residues in forage from application at 100 g ac/ha. However, residue trials for pulses that address all relevant food and feed commodities (seed, forage and fodder) involve foliar application at 450 or 675 g ac/ha, which are summarised in the preliminary review findings report (APVMA 2009). This residues data indicates that finite residues are expected in pulse grains.

The rate associated with the specific use pattern (100 g ac/ha) is 0.22× or 0.15× the rate addressed in the seed residues trials and [OECD guidance](#) for crop field trials indicates that the proportionality concept can only be applied to data from field trials conducted within a rate range of between 0.3× and 4× the rate. The fact that the trials involved foliar applications to actively growing crops is another difference to the supported pre-emergent use pattern. It is therefore considered that proportionality cannot be applied to estimate the level of chlorpyrifos residues expected in pulse grains from this specific use pattern from the available dataset with confidence.

Due to the differences between the use pattern addressed in residues trials and the specific use pattern supported in the environment and worker health and safety assessments, it is concluded that there is insufficient data for a robust assessment of the level of chlorpyrifos residues expected in pulse grains. Therefore, the specific uses on pulses (field peas, lupins, broad beans and chickpeas) cannot be supported at this time from a residues and trade perspective.

Forage crops

The [APVMA definition](#) of a forage crop is “A crop grown specifically for the purpose of being grazed by, or fed to, livestock, but excluding pasture. The term excludes crops such as cereals, oilseeds, vegetables and cole crops, which may be grazed as opportunity crops. If any of these other crops are grown for forage, they should be referred to as crops for forage, eg 'cereals for forage'.” The specific supported uses on forage crops (including clover seed crops, lucerne, lucerne seed crops and medics) involve a single application per season as follows:

- A maximum rate of 130 g ac/ha, made prior to seedling emergence
- A maximum rate of 130 g ac/ha, made prior to BBCH 20
- A maximum rate of 70 g ac/ha, made prior to BBCH 40

Residues data were available in lucerne, vetch and clover forage which are relevant for these specific use patterns. Residues (dry weight) after 28 days (the supported grazing WHP for legume animal feeds) from trials which were conducted at an application rate not greater than 4× the supported rate, ranged from 0.03 – 4.3 mg/kg (n = 10) (Gaven 2003a-f, 2004a-d). An MRL for AL 1057 Legume animal feeds (except pulses) at 7 mg/kg is considered appropriate to cover chlorpyrifos residues arising from the specific supported uses on forage crops listed above, in conjunction with a 28-day grazing WHP.

Animal transfer studies – forage crops

As forage crops are a crop grown specifically for the purpose of being grazed by, or fed to, livestock, the supported uses of chlorpyrifos on forage crops would result in chlorpyrifos exposure to livestock. Based on consideration of the residues trials above, the highest observed (dry weight) residues are 4.3 mg/kg, after conversion to expected residues at 1× the maximum supported application rate on forage crops (130 g ac/ha). Assuming consumption of forage crops at 100% of the mammalian diet, the maximum dietary burden (beef and dairy cattle and pigs) is therefore 4.3 ppm. The residues expected in beef and dairy cattle and pigs from chlorpyrifos treated animal feeds are summarised below.

Milk and milk fats: Residues of chlorpyrifos were determined in whole milk and cream, following the feeding of cattle at 0.3, 1, 3, 10 or 30 ppm for 14 days. Residues in whole milk were < 0.01 mg/kg following feeding at 10 ppm. Residues in cream were a maximum of 0.04 mg/kg (45% butterfat content), therefore residues in milk fats would be 0.09 mg/kg. After 1 day removal from dosing, residues in whole milk after feeding at 30 ppm were <0.01 mg/kg, while residues in cream were <0.01 mg/kg after 3 days (not determined at 1 day withdrawal). Based on extrapolation for an estimated burden of 4.3 ppm (estimated highest residues of <0.01 mg/kg in milk and 0.039 mg/kg in milk fats), MRLs of *0.01 mg/kg for milk and 0.05 mg/kg for milk fats are appropriate for the supported uses in forage crops.

Offal: In a study involving the feeding of cattle at 10 ppm in the diet, the highest observed chlorpyrifos residues in liver were 0.02 mg/kg and in kidney were <LOQ (<0.01 mg/kg). In a study involving the feeding of pigs at 10 ppm in the diet, the highest observed chlorpyrifos residues in liver were 0.01 mg/kg and in kidney were <LOQ (<0.01 mg/kg). Based on extrapolation for an estimated burden of 4.3 ppm (estimated highest residues of 0.01 mg/kg for cattle liver and <0.01 mg/kg for cattle kidney, pig liver and pig kidney) and noting that sheep can also graze forage crops, an MRL of 0.03 mg/kg for mammalian edible offal is appropriate for the supported uses in forage crops.

Muscle and fat: In a study involving the feeding of cattle at 10 ppm in the diet, the highest observed chlorpyrifos residues in muscle were 0.02 mg/kg and in fat were 0.15 mg/kg. In a study involving the feeding of pigs at 10 ppm in the diet, the highest observed chlorpyrifos residues in muscle were 0.03 mg/kg and in fat were 0.18 mg/kg. Based on extrapolation for an estimated feeding level burden of 4.3 ppm (estimated highest residues of 0.01 mg/kg for cattle muscle and 0.065 mg/kg for cattle fat and 0.013 mg/kg for pig muscle and 0.077 mg/kg for pig fat), and noting that sheep can also graze forage crops, an MRL of 0.1 mg/kg for mammalian meat (in the fat) is appropriate for the supported uses in forage crops.

Trade assessment – forage crops

Cattle and pig commodities are major export commodities and finite residues in fat are expected to result from the proposed forage crop uses with a 28-day grazing withholding period. Codex has revoked all MRLs

for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at *0.01 mg/kg. Therefore, to ensure that residues are <LOQ and to prevent an undue risk to international trade, a clean feed export slaughter interval of 21 days is recommended for grazing animals and a clean feed export slaughter interval of 14 days is recommended for pigs. The following trade advice is recommended for all products that are approved for use on forage crops.

Livestock Destined for Export Markets: The label withholding periods for grazing only apply to stock slaughtered for the domestic market. Some export markets apply different standards. To meet these standards, ensure that the ESI is observed before stock are sold or slaughtered.

EXPORT SLAUGHTER INTERVALS (ESIs)

Grazing animals: Grazing animals that have been grazing on or fed treated crops should be placed on clean feed for 21 days prior to slaughter for export.

Pigs: Pigs that have been fed treated crops should be placed on clean feed for 14 days prior to slaughter for export.

Required animal commodity MRLs

The MRLs recommended for mammalian livestock and poultry commodities in the [Animal transfer studies and animal commodity MRLs](#) section above were driven by chlorpyrifos uses in animal feeds that are not supported by worker health and safety and/or environment risk assessments. Based on the livestock feed burden associated with supported uses on forage crops, it is recommended that the:

- meat (mammalian)[in the fat] MRL should be 0.1 mg/kg
- mammalian edible offal MRL should be 0.03 mg/kg
- whole milk MRL should be *0.01 mg/kg
- milk fat MRL should be 0.05 mg/kg.

Revised dietary exposure assessment

A revised dietary exposure assessment has been undertaken based on the use patterns supported by all risk assessments (forage crops including clover seed crops, lucerne, lucerne seed crops and medics), the revised ADI of 0.001 mg/kg bw/day and the revised ARfD of 0.03 mg/kg bw/day.

Chronic dietary exposure assessment

The chronic dietary exposure to chlorpyrifos is estimated by the National Estimated Daily Intake (NEDI) calculation encompassing all registered/temporary uses of chlorpyrifos and the mean daily dietary consumption data derived from the 2011–2012 National Nutritional and Physical Activity Survey. The NEDI calculation is made in accordance with World Health Organization (WHO) Guidelines and is a conservative estimate of dietary exposure to chemical residues in food.

Based on the supported uses and MRLs expected to remain as an outcome of this assessment (excluding current permit uses), the NEDI for chlorpyrifos is equivalent to <30 % of the ADI for domestic MRLs and <50% of the ADI if import MRLs in Schedule 20 of the food standards code are also considered. It is concluded that the chronic dietary exposure of chlorpyrifos is acceptable.

Acute dietary exposure assessment

The acute dietary exposure to chlorpyrifos is estimated by the National Estimated Short-Term Intake (NESTI) calculation. The NESTI calculations are made in accordance with the deterministic method used by the JMPR with 97.5th percentile food consumption data derived primarily from the 2011–2012 National Nutritional and Physical Activity Survey. NESTI calculations are conservative estimates of short-term exposure (24-hour period) to chemical residues in food.

The NESTIs for all food commodities relevant to the use patterns and MRLs supported by all risk assessment have been calculated. The maximum estimated acute dietary exposure for the uses supported by the APVMA review of chlorpyrifos was associated with milk and was 5 % of the ARfD for the 2–6 years age group of 2 % for the general population (2+ years). It is concluded that the acute dietary exposure of chlorpyrifos is acceptable.

Residues and trade recommendations

The following uses of chlorpyrifos on food crops are not supported based on potential risks identified in the residues safety assessment, including due to data gaps or acute dietary exposure concerns:

- Post-planting, foliar use on brassica vegetables (i.e. the control of butterflies, moths, caterpillars, aphids, budworm and corn earworms)
- Post-planting, foliar use on root and tuber vegetables other than potato (i.e. the control of light brown apple moth, earwig, redlegged earth mite and blue oat mite, wingless grasshopper and/or vegetable weevil in beetroot, carrots, parsnip, radishes, sweet potato, swede and/or turnips)
- Use on cucurbits other than cucumber
- Foliar use on peaches
- Use on pome fruit (apples and pears) at an application rate of 50 g ac/100 L
- Use on chard (silver beet) for control of vegetable weevil at 400 g ac/ha
- Use on cucumbers at an application rate that exceed 750 g ac/ha
- Use on kiwifruit with edible peel

The uses of chlorpyrifos on the major export commodities cereal grains, sorghum, rice, canola, cotton, pulses, citrus, grapes, pome fruit and stone fruit are not supported based on potential risks to international trade, with the exception of application made to cereals, canola, cotton and pulses prior to crop emergence or applications made to grapes, pome fruit and stone fruit prior to the end of dormancy.

While a number of chlorpyrifos use patterns could be supported from a residues and trade perspective, the contemporary worker health and safety and environmental risk assessments have only supported the use of chlorpyrifos in food-producing situations listed in Table 37. The specific uses of chlorpyrifos on brassica vegetables at a maximum rate of 70 g ac/ha and forage crops (including clover seed crops, lucerne, lucerne seed crops and medics) at a maximum rate of 130 g ac/ha are supported from a residues and trade perspective.

For use of chlorpyrifos on brassica vegetables, the following application timing instructions and withholding period should be added to relevant product labels:

- DO NOT apply after 14 days of transplanting
- HARVEST: NOT REQUIRED WHEN USED AS DIRECTED

For uses of chlorpyrifos on forage crops (including clover seed crops, lucerne, lucerne seed crops and medics), the following withholding period and trade advice should be added to relevant product labels:

- DO NOT GRAZE OR CUT FOR STOCK FOOD FOR 28 DAYS AFTER APPLICATION.
- Livestock Destined for Export Markets: The label withholding periods for grazing only apply to stock slaughtered for the domestic market. Some export markets apply different standards. To meet these standards, ensure that the ESI is observed before stock are sold or slaughtered.

EXPORT SLAUGHTER INTERVALS (ESIs)

Grazing animals: Grazing animals that have been grazing on or fed treated crops should be placed on clean feed for 21 days prior to slaughter for export.

Pigs: Pigs that have been fed treated crops should be placed on clean feed for 14 days prior to slaughter for export.

The specific uses of chlorpyrifos on cereals (application between BCCH 30 and 39) and canola (post-emergent application) at a maximum application rate of 70 g ac/ha are not supported based on potential risks to international trade. The following specific uses of chlorpyrifos cannot currently be supported from a residues and trade perspective due to insufficient data for a robust assessment of the level of chlorpyrifos residues expected, as required to establish MRLs for the relevant commodities:

- Chard (silver beet) and lettuce involving application at a maximum rate of 70 g ac/ha, made prior to BCCH 40
- Oilseeds (except canola and cotton) involving pre-emergent application at a maximum rate of 70 g ac/ha
- Cotton involving pre-emergent application at a maximum rate of 130 g ac/ha
- Canola and pulses (field peas, lupins, broad beans and chickpeas) involving pre-emergent application at a maximum rate of 100 g ac/ha

Amendments to the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

Table 38 and Table 39 include the recommended MRL changes in the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 which will be required as an outcome of the review of registered products. MRLs established for minor use permits and a corresponding entry in Table 5 of the MRL Standard for Residues of Chemical Products Instrument 2023 will be reconsidered separately, and additional amendments may be required after consideration of these permit uses. MRLs for registered uses not supported by the APVMA chemical review will be deleted after the completion of any phase out period. The MRL for brassica (cole or cabbage) vegetables, head cabbages and flowerhead brassicas will be driven by the residues expected from the control of redlegged earth and blue oat mites and

the MRLs for mammalian commodities (muscle, fat, offal, milk and milk fat) and legume animal feeds will be driven by the residues expected from use on forage crops at a maximum rate of 130 g ac/ha.

Table 38: Amendments to Table 1 of the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

Code		Commodity	MRL (mg/kg)	
			DELETE	ADD
VS	0621	Asparagus	T0.5	
FI	0326	Avocado	0.5	
FI	0327	Banana	T0.5	
VB	0040	Brassica (cole or cabbage) vegetables, head cabbages, flowerhead brassicas	T0.5	*0.01
VR	0463	Cassava	T*0.02	
VS	0624	Celery	T5	
GC	0080	Cereal grains {except Sorghum}	T0.1	
FC	0001	Citrus fruits	T0.5	
SB	0716	Coffee beans	T0.5	
SO	0691	Cotton seed	0.05	
OC	0691	Cotton seed oil, crude	0.2	
DF	0167	Dried fruits	T2	
MO	0105	Edible offal (mammalian)	T0.1	0.03
PE	0112	Eggs	T*0.01	
HS	0784	Ginger, root	*0.02	
FB	0269	Grapes	T1	
FI	0341	Kiwifruit	2	
VA	0384	Leek	T5	
FI	0345	Mango	*0.05	
MM	0095	Meat (mammalian)[in the fat]	T0.5	0.1
FM	0183	Milk fats		0.05
ML	0106	Milks		*0.01

Code	Commodity	MRL (mg/kg)	
		DELETE	ADD
ML	0106	Milks [in the fat]	T0.2
SO	0089	Oilseed {except Peanut}	T0.01
FI	0351	Passion fruit	*0.05
SO	0697	Peanut	T*0.01
VO	0445	Peppers, sweet [capsicum]	T1
FI	0353	Pineapple	T0.5
FP	0009	Pome fruits {except Persimmon, Japanese}	T0.5
VR	0589	Potato	0.05
PM	0110	Poultry meat [in the fat]	T0.1
PO	0111	Poultry, edible offal of	T0.1
GC	0651	Sorghum	T3
FS	0012	Stone fruits	T1
FB	0275	Strawberry	0.05
GS	0659	Sugar cane	T0.1
VR	0497	Swede	T0.3
VR	0508	Sweet Potato	T0.05
VR	0505	Taro	0.05
VO	0448	Tomato	T0.5
		Vegetables [except Asparagus; Brassica vegetables; Cassava; Celery, Leek; Peppers, sweet [capsicum]; Potato; Swede; Sweet potato; Taro; Tomato]	T*0.01

Table 39: Amendments to Table 4 of the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

Code	Commodity	MRL (mg/kg)	
		DELETE	ADD
AM	0691	Cotton fodder, dry	30
		Cotton meal and hulls	0.05

Code		Commodity	MRL (mg/kg)	
			DELETE	ADD
AL	1057	Legume animal feeds (except pulses)		7
AL	1270	Peanut forage (green)	T10	
		Peanut hay	T2	

Efficacy and target safety

Efficacy

The label variations recommended in this Technical Report are within the currently approved use patterns. The APVMA's risk assessments for worker health and safety, environment, residues and trade were revised upon consideration of the submissions received in response to public consultation on the Proposed Regulatory Decisions for the reconsideration, and the use of chlorpyrifos in brassica crops, forage crops was supported with application rate and application timing restrictions. These restrictions are within the application rate and timing range indicated on currently approved labels; however, the following statement is required for use patterns where current instructions state to use a higher rate than now supported when there is high pest pressure.

[When pest pressure is severe] [When a large number of aphids are invading the crop] [For heavier infestations], use of this product may not result in full control of pests.

The use of chlorpyrifos products, when used according to label directions, is expected to meet the efficacy criteria as described in the Agricultural and Veterinary Chemicals Code (Efficacy Criteria) Determination 2014 based on previous assessments and a demonstrated history of effective use.

Target crop safety

The label variations recommended in this Technical Report are within existing use patterns. Based on the previous satisfaction that the uses would be safe to target crops and that the APVMA has not received any adverse experience reports in relation to in-crop damage or off target damage from chlorpyrifos products, the APVMA is satisfied that the products will meet the safety criteria as they relate to target crop safety when used according to the proposed labels.

Target animal safety

The label variations recommended in this Technical Report are within the existing use patterns. The APVMA has received no adverse experience reports on animals that were considered likely to be caused by a chlorpyrifos product used according to label directions. Accordingly, the APVMA is satisfied that the products meet the safety criteria as they relate to target animal safety when chlorpyrifos products are used according to the proposed labels.

Spray drift

The APVMA's approach to spray drift management set out in the [APVMA Spray Drift Policy July 2019](#) specifies consideration of spray drift in bystander areas, livestock areas, natural aquatic areas, pollinator areas and vegetation areas. The regulatory acceptable levels (RALs) for each area are summarised in Table 40, which is the maximum amount of spray drift exposure that is not expected to cause undue harm to sensitive areas.

Table 40: Regulatory acceptable levels of chlorpyrifos resulting from spray drift

Area considered	Regulatory acceptable level
Natural aquatic areas	0.10 µg ac/L
Pollinator areas	12 g ac/ha
Vegetation areas	1200 g ac/ha
Bystander areas	3.87 g ac/ha
Livestock areas	0.75 mg/kg

The APVMA has only considered spray drift implications for uses of chlorpyrifos that are supported by the worker health and safety, residues, trade and environment risk assessments. These uses include:

- insect control in agricultural, commercial and industrial areas, commercial turf, container plants, hides/skins and potted ornamentals using manually pressurised handwand application equipment
- treatment of termite nest or colony in wall cavities using manually pressurised handwand application equipment
- insect control in brassica crops, forage crops clover seed crops, lucerne, lucerne seed crops and medics using boomspray application equipment.

In accordance with the APVMA Spray Drift Policy July 2019, mandatory downwind buffer zones are not required for backpack/knapsack or low and high-pressure handwand application methods. Therefore, based on the supported uses in brassica crops, forage crops clover seed crops, lucerne, lucerne seed crops and medics, the following spray drift restraints and downwind buffer zones would be required for application of relevant chlorpyrifos products:

SPRAY DRIFT RESTRAINTS

Specific definitions for terms used in this section of the label can be found at apvma.gov.au/spraydrift

DO NOT allow bystanders to come into contact with the spray cloud.

DO NOT apply in a manner that may cause an unacceptable impact to native vegetation, agricultural crops, landscaped gardens and aquaculture production, or cause contamination of plant or livestock commodities, outside the application site from spray drift. The advisory buffer zones in the relevant buffer zone table/s below provide guidance but may not be sufficient in all situations. Wherever possible, correctly use application equipment designed to reduce spray drift and apply when the wind direction is away from these sensitive areas.

DO NOT apply unless the wind speed is between 3 and 20 kilometres per hour at the application site during the time of application.

DO NOT apply if there are surface temperature inversion conditions present at the application site during the time of application. These conditions exist most evenings one to 2 hours before sunset and persist until one to 2 hours after sunrise.

DO NOT apply by a boom sprayer unless the following requirements are met:

- spray droplets not smaller than a MEDIUM spray droplet size category
- minimum distances between the application site and downwind sensitive areas (see 'Mandatory downwind buffer zones' section of the following table titled 'Buffer zones for boom sprayers') are observed.

Buffer zones for boom sprayers

Application rate	Boom height above the target canopy	Mandatory downwind buffer zones (metres)				
		Bystander areas	Natural aquatic areas	Pollinator areas	Vegetation areas	Livestock areas
Up to 130 g ac/ha	0.5 m or lower	5	240	0	0	0
70 g ac/ha or lower	0.5 m or lower	0	110	0	0	0
	1.0 m or lower	20	350	10	0	10
35 g ac/ha or lower	0.5 m or lower	0	55	0	0	0
	1.0 m or lower	10	150	0	0	0



Appendices

Appendix A – Public Consultation

The APVMA received 14 written submissions in response to the publication of the of the Proposed Regulatory Decision. The APVMA received permission to publish [11 of these submissions](#), which are accessible on the APVMA website. Details of the submissions are listed in Table 41 and the APVMA's considerations of these submissions are summarised below.

Table 41: Submissions in response to the proposed regulatory decisions on the reconsideration of chlorpyrifos

Submitter	Comments
Australian Banana Growers Council (ABGC)	Highlighted the importance of chlorpyrifos in the industry. Raised concerns on the use patterns, work rate assumptions and application rates assessed.
Australian Table Grape Association (ATGA)	Highlighted the importance of chlorpyrifos in the industry. Raised concerns on some of the assumptions used in the worker health and safety and environment assessments. Suggested trade concerns can be managed by industry.
AUSVEG	Raised concerns on the impact the decision as proposed would have on industry, on some of the assumptions uses in the worker health and safety and environmental assessments and on the outcomes of the residues and trade risk assessments.
Avocados Australia	Raised concerns on some of the assumptions used in the worker health and safety and environment assessments. Requested clarification of use patterns assessed. Suggested trade concerns could be managed by industry.
Delta Agribusiness	Raised concerns on the impact the decision as proposed would have on industry.
GeneEthics	Advocated for a total ban on chlorpyrifos based on the adverse human health and environmental effects and referencing the regulatory status of chlorpyrifos in other countries. Raised concerns regarding the human exposure assessment, proposed maximum residues limits and environment assessment outcomes.
GRDC	Raised concerns on the impact the decision as proposed would have on industry and on some of the assumptions used in the worker health and safety and environmental assessments. Suggested that the high priority pre-plant or early post-emergent uses of chlorpyrifos would not pose an undue risk to international trade.
National Working Party on Grains Protection (NWPGP)	Supported the APVMA's proposed course of action based on international market access concerns.
Summerfruit Australia Ltd.	Raised concerns on the impact the decision as proposed would have on industry, on some of the assumptions uses in the worker health and safety and environmental assessments and on the outcome of the residues assessment for peaches. Acknowledged that there may be risks to international trade with continued foliar uses of chlorpyrifos on stone fruit.
Private citizen	Raised concerns on some of the assumptions used in the environment assessment and the transparency of the environment assessment.
Private citizen - on behalf of Potato Growers	Highlighted regions reliance on specific chlorpyrifos minor use permits.

