Australian Government

Australian Pesticides and Veterinary Medicines Authority

Chlorpyrifos

Review Technical Report

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Contents

List of tables

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 Codes. 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. There are also limited uses of veterinary ear tags for the control of some animal pests.

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

The US EPA made a decision to end the use of chlorpyrifos on food crops in August 2021. To this effect, all tolerances for residues of chlorpyrifos on food commodities were revoked as of 28 February 2022. The non-food uses of chlorpyrifos were not impacted by these decisions, and use of chlorpyrifos in non-food situations such as for pest control in commercial establishments, industrial sites, non-food plantations and turfgrass are still 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.

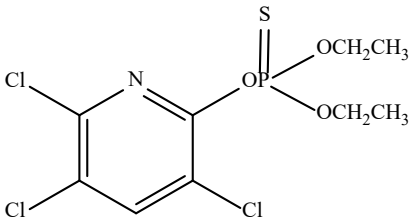
Codex Alimentarius Commission

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.

Chemistry

Active constituents

Table 1: Nomenclature and structural formula of the active constituent chlorpyrifos[1]

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:	$C_9H_{11}Cl_3NO_3PS$
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[2],[3]

Parameter	Physicochemical property
Appearance:	Technical active constituent: colourless crystals with a mild mercaptan odour
Melting point:	42–43.5°C
Boiling point:	>400°C

[1]The Pesticide Manual, British Crop Production Council, 18th edition, 2016.

[2]JMPR 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.

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

Parameter	Physicochemical property
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 $Pa.m^3mol^{-1}$
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 30 active constituent approvals for chlorpyrifos, which are listed in Table 3 below.

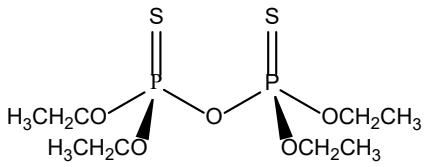
Table 3: Current active approvals for chlorpyrifos

Approval number	Approval holder
44005	ADAMA Australia Pty Limited
44111	Corteva Agriscience Australia Pty Ltd
44112	Corteva Agriscience Australia Pty Ltd
44113	Corteva Agriscience Australia Pty Ltd
44160	Corteva Agriscience Australia Pty Ltd
46888	Gharda Australia Pty Ltd
47155	Sumitomo Chemical Australia Pty Ltd

Approval number	Approval holder
48521	FMC Australasia Pty Ltd
49124	Corteva Agriscience Australia Pty Ltd
49340	Corteva Agriscience Australia Pty Ltd
50886	Imtrade Australia Pty Ltd
55457	Agrogill Chemicals Pty Ltd
56174	Corteva Agriscience Australia 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 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 62 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), granular formulations (GR), a slow release generator (SR) in the form of a bag to attach to banana bunches, and a chlorpyrifos-impregnated ear tag for use on cattle. Chlorpyrifos is the only active constituent in most of these registered products. There are 5 EC products that also contain the active constituent bifenthrin and one ear tag product that also contains the active constituent diazinon.

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

Registration number	Product name	Holder	Formulation type
51190	Imtrade Chlorpyrifos 500 Insecticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
51524	Y-Tex Warrior Insecticidal Cattle Ear Tags	Nutrien Ag Solutions Limited	1J – ear tag
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
54546	Pyritilene Banana Bags	ADAMA Australia Pty Limited	SR – slow release generator (inc. flea collars)
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

Registration number	Product name	Holder	Formulation type
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
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 Limited	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
81786	Chlorphos 500EC Insecticide	Nutrien Ag Solutions Limited	EC – emulsifiable concentrate
83386	Sharda Chlorpyrifos 500 Insecticide	Sharda Cropchem Espana S.L	EC – emulsifiable concentrate
83426	Echem Chlorpyrifos 500 Insecticide	Echem (Aust) Pty Limited	EC – emulsifiable concentrate
86189	Sinon Chlorpyrifos 500 Insecticide	Sinon Australia Pty Limited	EC – emulsifiable concentrate

Registration number	Product name	Holder	Formulation type
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
89696	Clip Insecticide	Sharda Cropchem Espana S.L	EC – emulsifiable concentrate
89815	Relyon Chlorpyrifos 500 Insecticide	Nutrien Ag Solutions Limited	EC – emulsifiable concentrate
90087	Imtrade Outperform 630 EC Insecticide/Miticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
90088	Imtrade Outplay 700 EC Insecticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
90204	Cropsure Sureban 500EC Insecticide	Cropsure Pty Ltd	EC – emulsifiable concentrate
90392	4Farmers Chlorpyrifos 750 WG Insecticide	4 Farmers Australia Pty Ltd	WG – water dispersible granule
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
91222	IA Outperform 630 EC Insecticide/Miticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
91352	Agmerch Chlorpyrifos 500 Insecticide	Agmerch 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

Registration number	Product name	Holder	Formulation type
92590	IA Outplay 700 Veriphy EC Insecticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate
92594	IA Outperform 630 Veriphy EC Insecticide/Miticide	Imtrade Australia Pty Ltd	EC – emulsifiable concentrate

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 Identification of the active constituent	Column B Description	Column C Minimum purity	Column D 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	*0,0,0',0'*-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 the recent 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
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 elected to apply the full 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 $10^{0.5}$-fold to account for any remaining uncertainties. The total uncertainty factor applied is thus $10 \times 10^{0.5}$.

The ARfD for chlorpyrifos was therefore calculated as follows:

$1/(10 \times 10^{0.5}) \approx 0.03$ mg/kg bw/day (30 µg/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/m^3 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).

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

Parameter	Value
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)	600 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/m^3 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.

Crop	Rate	Application	Formulation Type[1]	Mitigation for mixing/ loading and application (MOE ≥ 100) [2]	Re-entry interval
	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
Banana	One bag per bunch (0.45 g ac/bag)	Manual	SR	PPE (M/L&A): Elbow-length chemical resistant gloves