International regulatory status

GeneEthics advocated for a total ban on all uses of chlorpyrifos in line with some other countries.

APVMA Response: The APVMA is an independent statutory authority responsible for regulating agricultural and veterinary (agvet) chemicals in the Australian marketplace up to and including the point of retail sale. Our registration and chemical review processes involve scientifically evaluating the safety and efficacy (effectiveness) of active constituents and chemical products to protect Australia's trade and the health and safety of people, animals, and the environment. While the APVMA collaborates regularly with many overseas regulators, international agencies and working groups, we independently evaluate the safety and efficacy of agvet chemicals in the Australian marketplace. These scientific risk assessments consider the legislative provisions set out in the Agvet Code and the specific uses of the agvet chemical approved within (or requested for use in) Australia, in addition to factors such as the Australian environment and Australian agricultural practices.

Chlorpyrifos use patterns considered

The ABGC suggested that many of the usage patterns used in the technical report are not relevant to today's banana farming and supplied information on how chlorpyrifos is used in the banana industry.

APVMA Response: It appears that the uses described by the ABGC are not included on any registered product labels and may only be authorized only under permit. The chlorpyrifos chemical review did not consider uses approved under minor use permits, these will be considered separately upon completion of the review of registered products. The chlorpyrifos uses on registered products labels are summarised in Table 44, and were not supported due to environment and/or worker health and safety concerns.

Avocados Australia have requested clarification on the application rates considered and the associated assessment outcomes.

APVMA Response: The APVMA considered a range of approved uses of chlorpyrifos on avocados which are summarised in Table 44. This includes:

- use at 50 g ac/100 L (1000 g ac/ha) for the control of fiorinia scale, latania scale, hairy caterpillar, light brown apple moth, red shouldered leaf beetle, avocado leafroller and ivy leafroller
- use at 25 g ac/100 L (500 g ac/ha) for the control of hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle, avocado leafroller and ivy leafroller
- use at 0.1 to 0.2 g ac/tree or 30 to 60 g ac/ha for the control of Queensland fruit fly.

In the worker health and safety assessment, application at 500 g ac/ha (25 g ac/100 L, spot spray) using a mechanically pressurised handgun was the only use supported from an occupational exposure perspective (Table 8). Application at 1000 g ac/ha (25 g ac/100 L, spot spray) using a mechanically pressurised handgun, application at either 500 g ac/ha or 1000 g ac/ha using airblast spray equipment and application at 0.1 to 0.2 g ac/tree or 30 to 60 g ac/ha (strip or patch low on tree/vine) using a mechanically pressurised handgun (outcomes under Crop: Various (Queensland

fruit fly control)) were not supported from an occupational exposure perspective (Table 9). These application rates assessed are included on the labels of registered chlorpyrifos chemical products.

In the interest of efficiency, a number of uses that were not supported by the health assessments were not assessed from the viewpoint of environmental safety. For this reason, in the draft Chlorpyrifos Review Technical Report, only the application at 500 g ac/ha was considered in the environmental safety risk assessment. The rates assessed were quoted in Tables 24, Table A1 and the footnote to Table 34; however, the inclusion of the rate 250 g ac/ha in Table 28 was a typographical error. The APVMA thanks the Avocados Australia for identifying this error in the draft Chlorpyrifos Review Technical Report.

The APVMA has refined its environment assessment in this final Chlorpyrifos Review Technical Report and evaluated a number of additional use patterns. For uses in avocados, foliar applications at 30 to 1000 g ac/ha, ground directed applications at 30 to 60 g ac/ha and spot spray applications at 500 g ac/ha were considered from the viewpoint of environmental safety. The updated environmental safety risk scenarios are outlined in Table 18 and the environmental safety risk assessment outcomes are summarised in Table 31 and Table 32.

Potato growers highlighted their reliance on chlorpyrifos uses authorised under minor use permits.

APVMA Response: The chlorpyrifos chemical review did not consider uses authorised under minor use permits. The safety and efficacy of chlorpyrifos uses authorised under permit in specific situations will be considered following the Final Regulatory Decision on active constituents, products and labels.

Impact of the regulatory decision as proposed

Many submissions highlighted the detrimental impact the decision as proposed would have on their respective industries. Many submissions also provided information on the priority pests for control in their respective industries, including early season control of sap-sucking insects in grapes, control of San Jose scale in stone fruit, early season control of soil residing pests such as redlegged earth mite or cutworm in vegetables, and control of soil residing pests including blue oat mite, lucerne flea and redlegged earth mite in field crops (application pre-plant or early post-emergent) and pasture.

APVMA Response: The chemical review process involves evaluating the safety and efficacy of active constituents and chemical products to protect Australia's trade and the health and safety of people, animals, and the environment. To affirm (or vary and affirm) active constituents, chemical product registrations or label approvals at the conclusion of a chemical review, the APVMA must be satisfied that they meet the relevant legislated safety, efficacy, trade and/or labelling criteria. As such, the APVMA must be satisfied that use in accordance with instructions (or varied instruction) would be safe, efficacious and not pose an undue risk to trade and that labels contain adequate instructions, and the scientific risk assessments must be completed to a contemporary standard. There are no legislative provisions that allows the APVMA to complete a cost/benefit analysis for the usage of an agvet chemical, nor for the APVMA to consider factors such the impact on industry or lack of suitable alternatives.

That said, the APVMA has further refined the worker health and safety and environment risk assessments upon consideration of all submissions received in response to the public consultation. For the worker health and safety risk assessment, this included consideration of whether occupational exposure risks can be mitigated using engineering controls during mixing and loading (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank). For the environmental safety risk assessment, this included consideration of the maximum rate supported in crops across all crop growth stages (Table 23, Table A1) and the assessment of additional chlorpyrifos uses which were supported by the revised health assessment. In the draft Chlorpyrifos Review Technical Report (APVMA 2023), in the interest of efficiency, a number of uses, not supported by the health or trade assessments, were not assessed from the viewpoint of environmental safety. The use patterns considered or not considered in the revised environment assessment are set out in Table 18 and Table 19. Following the revised environment assessment any additional uses (or applications rates) supported by health and environment were assessed for risk to residues and trade (Table 37).

The APVMA has also committed to prioritising applications for off-label permits and applications to vary current products or register new products where there may be no approved alternatives to chlorpyrifos.

Chemistry assessment

Toxicologically significant impurities

GeneEthics raised concerns that the APVMA Standard for chlorpyrifos permits a level of 3 g/kg maximum for the toxicologically significant manufacturing impurity O,O,O',O'-tetraethyl dithiopyrophosphate (S,S-TEPP) and questioned why these are acceptable levels of toxicological impurities.

APVMA Response: While S,S-TEPP is a toxicologically significant manufacturing impurity, the presence of S,S-TEPP at a maximum level of 3 g/kg (0.3%) is not expected to have an impact that is harmful to human beings or to the environment. The maximum limit of 3 g/kg for S,S-TEPP for chlorpyrifos active constituents in the APVMA Standard is internationally considered a safe and appropriate maximum limit, as it is consistent with the S,S-TEPP maximum limit included in the Food and Agriculture Organization of the United Nations (FAO) specification for chlorpyrifos technical active constituent (FAO 2020).

Worker health and safety assessment

Exposure to children

GeneEthics raised concerns that the human exposure assessment did not adequately consider the impacts of child exposure.

APVMA Response: The APVMA conducts scientific determination of health risks to users and individuals incidentally exposed to pesticides through their normal use. The [2019 residential exposure assessment and risk characterisation report](#) highlighted the risks of using chlorpyrifos in areas to which children have access, which in part resulted in the cancellation of all home garden

chlorpyrifos products in 2019 and the variation or cancellation of commercial chlorpyrifos products to remove residential uses in 2019-20. As an outcome of the reconsideration, the standard restraints 'DO NOT use in or around publicly accessible residential, public or commercial areas.' and 'DO NOT use in areas accessible to children' are included on the label of all applicable products.

The commercial uses of chlorpyrifos considered in the worker health and safety assessment are expected to result in no or negligible exposure to children, when the product is used in accordance with instructions. The commercial use of chlorpyrifos to control certain pests in the turf industry remain acceptable when evaluated using contemporary risk assessment methodology, as the amount of exposure from transplanted, chlorpyrifos-treated turf was several orders of magnitude below levels that are considered acceptable by regulatory authorities worldwide. Chlorpyrifos exposure from impregnated materials (cattle ear tags and banana bags) is considered negligible; however, a restraint to keep children from playing with these chemical products is included in the safety directions as a standard precaution.

For uses of chlorpyrifos in forage crops, which have been reassessed after consideration of submissions received in response to the public consultation and are now supported by all risk assessments at a maximum rate of 130 g ac/ha, mandatory no-spray buffer zones are included to prevent unintentional exposure to bystanders (including children) from spray drift.

Work rate assumptions (fruit and vegetables)

Multiple submissions raised concerns that the work rate assumption of 30 ha per day for airblast foliar application (orchard/vineyards) is an overestimation. It was suggested by Avocados Australia Limited and Summerfruit Australia (SAL) that 10 ha/workday is a more realistic assumption. It was also suggested by Australian Table Grape Association (ATGA) that 15 ha/workday is a more realistic assumption.

APVMA Response: The risk assessments for occupational health and safety must take into consideration reasonable worst-case exposure scenarios, which represent likely exposure estimates for high-end users. While we accept that there are a number of variables that can determine maximum area treated in a day, a small change in one or 2 of the parameters (such as differences in tree size, row spacing, thickness of canopy, stage of growth, type of sprayer, spray tank capacity, tractor speed etc.) can significantly change a calculated maximum area that can be treated per day. For example, airblast spray equipment is available with tank volumes up to 7000 L (more than double the capacity referenced in some submissions) which would reduce re-fill and ferrying times, allowing more time for spraying thereby increasing the area that may be treated in a single day. In orchards, application at higher speeds than noted in submissions (such as up to 7 km/h) is considered likely to be undertaken by some operators, particularly for early season spraying. In vineyards, retail sprayers with large spray tanks that can deliver outputs of greater than 180 L/min are available, which would easily enable treatment of 30 ha in a single day with a three-row sprayer.

Therefore, the suggested maximum of 10 ha/day or 15 ha/day were not accepted as a realistic worst-case exposure scenario as they are likely to be exceeded by some users. While a typical grower may spray less than this in an average day, the APVMA still considers the work rate assumption of 30 ha/day for airblast foliar application (orchard/vineyards) to be a reasonable worst-case scenario that would address likely exposures to high-end users. It is also noted that the application of chlorpyrifos

using airblast application was supported by the worker health and safety exposure assessment at rates up to 250 g ac/ha using PPE and closed cab application equipment (or up to 500 g ac/ha using closed mixing/loading systems and closed cab application equipment). This excludes seasonal application to grapevines where a practical re-entry period for girdling could not be established, which does not rely on the area treated per day.

A submission raised concerns that the work rate assumption of 50 ha per day for ground boom application of chlorpyrifos to vegetable crops is an overestimation. It was suggested by AUSVEG that an upper limit of 20 ha/day is more realistic for insecticide and fungicide spraying in vegetables, based on calculated time it would take to spray this area using an 8 m boom length and a water volume of 1000 L/ha.

APVMA Response: The risk assessments for occupational health and safety must take into consideration reasonable worst-case exposure scenarios, which represent likely exposure estimates for high-end users. There are many variables that influence the area that can be treated in a day. Boom spraying apparatus is commercially available with a range of tank capacities and boom widths. For example, there is boom spraying apparatus commercially available with a 3000 L capacity spray tank, a 24 m wide boom and a spray output up to 170 L/min, which would spray 50,000 L within 5 hours (50 ha at 1000 L/ha). It is also feasible that a water volume much lower than 1000 L/ha may be used in the treatment of vegetable crops (e.g. a minimum of 250 L/ha), decreasing the time it takes to spray an area and reducing the number of times the boom sprayer may need to be refilled.

Therefore, the suggested maximum of 20 ha/day was not accepted as a realistic worst-case exposure scenario as it is likely to be exceeded by some users. The APVMA still considers the work rate assumption of 50 ha/day to be a reasonable worst-case estimate for vegetable crops. It is also noted that the application of chlorpyrifos to vegetable crops by groundboom was supported by the worker health and safety exposure assessment at rates up to 400 g ac/ha using PPE and closed cab application equipment (or up to 750 g ac/ha using closed mixing/loading systems and closed cab application equipment).

Work rate assumption (broadacre crops)

A submission from GRDC questioned the basis of the work rate assumption of 600 ha per workday for broadacre crops and suggested that 250 ha a workday of 7 hours provides a more accurate and realistic figure. This was based on calculations involving a spray equipment with a 16 m boom, medium nozzles, an application volume of 70 - 100 L/ha and a spray output of 55 L/minute.

APVMA Response: The risk assessments for occupational health and safety must take into consideration reasonable worst-case exposure scenarios, which represent likely exposure estimates for high-end users. While a typical user may use application equipment as described in the GRDC submission, boom sprayers are commercially available with boom widths up to and including 48 m and a spray tank capacity of 8500 L. The APVMA has considered a range of calculated maximum work rates for broadacre boomspray application, which include parameters such as boom length, tank size, crop growth stage, ground speed, field length, turning speed, ferrying and refilling. After this consideration, the APVMA believes that a work rate of 500 ha per workday is a reasonable worst-case estimate to use in worker health and safety risk assessments

The APVMA has reassessed the occupational exposure for broadacre applications with this reduced work rate assumption, accounting for the use of closed cab application and use of PPE when mixing and loading (Table 9) or use of engineering controls (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank, Table 10). In this revised assessment, broadacre uses were supported by the worker exposure assessment at low rates (35 – 100 g ac/ha) using closed mixing/loading systems and closed cab application.

Environment assessment

Persistence of chlorpyrifos in soil

Some submissions have noted that a single DT₅₀ value was used as the key regulatory endpoint for soil exposure estimates based on the geomean DT₅₀ from field dissipation data. However, dissipation is expected to be biphasic and highly variable due to number of factors (including pH and initial concentration). It was proposed that the APVMA consider the use of half-lives that reflect the likely circumstances associated with the use of chlorpyrifos, rather than rely on a single value.

APVMA Response: The persistence of chlorpyrifos in soil is relevant to soil exposure estimates for the assessment of risks to soil organisms, terrestrial vertebrates (via food chain) and aquatic species (via runoff). The DT₅₀ values reported by the APVMA in Appendix B, Table 46 were derived for use in modelling and account for the dissipation kinetics. Further details on the studies and the derivation of the values used for modelling is publicly accessible in Volume 3 B8 (AS) of EFSA (2017).

Use of a single conservative soil DT₅₀ in these assessments is consistent across multiple comparable international organisations. Because multiple values increase the number of assessment scenarios exponentially, it is more practical to refine assessments in other ways (for example, new refinements to the food chain assessment are discussed in the [Environment](#) section). In the case of chlorpyrifos, the APVMA considered dissipation under field conditions 'on average' to be a reasonable approach given multiple points of conservatism are built into other aspects of the assessments.

Endocrine disrupting and POP properties

It was suggested that chlorpyrifos is an endocrine-disrupting substance. Based on this assertion and its persistent organic pollutant (POP) characteristics, a total ban on all uses of chlorpyrifos was requested.

APVMA Response: The APVMA assessment of endocrine disruption potential was based on OECD Revised Guidance Document 150 (OECD 2018). The environmental assessment focussed on non-mammalian tests, while the health assessment considered any relevant mammalian studies. The non-mammalian assessment was undertaken as part of Level 3, Level 4 and Level 5 of the OECD conceptual framework as indicated in Table 42 (below).

There are 3 studies available that specifically assessed endocrine disruption effects of chlorpyrifos in non-mammalian receptors. Two fish short-term reproduction assays with *Pimephales promelas* were undertaken to ascertain whether the test material, chlorpyrifos, has potential endocrine activity in the HPG axis of fish. One study only showed an adverse effect on fecundity and this effect could not be mediated by an endocrine disruption mode of action. The other study did not find effects on fertility or

fecundity; however, the test deviated from the guideline and the exposure period may not have encompassed a vulnerable period of development. The third study was an amphibian metamorphosis study that found adverse effects on endpoints for thyroid related activity.

Outside of those reports, there are no other available studies specifically designed to assess the potential of chlorpyrifos to impact endocrine systems. The evidence available from the reproduction study in mallard duck indicates some of the endpoints in this apical test that are potentially affected by EATS endocrine disruptors were observed. Of particular interest in the context of estrogens, androgens and steroidogenesis disrupters were observations that egg production, embryo viability and hatchability were all affected at the higher treatment rate. Further endpoints that might also be responsive to some endocrine disruptors were observed, including growth, which may respond to some thyroid disrupters and eggshell thickness, which may respond to chemicals interfering with the control of shell deposition.

Given these findings and the overall lack of endocrine specific testing for chlorpyrifos, the environmental assessment did not rule out chlorpyrifos as an endocrine disrupting chemical. Key regulatory endpoints used in the environmental assessment were concentrations or doses at which no effects of concern were noted. Therefore, the assessment is considered to address any effects potentially mediated by an endocrine disruption mode of action.

While the APVMA has concluded that chlorpyrifos meets the characteristics of a POP substance, continued use is supported by the environmental assessment under certain conditions where it is satisfied that it is unlikely to have an unintended effect that is harmful to animals, plants or things, or to the environment. This included consideration of its persistence and the food chain risks.

Table 42: Chlorpyrifos – Non-mammalian ecotoxicity studies for considering endocrine disrupting effects

Level of OECD conceptual framework	Test ¹	Reference
Level 3: In vivo assays providing data about selected endocrine mechanism(s)/ pathway(s)	OECD 231: amphibian metamorphosis assay	Coady et al. 2012
	OECD 229: fish short-term reproduction assay	Coady et al. 2015, Currie et al. 2011
	OECD 230: 21-day fish assay	— ²
	OECD 148: androgenised female stickleback screen	—
	draft OECD TG: EASZY assay – detection of substances acting through estrogen receptors using transgenic cyp19a1b GFP zebrafish embryos	—
	draft OECD TG: <i>Xenopus</i> embryonic thyroid signalling assay	—
	draft OECD TG: juvenile medaka anti-androgen screening assay	—
	draft OECD TG: short-term juvenile hormone activity screening assay using <i>Daphnia magna</i>	—

	draft OECD TG: rapid androgen disruption adverse outcome reporter assay	—
Level 4: In vivo assays providing data on adverse effects on endocrine-relevant endpoints	OECD 234: fish sexual development test	—
	OECD 241: larval amphibian growth and development assay	—
	OECD 206: avian reproduction assay	Beavers & Fink 1978a, Beavers & Fink 1978b
	OECD 210: fish early life stage toxicity test	Goodman et al. 1985
	OECD 201: harpacticoid copepod development and reproduction test with <i>Amphiascus</i>	—
	OECD 242: <i>Potamopyrgus antipodarum</i> reproduction test ³	—
	OECD 243: <i>Lymnaea stagnalis</i> reproduction test	—
	OECD 218-219: chironomid toxicity test	—
	OECD 211: <i>Daphnia magna</i> reproduction test (with male induction)	Adema & De Ruiter 1990
	OECD 222: earthworm reproduction test	Hayward 2002
	OECD 220: enchytraeid reproduction test	—
	OECD 225: sediment water <i>Lumbriculus</i> toxicity test using spiked sediment	—
	OECD 226: predatory mite reproduction test in soil	—
OECD 232: collembolan reproduction test in soil	—	
Level 5: In vivo assays providing more comprehensive data on adverse effects on endocrine-relevant endpoints over more extensive parts of the life cycle of the organism	OPPTS 850.1500: fish life cycle toxicity test	Mayes et al. 1993
	OECD 240: medaka extended one-generation reproduction test	—
	OCSP 89.2100: avian two-generation toxicity test in the Japanese quail	—
	OECD 233: sediment water chironomid life cycle toxicity test	—
	draft OECD TG: <i>Daphnia</i> multigeneration test for assessment of EDCs	—
draft OECD TG: zebrafish extended one-generation reproduction test	—	

1 Some assays may also provide some evidence of adverse effects; some endpoints at Levels 4 and 5 can be sensitive to more than one mechanism and may be due to non-endocrine mechanisms

2 No study available

RAL for acute mammal assessment

Clarification was requested on why the acute LD₅₀ of 97 mg/kg was applied as the key regulatory endpoint for all wild mammals, noting that the 1999 JMPR reported a range of LD₅₀ values for rats (Henck & Kociba 1980) as well as for guinea pigs and rabbits (Lackenby 1985). Given the interspecies variability reported, an LD₅₀ of 1000 mg/kg bw was proposed as a more representative value for use in large terrestrial vertebrates risk assessments

APVMA Response: The data available to the APVMA that are considered reliable and of sufficient quality to inform the wild mammal assessment are listed in Appendix B, Table 49. The LD₅₀ 97 mg/kg bw was the only definitive value available for the acute assessment and was considered most suitable. It is noted this endpoint is the same order of magnitude as used by other regulatory agencies for their wild mammal assessments. Other international values were LD₅₀ 60 mg/kg (PMRA 2019, USEPA 2020) and LD₅₀ 64 mg/kg (EFSA 2017).

The JMPR assessment does not appear to report acute oral LD₅₀ values for guinea pigs or rabbits. Lackenby 1985 appears to report an LD₅₀ of 504 mg/kg for guinea pigs and 1000-2000 mg/kg for rabbits; the underlying data (Dow 1963) have not been supplied to the APVMA and therefore have not been considered in the environmental assessment. Nevertheless, it should be noted that assessment model species are always of small size, whether they are 'indicator', 'generic' or 'focal', as small animals are at greatest risk. Further, mortality from acute exposure to chlorpyrifos was not identified as the effect of greatest concern in wild mammals, and refining this value does not affect the overall conclusions on risks to wild mammals.

RAL for chronic mammal assessment

Clarification was requested on the determination of the NOEL value of 1.0 mg/kg bw/d, used as the basis of the RAL for the chronic mammal assessment. The value used by the APVMA, based on the Breslin (1991) study, related to developmental effects in rat offspring, i.e., decreased body-weight gain and survival of F1 pups in the 0 treatment and the 5 mg/kg bw/d. This effect was, in part, attributed to maternal neglect. Whereas Breslin also proposed a reproductive NOEL of 5 mg/kg bw/d level, the highest dose tested and a potentially a more relevant threshold from a chronic exposure perspective.

APVMA Response: A justification for the RAL for the chronic mammal assessment was outlined in the Supplementary Environmental Assessment (APVMA 2019b) and is also outlined in Appendix D – Wild mammal assessments. Guidance for selection of key regulatory endpoints for the wild mammal assessment can be found in EFSA (2009). The Interim Toxicology Assessment (APVMA 2019a) provides a study summary of Breslin (1991) which noted maternal neglect of the F2 pups; however, the decreased body weight gain and survival of the F1 pups at 5 mg/kg bw/d was considered to be treatment related (NOEL 1.0 mg/kg bw/d) and is considered to be ecologically relevant. It is noted this endpoint is in line with EFSA (2017) and PMRA (2019) who used the same NOEL for their wild mammal assessments. In contrast, the USEPA (2020) used a more conservative value (NOAEL 0.33 mg/kg bw/d) based on 4-5% decreased body weight of rats following dietary exposure to 7.0 mg/kg bw/d in an oncogenicity study (Crown et al. 1988).

Chronic dietary exposure of wild mammals

Clarification was sought on how seasonal exposure rates were derived for the wild mammal assessment. Seasonal rates to insects and foliage appeared to be overestimates when comparing to the soil exposure calculations, which consider crop interception.

Many have noted uncertainty over the assumption that 50% of an animal's food items are obtained from the treatment area in a chronic dietary assessment. Most considered this an overestimate, while one commenter believes that data should be supplied to assume anything other than 100%.

The relevance of 21 day timeframe for chronic dietary exposure was also unclear to many given the resultant daily dietary dose levels reported in Table A2 in the draft Chlorpyrifos Review Technical Report appear to be zero-day estimates. It was not believed to be representative of any mammal's life span, and also thought to be arbitrary/subjective.

Fruit growers also noted that the potential for dietary exposure of frugivores such as possums is low on the basis of them not being common in orchards. Furthermore, frugivores tend to consume ripe fruit, while fruit such as mangos and avocados are harvested green/ unripe. The MRL for whole fruit was suggested as a refinement option for frugivores.

Some growers have noted there are several agricultural practices that reduce the likelihood of terrestrial vertebrates foraging in the treatment area, including mowing interrow and netting. In the case of grapes, vertebrate pests such as birds and rabbits are typically controlled by 'bird scarers' and rabbit proof fencing.

APVMA Response: The term 'seasonal exposure rate' might be better referred to as a 'seasonal application rate' or 'seasonal cumulative rate'. Because the APVMA also accounts for dissipation between applications and fraction of field treated (FFT), it prefers the term 'seasonal exposure rate'. Exposure is assumed to begin on the last day of application. The footnote of Table A1 in Appendix B of the draft Chlorpyrifos Review Technical Report (APVMA 2023) indicates that the seasonal exposure rates are based on the indicated application rate, frequency, DT₅₀ (dependent on food item of interest), and fraction of field treated (FFT). The specific equation is as follows: (seasonal rate in g/ha) = (application rate in g/ha) × (1 - EXP(- (number of applications) * LN(2) / (DT50 in d) × (retreatment interval in d))) / (1 - EXP(- LN(2) / (DT50 in d) × (retreatment interval in d))) * FFT.

Given the treatment areas of chlorpyrifos are managed areas that are not natural habitats of terrestrial vertebrates, the APVMA considered that 50% proportion of food obtained from the treatment area was a reasonable worst- case scenario for the chronic assessment (PT 0.5) in the initial assessment. However, given the chronic endpoint is based on neonatal effects that may result from short-term exposure at a critical life stage, the APVMA considers the PT 1.0 more appropriate for chlorpyrifos and has revised the assessment accordingly.

The daily dietary dose (DDD) for reproductive risk assessments is the 'seasonal exposure rate' × 'shortcut value' × PT × 'TWA factor'. The shortcut values include consideration of the body weight of the focal species and its energy requirements, foraging strata, crop interception relevant to the crop growth stage, and the 'residue per unit dose' (RUD) for the dietary item of interest (RUD). The RUD is defined as the initial residue on the food item following an application rate of 1 kg ac/ha. Please refer to EFSA (2009) for more information on shortcut values and RUDs.

The 21-day period is the default timeframe for the assessment of reproductive risks to terrestrial vertebrates and is the convention applied internationally. Appendix H of EFSA (2023) provides some background on the selection of the 21-day default and the reasoning behind its continued use. However, given that the TWA factor was not applied (see rationale in Appendix C of the Chlorpyrifos Review Technical Report), the length of exposure does not influence the risk assessment.

The generic focal species are representative of feeding guilds; however, it is important to note that they are not intended to refer to strict herbivores, insectivores, granivores, or frugivores. An animal referred to as a frugivore, for example, may actually be omnivorous but at certain times of the year takes in a high proportion of fruit.

Different frugivores will have clear preferences for different types of fruits and nuts and different crop structures. Crop-specific focal species may be determined using field studies or published data. Please refer to Appendix M of EFSA (2009) and section 6.5.3 of EFSA (2023) for guidance on how to identify a crop-specific focal species.

Where unacceptable risks have been identified, use might be acceptable with risk mitigation measures in certain situations provided there is supporting information to demonstrate a quantifiable reduction in risk. Prior to making an application to propose the assessment of use patterns with additional mitigation measures, prospective applicants are encouraged to seek pre-application assistance to discuss any proposed mitigations and relevant data requirements.

Foliar interception

A foliar interception of 0.60 was used for all orchard crops in the draft Chlorpyrifos Review Technical Report (APVMA 2023). However, it was proposed that the citrus interception factor of 0.80 was a more suitable value for evergreen trees such as avocado (citing EFSA 2014).

APVMA Response: The APVMA agrees with a crop interception factor of 0.80 for evergreen trees (avocado, citrus, loquats), which is relevant to the soil exposure estimates, and has revised the assessment accordingly. With respect to the direct dietary exposure assessment of wild mammals, crop interception is already factored into the shortcut values used in the assessment. Because 70% crop interception is assumed for applications at BBCH ≥ 40 in the direct dietary assessment of wild mammals in orchards (EFSA 2009), results for BBCH ≥ 40 can apply to any application timing for evergreen trees.

Fraction catchment treated

Some submissions noted that the assumption that 50% of the catchment being treated overestimates the potential levels of environmental exposure and questioned why MCAS-S data were not used to determine a more accurate estimate of catchment fraction treated. Another noted that 50% of the catchment being treated is an underestimate for the Tier 1 and Tier 2 levels of assessment because the catchment size is 10 ha at these levels, while crops such as cotton are typically much larger than 10 ha in area.

APVMA Response: Although the Tier 1 and Tier 2 levels of assessment assume a catchment is 10 ha in size, this is not considered to be representative of a real catchment. Rather, the scenarios at these levels of assessment are theoretical and conservative and are designed to overpredict risks so

that adverse effects via runoff can be confidently ruled out. Based on MCAS-S data, the APVMA considers that 50% is a reasonable worst-case for FCT and informs risks at these levels of assessment on a proportional basis. Nevertheless, the APVMA agrees applying this assumption at the Tier 1 and Tier 2 levels of assessment is less conservative than assuming 100%. As a result, runoff has been reassessed for fruit, vegetable and field crops supported by the terrestrial vertebrates assessment, assuming FCT 1.0 at the Tier 1 and Tier 2 levels of assessment to demonstrate an even higher confidence in the conclusion of acceptable risk (Appendix E). FCT values based on MCAS-S data are only applied at the Tier 3 level of assessment and apply to real-world catchment areas; though, it is noted that no uses supported by the terrestrial vertebrates assessment required a Tier 3 level of assessment.

Heterogeneity factor

It was noted that the heterogeneity factor of 0.5 (based on Dunne & Black 1970) was not applied in the Tier 2 assessment.

APVMA Response: In the Tier 1 runoff assessment, the APVMA applied the heterogeneity factor of 0.50, but should not have applied it in combination with an FCT value less than 1 for a small (10-hectare) catchment. The updated Tier 1 assessment is presented in Appendix E.

In the Tier 2 runoff assessment, the APVMA assumed a FCT (0.50) for a small (10-hectare) catchment rather than the heterogeneity factor (also 0.50). Given the factors are the same, this does not change the outcome of the Tier 2 results that were presented in the draft Chlorpyrifos Review Technical Report (APVMA 2023).

There are no changes to the Tier 3 runoff assessment outcomes. In the Tier 3 runoff assessment, a heterogeneity factor of 1.0 is applied given exposure estimates are refined on spatial and temporal scales. MCAS-S data were used to derive FCT values for various regions and uses. Bureau of Meteorology data were used to derive percentile rainfall values for various regions and timings.

Integrated pest management

It was noted that chlorpyrifos can be an important tool in an integrated pest management approach for various crops, and that chlorpyrifos can be used judiciously and in combination with other IPM practices to effectively manage pest populations while minimizing the overall use of pesticides.

APVMA Response: Available data indicate that chlorpyrifos is harmful to beneficial (predatory and parasitic) arthropods, but the information was not sufficient to perform a risk assessment at field relevant rates. Therefore, the APVMA requires a non-compatibility statement on labels for situations where IPM might be practiced until sufficient information is available to demonstrate otherwise.

Transparency of assessment

The author of a submission was not satisfied that the environmental risk assessment section of the report fulfills the obligations and commitments of the APVMA to be science-based and transparent, in its decision making.

APVMA Response: The APVMA considers that the published assessment is science-based and fully transparent in its assumptions, inputs and methods, with provision of a full listing of endpoints that are considered reliable to inform the environmental assessment. Through the public consultation process, all stakeholders have had the opportunity to identify errors, challenge assumptions, and seek clarification on any aspects of the assessment that have not been clearly communicated or are not fully understood. All comments pertaining to the environmental assessment have been addressed in this document and have been factored into the Final Regulatory Decision.

Insect baits

It was suggested that use of chlorpyrifos treated insect baits in established crops (i.e. at advanced growth stages, such as BBCH 60 and above) would pose a significantly lower risk to terrestrial vertebrates, as the crop canopy would effectively act to screen the baits from birds and small vertebrates.

APVMA Response: No information has been submitted which would allow the exposure estimates for terrestrial vertebrates to be refined in this manner.

Residues and trade assessment

Residues in vegetables

AUSVEG requested clarification on the residues data deficiencies identified for specific vegetable commodities and the basis for the associated conclusions.

APVMA Response: In 2000, an [interim agricultural assessment for chlorpyrifos](#) was published by the APVMA (including a residues and trade assessment) which identified that further residue data was required to confirm temporary MRLs (or TMRLs) for a number of plant and animal commodities. A [preliminary review findings](#) report (APVMA 2009) was published in 2009, which included consideration of additional residues data submitted for 27 fruit and vegetable crops. This report recommended that the use of chlorpyrifos in a range of situations be removed or restricted to specific application timings, as follows:

- No post-planting foliar applications to asparagus, celery, carrot, lettuce, onion and sweet potato (treatment at or before planting and baiting for crickets still permitted)
- No use on pulses, canola, linseed and safflower beyond the 4–10 leaf stage
- No use on sugarcane after the 3 months following planting or ratooning
- No application to bananas after the exposure of the fingers
- No use for the control of spur throated locust in rice
- No use on peaches, tree nuts or tomatoes, other than tomatoes used for processing or use of cracked grain baits (for earwig control) in peaches

The preliminary review findings report (APVMA 2009) report discusses crops for which residues data was considered to be deficient and additional information had been included in the residues risk assessment above. Although public submissions have been received, no additional residues data

have been submitted since 2009. The conclusions in the residues assessment are a result of re-evaluation of the previously submitted data.

AUSVEG requested clarification on dietary exposure concerns for chard (silver beet) and cucumbers; specifically, which uses resulted in possible exceedances of the acute reference dose (ARfD). It was suggested that any short-term dietary exposure concerns for cucumbers may be mitigated by the inclusion of a withholding period, and that this support could be extrapolated to zucchini (summer squash).

APVMA Response: The use of chlorpyrifos on chard (silverbeet) at an application rate of 400 g ac/ha posed a dietary exposure concern due to theoretical exceedance of the ARfD for the 2-6 years cohort. Therefore, this specific use on chard was not supported by the residues safety assessment. All other uses on chard were supported in dietary exposure assessments, including uses on cutworms, redlegged earth mite, blue oat mite, crickets (bran baits) and wingless grasshopper up to a rate of 350 g ac/ha.

Use of chlorpyrifos in cucumbers at an application rate of 750 g ac/ha or less were supported from a residues perspective, including the control of whiteflies, ants, mealybug, cutworm, wingless grasshopper, wireworms, weevils, crickets (bran baits). Based on the data considered, it was recommended in the preliminary review findings report (APVMA 2009) that these cucumber uses have a harvest WHP of 7 days, with an MRL of 1 mg/kg considered appropriate. The use of chlorpyrifos in cucumbers at an application rate greater than 750 g ac/ha is not supported by this residues safety assessment due to theoretical exceedance of the ARfD for the 2-6 years cohort, nor are uses in protected cropping situations.

Chlorpyrifos uses on cucumbers could not be extended into all cucurbits, as residue data addressing the 7-day WHP was only available for cucumbers. Cucumbers and zucchinis are both members of Subgroup 011A, Fruiting vegetables, Cucurbits – Cucumbers and Summer squashes, and cucumbers are a representative crop for this subgroup. The APVMA agrees that any chlorpyrifos uses in cucumbers supported by the residues assessment could also be supported for zucchinis from a residues perspective; however, it is noted that all uses on cucurbits (including cucumbers and zucchinis) are not supported in the environmental safety assessment.

Clarification was requested on the residues assessment outcomes for brassica vegetables.

APVMA Response: In the preliminary review findings report (APVMA 2009), use on brassica vegetables was supported at or prior to planting, with an MRL of *0.01 mg/kg and no WHP required, but foliar applications applied later in the crop production cycle were not supported. As shown in Table 33, the use of chlorpyrifos to control African black beetle, cutworms, mites, vegetable weevil and wingless grasshoppers was supported from a residues perspective within 7 or 14 days of transplanting, in conjunctions with a WHP of 'Not required when used as directed' and an MRL of 0.05 mg/kg.

Based on the specific use now supported by other risk assessment areas, residues and trade support use on brassica vegetables for control of red legged earth mite and blue oat mite within 14 days of transplanting, at 70 g ac/ha. An MRL at *0.01 mg/kg is appropriate.

Residues in stone fruit

Summerfruit Australia agreed with the APVMA that finite residues are not expected in harvested fruit from applications made during dormancy and highlighted that the priority use of chlorpyrifos in stone fruits is the management of San José scale, with applications made during dormancy or very early season. Summerfruit Australia also suggested that there is sufficient information regarding the level of residues expected from the foliar use of chlorpyrifos on peaches to control San José scale.

APVMA Response: No foliar uses on peaches (including for the control of scale, earwigs and fruit flies) were supported in the preliminary review findings report (APVMA 2009), as adequate data had not been submitted. [APVMA residue guidelines](#) suggests that 8 relevant residue trials each are generally required to support a permanent MRL for use in peaches. No additional residues data on peaches have been submitted since 2009.

The support for specific uses of chlorpyrifos in stone fruit (except peaches) cannot be extended to peaches from a residues perspective, because of differences in application timings. In peaches, the use of chlorpyrifos for Queensland fruit fly control, the use of cracked grain baits for earwig control and applications in the dormancy period for scale control are supported by the available data, with a peach MRL of 0.05 mg/kg considered appropriate.

While various uses of chlorpyrifos in stone fruit (excluding peaches) and peaches are supported from a residues perspective (Table 33), it is noted that no uses of chlorpyrifos on stone fruit are supported by all risk assessments completed (Table 43). Worker health and safety and/or environment concerns were identified for all uses of chlorpyrifos on stone fruit and trade concerns were identified for all uses on stone fruit (excluding the control of San José scale in the dormant period).

Residues in broadacre crops

It was suggested that the priority broadacre uses of chlorpyrifos are unlikely to result in detectable chlorpyrifos in harvestable commodities and would not pose a risk to trade, as they are either pre-plant or early post-emergent against soil residing arthropods pests.

APVMA Response: The uses of chlorpyrifos on cereals, canola, cotton and pulses were considered to pose an undue risk to international trade, excluding application made prior to crop emergence (eg. ground sprays). The use of chlorpyrifos on cereals were only supported by the environment risk assessment at a maximum rate of 70 g ac/ha, with application timing between BCCH 30 and 39.

The use of chlorpyrifos in oilseeds (except canola and cotton) at a maximum rate of 70 g ac/ha, canola and pulses (field peas, lupins, broad beans and chickpeas) at maximum rate of 100 g ac/ha and cotton at a maximum rate of 130 g ac/ha were supported by the worker health and safety and environment risk assessments. There was insufficient data for a robust assessment of the levels of chlorpyrifos residues expected from these specific uses of chlorpyrifos, which is required to establish MRLs for the relevant commodities.

While these low-rate, pre-emergent uses of chlorpyrifos were not supported as an outcome of this reconsideration, these uses may be supported in the future following the provision and consideration of residues information, relevant to the specific uses with regards to rate and timing of application.

Animal commodity MRLs

GeneEthics suggested that the animal commodity MRLs for chlorpyrifos were proposed to increase; specifically, that the fat of mammalian meat MRL was proposed to increase from 0.5 mg/kg to 2 mg/kg.

APVMA Response: The APVMA sets maximum residue limits (MRLs) for agricultural and veterinary chemicals in agricultural produce, particularly produce entering the food chain. These MRLs are set at levels that are not likely to be exceeded if the agricultural or veterinary chemicals are used in accordance with approved label instructions.

In the draft Chlorpyrifos Review Technical Report (APVMA 2023), the APVMA did not propose to increase the MRL for Meat (mammalian)[in the fat], but rather proposed to remove all mammalian animal commodity MRLs and establish animal commodity MRLs specific to cattle.

The MRLs referenced in the [Animal transfer studies and animal commodity MRLs](#) section are based on the residues safety assessment outcomes and livestock feed burden associated with currently approved uses, including the referenced meat (mammalian)[in the fat] MRL of 2 mg/kg. However, the majority of chlorpyrifos uses have not been supported by the worker health and safety and/or environmental safety risk assessment.

In the draft Chlorpyrifos Review Technical Report (APVMA 2023), cattle ear tags were the only food producing situation pertaining to livestock or animal feeds supported by all risk assessments. The MRLs for cattle commodities (muscle, fat, offal, milk and milk fat) were therefore driven by the residues expected from the ear tag use, and were 0.05 mg/kg for cattle milk fat, *0.02 mg/kg for cattle milk, *0.02 mg/kg for cattle edible offal, *0.02 mg/kg for cattle muscle and 0.05 mg/kg for cattle fat.

In this final Chlorpyrifos Review Technical Report, the food producing situation pertaining to livestock or animal feeds supported by all risk assessments include forage crops (at a maximum rate of 130 g ac/ha). The animal commodity MRLs that are driven by these uses are set out in the [Required animal commodity MRLs](#) section above, with the highest MRL being 0.1 mg/kg for the meat (mammalian)[in the fat] MRL (a decrease from the current MRL at T0.5 mg/kg).

GeneEthics also raised concerns that the proposed animal commodity MRLs for chlorpyrifos are higher than comparable international regulators, citing that the international Codex Standard and the European Union have revoked their MRLs on safety grounds.

APVMA Response: At the time the MRLs are set, the APVMA undertakes a dietary exposure evaluation to ensure that the levels do not pose an undue hazard to human health. The dietary exposure evaluations for chlorpyrifos are set out in the [Dietary exposure](#) and [Revised dietary exposure assessment](#) sections above. These calculations reference the established health-based guidance values (HBGVs), including the acceptable daily intake (ADI) and acute reference dose (ARfD).

The ADI for humans is the level of intake of a substance that can be ingested daily over an entire lifetime without appreciable risk to health on the basis of the available information at the time of evaluation. It is expressed in milligrams of the substance per kilogram of body weight per day

(mg/kg bw/day). For this purpose, 'without appreciable risk' means that adverse effects are unlikely to result even after a lifetime of exposure. The acceptable daily intake is intended to give a guide to the maximum amount of a substance that can be ingested daily in the food without appreciable risk to the consumer. Accordingly, the figure is derived as far as possible from feeding studies in animals.

The ARfD of a substance is an estimate of the amount of a substance in food and/or drinking water, expressed in milligrams of substance per kilogram of body weight (mg/kg bw), that can be ingested over a short period of time, usually in one meal or during one day, without appreciable health risk to the consumer, on the basis of all known facts at the time of the evaluation. For some substances, an acute reference dose may not be necessary because the substance is not considered to cause appreciable acute risk after a single dose or exposure (that is, 24 hours or less).

The APVMA is confident that all uses approved for continued use, including uses leading to residues arising in animal commodities from the consumption of animal feeds from treated crops, are acceptable on the grounds of safety, noting the safety factors that are inbuilt into the establishment of the ADI and ARfD values. Export slaughter intervals have also been included for relevant uses approved for continued uses, to ensure that the chlorpyrifos residues are <LOQ at the time of slaughter of animals intended for export to prevent an undue risk to international trade.

Scope of the trade assessment

Some submissions provided information or requested clarification in relation to trade concerns for crops that are not considered major export commodities.

APVMA Response: The scope of the chlorpyrifos review included the risks to international trade resulting from the use of chlorpyrifos on major export commodities. Commodities considered to be major export commodities are defined in the APVMA's [Overseas trade \(Part 5B\) guidance](#). Of the major export plant commodities, there are uses of chlorpyrifos in cereal grains, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit. In relation to major export animal commodities, there are uses on chlorpyrifos on cattle and in commodities generally accepted as being fed to animals (eg. grains, pulses, oilseeds, fruit by-products, forage, fodder and tomato pomace). The use of chlorpyrifos on crops that are not a major export commodity, or on crops that are not expected to be fed to livestock, are not expected to pose an undue risk to international trade.

Management of trade risks by industry

The National Working Party on Grain Protection (NWPGP) supported the APVMA's proposed decision to remove use of chlorpyrifos on cereals, pulses and oilseeds based on current and future international market access concerns.

APVMA Response: The APVMA acknowledges the support of the NWPGP to remove use of chlorpyrifos on cereals, pulses and oilseeds based on market access concerns as the use of chlorpyrifos on cereals, pulses, cotton and canola may pose an undue risk to international trade.

Summerfruit Australia acknowledged that the management of trade risk by industry could be problematic based on the MRLs listed in Table 33 for stone fruit and peaches, which stem from foliar chlorpyrifos uses.

APVMA Response: The APVMA agrees and considers that the uses of chlorpyrifos on stone fruit would pose an undue risk to international trade, except for the control of San Jose scale in the dormant period. The registered foliar uses on stone fruit for the control of European earwig, San Jose scale and Queensland fruit fly have a harvest WHP of 14 days, with an MRL at 1 mg/kg considered appropriate. Stone fruit are a major export commodity and finite residues above 0.01 mg/kg in stone fruit are expected from these uses. Some overseas markets do not have MRLs, noting for example that Codex MRLs (which some countries defer to) were removed in 2022 while European Union replaced previously established chlorpyrifos MRLs with a default value at *0.01 mg/kg.

The control of San Jose scale with applications made during the dormancy period are not expected to lead to quantifiable residues in stone fruit. This use in stone fruit is therefore supported from a residues and trade perspective. However, it is noted that the control of San Jose scale in both the seasonal and dormant period was not supported from an environmental safety perspective.

The ATGA suggested that the trade risks associated with use of chlorpyrifos on grapes can continue to be effectively managed by industry. This was primarily on the basis that the MRL disparities and management of residues have been ongoing and high priority issues, and that the table grape industry has a history of effectively managing these issues.

APVMA Response: All uses of chlorpyrifos on grapes were supported in the residues safety assessment; however, excluding the control of grapevine scale with application during the dormant period, uses of chlorpyrifos on grapes were not supported in the trade assessment. The registered uses on grapes for the control of light brown apple moth, grapevine moth, mealybug and tuber mealybug have a harvest WHP of 14 days. Finite residues above the LOQ (0.1 mg/kg) are expected on grapes as a result of these uses, with an MRL at 1 mg/kg considered appropriate. Some overseas markets do not have MRLs, noting for example that Codex MRLs (which some countries defer to) were removed in 2022 and other MRLs are established at the LOQ (0.01 mg/kg) or at 0.05 mg/kg, including China the major market for Australian table grapes in 2022-2023⁸.

The APVMA therefore considers that the assessed uses of chlorpyrifos on grapes (excluding the control of grapevine scale during dormancy) poses an undue risk to international trade and is not supported from a trade perspective. In relation to the control of grapevine scale prior to the end of dormancy, finite residues are not expected in harvested fruit and the risk to trade is considered to be low. It is noted however that no uses of chlorpyrifos on grapes were supported in the environmental safety assessment, including application made prior to the end of the dormancy period.

⁸ Australian Horticulture Statistics Handbook 2022/23 (page 160), <https://www.horticulture.com.au/contentassets/a36fdfa2427d4ad284c426663b06f15c/hort-stats-fruit-22-23.pdf>, Hort Innovation, accessed 16/4/2024

Appendix B – Summary of assessment outcomes

Table 43: Chlorpyrifos uses that are supported by all risk assessments

Crop/host ¹	Pest	Rate	Amended instructions for use ²
Vegetable and field crop uses			
Brassica crops (broccoli, brussels sprouts, cabbage and cauliflower)	Blue oat mite, redlegged earth mite	70 ac/ha	<p>Restraints: DO NOT apply by aircraft. Spray drift restraints and relevant buffer zones (see Spray drift)</p> <p>Directions for use: DO NOT apply after 14 days of transplanting. DO NOT apply more than once per year. For severe infestations, use of this product may not result in full control of pests.</p> <p>Withholding periods: HARVEST: NOT REQUIRED WHEN USED AS DIRECTED.</p> <p>Trade advice: EXPORT SLAUGHTER INTERVALS Grazing animals: Grazing animals that have been grazing on or fed treated crops should be placed on clean feed for 21 days prior to slaughter for export. Pigs: Pigs that have been fed treated crops should be placed on clean feed for 14 days prior to slaughter for export.</p> <p>Precautions: DO NOT enter treated crops for 8 days after treatment for scouting, hand harvesting or hand weeding. When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be washed after each day's use. These re-entry intervals do not apply if crops are treated pre-emergence or product is applied to soil at seed planting.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13).</p>

Crop/host ¹	Pest	Rate	Amended instructions for use ²
Forage crops	Blue oat mite, redlegged earth mite	35 to 70 g ac/ha	<p>Restrictions: DO NOT apply by aircraft. Spray drift restraints and relevant buffer zones (see Spray drift)</p> <p>Directions for use (forage crops up to 70 g ac/ha): DO NOT apply after stem elongation or rosette growth senescence (BBCH ≥ 40). DO NOT apply more than once per year.</p>
	Lucerne flea	35 g ac/ha	<p>Directions for use (forage crops, lucerne, medics up to 130 g ac/ha): DO NOT apply once side shoots start to appear (BBCH ≥ 20). DO NOT apply more than once per year. DO NOT apply more than once per year. When a large number of aphids are invading the crop, use of this product may not result in full control of pests.</p> <p>Directions for use (lucerne, clover seed crops up to 130 g ac/ha): DO NOT apply after seedling emergence.</p>
Forage crops, lucerne and medics	Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 to 130 g ac/ha	<p>Withholding periods: DO NOT GRAZE OR CUT FOR STOCK FOOD FOR 28 DAYS AFTER APPLICATION.</p> <p>Trade advice: EXPORT SLAUGHTER INTERVALS Grazing animals: Grazing animals that have been grazing on or fed treated crops should be placed on clean feed for 21 days prior to slaughter for export. Pigs: Pigs that have been fed treated crops should be placed on clean feed for 14 days prior to slaughter for export.</p> <p>Precautions: DO NOT enter treated crops for 2 days after treatment for scouting or for 8 days after treatment for irrigation (hand set). When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be washed after each day's use. These re-entry intervals do not apply if crops are treated pre-emergence or product is applied to soil at seed planting</p> <p>Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13 or chlorpyrifos EC 700 g/L (or less) in Table 15).</p>
Lucerne and clover seed crops	Blue oat mite, redlegged earth mite	70 to 130 g ac/ha	

Crop/host ¹	Pest	Rate	Amended instructions for use ²
Lucerne seed crops	Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 to 130 g ac/ha	<p>Restrictions: DO NOT apply by aircraft. Spray drift restraints and relevant buffer zones (see Spray drift)</p> <p>Directions for use: DO NOT apply once side shoots start to appear (BBCH ≥20). DO NOT apply more than once per year. [When a large number of aphids are invading the crop] [For heavier infestations], use of this product may not result in full control of pests.</p> <p>Withholding periods: DO NOT GRAZE OR CUT FOR STOCK FOOD FOR 28 DAYS AFTER APPLICATION.</p> <p>Trade advice: EXPORT SLAUGHTER INTERVALS Grazing animals: Grazing animals that have been grazing on or fed treated crops should be placed on clean feed for 21 days prior to slaughter for export. Pigs: Pigs that have been fed treated crops should be placed on clean feed for 14 days prior to slaughter for export.</p> <p>Precautions: DO NOT enter treated crops for 2 days after treatment for scouting or for 8 days after treatment for irrigation (hand set). When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be washed after each day's use. These re-entry intervals do not apply if crops are treated pre-emergence or product is applied to soil at seed planting.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after application.</p> <p>Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds or wild mammals.</p> <p>Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 600 g/L (or less) with bifenthrin 30 g/L (or less) in Table 14).</p>
	Lucerne flea	70 to 130 g ac/ha	

Crop/host ¹	Pest	Rate	Amended instructions for use ²
Miscellaneous uses			
Agricultural, commercial and industrial areas (not publicly accessible)	Ants (including Argentine ants) Fleas	4.5 g ac/L water to 5 g ac/L water	<p>Restrictions: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13 or chlorpyrifos EC 700 g/L (or less) in Table 15).</p>
Container plants in soil or other growing media (commercial)	Argentine ants	5 g ac/L water	<p>Restrictions: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers DO NOT apply if heavy rains or storms are forecast within 3 days. Highly toxic to bees. To protect bees and pollinating insects when controlling Argentine ants in container plants, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos WP 500 g/kg (or less) in Table 16 or chlorpyrifos WG 750 g/kg (or less) in Table 17).</p>
Hides/skins	Hide beetles	1 g ac/L water (<i>minimum 15 g ac/skin</i>)	<p>Restrictions: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13 or chlorpyrifos EC 700 g/L (or less) in Table 15).</p>

Crop/host ¹	Pest	Rate	Amended instructions for use ²
Potted ornamentals (commercial)	Scarab beetles – larvae	0.1 – 0.2 g ac/L water	<p>Restrictions: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT apply if heavy rains or storms are forecast within 3 days. DO NOT irrigate to the point of field runoff for at least 3 days after planting out.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13).</p>
Treatment of termite nest or colony (in wall cavities)	Termites	5 g ac/L water	<p>Restrictions: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13).</p>
Turf (commercial)	Funnel ant	2.5 g ac/5L water or 0.015 g ac/per mound (spot spray)	<p>Withholding period: DO NOT graze treated turf or lawn; or feed turf or lawn clippings from any treated area to poultry or livestock</p> <p>Protection statements: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees.</p> <p>First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 12).</p> <p>Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 13).</p>

¹ Horticultural use of banana bags were supported by all risk assessment areas with the amended instructions for use and MRLs set out in the draft [Chlorpyrifos Review Technical Report](#). However, there are no remaining chlorpyrifos products registered by the APVMA with this use pattern.

² All instructions for use on labels of agricultural chemical products and veterinary chemical products should align with requirements set out in the [Agricultural Labelling Code](#) and [Veterinary Labelling Code](#) respectively.

Table 44: Chlorpyrifos uses that are not supported due to safety and/or trade concerns

Crop/host	Pest	Rate	Assessment outcome
Fruit and vegetables			
Apples, pears	Woolly aphid, mealybug, apple dimpling bug	750 to 1,000 g ac/ha <i>(50 g ac/100 L water applied using 1,500 to 2,000 L water/ha)</i>	Not supported – safety (environment, residues and worker exposure) and trade concerns.
	San Jose' scale	750 to 1,000 g ac/ha <i>(50 g ac/100 L water applied using 1,500 to 2,000 L water/ha, seasonal period)</i>	Not supported – safety (environment, residues and worker exposure) and trade concerns.
		250 g ac/ha <i>(50 g ac/100 L water applied using 500 L water/ha, 2% miscible winter oil may be added in dormant period)</i>	Not supported – safety (environment) concerns.
	Light brown apple moth	375 to 500 g ac/ha <i>(25 g ac/100 L water applied using 1,500 to 2,000 L water/ha)</i>	Not supported – safety (environment, worker exposure) and trade concerns.
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) and trade concerns.
Queensland fruit fly	0.1 to 0.2 g ac/tree or 30 or 60 g ac/ha <i>(200 g ac/100 L water applied using 50 to 100 mL/tree or 15 to 30 L/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns.	
Avocado	Fiorinia scale, latania scale	1,000 g ac/ha <i>(50 g ac/100 L water applied using 2,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
	Hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle	1,000 g ac/ha <i>(50 g ac/100 L, spot spray)</i>	Not supported – safety (environment and worker exposure) concerns.
	Hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle	500 g ac/ha <i>(25 g ac/100 L, spot spray)</i>	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Avocado leafroller, ivy leafroller	500 g ac/ha or 1,000 g ac/ha + 500 g ac/ha dichlorvos <i>(25 or 50 g ac/100 L + 250 g ac/100 L dichlorvos)</i>	Not supported – safety (environment and worker exposure) concerns.
	Ivy leafroller	500 or 1,000 g ac/ha <i>(25 or 50 g ac/100 L)</i>	Not supported – safety (environment and worker exposure) concerns.
	Queensland fruit fly	0.1 to 0.2 g ac/tree or 30 to 60 g ac/ha <i>(200 g ac/100 L water applied using 50 to 100 mL/tree or 15 to 30 L/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Banana	Banana scab moth, banana flower thrips	500 g ac/ha to 1,000 g ac/ha <i>(Aerial – minimum 10 L water; Airblast – 100 g ac/100 L water applied at 500 L water/ha to 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
	Banana scab moth*	5 g ac/5 L (<i>knapsack</i>)	Not supported – safety (worker exposure) concerns.
	Caterpillars, lepidopterous caterpillars	500 to 1,000 g ac/ha <i>(100 g ac/100 L water applied at 500 L water/ha to 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
	Cluster caterpillars*	75 to 100 g ac/ha (<i>spot spray</i>)	Not supported – safety (worker exposure) concerns.
	Banana weevil borer*	500 to 900 g ac/100 L water or 2.5 to 3.5 g ac/stool	Not supported – safety (worker exposure) concerns.
		250 g ac/100 L water or 250 g ac/4 kg sand	Not supported – safety (worker exposure) concerns.
Beetroot	Earwigs	350 g ac/ha <i>(35 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment and residues) concerns.
Beetroot, carrots, cassava, radishes, sweet potato, turnips	Cutworm	350 g ac/ha <i>(35 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
Beetroot, carrots, parsnip, radishes, sweet potato, turnips	Vegetable weevil	400 g ac/ha	Not supported – safety (environment and residues) concerns.
Beetroot, carrots, radishes, sweet potato, turnips	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns, based on pest activity in relevant crop growth stages.
Beetroot, carrots, radish, shallots, turnips, onions	Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets	250 g ac/10 kg seed	Not supported – safety (environment and worker exposure) concerns.
Capsicum, eggplant	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
Carrots	Light brown apple moth	250 to 350 g ac/ha	Not supported – safety (environment and residues) concerns.
Cabbage, cauliflower	African black beetle	1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	African black beetle*	150 g ac/100 L water <i>(drench at 100 mL/plant)</i>	Not supported – safety (worker exposure) concerns.
Chard (silver beet)	Vegetable weevil	400 g ac/ha	Not supported – safety (environment and residues) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Redlegged earth mite, blue oat mite	> 70 to 150 g ac/ha	Not supported – safety (environment) concerns.
		70 g ac/ha	Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL. Application prior to BCCH 40 required to mitigate safety (environment) concerns.
Citrus fruits	California red scale (Citrus red scale)	1,000 to 2,000 g ac/ha <i>(25 to 50 g ac/100 L water applied using 4,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
	Citrus rust thrips, citrus leaf eating weevil, citrus mealy bug, fruit eating weevil, fullers rose weevil, purple scale, white louse scale	2,000 g ac/ha <i>(50 g ac/100 L water applied using 4,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
	Ants	1,000 g ac/ha <i>(or 100 g ac/100 L water applied at 1.5 L spray per butt)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
		1,000 g ac/100 L water	Not supported – safety (environment and worker exposure) and trade concerns.
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) and trade concerns.
	Queensland fruit fly	0.1 to 0.2 g ac/tree or 30 to 60 g ac/ha <i>(200 g ac/100 L water applied using 50 to 100 mL/tree or 15 to 30 L/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
Cole (brassica) crops (including broccoli, brussels sprouts,	Cabbage moth, cabbage white butterfly, cabbage aphid, cluster caterpillar, cabbage cluster caterpillar, butterflies	750 or 1,000 g ac/ha <i>(75 or 100 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment, residues and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
cabbage, cauliflower)	Helicoverpa spp (including corn earworm, native budworm)	750 or 1,000 g ac/ha <i>(75 or 100 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment, residues and worker exposure) concerns.
	Vegetable weevil	500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages.
	African black beetle	350 to 450 g ac/ha	Not supported – use is not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages.
Red earth mite, blue oat mite	> 70 to 150 g ac/ha	Not supported – safety (environment) concerns.	
Cucumbers	Ants, mealybugs	500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Wingless grasshopper, white flies	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
Cucurbit vegetables or cucurbits (excluding cucumbers)	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment and residues) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment and residues) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment and residues) concerns.
	White flies	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment and residues) concerns.
	Ants, mealybugs	500 g ac/ha	Not supported – safety (residues and worker exposure) concerns.
Custard apple	Ants	1,000 to 10,000 g ac/ha <i>(100 to 1,000 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Ginger	African black beetle, cutworm	350 to 450 g ac/ha <i>(35 to 45 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
Grapes (grape vines)	Light brown apple moth, grapevine moth	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) and trade concerns.
	Grapevine scale	250 g ac/ha or 125 g ac/ha + 5 L miscible winter oil <i>(50 g ac/100 L water or 25 g ac + 1 L miscible winter oil/100 L water applied using 500 L water/ha, dormant period)</i>	Not supported – safety (environment) concerns.
	Mealybug, tuber mealybug	500 g ac/ha <i>(50 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome
Green beans, peas	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Wingless grasshopper, white flies	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
Kiwifruit	Common and southern armyworms, light brown apple moth, scale insects	500 g ac/ha <i>(25 g ac/100 L water, applied using 2,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Leafy crucifers including chou moullier, kale, mustard, rape	Vegetable weevil	500 g ac/ha	Not supported – safety (environment and residues and worker exposure) concerns.
		400 g ac/ha	Not supported – safety (environment and residues) concerns.
	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha	Not supported – safety (environment and residues) concerns.
Lettuce	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Redlegged earth mite, blue oat mite	> 70 to 150 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
		70 g ac/ha	Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL. Application prior to BCCH 40 required to mitigate safety (environment) concerns.
Loquats	Queensland fruit fly	0.1 to 0.2 g ac/tree or 30 to 60 g ac/ha <i>(200 g ac/100 L water applied using 50 to 100 mL/tree or 15 to 30 L/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Mango	Green tree ant	1,000 g ac/ha <i>(50 g ac/100 L water applied using 2,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
	Common mango scale	2,000 g ac/ha <i>(100 g ac/100 L water applied using 2,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Onions, shallots	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages.
Passionfruit	Queensland fruit fly	60 g ac/ha <i>(200 g ac/100 L water applied using 30 L/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Pineapples	White grubs	2,500 g ac/ha (<i>pre-plant, soil-incorporated</i>)	Not supported – safety (environment and worker exposure) concerns.
	Pineapple scale	1,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Pineapple mealybug, ants	750 or 1,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
Pome fruits	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment) and trade concerns.
	Queensland fruit fly	0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha <i>(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)</i>	Not supported – safety (safety and worker exposure) and trade concerns.
Potatoes	Wireworm	3,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	African black beetle	1,500 to 3,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		450 to 500 g ac/ha	Not supported – safety environment and (worker exposure) concerns.
	White fringed weevil	3,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		450 to 500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages.	

Crop/host	Pest	Rate	Assessment outcome
Stalk and stem vegetables (including asparagus, celery and rhubarb)	Wingless grasshopper	250 g ac/ha <i>(25 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha <i>(35 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
Stone fruits	European earwig	750 to 1,000 g ac/ha <i>(50 g ac/100 L water applied using 1,500 to 2,000 L water/ha)</i>	Not supported – safety (worker exposure) and trade concerns. <i>Peaches: Not supported – safety (residues and worker exposure) and trade concerns.</i>
		100 g ac/ha <i>(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
	San Jose' scale	750 g ac/ha <i>(50 g ac/100 L water applied using 1,500 L water/ha, seasonal period)</i>	Not supported – safety (worker exposure) and trade concerns. <i>Peaches: Not supported – safety (residues, environment and worker exposure) and trade concerns.</i>
		250 g ac/ha <i>(50 g ac/100 L water applied using 500 L water/ha, 2% miscible winter oil may be added, dormant period)</i>	Not supported – safety (environment) concerns.
	Light brown apple moth	375 g ac/ha <i>(25 g ac/100 L water applied using 1,500 L water/ha)</i>	Not supported – safety (environment and worker exposure) and trade concerns. <i>Peaches: Not supported – safety (environment, residues and worker exposure) and trade concerns.</i>
		0.0125 to 0.025 g ac/tree <i>(25 g ac/100 L water applied using 50 – 100 mL/tree)</i>	Not supported – safety (environment) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome
	Queensland fruit fly	0.1 to 0.2 g ac/tree <i>(200 g ac/100 L water applied using 50 to 100 mL/tree)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
Strawberry	Field cricket, mole cricket	50 g ac/ha <i>(in 10 kg bran bait)</i>	Not supported – safety (environment and worker exposure) concerns.
Swede, turnip	Vegetable weevil	350 to 500 g ac/ha <i>(35 to 50 g ac/100 L water to 50 g ac/100 L water applied using 1,000 L water/ha)</i>	Not supported – safety (environment, residues and worker exposure) concerns.
	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha	Not supported – safety (environment and residues) concerns.
Tomatoes	False wireworm, wireworm	2,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Whitefly <i>(Trialeurodes vaporariorum)</i>	1,500 g ac/ha <i>(60 g ac/100 L water applies using 2,500 L water)</i>	Not supported – safety (environment and worker exposure) concerns.
	African black beetle	1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	African black beetle*	150 g ac/100 L water <i>(drench at 100 mL/plant)</i>	Not supported – safety (worker exposure) concerns.
	Silverleaf whitefly	1,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		750 to 1,000 g ac/ha <i>(75 to 100 g ac/100 L water, applied using 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
	Green vegetable bug, <i>Helicoverpa</i> spp. (including tomato grub, native budworm)	750 to 1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Green peach aphid	500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm, false wireworm	350 g ac/ha (35 g ac/100 L water applied using 1,000 L water/ha)	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha (25 g ac/100 L water applied using 1,000 L water/ha)	Not supported – safety (environment) concerns.
Vegetables (various)	Field cricket, mole cricket	50 g ac/ha (in 10 kg bran bait)	Not supported – safety (environment and worker exposure) concerns.
Field crops and pasture			
Barley, wheat	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea	100 to 200 g ac/ha (ground spray)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
	Blue oat mite, pasture webworm	200 g ac/ha (ground spray)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
	Bryobia Mite	400 g ac/ha (ground spray)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
Barley, wheat, oats, rye, triticale	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha (ground spray)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
Canola (rapeseed)	False wireworm, wireworms	500 or 750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Balaustium mite	400 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
	Cutworms	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
	Bryobia mite	400 g ac/ha (ground spray)	Not supported – safety (environment and worker exposure with broadacre use) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Vegetable weevil	200 to 400 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
	Blue oat mite, pasture webworm	200 g ac/ha (<i>ground spray</i>)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea	100 to 200 g ac/ha (<i>ground spray</i>)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
	Redlegged earth mite, blue oat mite	> 100 to 150 g ac/ha (<i>ground spray</i>)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
> 70 to 100 g ac/ha (<i>ground spray</i>)		Not supported - safety (environment) concerns.	
70 g ac/ha (<i>ground spray</i>)		Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL. Closed mixing and loading systems required to mitigate safety (worker exposure with broadacre use) concerns.	
	Lucerne flea	70 to 150 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
		35 g ac/ha	Not supported – trade concerns.
	Redlegged earth mite	70 g ac/ha	Not supported – trade concerns.
	False wireworms	125 g ac/310 kg seed	Not supported – safety (environment and worker exposure) concerns.
Cereals	Spur throated locust	625 to 750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome
	Blackheaded pasture cockchafer	450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Southern armyworm, common armyworm	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Cutworm	350 or 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Pasture webworm	350 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) and trade concerns.
		150 g ac/ha (post emergence)	Not supported – safety (worker exposure with broadacre use) and trade concerns.
		150 g ac/ha (pre-plant)	Not supported – safety (environment and worker exposure with broadacre use) concerns.
	Australian plague locust	280 or 175 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns. Environmental safety concerns at rates greater than 255 g ac/ha.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Migratory locust	175 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Redlegged earth mite, blue oat mite	35 or 70 g ac/ha	Not supported – trade concerns.
	Lucerne flea	35 g ac/ha	Not supported – trade concerns.
	Black soil scarab, wheat root scarab	250 g ac/125 kg seed or 250 g ac/10 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
	Spine-tailed weevil	125 g ac/210 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
	False wireworms, wireworms	125 g ac/310 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome
	Cereal curculio	125 g ac/210 kg seed or 60 g ac/100 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
	Spotted vegetable weevil	125 g ac/210 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
	Seed harvesting ants	40 g ac/100 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
Clover, subterranean clover	Bryobia mite	400 g ac/ha	Not supported – safety (environment) concerns.
	Blue oat mite, pasture webworm	200 g ac/ha	Not supported – safety (environment) concerns.
	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea	100 to 200 g ac/ha	Not supported – safety (environment) concerns.
Clover seed crops	Blue oat mite, redlegged earth mite	>130 to 150 g ac/ha	Not supported – safety (environment) concerns.
Coffee beans (non-bearing)	Mealybugs	1,000 g ac/ha <i>(but and soil treatment applied at 100 g ac/100 L water using 1,000 L water/ha)</i>	Not supported – safety (environment and worker exposure) concerns.
Cotton	Spur throated locusts	625 g or 750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Cotton flea beetle, red shouldered leaf beetle	450 or 750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Mites	750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
		300 to 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Pink spotted bollworm moth (<i>Pectinophora scutigera</i>)	500 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome
	Cutworm	350 or 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Southern armyworm, common armyworm	350 or 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Cotton aphid	150 or 200 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Migratory locusts	175 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Springtails	150 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Blue oat mite, redlegged earth mite	> 130 to 150 g ac/ha (<i>ground spray</i>)	Not supported – safety (environment and worker exposure) concerns.
		70 to 130 g ac/ha (<i>ground spray</i>)	Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL. Closed mixing and loading systems required to mitigate safety (worker exposure with broadacre use) concerns.
	False wireworms	125 g ac/310 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
	Wireworm, false wireworm, sugarcane wireworm*	2.5 g to 7.5 g ac/100 m row or 250 to 750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and trade concerns.
Cotton, lucerne, maize, sorghum, sunflower	False wireworms, brown field cricket, cockroaches	50 g ac/ha (<i>with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait</i>)	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome	
	Earwigs	100 g ac/ha <i>(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)</i>	Not supported – safety (environment and worker exposure) and trade concerns.	
Field peas, lupins, broad beans, and chickpeas	Redlegged earth mite, blue oat mite	> 100 to 150 g ac/ha <i>(ground spray)</i>	Not supported – safety (environment and worker exposure with broadacre use) concerns.	
		> 70 to 100 g ac/ha <i>(ground spray)</i>	Not supported – safety (environment) concerns.	
		70 g ac/ha <i>(ground spray)</i>	Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL. Closed mixing and loading systems required to mitigate safety (worker exposure with broadacre use) concerns.	
Field peas, lupins	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), brown pasture, looper, lucerne flea	100 to 200 g ac/ha <i>(ground spray)</i>	Not supported – safety (environment and worker exposure with broadacre use) concerns.	
		Blue oat mite	200 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) concerns.
		Pasture webworm	200 g ac/ha	Not supported – safety (environment and worker exposure with broadacre use) concerns.
Forage crops	Corbie, winter corbie	450 or 750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.	
	Spur throated locust	625 or 750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.	
	Blackheaded pasture cockchafer	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.	
	Cutworms	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.	
	Underground grass grub	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.	

Crop/host	Pest	Rate	Assessment outcome
	Armyworm	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Cutworms, lawn armyworm, sod webworm, brown pasture looper, pasture webworm	350 g ac/ha	Not supported – safety (environment) concerns.
	Australian plague locust	280 g ac/ha	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment) concerns.
	Australian plague locust, migratory locust, sitonia weevil	175 g ac/ha	Not supported – safety (environment) concerns.
	Pasture webworm	150 g ac/ha	Not supported – safety (environment) concerns.
	Spotted alfalfa aphid, blue-green aphid, pea aphid	>130 to 150 g ac/ha	Not supported – safety (environment) concerns.
Hops	Common armyworm, southern armyworm, light brown apple moth*	800 g ac/ha (80 g ac/100 L water, applied using 1,000 L water/ha)	Not supported – safety (worker exposure) concerns.
Improved annual pastures, established perennial pastures	Blue oat mite, redlegged earth mite	70 to 150 g ac/ha	Not supported – safety (environment) concerns.
Lucerne	Cutworms	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Bryobia mite	400 g ac/ha	Not supported – safety (environment) concerns.
	Webspinner, caterpillar	350 g ac/ha	Not supported – safety (environment) concerns.
	Blue oat mite, pasture webworm	200 g ac/ha	Not supported – safety (environment) concerns.
	Lucerne leafroller	150 to 200 g ac/ha	Not supported – safety (environment) concerns.
	Sitona Weevil	175 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea	100 to 200 g ac/ha	Not supported – safety (environment) concerns.
	Blue oat mite, redlegged earth mite, bluegreen aphid, spotted alfalfa aphid, pea aphid	>130 to 150 g ac/ha	Not supported – safety (environment) concerns.
Lucerne pastures	Blue oat mite, redlegged earth mite	70 to 150 g ac/ha	Not supported – safety (environment) concerns.
Lucerne seed crops	Webspinner caterpillar	350 g ac/ha	Not supported – safety (environment) concerns.
	Lucerne leafroller	150 to 200 g ac/ha	Not supported – safety (environment) concerns.
	Sitona Weevil	175 g ac/ha	Not supported – safety (environment) concerns.
	Bluegreen aphid, spotted alfalfa aphid, pea aphid, lucerne flea	>130 to 150 g ac/ha	Not supported – safety (environment) concerns.
Maize	African black beetle	10 g/100 m row or 1,000 g ac/ha for row spacing of 1 m	Not supported – safety (environment and worker exposure) and trade concerns.
	Wireworm, false wireworm, sugarcane wireworm*	2.5 g to 7.5 g ac/100 m row or 250 to 750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and trade concerns.
Medics	Sitona Weevil	175 g ac/ha	Not supported – safety (environment) concerns.
	Bluegreen aphid, spotted alfalfa aphid, pea aphid	>130 to 150 g ac/ha	Not supported – safety (environment) concerns.
Oilseeds (excluding canola and cotton)	Cutworms	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		350 g ac/ha	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment) concerns.
	Redlegged earth mite, blue oat mite	> 70 to 150 g ac/ha (<i>ground spray</i>)	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
		70 g ac/ha (<i>ground spray</i>)	Not supported - insufficient data to complete a robust assessment of the level of chlorpyrifos residues expected and establish an MRL.
	False wireworms	125 g ac/310 kg seed	Not supported – safety (environment and worker exposure) concerns.
Pasture	Corbie, winter corbie	450 or 750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Spur throated locust	625 or 750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Blackheaded pasture cockchafer	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Cutworms	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Underground grass grub	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Armyworm	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Cutworms, lawn armyworm, sod webworm, brown pasture looper, pasture webworm	350 g ac/ha	Not supported – safety (environment) concerns.
	Australian plague locust	280 g ac/ha	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment) concerns.
	Australian plague locust, migratory locust, sitonia weevil	175 g ac/ha	Not supported – safety (environment) concerns.
	Pasture webworm	150 g ac/ha	Not supported – safety (environment) concerns.
	Spotted alfalfa aphid, blue-green aphid, pea aphid	100 to 150 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Blue oat mite, redlegged earth mite, pea aphid	35 to 70 g ac/ha	Not supported – safety (environment) concerns.
	Lucerne flea	35 g ac/ha	Not supported – safety (environment) concerns.
Pulses (cowpea, chickpea, mung bean, pigeon pea navy bean, and soybean)	False wireworms, wireworms, brown field cricket, cockroaches	50 g ac/ha <i>(with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)</i>	Not supported – safety (environment and worker exposure) and trade concerns.
Rice	Brown plant hopper	750 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Bloodworm	30 or 75 g ac/ha	Not supported – safety (environment) and trade concerns.
Safflower	Wireworm, false wireworm*	2.5 g to 7.5 g ac/100 m row or 250 to 750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) concerns.
Sorghum (excluding Sugar Drip or Alpha Sorghum)	Wireworm, false wireworm*	2.5 g to 7.5 g ac/100 m row or 250 to 750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and trade concerns.
	Spur throated locust	625 to 750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Armyworms, Cutworm	350 to 450 g ac/ha	Not supported – safety (environment and worker exposure) and trade concerns.
	Corn aphid, sorghum midge	250 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Australian plague locust, migratory locust	175 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
Sugarcane	Symphylids	1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Sugarcane wireworm, African black beetle, beetle	750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Spur throated locust	625 or 750 g ac/ha	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Southern armyworm, common armyworm	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Southern armyworm, common armyworm	350 g ac/ha	Not supported – safety (environment) concerns.
	Australian plague locust, migratory locust	175 g ac/ha	Not supported – safety (environment) concerns.
Sunflower	Wireworm, false wireworm*	2.5 g to 7.5 g ac/100 m row or 250 to 750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and concerns.
Tobacco	Wireworm, false wireworm, cutworm*	1,500 g ac/ha (<i>pre-plant, soil incorporated</i>)	Not supported – safety (worker exposure) concerns.
Miscellaneous uses			
Agricultural, commercial and industrial areas (not publicly accessible)	Cockroaches, spiders, silverfish	4.5 g ac/L water to 5 g ac/L water	Not supported – safety (worker exposure) concerns.
Chemical soil barrier around buildings (not publicly accessible)	Termites	50 g ac/m ² or 100 g ac/m ² (<i>horizontal barrier</i>) 1000 g ac/m ³ or 2000 g ac/m ³ (<i>vertical barrier</i>)	Not supported – safety (environment and worker exposure) concerns.
Chemical soil barrier around buildings (reticulated or AS Series 3660 systems)	Termites	50 g ac/m ² (<i>horizontal barrier</i>)	Not supported – safety (environment) concerns
Chemical soil barrier under buildings (not publicly accessible)	Termites	50 g ac/m ² or 100 g ac/m ² (<i>horizontal barrier</i>) 1000 g ac/m ³ or 2000 g ac/m ³ (<i>vertical barrier</i>)	Not supported – safety (worker exposure) concerns.
Chemical soil barrier around poles	Termites	10 g ac/L water	Not supported – safety (worker exposure) concerns.
Commercial and industrial areas (not publicly accessible)	Argentine ants	10 g ac/100 m ²	Not supported – safety (worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
Duboisia	Cutworms	450 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
Grapevine rootlings	African black beetle	8000 g ac/ha (2 g ac/vine at 4000 vines/ha)	Not supported – safety (environment and worker exposure) concerns.
Macrocarpa hedges	Dimpling bug	250 g ac/ha (25 g ac/100 L water applied using 1,000 L water/ha)	Not supported – safety (environment and worker exposure) concerns.
Ornamental nursery plants	Sciarid fly, shore fly*	250 g ac/m ³ potting medium	Not supported – safety (worker exposure) concerns.
	Pruinose scarab, Argentine scarab, fiddler beetle, opaline cockchafer, black vine weevil*	375 to 500 g ac/m ³ potting medium	Not supported – safety (worker exposure) concerns.
Outdoor areas (not publicly accessible)	Ants, Argentine Ants	1 g ac/10 m ²	Not supported – safety (worker exposure) concerns.
Polluted water impoundments (permanent water pools)	Mosquito larvae	1 g ac/10,000 L water or 10 g ac/100 m ³	Not supported – safety (environment and worker exposure) concerns.
Polluted water impoundments (temporary water pools)	Mosquito larvae	1 g ac/10,000 L water or 10 g ac/100 m ³	Not supported – safety (worker exposure) concerns.
Tasmanian blue gum	African black beetle*	1500 g ac/ha (1.5 g ac/seedling at 1000 seedlings/ha)	Not supported – safety (worker exposure) concerns.
Treatment of termite nest or colony (outdoor)	Termites	5 g ac/L water	Not supported – safety (environment) concerns.
Turf (Commercial)	African black beetle	3,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Argentine stem weevil	2,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome
	Funnel ant, crickets	1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Blackheaded pasture cockchafer, underground grass grub, winter corbie	450 g ac/ha	Not supported – safety (environment) concerns.
	Brown pasture looper, pasture webworm, lawn armyworm, sod webworm	350 g ac/ha	Not supported – safety (environment) concerns.
	Crickets	10 g ac/20 L water	Not supported – safety (environment) concerns.
		12.5 g ac/ha (<i>applied in 2.5 kg bran bait</i>)	Not supported – safety (environment and worker exposure) concerns.
		50 g ac/ha (<i>with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait</i>)	Not supported – safety (environment and worker exposure) concerns.
Vegetation (light to medium, not publicly accessible)	Mosquito adults	29 to 32 g ac/ha	Not supported – safety (environment) concerns.
Vegetation (medium to heavy, not publicly accessible)	Mosquito adults	52 to 54 g ac/ha	Not supported – safety (environment) concerns.
Vegetation (light, not publicly accessible)	Mosquito larvae	13 to 15 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation.
Vegetation (medium, not publicly accessible)	Mosquito larvae	29 to 32 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation.
Vegetation (heavy, not publicly accessible)	Mosquito larvae	52 to 54 g ac/ha	Not supported – use is not considered practical based on pest activity in this situation.

* Use patterns were not reconsidered in the environment assessment as they were not supported on human health and/or food safety grounds. Additional environmental concerns not indicated in this table may therefore exist for these use patterns.

Appendix C – Listing of environmental endpoints

Table 45: Physical and chemical properties

Substance	Study	Result	Reference	
Chlorpyrifos	Vapour pressure	2.4 × 10 ⁻⁴ Pa at 25°C	Karambelkar 2011a	
		2.3 × 10 ⁻³ Pa at 25°C	Shubha 2015a	
		3.4 × 10 ⁻³ Pa at 20°C		
		4.3 × 10 ⁻³ Pa at 25°C	Vohra 2009a	
	Henry's law constant	0.30 Pa m ³ /mol	Calculated	
	Solubility in water	0.64 mg/L at 25°C	Karambelkar 2011b	
		1.3 mg/L at 20°C	Shubha 2015b	
		1.4 mg/L at 20°C	Vohra 2009b	
	Partition coefficient	log P _{ow} 4.89 at 25°C	Shubha 2014a	
		log P _{ow} 4.76 at 20°C	Suratwala 2009	
Dissociation constant	No dissociation	Shubha 2014b		
UV-VIS absorption (max)	Solution	λ _{max} ε (L/mol/cm)		
		Acidic 285 nm	5377	Shubha 2014c
		Neutral 285 nm	5274	
	Alkaline 285 nm	5206		
	Solution	Acidic 289 nm	6167	Singh 2009
		Acidic 230 nm	11787	
		Acidic 206 nm	11620	
		Neutral 289 nm	6027	
		Neutral 230 nm	11301	
		Neutral 207 nm	9903	
		Alkaline 324 nm	1157	
		Alkaline 290 nm	5630	
		Alkaline 230 nm	1991	
TMP		Vapour pressure	1.3 × 10 ⁻³ Pa at 25°C	Comb 2002
	0.9 × 10 ⁻³ Pa at 20°C			
	Solubility in water	7.8 mg/L at 20°C	Sabourin & South 2002a	
Partition coefficient	log P _{ow} 3.7	Sabourin & South 2002b		
TMP	UV-VIS absorption (max)	Solution	λ _{max} ε (L/mol/cm)	Madsen & Humfleet 2004
		Acidic 205 nm	9400	
		Acidic 233 nm	9400	
		Acidic 296 nm	6700	
		Neutral 206 nm	8800	
		Neutral 232 nm	9500	
		Neutral 296 nm	6700	
		Alkaline 232 nm	8400	
		Alkaline 296 nm	6000	
		TCP	Vapour pressure	
Henry's law constant	2.0 × 10 ⁻³ Pa m ³ mol ⁻¹ at 20°C		Watson 2002	
Solubility in water	pH 4, 20°C: 195 mg/L pH 7, 20°C: 3,007 mg/L pH 9, 20°C: 12,340 mg/L		Roulin 2002	
Partition coefficient	log P _{ow} 1.8		Comb 2001	
Dissociation constant	pKa 4.55		Meikle & Hamaker 1981	

Table 46: Fate and behaviour in soil

Study	Substance	Result	Reference																																										
Soil photolysis	Chlorpyrifos	Silt loam DT ₅₀ 30 h (light), 29 h (dark) 5% mineralisation, 32% bound residues after 30d Max 47% TCP	Havens et al. 1992																																										
	TCP	Silt loam DT ₅₀ 14 d (light), 102 d (dark)	Shepler et al. 1994																																										
Aerobic laboratory soil	Chlorpyrifos	Silt loam: DT ₅₀ 30 d Sandy clay loam: DT ₅₀ 6.0 d Sandy loam: DT ₅₀ 30 d Clay loam: DT ₅₀ 42 d	Abu 2015a, Clark 2013																																										
		Sandy clay loam: DT ₅₀ 90 d Silty clay loam: DT ₅₀ 65 d Sand: DT ₅₀ 110 d Sandy silt loam: DT ₅₀ 47 d	Abu 2015a, de Vette & Schoonmade 2001a																																										
	Geomean DT ₅₀ 40 d																																												
	8–54% mineralisation, 8.4–25% bound residues at 84–120 d Max 60% TCP																																												
Aerobic laboratory soil	TMP	Sandy clay loam: DT ₅₀ 17 d Clay loam: DT ₅₀ 12 d	Abu 2015a, Clark 2013																																										
	TCP	Silt loam: DT ₅₀ 13 d Sandy loam: DT ₅₀ 27 d Sandy clay loam: DT ₅₀ 22 d Clay loam: DT ₅₀ 10 d	Abu 2015a, Clark 2013																																										
		Silty clay loam: DT ₅₀ 6.0 d Sand: DT ₅₀ 8.6 d	Abu 2015a, de Vette & Schoonmade 2001a																																										
		Sandy clay loam: DT ₅₀ 121 d Silty clay loam: DT ₅₀ 7.2 d Sand: DT ₅₀ 12 d Sandy silt loam: DT ₅₀ 47 d	Abu 2015a, Brüll et al. 2002, de Vette & Schoonmade 2001b																																										
	DCP	Clay loam: DT ₅₀ 9.3 d Sandy loam: DT ₅₀ 11 d Silt loam: DT ₅₀ 8.5 d Sandy loam: DT ₅₀ 7.5 d	Abu 2015b, Ross 2015																																										
	Anaerobic laboratory soil	Chlorpyrifos	Sandy loam: DT ₅₀ 11 d Loam: DT ₅₀ 13 d Clay: DT ₅₀ 23 d Sandy loam: DT ₅₀ 23 d Geomean DT ₅₀ 17 d 2.1–5.5% mineralisation, 13–22% bound residues at 120 d Max 82% TCP Max 67% DCP	Jackson 2015, Kang 2014a																																									
Anaerobic laboratory soil	TCP	Sandy loam: DT ₅₀ 46 d Loam: DT ₅₀ 21 d Clay: DT ₅₀ 82 d Sandy loam: DT ₅₀ 47 d Geomean DT ₅₀ 44 d	Jackson 2015, Kang 2014a																																										
Adsorption/desorption	Chlorpyrifos	<table border="1"> <thead> <tr> <th>Soil</th> <th>%OC</th> <th>K_f</th> <th>K_{foc}</th> <th>1/n</th> <th></th> </tr> </thead> <tbody> <tr> <td>Clay loam</td> <td>3.5</td> <td>53</td> <td>1520</td> <td>0.86</td> <td></td> </tr> <tr> <td>Sand</td> <td>1.5</td> <td>77</td> <td>5113</td> <td>0.90</td> <td></td> </tr> <tr> <td>Loam</td> <td>1.0</td> <td>49</td> <td>4870</td> <td>0.97</td> <td></td> </tr> <tr> <td>Sandy clay loam</td> <td>1.6</td> <td>45</td> <td>2825</td> <td>0.90</td> <td></td> </tr> <tr> <td>Sandy loam</td> <td>4.3</td> <td>234</td> <td>5442</td> <td>0.94</td> <td></td> </tr> <tr> <td colspan="5">Geomean K_{foc} 3572 mL/g, mean 1/n 0.92</td> <td></td> </tr> </tbody> </table>	Soil	%OC	K _f	K _{foc}	1/n		Clay loam	3.5	53	1520	0.86		Sand	1.5	77	5113	0.90		Loam	1.0	49	4870	0.97		Sandy clay loam	1.6	45	2825	0.90		Sandy loam	4.3	234	5442	0.94		Geomean K _{foc} 3572 mL/g, mean 1/n 0.92						Damon & Heim 2001
Soil	%OC	K _f	K _{foc}	1/n																																									
Clay loam	3.5	53	1520	0.86																																									
Sand	1.5	77	5113	0.90																																									
Loam	1.0	49	4870	0.97																																									
Sandy clay loam	1.6	45	2825	0.90																																									
Sandy loam	4.3	234	5442	0.94																																									
Geomean K _{foc} 3572 mL/g, mean 1/n 0.92																																													

Study	Substance	Result	Reference
Adsorption/ desorption	TMP	Soil %OC Kf Kfoc 1/n	Heim & Damon 2001
		Clay loam 3.1 11 323 0.81	
		Sand 1.5 9.3 619 0.88	
		Loam 1.0 5.6 562 0.88	
		Sandy clay loam 1.5 8.7 543 0.73	
		Sandy loam 4.3 28 640 0.89	
	Geomean Kfoc 523 mL/g, mean 1/n 0.84		
	TCP	Soil %OC Kf Kfoc 1/n	Damon & Sarff 2001
		Clay loam 3.5 1.8 51 0.89	
		Sand 1.5 1.3 86 0.83	
Loam 1.0 0.68 68 0.79			
Sandy clay loam 1.6 1.7 105 0.75			
Sandy loam 4.3 6.4 14 0.80			
Clay loam 2.5 2.0 77 0.78		Racke & Lubinski 1992	
Sandy loam 0.3 0.60 194 0.81			
Silt loam 2.1 1.7 81 0.78			
Geomean Kfoc 93 mL/g, mean 1/n 0.80			
Adsorption/ desorption	DCP	Soil %OC Kf Kfoc 1/n	Grant & McLachlan 2015
		Sandy loam 0.81 0.69 85 0.80	
		Clay loam 3.5 3.5 99 0.77	
		Sandy loam 1.3 0.23 18 0.78	
		Silt loam 5.3 0.69 13 0.81	
		Loam 0.64 0.12 19 0.75	
		Geomean Kfoc 33 mL/g, mean 1/n 0.78	
Field dissipation	Chlorpyrifos	France: DT ₅₀ 25 d	Abu 2015c, Old 2002b
		Greece: DT ₅₀ 15 d	Abu 2015c, Old 2002c
		Spain: DT ₅₀ 5.2 d	Abu 2015c, Old 2002d
		Illinois: DT ₅₀ 106 d	Abu 2015c, Fontaine et al. 1987
		Michigan: DT ₅₀ 38 d	
	California: DT ₅₀ 66 d		
	Geomean DT ₅₀ 28 d		
	TCP	Greece: DT ₅₀ 43 d	Abu 2015c, Old 2002c
		Spain: DT ₅₀ 111 d	Abu 2015c, Old 2002d
		California: DT ₅₀ 42 d	Abu 2015c, Fontaine et al. 1987
Geomean DT ₅₀ 58 d			

Table 47: Fate and behaviour in water and sediment

Study	Substance	Result	Reference
Ready biodegradability	Chlorpyrifos	Not readily biodegradable	Douglas & Pell 1985
Hydrolysis	Chlorpyrifos	pH 4.0, 25°C: DT ₅₀ 93 d pH 7.0, 25°C: DT ₅₀ 63 d pH 9.0, 25°C: DT ₅₀ 34 d	Anand 2016a
		pH 5.0, 25°C: DT ₅₀ 73 d pH 7.0, 25°C: DT ₅₀ 72 d pH 9.0, 25°C: DT ₅₀ 16 d	McCall 1986
		pH 4.7, 25°C: DT ₅₀ 63 d pH 6.9, 25°C: DT ₅₀ 35 d pH 8.1, 25°C: DT ₅₀ 23 d	Meikle & Youngson 1977
Aqueous photolysis	Chlorpyrifos	DT ₅₀ 17 d at 40°N in summer DT ₅₀ 21 d at 40°N in spring DT ₅₀ 36 d at 40°N in fall	Anand 2016b
Aerobic mineralisation in surface water	Chlorpyrifos	Low dose: DT ₅₀ 55 d High dose: DT ₅₀ 25 d 0.8–0.9% mineralisation at 61 d	Curtis-Jackson & Gassen 2015
Degradation in water/sediment	Chlorpyrifos	Calwich Abbey: DT ₅₀ 31 d Swiss Lake: DT ₅₀ 58 d Geomean DT ₅₀ 42 d 7.4–9.2% mineralisation, 6.7–12% bound residue after 150 d Max 54% chlorpyrifos in sediment Max 67% TCP (47% in water, 27% in sediment)	Abu 2015d, Kang 2015

Table 48: Fate and behaviour in air

Study	Substance	Result	Reference
Photochemical oxidative degradation	Chlorpyrifos	DT ₅₀ 1.4 h	Simon 2001
	TMP	DT ₅₀ 60 d	Simon 2001
	TCP	DT ₅₀ 12 d	Simon 2001
Volatilisation	Chlorpyrifos	79–81% after 24 h from plant surfaces 22–26% after 24 h from soil surfaces	Day & Rüdél 1993

Table 49: Effects on mammals

Exposure	Species	Test substance	Toxicity value	Reference
Acute	<i>Rattus norvegicus</i>	Chlorpyrifos	LD ₅₀ >50 mg ac/kg bw/d	Kumar 2014, Pandya 2008, Patel 2015, Suryawanshi 2008
			LD ₅₀ 97 mg ac/kg bw/d	Henck & Kociba 1980
			LD ₅₀ >300 mg ac/kg bw/d	Ilamurugan 2011
		TMP	LD ₅₀ >2000 mg/kg bw/d	Verma 2013a
		TCP	LD ₅₀ 3129 mg/kg bw/d	Durando 2005
		DCP	LD ₅₀ >2000 mg/kg bw/d	Verma 2015
	<i>Mus musculus</i>	Chlorpyrifos	LD ₅₀ >50 mg ac/kg bw/d	Verma 2013b
Chronic	<i>Rattus norvegicus</i>	Chlorpyrifos	NOEL 1.0 mg ac/kg bw/d	Breslin et al. 1991

Table 50: Effects on birds

Test substance	Exposure	Species	Toxicity value	Reference
Chlorpyrifos	Acute	<i>Quiscalus quiscula</i>	LD ₅₀ 5.6 mg ac/kg bw	Schafer & Brunton 1979
			LD ₅₀ 13 mg ac/kg bw	Schafer & Brunton 1971
			Geomean LD ₅₀ 8.5 mg ac/kg bw	
		<i>Phasianus colchicus</i>	LD ₅₀ 12 mg ac/kg bw	Hudson et al. 1984
		<i>Agelaius phoeniceus</i>	LD ₅₀ 13 mg ac/kg bw	Schafer & Brunton 1979
		<i>Columba livia</i>	LD ₅₀ 10 mg ac/kg bw	Schafer & Brunton 1979
			LD ₅₀ 27 mg ac/kg bw	Hudson et al. 1984
			Geomean LD ₅₀ 16 mg ac/kg bw	
		<i>Coturnix japonica</i>	LD ₅₀ 12 mg ac/kg bw	Yogeesh 2014
			LD ₅₀ 13 mg ac/kg bw	Schafer & Brunton 1979
			LD ₅₀ 17 mg ac/kg bw	Hudson et al. 1984
			LD ₅₀ 60 mg ac/kg bw	Sharma 2008a
		Geomean LD ₅₀ 20 mg ac/kg bw		
		<i>Passer domesticus</i>	LD ₅₀ 10 mg ac/kg bw	Schafer & Brunton 1979
			LD ₅₀ 21 mg ac/kg bw	Hudson et al. 1984
			LD ₅₀ 122 mg ac/kg bw	Gallagher et al. 1996
			Geomean LD ₅₀ 29 mg ac/kg bw	
		<i>Gallus gallus</i>	LD ₅₀ 25 mg ac/kg bw	Sherman et al. 1967
			LD ₅₀ 32 mg ac/kg bw	Stevenson 1963
			LD ₅₀ 35 mg ac/kg bw	Miyazaki & Hodgson 1972
			Geomean LD ₅₀ 30 mg ac/kg bw	
<i>Grus canadensis</i>	LD ₅₀ 38 mg ac/kg bw	Hudson et al. 1984		

Test substance	Exposure	Species	Toxicity value	Reference	
Chlorpyrifos	Acute	<i>Colinus virginianus</i>	LD ₅₀ 25 mg ac/kg bw	Lloyd et al. 1989a	
			LD ₅₀ 32 mg ac/kg bw	Smith 1987	
			LD ₅₀ 38 mg ac/kg bw	Rodgers 1996	
			LD ₅₀ 53 mg ac/kg bw	Bull & Cameron 2013	
			LD ₅₀ 128 mg ac/kg bw	Lloyd et al. 1989b	
				Geomean LD ₅₀ 46 mg ac/kg bw	
			<i>Brania canadensis</i>	LD ₅₀ 60 mg ac/kg bw	Hudson et al. 1984
			<i>Alectoris chukar</i>	LD ₅₀ 61 mg ac/kg bw	Hudson et al. 1984
			<i>Callipepla californica</i>	LD ₅₀ 68 mg ac/kg bw	Hudson et al. 1984
			<i>Agelaius phoeniceus</i>	LD ₅₀ 75 mg ac/kg bw	Schafer & Brunton 1979
			<i>Anas platyrhynchos</i>	LD ₅₀ 95 mg ac/kg bw	Hudson et al. 1972
Dietary	<i>Colinus virginianus</i>		LD ₅₀ 75 mg ac/kg bw/d	Gallagher & Beavers 2007	
	<i>Anas platyrhynchos</i>		LD ₅₀ 71 mg ac/kg bw/d	Roberts & Phillips 1987	
Chronic	<i>Colinus virginianus</i>		NOEL 11 mg ac/kg bw/d	Beavers & Fink 1978a	
	<i>Anas platyrhynchos</i>		NOEL 2.9 mg ac/kg bw/d	Beavers & Fink 1978b	
TCP	Acute	<i>Colinus virginianus</i>	LD ₅₀ >2000 mg/kg bw	Campbell et al. 1990	
	Dietary	<i>Anas platyrhynchos</i>	LD ₅₀ >1027 mg/kg bw/d	Long et al. 1990	

Table 51: Field studies on birds

Test substance	Crop	Exposure	Effect	Reference
EC 480 g/L	Brassica	2 × 960 g ac/ha 14d interval	No impact on bird community (1,598 bird sightings of 46 species; 6 nests monitored, 53 birds radiotracked)	Moosmayer & Wilkens 2008
	Grapes	2 × 360 g ac/ha 15d interval	No short-term negative impacts on birds, including buntings, redstarts, stonechats and jays	Brown et al. 2007
WG 750 g/kg	Citrus	2 × 2400 g ac/ha 14d interval	No impact on bird community, including warblers, blackbirds, tits, serins, and martins	Selbach & Wilkens 2008
	Pome fruit	2–3 × 960 g ac/ha 14–28d interval	No impact on bird community, including blackbirds, blackcaps, warblers, tits, nightingales, flycatcher	Wilkens et al. 2008b
Various commercial	Citrus	1200–3360 g ac/ha	No impact on bird community, including serins, finches, sparrows, swallows, nightingales and warblers	Dittrich & Staedler 2010
	Citrus, brassicas, pome fruit	1–3 × 500–2400 g ac/ha 14d interval	No impact on bird community, including warblers, flycatchers, wagtails, blackbirds, blackcaps, tits and skylarks	Wolf et al. 2010

Table 52: Effects on fish

Exposure	Species	Test substance	Toxicity value	Reference
Acute	<i>Oncorhynchus mykiss</i>	Chlorpyrifos	LC ₅₀ 0.025 mg ac/L	Bowmann 1988
		EC 480 g/L	LC ₅₀ 0.022 mg ac/L	McMinn 1995
		CS 250 g/L	LC ₅₀ 26 mg ac/L	Sewell & Grant-Salmon 1993
		TMP	LC ₅₀ 1.0 mg/L	Hamitou 2010a
		TCP	LC ₅₀ 13 mg/L	Gorzinski et al. 1991a
	<i>Leuciscus idus</i>	Chlorpyrifos	LC ₅₀ 0.010 mg ac/L	Douglas & Bell 1985a
	<i>Cyprinus carpio</i>	Chlorpyrifos	LC ₅₀ 0.024 mg ac/L	Bopanna 2014a
	<i>Cyprinodon variegatus</i>	Chlorpyrifos	LC ₅₀ >0.076 mg ac/L	Surprenant 1989a
	<i>Rutilus rutilus</i>	Chlorpyrifos	LC ₅₀ 0.25 mg ac/L	Douglas & Bell 1985b
	<i>Pimephales promelas</i>	Chlorpyrifos	LC ₅₀ 0.14 mg ac/L	Jarvinen & Tanner 1982
		CS 100 g/L	LC ₅₀ 0.12 mg ac/L	Jarvinen & Tanner 1982
		DCP	LC ₅₀ >15 mg/L	Tanneberger 2015
	<i>Lepomis macrochirus</i>	TCP	LC ₅₀ 12 mg/L	Gorzinski et al. 1991b
	<i>Menidia menidia</i>	TCP	LC ₅₀ 58 mg/L	Graves & Smith 1991
	Chronic	<i>Oncorhynchus mykiss</i>	Chlorpyrifos	NOEC 0.00051 mg ac/L
TCP			NOEC 0.081 mg/L	Marino et al. 1999
<i>Menidia peninsulae</i>		Chlorpyrifos	NOEC 0.00038 mg ac/L	Goodman et al. 1985
<i>Pimephales promelas</i>		Chlorpyrifos	NOEC 0.00057 mg ac/L	Mayes et al. 1993
<i>Menidia beryllina</i>		Chlorpyrifos	NOEC 0.00075 mg ac/L	Goodman et al. 1985

Table 53: Effects on aquatic invertebrates and sediment dwellers

Exposure	Species	Test substance	Toxicity value	Reference
Acute	<i>Daphnia magna</i>	Chlorpyrifos	EC ₅₀ 0.0013 mg ac/L	Bopanna 2014b
			EC ₅₀ 0.00010 mg ac/L	Burgess 1988
		EC 480 g/L	EC ₅₀ 0.0012 mg ac/L	van der Kolk 1995a
		TMP	EC ₅₀ 4.0 mg/L	Hamitou 2010b
		TCP	EC ₅₀ 10 mg/L	Gorzinski et al. 1991c
		DCP	EC ₅₀ 39 mg/L	Hoberg 2005
	<i>Mysidopsis bahia</i>	Chlorpyrifos	LC ₅₀ 0.000045 mg ac/L	Surprenant 1989b
	<i>Hyalella azteca</i>	Chlorpyrifos	LC ₅₀ 0.00014 mg ac/L	Brown et al. 1997
	<i>Crassostrea virginica</i>	Chlorpyrifos	EC ₅₀ 0.084 mg ac/L	Surprenant 1989c
	Chronic	<i>Daphnia magna</i>	Chlorpyrifos	NOEC 0.000056 mg/L
TCP			NOEC 0.029 mg/L	Machado 2003
<i>Mysidopsis bahia</i>		Chlorpyrifos	NOEC 0.0000046 mg ac/L	Sved et al. 1993
<i>Chironomus riparius</i>		DCP	NOEC 33 mg/L	Putt 2005

Exposure	Species	Test substance	Toxicity value	Reference
Chronic	Microcosm/mesocosm	EC 480 g/L	NOEC 0.00010 mg ac/L	Daam 2008, Giddings 1993, 2011, López-Mancisidor 2015, López-Mancisidor et al. 2008, van den Brink et al. 1996, van Wijngaarden et al. 2005

Table 54: Effects on algae and aquatic plants

Group	Species	Test substance	Toxicity value	Reference
Algae	<i>Pseudokirchneriella subcapitata</i>	Chlorpyrifos	E _r C ₅₀ 1.0 mg ac/L	Bopanna 2014c
		EC 480 g/L	E _b C ₅₀ 0.064 mg/L	van der Kolk 1995b
		TMP	E _r C ₅₀ 3.3 mg/L	Biester 2010
		TCP	E _r C ₅₀ 1.1 mg/L	Kirk et al. 1999
	<i>Scenedesmus subspicatus</i>	Chlorpyrifos	E _b C ₅₀ 0.48 mg/L	Douglas et al. 1990
	<i>Anabaena flos-aquae</i>	TCP	EC ₅₀ 1.4 mg/L	Kirk et al. 2000a
	<i>Navicula pelliculosa</i>	TCP	E _r C ₅₀ 8.9 mg/L	Sayers 2003
DCP		E _r C ₅₀ 12 mg/L	Hoberg 2006	
TCP		EC ₅₀ 8.8 mg/L	Kirk et al. 2000b	
Aquatic plants	<i>Lemna gibba</i>	TCP	EC ₅₀ 8.8 mg/L	Kirk et al. 2000b

Table 55: Effects on bees

Species	Life stage	Exposure	Test substance	Toxicity value	Reference
Apis mellifera	Adult	Acute contact	Chlorpyrifos	LD ₅₀ 0.080 µg ac/bee	Suresh 2015
				LD ₅₀ 0.070 µg ac/bee	Bell 1994
				Geomean LD ₅₀ 0.075 µg ac/bee	
			EC 480 g/L	LD ₅₀ 0.10 µg ac/bee	Bell 1993
		Acute oral	Chlorpyrifos	LD ₅₀ 0.21 µg ac/bee	Suresh 2014
				LD ₅₀ 0.13 µg ac/bee	Sharma 2008b
			LD ₅₀ 0.36 µg ac/bee	Bell 1994	
			Geomean LD ₅₀ 0.21 µg ac/bee		
			EC 480 g/L	LD ₅₀ 0.15 µg ac/bee	Bell 1993
	Larval	Acute	Chlorpyrifos	LD ₅₀ 0.021 µg ac/bee	Odemer 2015

Table 56: Semi-field studies on bees

Test substance	Crop	Application	Effect	Reference
WG 750 g/kg	<i>Phacelia tanacetifolia</i> Flowering	1000 g ac/ha Before flight	Reduced foraging activity in aged residues up to 14 days, but no increased mortality	Bakker 2000
		1000 g ac/ha During flight	Significant mortality during flight and 1-day old residues. Reduced foraging activity in aged residues up to 3 days	Bakker 2002
EC 225 g/L	<i>Phacelia tanacetifolia</i> Flowering	1000 g ac/ha During flight	Significant mortality during flight and 1-day old residues. Reduced foraging activity in aged residues up to 3 days	Bakker 2002

Table 57: Field studies on non-target arthropods

Test substance	Crop	Application	Effect	Reference
EC 480 g/L	Grassland	720 g ac/ha	Initial high toxicity to spring populations of carabid and staphylinid beetles and linyphiid. All groups recovered by following spring except Collembola.	Brown 1993
	Pome fruit	960 g ac/ha	Acute toxicity to most non-target and beneficial taxa (predatory bugs, ladybirds, spiders, earwigs, parasitic wasps). Most species showed recovery 11–23 days after treatment except Heteroptera.	Brown 1991

Table 58: Effects on soil macro-organisms

Exposure	Species	Test substance	Toxicity value	Reference
Acute	<i>Eisenia fetida</i>	Chlorpyrifos	LC _{50corr} 160 mg ac/kg dry soil	Bopanna 2014d
			LC _{50corr} 105 mg ac/kg dry soil	Rodgers 1994
			Geomean LC _{50corr} 130 mg ac/kg dry soil	
		EC 480 g/L	LC _{50corr} 82 mg ac/kg dry soil	Candolfi 1995
			LC _{50corr} 71 mg ac/kg dry soil	Johnson 1993
			Geomean LC _{50corr} 76 mg ac/kg dry soil	
		TMP	LC _{50corr} 48 mg/kg dry soil	Hoffmann 2009
TCP	LC _{50corr} 9.8 mg/kg dry soil	Ward & Boeri 1999		
Chronic	<i>Eisenia fetida</i>	EC 480 g/L	NOEC _{corr} 6.4 mg ac/kg dry soil	Hayward 2002
		TCP	NOEC _{corr} 1.1 mg/kg dry soil	Mallett 2003
		DCP	EC _{10corr} 0.88 mg/kg dry soil	Ganßmann 2015
	<i>Hypoaspis aculeifer</i>	TCP	EC ₁₀ >50 mg/kg dry soil	Vinall 2011a
	<i>Folsomia candida</i>	TCP	NOEC 50 mg/kg dry soil	Vinall 2011b

Table 59: Effects on soil processes

Exposure	Process	Test substance	Toxicity value	Reference
Chronic	Respiration	EC 480 g/L	NOEC 6.4 mg ac/kg dry soil	Baloch & Hund 1990
		TMP	NOEC 2.1 mg/kg dry soil	Baumgartner 2009
		TCP	NOEC 4.7 mg/kg dry soil	Mallett & Hayward 1999
	Nitrification	EC 480 g/L	NOEC 6.4 mg ac/kg dry soil	Baloch & Hund 1990, Baloch & Todt 1990
			NOEC 9.6 mg ac/kg dry soil	McGibbon et al. 1989
		TMP	NOEC 2.1 mg/kg dry soil	Baumgartner 2009
	TCP	NOEC 4.7 mg/kg dry soil	Mallett & Hayward 1999	

Table 60: Effects on non-target terrestrial plants (pre-emergent exposure)

Test substance	Species	ER ₂₅	ER ₅₀	Reference
EC 480 g/L	<i>Abutilon theopasti</i>	>2400 g ac/ha	>2400 g ac/ha	Paterson & Toft 2007a
WG 750 g/kg	<i>Alopecurus myosuroides</i>	>2400 g ac/ha	>2400 g ac/ha	
CS 200 g/L	<i>Avena fatua</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Beta vulgaris</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Chenopodium album</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Digitaria sanguinalis</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Echinochloa crus-galli</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Euphorbia heterophylla</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Glycine max</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Helianthus annuus</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Ipomoea hederacea</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Oryza sativa</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Sorghum bicolor</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Triticum aestivum</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Zea mays</i>	>2400 g ac/ha	>2400 g ac/ha	
EW 450 g/L	<i>Lactuca sativa</i>	2670 g ac/ha	>6400 g ac/ha	Bergfield 2011a, 2012a
	<i>Cucumis sativus</i>	5720 g ac/ha	>6400 g ac/ha	
	<i>Allium cepa</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Avena sativa</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Brassica oleraca</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Daucus carota</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Glycine max</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Lolium perenne</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Lycopersicon esculentum</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Zea mays</i>	>6400 g ac/ha	>6400 g ac/ha	

Table 61: Effects on non-target terrestrial plants (post-emergent exposure)

Test substance	Species	ER ₂₅	ER ₅₀	Reference
EC 480 g/L	<i>Abutilon theopasti</i>	>2400 g ac/ha	>2400 g ac/ha	Paterson & Toft 2007b
WG 750 g/kg	<i>Alopecurus myosuroides</i>	>2400 g ac/ha	>2400 g ac/ha	
CS 200 g/L	<i>Amaranthus retroflexus</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Avena fatua</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Beta vulgaris</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Brassica napus</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Chenopodium album</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Cirsium arvensis</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Digitaria sanguinalis</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Echinochloa crus-galli</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Euphorbia heterophylla</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Glycine max</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Helianthus annuus</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Ipomoea hederacea</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Oryza sativa</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Polygonum convolvulus</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Setaria faberii</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Sorghum bicolor</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Stellaria media</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Triticum aestivum</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Viola tricolor</i>	>2400 g ac/ha	>2400 g ac/ha	
	<i>Zea mays</i>	>2400 g ac/ha	>2400 g ac/ha	

Test substance	Species	ER ₂₅	ER ₅₀	Reference
EW 450 g/L	<i>Allium cepa</i>	>6400 g ac/ha	>6400 g ac/ha	Bergfield 2011b, 2012b
	<i>Avena sativa</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Brassica oleracea</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Cucumis sativus</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Daucus carota</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Glycine max</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Lactuca sativa</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Lolium perenne</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Lycopersicon esculentum</i>	>6400 g ac/ha	>6400 g ac/ha	
	<i>Zea mays</i>	>6400 g ac/ha	>6400 g ac/ha	

Appendix D – Wild mammal assessments

Risks to terrestrial vertebrates following dietary exposure to contaminated food items are assessed using a tiered approach. Based on current assessment methodology, risks to mammals from long-term exposure have been determined to be significantly higher than previously assessed in 2019. Therefore, the updated assessment in this Appendix focuses only on the long-term risks to wild mammals.

In the draft Chlorpyrifos Review Technical Report, the chronic assessment assumed 50% of food items are obtained from the treatment area for the first 21 days after the last application (PT 0.5). However, given the critical endpoint is based on neonatal effects that may result from short-term exposure at a critical life stage, the PT has been revised from 0.5 to 1.0.

In the 2019 assessment, a long-term time-weighted average (TWA) factor of 0.53 was applied (based on default foliar DT₅₀ 10 days). However, a TWA factor is no longer automatically applied under the current assessment methodology. In the case of the neonatal effects observed in the 2-generation dietary reproduction study in rats (Breslin et al. 1991), the effects being a result of short-term exposure at a critical life stage could not be excluded. As a result, the TWA was not applied in the current assessment.

For the wild mammal assessment, maximum acceptable application rate for each application timing calculated to compare against the full rate ranges registered for each situation (Table A1). It is assumed that the exposure of a 'generic focal species' within each group will be the same as they relate to feeding habits and other ecological needs. A 'generic focal species' is not a real species; however, it is considered to be representative of all those species potentially at risk. The APVMA utilises the EFSA (2009) generic focal species which are considered protective of species that occur in Australia. Interception of the spray by the crop is taken into account by calculating the residue level on the several food types, depending on the growth stage of the crop.

Table A1: Chlorpyrifos – Assessment of direct dietary risks to wild mammals (RAL 1.0 mg/kg bw/d)

Situation	Crop group	Generic focal species	Crop stage	Shortcut value	FFT	Maximum acceptable rate (g/ha)
Barley, wheat, cereals, oats, rice, rye, triticale, sorghum (excluding sugar drip or alpha sorghum)	Cereals	Large herbivore	BBCH 10-29	22.3	1.0	45
			BBCH ≥40	21.7	1.0	46
		Small omnivore	BBCH 10-29	7.8	1.0	128
			BBCH 30-39	3.9	1.0	256
			BBCH ≥40	2.3	1.0	435
		Small insectivore	BBCH 10-19	4.2	1.0	238
			BBCH ≥20	1.9	1.0	526
Broad beans, chickpeas, field peas, lupins	Pulses	Small herbivore	BBCH 40-49	72.3	1.0	14
			BBCH ≥50	21.7	1.0	46
		Large herbivore	BBCH 10-49	14.3	1.0	70
			BBCH ≥50	4.3	1.0	233
		Small omnivore	BBCH 10-49	7.8	1.0	128
			BBCH 50-79	2.3	1.0	435
			BBCH ≥80	6.6	1.0	152
		Small insectivore	BBCH 10-19	4.2	1.0	238
BBCH ≥20	1.9		1.0	526		

Situation	Crop group	Generic focal species	Crop stage	Shortcut value	FFT	Maximum acceptable rate (g/ha)
Cotton	Cotton	Small herbivore	BBCH 40-49	72.3	1.0	14
			BBCH ≥50	18.1	1.0	55
		Small omnivore	BBCH 10-49	7.8	1.0	128
			BBCH ≥50	1.9	1.0	526
		Small insectivore	BBCH 10-19	4.2	1.0	238
			BBCH ≥20	1.9	1.0	526
Pasture, sugarcane, commercial turf	Grassland	Small herbivore	All season	72.3	1.0	14
		Large herbivore	All season	17.3	1.0	58
		Small omnivore	All season	6.6	1.0	152
		Small insectivore	Late season	1.9	1.0	526
Lucerne, forage crops, combination products (subterranean clover, clover, lucerne), clover seed crops	Legume forage	Small herbivore	BBCH 40-49	72.3	1.0	14
			BBCH ≥50	21.7	1.0	46
		Large herbivore	BBCH 21-49	14.3	1.0	70
		Small omnivore	BBCH 10-49	7.8	1.0	128
			BBCH ≥50	2.3	1.0	435
		Small insectivore	BBCH 10-19	4.2	1.0	238
		BBCH ≥20	1.9	1.0	526	
Canola, oilseeds (excluding canola and cotton)	Oilseed rape	Small herbivore	BBCH ≥40	18.1	1.0	55
			Large herbivore	All season	14.3	1.0
		Small omnivore	BBCH 10-29	7.8	1.0	128
			BBCH 30-39	2.3	1.0	435
			BBCH ≥40	1.9	1.0	526
		Small insectivore	BBCH 10-19	4.2	1.0	238
		BBCH ≥20	1.9	1.0	526	
Duboisia, adult mosquito control	Ornamentals/nursery	Small herbivore	BBCH 40-49	72.3	1.0	14
			BBCH ≥50	36.1	1.0	28
		Small omnivore	BBCH 10-49	7.8	1.0	128
			BBCH ≥50	3.9	1.0	256
		Small insectivore	All season	1.9	1.0	526
		Grapevines, kiwifruit, passionfruit	Vineyards	Small herbivore	Ground directed	72.3
BBCH 10-19	43.4				1.0	23
BBCH 20-39	36.1				1.0	28
BBCH ≥40	21.7				1.0	46
Large herbivore	Ground directed			11.1	1.0	90
	BBCH 10-19			6.7	1.0	149
	BBCH 20-39			5.5	1.0	182
	BBCH ≥40			3.3	1.0	303
Small omnivore	Ground directed			7.8	1.0	128
	BBCH 10-19			4.7	1.0	213
	BBCH 20-39			3.9	1.0	256
	BBCH ≥40			2.3	1.0	435
Small insectivore	BBCH 10-19			4.2	1.0	238
	BBCH ≥20			1.9	1.0	526

Situation	Crop group	Generic focal species	Crop stage	Shortcut value	FFT	Maximum acceptable rate (g/ha)
Avocado, apple, banana, pear, citrus, stone fruit, Macrocarpa hedges adjacent to orchards, mango, loquats, pineapple	Orchards	Small herbivore	BBCH <10	72.3	1.0	14
			BBCH 10-19	57.8	1.0	17
			BBCH 20-39	43.4	1.0	23
			BBCH ≥40	21.7	1.0	46
		Frugivore	BBCH 71-79	22.7	1.0	44
			Large herbivore	BBCH <10	14.3	1.0
		BBCH 10-19		11.5	1.0	87
		BBCH 20-39		8.6	1.0	116
		BBCH ≥40		4.3	1.0	233
		Small omnivore	BBCH <10	7.8	1.0	128
			BBCH 10-19	6.2	1.0	161
			BBCH 20-39	4.7	1.0	213
			BBCH ≥40	2.3	1.0	435
		Small insectivore	BBCH <10	1.9	1.0	526
Avocado, mango (spot spray)	Small herbivore		BBCH <10	72.3	0.40	35
		BBCH 10-19	57.8	0.40	43	
		BBCH 20-39	43.4	0.40	58	
		BBCH ≥40	21.7	0.40	115	
	Frugivore	BBCH 71-79	22.7	0.40	110	
		Large herbivore	BBCH <10	14.3	0.40	175
	BBCH 10-19		11.5	0.40	217	
	BBCH 20-39		8.6	0.40	291	
	BBCH ≥40		4.3	0.40	581	
	Small omnivore	BBCH <10	7.8	0.40	321	
		BBCH 10-19	6.2	0.40	403	
		BBCH 20-39	4.7	0.40	532	
		BBCH ≥40	2.3	0.40	>850	
	Small insectivore	BBCH <10	1.9	0.40	>850	
Vegetables (band application)		Small herbivore	BBCH 40-49	72.3	0.50	28
	BBCH ≥50		21.7	0.50	92	
	Large herbivore	All season	14.3	0.50	140	
		Small omnivore	BBCH 10-49	7.8	0.50	256
	BBCH ≥50		2.3	0.50	>850	
	Small insectivore	BBCH 10-19	4.2	0.50	476	
		BBCH ≥20	1.9	0.50	>850	
	Vegetables (broadcast application)	Small herbivore	BBCH 40-49	72.3	1.0	14
BBCH ≥50			21.7	1.0	46	
Large herbivore		All season	14.3	1.0	70	
		Small omnivore	BBCH 10-49	7.8	1.0	128
BBCH ≥50			2.3	1.0	435	
Small insectivore		BBCH 10-19	4.2	1.0	238	
		BBCH ≥20	1.9	1.0	526	
Ginger		Root & stem vegetables	Small herbivore	BBCH ≥40	21.7	1.0
	Small omnivore			BBCH 10-39	7.8	1.0
			BBCH ≥40	2.3	1.0	436
	Small insectivore		BBCH 10-19	4.2	1.0	238
			BBCH ≥20	1.9	1.0	526

Situation	Crop group	Generic focal species	Crop stage	Shortcut value	FFT	Maximum acceptable rate (g/ha)
Combination products (field tomatoes)	Fruiting vegetables	Small herbivore	BBCH 10-49	72.3	1.0	14
			BBCH ≥50	21.7	1.0	46
		Frugivore	BBCH 71-89	25.2	1.0	40
		Small omnivore	BBCH 10-49	7.8	1.0	128
			BBCH ≥50	2.3	1.0	435
		Small insectivore	BBCH 10-19	4.2	1.0	238
	BBCH ≥20	1.9	1.0	526		

Generic focal species and shortcut values for indicated crop groups from EFSA (2009)
Maximum acceptable rate (g/ha) = (RAL 1.0 mg/kg bw/d) / (shortcut * PT 1.0 * FFT) * 1000
RQ = risk quotient = DDD/RAL, where acceptable RQ ≤1

Appendix E – Runoff assessments

Assessment scenarios

Runoff has been modelled following the methodology described in Appendix C, Aquatic species of the [APVMA Risk Assessment Manual, Environment](#). In order to perform the appropriate high tier calculations, the runoff assessment has been undertaken using the PERAMA⁹ software. All runoff calculations assume that 50% of residues intercepted by the foliage are washed off due a rainfall event and contribute to the total soil residue subject to runoff.

In the draft Chlorpyrifos Review Technical Report, it is assumed that no more than 50% of the catchment is treated at once, with a few exceptions as described below. However, after consideration of the submissions received in response to the public consultation on the Proposed Regulatory Decision, the fraction catchment treated (FCT) was revised from 0.5 to 1 fruit, vegetables, and field crops. It is noted that the use on pasture has not been reassessed as it was not supported by the terrestrial vertebrate assessment.

For ornamentals, in the draft Chlorpyrifos Review Technical Report, it was conservatively assumed that 0.1% of the catchment is treated. This was based on information from the Department of Agriculture, Fisheries and Forestry (DAFF) MCAS-S tool that indicates the maximum fraction of catchment area to nursery production is 0.07% (Victoria). However, after consideration of the submissions received in response to the public consultation on the Proposed Regulatory Decision, the FCT was revised from 0.001 to 0.40 for container plants (Argentine ants) and potted ornamentals (beetle larvae). Although MCAS-S data suggest the maximum fraction of catchment area to nursery production is below 1%, this value applies to a much larger catchment area. It is noted the average size of a nursery in Australia is 3.9 ha and therefore 40% was deemed more appropriate for a 10-ha catchment scenario. In addition, the fraction field treated (FFT) for containerised plants was set at 0.01 to account for spacing when planting out.

For crawling insect control, it is assumed that an industrial building has a perimeter of 250 m and a treatment width of 1.0 m (50 cm up wall, 50 cm on ground). Assuming one industrial building is treated at 5,000 g ac/ha in a 10-ha catchment, environmental exposure is equivalent to 13 g ac/ha (i.e. 0.0025% of catchment is treated).

A small fraction of the catchment is also assumed for termite protection. Assuming a perimeter of 250 m (industrial buildings), a diameter of 20 cm (transmission poles) and a barrier of 150 mm wide around each, the treated areas are equivalent to 37.5 m² per building and 0.26 m² per pole. Assuming 2 industrial buildings and 16 transmission poles are treated at 100 kg ac/ha in a 10-ha catchment, environmental exposure in the tropics is equivalent to 750 g ac/ha (buildings) and 40 g ac/ha (poles). Assuming all of these structures can be treated within the same 10-ha catchment, this equates to a total of 790 g ac/ha in the tropics (i.e. 0.079% of catchment is treated). Temperature regions would be half this rate.

⁹ © Australian Environment Agency Pty Ltd 2023

Further, after consideration of the submissions received in response to the public consultation on the Proposed Regulatory Decision, the foliar interception fractions (Fint) for avocado, citrus, and loquats have been revised from 0.60 to 0.80 as they are considered evergreen trees in EFSA (2020).

The revised assessment results in no changes to the conclusion of acceptable runoff risks, though it is noted that only situations that were supported by the terrestrial vertebrate assessment have been reassessed. All new situations listed in Table 18 (including cereals, canola, cotton and pulses) that were supported by the terrestrial vertebrate assessment also have acceptable runoff risks.

The soil exposure rates assessed for the runoff assessments of chlorpyrifos are set out in Table B1 (where there has been no change to assessment parameters) and Table B2 (which includes use situations to be reassessed with corrected parameters and new use situations assessed). Runoff modelling assessments were not required for treated materials (hides/skins), crawling insect control (nests and trails) and spot sprays to funnel ant mounds in commercial turf as exposure is considered negligible.

Table B1: Soil exposure rates assessed for the runoff assessments of chlorpyrifos – no change to parameters

Use pattern	Situation	Application rate and frequency	Foliar interception fraction (Fint)	Fraction catchment treated (FCT)	Seasonal catchment exposure rate (g/ha)
Ornamentals	Tasmanian blue gum planting hole soil	1× 5000 g ac/ha	0	0.001	5.0
Crawling insect control	In and around buildings	1× 5000 g ac/ha	0	0.0025	13
Mosquito control	Vegetation (mosquito adults)	4× 54 g ac/ha 7d interval	0.20	0.5	76
Commercial turf	Worst-case scenario	2× 500 g ac/ha 7d interval	0.90	0.5	253
Termite protection	External perimeter treatment (horizontal or vertical) around large buildings	1× 1000 kg ac/ha	0	0.00075	750
	New and existing poles	1× 1000 kg ac/ha	0	0.00004	40

Foliar interception (Fint) values are based on EFSA (2020) defaults for similar situations; seasonal catchment exposure rates based on indicated application rate, frequency, soil DT₅₀ 28 days, foliar interception (with 50% wash-off) and fraction of catchments (FCT) treated.

Table B2: Soil exposure rates assessed for the runoff assessment – parameters corrected

Category	Crop/host	Application rate (g/ha)	Fint	FFT	FCT	Soil exposure over 10 ha (g/ha)
Fruit and vegetables	Apples, pears, pome fruits, stone fruits	45	0.60	1	1	32
	Avocado, citrus, loquats	45	0.80	1	1	27
	Brussels sprouts, chard (silver beet), cole (brassica) crops (including broccoli, cabbage, cauliflower), leafy crucifers (including chou moulier, kale, mustard, rape), lettuce, swede, turnips	70	0.25	1	1	61

Category	Crop/host	Application rate (g/ha)	Fint	FFT	FCT	Soil exposure over 10 ha (g/ha)
Field crops & pasture	Barley, cereals, oats, rye, sorghum, triticale, wheat	255	0.80	1	1	153
	Broad beans, chickpeas, field peas, lupins	70	0.35	1	1	58
	Canola (rapeseed), oilseeds (excluding canola and cotton)	70	0.30	1	1	60
	Clover, clover seed crops, cotton, forage crops, lucerne, lucerne seed crops, medics, subterranean clover	130	0.30	1	1	111
Miscellaneous uses	Container plants (Argentine ants)	5000	0	0.01	0.4	20
	Potted ornamentals (beetle larvae)	4000	0	0.01	0.4	16

Risk assessment scenarios as supported by the terrestrial vertebrate assessment; foliar interception (Fint) values are based on EFSA (2020) defaults for similar situations; size of catchment is 10 hectares in the Tier 1 and Tier 2 assessments (Tier 3 assessments use refined values based on MCAS-S data); (soil exposure over 10 ha in g/ha) = (application rate in g/ha) * (1 – Fint * 0.5) * FFT * FCT

Tier 1 assessments

The Tier 1 (screening level) is a worst-case scenario where slope is fixed at 8%, which is considered protective of 95% of agricultural activities in Australia. The rainfall value is set at 8 mm, which results in the maximum receiving water concentration using the standard water body of 1 ha and 15 cm initial depth when the clay dominated Queensland soil profile is used; the catchment is 10 ha. Further, for this worst-case scenario, a fallow/bare soil runoff profile is assessed. Acceptable risks could be concluded for a large number of use patterns at the Tier 1 level of assessment (Table B3).

Table B3: Tier 1 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

Category	Crop/host	Soil exposure over 10 ha (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Fruit and vegetables	Apples, pears, pome fruits, stone fruits	32	8.00	8.00	67	1.34	0.029	0.29
	Avocado, citrus, loquats	27	8.00	8.00	67	1.34	0.025	0.25
	Brussels sprouts, chard (silver beet), cole (brassica) crops (including broccoli, cabbage, cauliflower), leafy crucifers (including chou moulier, kale, mustard, rape), lettuce swede, turnips	61	8.00	8.00	67	1.34	0.060	0.60
Field crops and pasture	Broad beans, chickpeas, field peas, lupins	58	8.00	8.00	67	1.34	0.057	0.57
	Canola (rapeseed), oilseeds (excluding canola and cotton)	60	8.00	8.00	67	1.34	0.059	0.59
Miscellaneous uses	Container plants (Argentine ants)	20	8.00	8.00	67	1.34	0.018	0.18
	Potted ornamentals (beetle larvae)	16	8.00	8.00	67	1.34	0.014	0.14

Category	Crop/host	Soil exposure over 10 ha (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
	Tasmanian blue gum planting hole soil	5.0*	8.00	8.00	67	1.34	0.0091	0.09
	Crawling insect control in and around buildings	13*	8.00	8.00	67	1.34	0.024	0.24
	Treatment of new and existing poles for termite protection	40*	8.00	8.00	67	1.34	0.073	0.73

Soil exposure rates from Table B2 (*Seasonal catchment exposure rates from Table B1); Rainfall, slope, and runoff parameters are defaults for Tier 1; Kf (1% OC) and soil DT50 from Table 20; RAL from Table 22; (PEC in µg/L) = (soil exposure rate in g/ha) * (0.02153 * %slope + 0.001423 * %slope²) * EXP(-3 * ln(2) / (DT50 28 d)) * (1/(1+((soil exposure rate in g/ha)/750)/(10[^](LOG((soil exposure rate in g/ha)/750) - LOG(Kf))/(1/n 0.92)))) * (heterogeneity factor 0.5) * (runoff in mm) / (rainfall in mm) * (10 ha) / (1500 + (runoff in mm) * 100 + (rainfall in mm) * 10) * 1000; RQ = PEC / RAL, where acceptable RQ ≤ 1

Tier 2 assessments

Where the assessment fails at Tier 1, a regional assessment (Tier 2) is undertaken as either a state based or tropical/subtropical based assessment depending on the cropping situation and production areas. At this level of assessment, the 90th percentile slope value is applied. The rainfall value used is determined as that required to result in the maximum water concentration using the standard water body (1 ha surface area, 15 cm deep). At this level of assessment, the rainfall value is determined to be that resulting in the maximum water body concentration and reflects the soil profile applied in the modelling, not the actual rainfall pattern of the region being assessed.

Runoff risks for a large number of use scenarios could be concluded at the Tier 2 level of assessment as indicated in Table B4. Acceptable risks could not be determined for external perimeter treatment (horizontal or vertical) around large buildings (Table B5). In-stream analyses cannot be undertaken for urban scenarios; thus, no further refinement can be undertaken and the use pattern is not supported. No higher tier runoff assessments were required for remaining uses supported by the terrestrial vertebrates assessment.

Table B4: Tier 2 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

Crop/host	Region	Soil exposure over 10 ha (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Field crops								
Barley, cereals, oats, rye, sorghum, triticale, wheat	Queensland and NT	153	19	1.97	67	2.79	0.023	0.23
	NSW and ACT	153	27	1.89	88	2.92	0.011	0.11
	Victoria	153	27	1.18	67	2.92	0.0091	0.09
	Tasmania	153	21	2.59	194	2.74	0.0086	0.09
	South Australia	153	28	2.49	77	2.92	0.017	0.17
	Western Australia	153	44	2.46	67	3.54	0.014	0.14
Clover, clover seed crops, cotton, forage crops, lucerne, lucerne seed crops,	Queensland and NT	111	19	1.97	67	2.79	0.016	0.16
	NSW and ACT	111	27	1.89	88	2.92	0.0080	0.08
	Victoria	111	27	1.18	67	2.92	0.0064	0.06

Crop/host	Region	Soil exposure over 10 ha (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
medics, subterranean clover	Tasmania	111	21	2.59	194	2.74	0.0061	0.06
	South Australia	111	28	2.49	77	2.92	0.012	0.12
	Western Australia	111	44	2.46	67	3.54	0.010	0.10
Miscellaneous uses								
Commercial turf	Queensland and NT	253*	24	4.27	108	2.98	0.06	0.57
	NSW and ACT	253*	35	4.27	108	3.07	0.04	0.40
	Victoria	253*	35	2.85	108	3.06	0.02	0.25
	South Australia	253*	37	2.81	88	3.19	0.03	0.30
	Western Australia	253*	57	3.78	108	4.05	0.03	0.26
	Wet tropics	253*	24	6.84	108	2.98	0.10	1.0
	Burdekin	253*	24	1.84	108	2.98	0.02	0.21
	Mackay Whitsunday	253*	24	4.64	108	2.98	0.06	0.63
	Mary Burnett	253*	24	3.59	108	2.98	0.05	0.46
	SE Queensland	253*	24	3.88	108	2.98	0.05	0.50
Mosquito control in vegetation (adults)	Queensland and NT	88*	17	4.27	108	2.39	0.04	0.42
	NSW and ACT	88*	27	4.27	108	2.99	0.03	0.32
	Victoria	88*	27	2.85	108	2.96	0.02	0.20
	Tasmania	88*	20	12.39	194	2.60	0.08	0.84
	South Australia	88*	28	5.36	88	2.91	0.05	0.50
	Western Australia	88*	46	3.78	108	3.29	0.02	0.17
	Wet tropics	88*	17	6.84	108	2.39	0.08	0.76
	Burdekin	88*	17	1.84	108	2.39	0.02	0.16
	Mackay Whitsunday	88*	17	4.64	108	2.39	0.05	0.46
	Fitzroy	88*	17	4.35	108	2.39	0.04	0.43
	Mary Burnett	88*	17	3.59	108	2.39	0.03	0.34
	SE Queensland	88*	17	3.88	108	2.39	0.04	0.37
	Northern NSW	88*	17	7.74	108	2.39	0.09	0.90

Soil exposure rates from Table B2 (* Seasonal catchment exposure rate from Table B1)

Table B5: Tier 2 scenarios showing unacceptable runoff risks of chlorpyrifos to aquatic species

Crop/host	Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff(mm)	PEC (µg/L)	RQ
Termite protection (external perimeter treatment around large buildings)	Queensland and NT	790	7.00	4.02	108	1.20	0.94	9.4
		395	7.00	4.02	108	1.20	0.46	4.6
	NSW and ACT	395	9.00	4.56	108	1.51	0.51	5.1
	Victoria	395	9.00	4.95	108	1.53	0.57	5.7
	Tasmania	395	7.00	9.50	108	1.15	1.33	13
	South Australia	395	9.00	2.28	108	1.53	0.23	2.3
	Western Australia	395	14.00	2.30	108	2.16	0.20	2.0

Seasonal catchment exposure rates from Table B1

Appendix F – PBT and POP assessments

At its 17th meeting, the Persistent Organic Pollutants Review Committee (POPRC) agreed that chlorpyrifos met the screening criteria in Annex D of the Stockholm Convention (decision POPRC-17/4).

Persistence criterion

The Stockholm Convention provides scientifically based criteria for potential POPs and a process that ultimately may lead to elimination of a POP substance globally. The criteria for persistence in Annex D of the convention are expressed as single-media criteria as follows:

- i. Evidence that the half-life of the chemical in water is greater than 2 months (60 days), or that its half-life in soil is greater than 6 months (180 days), or that its half-life in sediment is greater than 6 months (180 days); or
- ii. Evidence that the chemical is otherwise sufficiently persistent to justify its consideration within the scope of the Convention.

In support of meeting persistence criteria, the following information is reported in POPRC-17/4:

- i. In the water degradation studies evaluated, DT_{50} values range from 21 days at 22.5°C to 75 days at 8°C. Chlorpyrifos has shown half-lives in water of greater than 2 months, especially at lower temperatures.

In soil, at application rates for agricultural uses (below 100 mg/kg), the half-lives found span a wide range, from 6 days at 20°C to 224 days at 15°C.

In sediments, the threshold of 6 months is exceeded in some studies performed under anaerobic conditions.

Chlorpyrifos shows higher persistence when associated with sediments and at lower temperatures.
- ii. Monitoring data from the Arctic demonstrate that chlorpyrifos is sufficiently persistent to be transported to remote regions. Since it is more persistent at lower temperatures, it is expected to persist in these regions for a considerable length of time. Findings of chlorpyrifos in sediment cores in Arctic and sub-Arctic lakes (Landers et al. 2008) that can be dated back several decades provide further evidence of the persistence of chlorpyrifos in sediments.

From data provided to the APVMA, the DT_{50} of chlorpyrifos in soil exceeds 12 months in many soils with much longer half-lives at higher rates observed. APVMA data does not indicate chlorpyrifos exceeds the persistence criterion for sediment with DT_{50} values <6 months. Based on information assessed by the POPRC, there is sufficient evidence that chlorpyrifos meets the criterion on persistence.

Bioaccumulation criterion

As noted above, the criteria for bioaccumulation in Annex D of the Stockholm Convention are given as follows:

- i. Evidence that the bioconcentration factor or bioaccumulation factor in aquatic species for the chemical is greater than 5000 or, in the absence of such data, that the log Kow is greater than 5;
- ii. Evidence that a chemical presents other reasons for concern, such as high bioaccumulation in other species, high toxicity or ecotoxicity; or
- iii. Monitoring data in biota indicating that the bioaccumulation potential of the chemical is sufficient to justify its consideration within the scope of the Convention.

In support of meeting bioaccumulation criteria, the following information is reported in POPRC-17/4:

- i. log Pow for chlorpyrifos ranges between 4.7 and 5.2, indicating a potential for bioaccumulation in aquatic organisms. The available bioconcentration factor (BCF) values in fish cover a broad range from 440 to 5,100 in many species, developmental stages and exposure scenarios. Numerous BCF values in fish show a moderate bioconcentration.
- ii. Chlorpyrifos shows high toxicity in fish and other species, such as invertebrates, amphibians, birds and mammals. In combination with high toxicity, even moderate bioaccumulation can lead to body concentrations that can cause adverse effects.
- iii. Chlorpyrifos has been found in biota at different trophic levels in remote regions, in apex predators and in human breast milk, which is a concern for offspring.

The APVMA data holdings indicate bioaccumulation criteria are not met with a log Pow of 4.9 and a BCF of 1374 in whole fish. However, taking into account other information reported in the POPRC decision, there is sufficient evidence that chlorpyrifos meets the criterion for bioaccumulation.

Toxicity criterion

For persistent and bioaccumulative substances, exposure may be anticipated to cover the whole life of an organism as well as multiple generations. Consequently, chronic ecotoxicity data, preferably covering impacts on reproduction, are used to establish the toxicity within the PBT context.

As noted, the Stockholm Convention on POPs provides scientifically based criteria for potential POPs and a process that ultimately may lead to elimination of a POP substance globally. The criteria for toxicity in Annex D of the POPs convention do not consist of numerical values, but are given as follows:

- i. Evidence of adverse effects to human health or to the environment that justifies consideration of the chemical within the scope of this Convention; or
- ii. Toxicity or ecotoxicity data that indicate the potential for damage to human health or to the environment.

In support of meeting toxicity/adverse effects criteria, the following information is reported in POPRC-17/4:

The main effect following short- to long-term repeated oral administration of chlorpyrifos is the inhibition of acetylcholinesterase (AChE) activity. There is potential evidence that developmental neurotoxicity effects from chlorpyrifos may occur at doses below those causing cholinesterase inhibition. Several epidemiological studies and reviews from regulatory authorities have associated pre- and postnatal exposure to chlorpyrifos with changes in brain morphology, delays in cognitive and motor functions, problems with attention and tremors. This, in addition to high toxicity to mammals, indicates a potential for damage to human health. Chlorpyrifos shows a high toxicity to aquatic organisms at approximately 0.1 µg/L. Invertebrates, especially crustaceans and insects, are the most sensitive taxa among aquatic organisms. Chlorpyrifos shows high acute toxicity to terrestrial vertebrates, especially to birds (LD50 value of 13.3 mg/kg bw) and to non-target arthropods, especially pollinators. The very high acute and chronic toxicity to a wide range of vertebrates, invertebrates and insects (including bees) indicates a potential for damage to the environment.

There is sufficient evidence that chlorpyrifos meets the criterion on adverse effects. APVMA data holdings confirm this with higher tier (microcosm/mesocosm) data, the consistent finding was a NOEC value of 0.10 µg ac/L for the most sensitive aquatic species.

Potential for long-range environmental transport

The criteria for long-range transport in Annex D of the Stockholm convention are expressed as follows:

- i. Measured levels of the chemical in locations distant from the sources of its release that are of potential concern;
- ii. Monitoring data showing that long-range environmental transport, with the potential for transfer to a receiving environment, (via air, water or migratory species); or
- iii. Environmental fate properties and/or model results that demonstrate that the chemical has a potential for such transportation, with the potential for transfer to a receiving environment in locations distant from the sources of its release. For a chemical that migrates significantly through the air, its half-life in air should be greater than 2 days.

In support of meeting long range transport potential criteria, the following information is reported in POPRC-17/4:

(2) and (ii) Chlorpyrifos has been widely detected in remote areas far away from point sources and/or agricultural uses, both in abiotic compartments and in biota such as caribou, seals and polar bears in the Arctic, and in sea-ice meltwater and air in Antarctica. In the Bering and Chukchi marine ecosystems, it was found in marine fog, sea water and marine ice. From one study with 5 pesticides analysed, it was the most frequently identified in sea water. It was monitored in snow cores collected over sea ice from 4 north-west Alaskan Arctic estuaries. In a dated ice core from Svalbard, chlorpyrifos was the only pesticide detected continuously, with first detections between 1971 and 1980. Maximum concentrations were detected between 1995 and 2005, which corresponds to the period in which the most recent samples were taken in this study, with the accumulated burden of chlorpyrifos being the highest of all the analysed compounds. Potential

routes of transport include atmospheric transport in the gas or particulate phase and transport via water in rivers and ocean currents.

(iii) The half-life of gaseous chlorpyrifos does not exceed 2 days. Particulate chlorpyrifos, however, is more recalcitrant to degradation by hydroxy radical reaction and shows an atmospheric half-life of up to 66.4 hours.

While standard modelling for atmospheric reaction with hydroxyl radicals indicates the persistence of chlorpyrifos in air is not sufficient to meet the long range transport criterion, given measured data in remote areas considered by the POPRC, there is sufficient evidence that chlorpyrifos meets the criterion on potential for long range environmental transport.

Conclusion

Chlorpyrifos met the screening criteria specified in Annex D of the Stockholm Convention on Persistent Organic Pollutants.

Acronyms and abbreviations

Shortened term	Full term
ac	active constituent
AChE	Acetyl cholinesterase
ADI	Acceptable daily intake (for humans)
APVMA	Australian Pesticides and Veterinary Medicines Authority
AF	assessment factor
Agvet	Agricultural and veterinary
ARfD	Acute reference dose
BBCH	Biologische Bundesanstalt, Bundessortenamt and Chemical industry
BCF	bioconcentration factor
bw	Bodyweight
cm	centimetre(s)
Codex	Codex Alimentarius Commission
CS	capsule suspension
CXLs	Codex Maximum Residue Limits
d	Day(s)
DAR	draft assessment report
DCP	3,6-dichloro-2-pyridinol
DDD	daily dietary dose
DES	desethyl-chlopyrifos
ds	dry soil
DT ₅₀	period required for 50 percent dissipation
EC	Emulsifiable concentrate
EC _x	concentration causing X% effect (E _r C _x is used for growth rate; E _b C _x is used for biomass)
EFSA	European Food Safety Authority
EngC	Engineering controls

Shortened term	Full term
ER _x	rate causing X% effect
ESI	Export Slaughter Interval
EU	European Union
EW	emulsion, oil in water
ExpE	exposure estimate
FCT	fraction catchment treated
Fint	foliar interception
FFT	fraction field treated
g	gram(s)
GAP	Good Agricultural Practice
h	hour(s)
ha	Hectare(s)
IPM	Integrated pest management
JMPR	Joint Meeting on Pesticide Residues
Kf or Kd	(Freundlich) adsorption constant
kg	Kilogram(s)
Koc or Kfoc	(Freundlich) organic carbon partition coefficient
L	Litre(s)
LC _x	Lethal concentration to X% of the tested population (LC _{xcorr} is a corrected value to account for bioavailability in the test system)
LD _x	Lethal dose to X% of the tested population
LOC	Level of concern
LOQ	Limit of quantification
m	Metre(s)
max	Maximum
mg	Milligram
mL	Millilitre

Shortened term	Full term
mm	Millimetre(s)
MCAS-S	multi-criteria analysis shell for spatial decision support
MOE	Margin of Exposure
MRL	Maximum residue limit
NEDI	National Estimated Daily Intake
NESTI	National Estimated Short-Term Intake
nm	Nanometre(s)
NOEC/NOEL	No observable effect concentration/level
NOAEL	No observed adverse effect level
NOEC	No observed effect concentration (NOEC _{corr} is a corrected value to account for bioavailability in the test system)
NOEL	No observed effect level
OC	Organic carbon
OCS	Office of Chemical Safety within the Australian Government Department of Health
OECD	Organization for Economic Co-operation and Development
OHS	Occupational health and safety
Pa	Pascal(s)
PBT	Persistent – bioaccumulative – toxic
PEC	Predicted environmental concentration
PERAMA	Pesticide Environmental Risk Assessment Model for Australia
PHED	Pesticide Handler Exposure Database
pKa	negative logarithm (to the base 10) of the dissociation constant
PMRA	Health Canada's Pest Management Regulatory Agency
Pow	octanol-water partition coefficient
PPE	Personal protective equipment
ppm	Parts per million
POP	persistent organic pollutant

Shortened term	Full term
POPRC	Persistent Organic Pollutants Review Committee
PRD	Proposed Regulatory Decision
PRF	Preliminary Review Findings
PT	Proportion of an animal's daily diet obtained in habitat treated with pesticide
RAL	Regulatory acceptable level
RQ	Risk quotient
RUD	Residue per unit dose
RTR	Review technical report
SDRAM	Spray drift risk assessment manual
TCP	3,5,6-trichloropyridinol
TMP	3,5,6-trichloro-2-methoxy pyridine
TWA	time-weighted average
µg	microgram(s)
US EPA	United States Environmental Protection Agency
UV	ultraviolet
VIS	visible
WG	water dispersible
WP	wettable powder
WHO	World Health Organization
WHP	Withholding period

Glossary

Term	Description
acceptable daily intake	A level of intake of a chemical (expressed mg/kg bw/day; milligrams per kilogram of body weight per day) that can be ingested daily over an entire lifetime without any appreciable risk to health.
acute exposure	Contact between a pesticide and a target occurring over a short time (e.g., less than a day)
acute reference dose	The amount of a substance in food or drinking-water, (expressed as mg/kg of body weight), that can be ingested or absorbed over 24 hours or less, without appreciable health risk.
acute toxicity	Adverse effects of finite duration occurring within a short time (up to 14 d) after administration of a single dose (or exposure to a given concentration) of a test substance or after multiple doses (exposures), usually within 24 h of a starting point (which may be exposure to the toxicant, or loss of reserve capacity, or developmental change, etc.)
active constituent	The substance that is primarily responsible for the effect produced by a chemical product
adsorption constant	A measure of the tendency of a chemical to bind to soils
adverse effect	Change in the morphology, physiology, growth, development, reproduction or life span of an organism, system, or subpopulation that results in impairment of the capacity to compensate for additional stress, or an increase in susceptibility to other influences
aged residue	Residues of a pesticide or its degradates in soil that have diffused into intra-particulate regions following application and have become less accessible to mass transfer and bioabsorption processes, although still amenable to solvent extraction
agricultural crop	Any terrestrial plant species grown commercially for food, fibre, foliage, fuel or medicinal production, with the exception of plants that are not part of a crop under management at the time of pesticide application (eg blackberries or volunteer grain plants that have escaped from a cropped area and become weeds in another area).
aquatic	Relating to water, as distinct from land or air.
assessment factor	reductive factor by which an observed or estimated endpoint of a pesticide is divided to arrive at a regulatory acceptable level
bioaccumulation	Progressive increase in the amount of a substance in an organism or part of an organism that occurs because the rate of intake exceeds the organism's ability to remove the substance from the body
bioconcentration	Uptake of a pesticide residue from an environmental matrix, usually through partitioning across body surfaces to a concentration in the organism that is usually higher than in the environmental matrix
bioconcentration factor	Ratio between the concentration of pesticide in an organism or tissue and the concentration in the environmental matrix (usually water) at apparent equilibrium during the uptake phase
bound residue	Residue associated with one or more classes of endogenous macromolecules that cannot be disassociated by extraction or digestion without alteration

buffer zone	An area where pesticide application does not occur between the application site and an identified sensitive area which is downwind from the application site. For boom and aerial spraying, a buffer zone is measured from the edge of the sprayer swath closest to the downwind sensitive area; for vertical spraying, a buffer zone is measured from half a row width (ie trees, vines, other plants) outside the application site closest to the downwind sensitive area.
capsule suspension	A stable suspension of capsules in a fluid normally intended for dilution with water before use
catchment	Landform that collects precipitation and retains it in an impoundment or drains it through a single outlet.
chronic exposure	Continued or intermittent long-term contact between an agent and a target
chronic toxicity	Adverse effects following chronic exposure
concentration	Amount of a material, agent (e.g., pesticide) dissolved or contained in unit quantity in a given medium or system
degradate	Chemical that is formed when a substance breaks down
dissipation	Loss of pesticide residues from an environmental compartment due to degradation and transfer to another environmental compartment
dissociation constant	The ratio of concentration of dissociated ions to the concentration of original acid
dose	Total amount of a pesticide or agent administered to, taken up or absorbed by an organism, system, or (sub-) population
effect assessment	Combination of analysis and inference of possible consequences of the exposure to a pesticide based on knowledge of the dose–effect relationship associated with that agent in a specific target organism, system, or (sub-) population
emergence	The event in seedling establishment when a shoot becomes visible by pushing through the soil surface
emulsifiable concentrate	A liquid, homogenous preparation to be applied as an emulsion after dilution in water
emulsion, oil in water	A fluid, heterogeneous preparation consisting of a dispersion of fine globules of pesticide in an organic liquid in a continuous water phase
endpoint	Measurable ecological or toxicological characteristic or parameter of the test system that is chosen as the most relevant assessment criterion
environmental fate	Destiny of a pesticide or chemical after release to the environment involving considerations such as transport through air, soil, or water, bioconcentration, degradation, etc.
environmental risk	probability that an adverse effect on humans an environmental system/receptor will be observed for a given exposure to a pesticide based on the probability of that exposure and the sensitivity of the system/receptor
exposure	Concentration or amount of a particular substance that is taken in by an individual, population or ecosystem in a specific frequency over a certain amount of time.

exposure assessment	Evaluation of the exposure of an organism, system, or (sub-) population to a pesticide or agent (and its derivatives)
Freundlich isotherm	Empirical relationship describing the adsorption of a solute from a liquid or gaseous phase to a solid in which the quantity of material adsorbed per unit mass of adsorbent is expressed as a function of the equilibrium concentration of the sorbate
good laboratory practice	The formalized process and conditions under which laboratory studies on pesticides are planned, performed, monitored, recorded, reported, and audited. Studies performed under GLP are based on the national regulations of a country and are designed to assure the reliability and integrity of the studies and associated data
half-life	The time taken for the reactant concentration to fall to one-half its initial value
hazard	Inherent property of a pesticide having the potential to cause adverse effects when an organism, system, or (sub-) population is exposed to that agent or situation
Henry's law constant	A gas law that states the amount of gas absorbed by a given volume of liquid at a given temperature is directly proportional to the partial pressure of that gas in equilibrium with that liquid. As such it provides an indication of the preference of a chemical for air relative to water i.e. its volatility
hydrolysis	Chemical decomposition induced by water
indicator species	Species whose presence shows the occurrence of defined environmental conditions
intake	Process by which a pesticide or agent crosses an outer exposure surface of a target without passing an absorption barrier, i.e., through ingestion or inhalation
integrated pest management	Use of pest and environmental information in conjunction with available pest control technologies to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to persons, property, and the environment
larva	Recently hatched insect, fish, or other organism that has different physical characteristics than those seen in the adult, requiring metamorphosis to reach the adult body structure.
leaching	Downward movement of pesticides into a soil profile with soil water
metabolite	Substance formed as a consequence of metabolism in an organism
microcosm or mesocosm	Man-made study system containing associated organism and abiotic components that is large enough to be representative of a natural ecosystem, yet small enough to be experimentally manipulated. Microcosms are generally smaller indoor systems; mesocosms are larger outdoor systems.
mineralisation	Conversion of an element from an organic form to an inorganic form. Mineralisation of pesticides most commonly refers to the microbial degradation to carbon dioxide as a terminal metabolite
no observed effect level	Greatest concentration or amount of a substance, found by experiment or observation, which causes no detectable adverse alteration of morphology, functional capacity, growth, development, or life span of the target organism under defined conditions of exposure
non-target species	Organisms that are not the intended targets of a particular use of a pesticide.

organophosphorus pesticide	Generic term for pesticides containing phosphorus but commonly used to refer to insecticides consisting of acetylcholinesterase inhibiting esters of phosphate or thiophosphate
partition coefficient	log Pow is the logarithm (base-10) of the partition coefficient between n-octanol and water
persistence	Residence time of a chemical species (pesticide and/or metabolites) subjected to degradation or physical removal in a soil, crop, animal, or other defined environmental compartment
photolysis	Chemical decomposition induced by light or other radiant energy
regulatory acceptable level	Criterion or standard that is considered safe or without appreciable risk
runoff	Transport of water and soil from the surface of an agricultural field to a non-target area such as a stream due to a precipitation event
solubility in water	The mass of a given substance (the solute) that can dissolve in a given volume of water
surface water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors which are directly influenced by surface water
technical material	Commercial grade of the pesticide as it comes from the manufacturing plant comprising the active ingredient and associated impurities. It may also contain small quantities of additives necessary for stability.
terrestrial	Relating to land, as distinct from water or air.
vapour pressure	The pressure at which a liquid is in equilibrium with its vapour at a given temperature. It is a measure of the tendency of a material to vaporise. The higher the vapour pressure the greater the potential.
volatilisation	Evaporation of pesticides during and after application
water dispersible	A preparation granule consisting of granules to be applied after disintegration and dispersion in water
watercourse	<p>A river, creek or other natural watercourse (whether modified or not) in which water is contained or flows (whether permanently or from time to time); and includes:</p> <ul style="list-style-type: none">• a dam or reservoir that collects water flowing in a watercourse• a lake or 'wetland' through which water flows• a channel into which the water of a watercourse has been diverted• part of a watercourse <p>An estuary through which water flows.</p>
wetland	<p>An area of land where water covers the soil—all year or just at certain times of the year. They include:</p> <ul style="list-style-type: none">• swamps, marshes• billabongs, lakes, lagoons• saltmarshes, mudflats

-
- mangroves, coral reefs
 - bogs, fens, and peatlands.

A 'wetland' may be natural or artificial and its water may be static or flowing, fresh, brackish or saline.

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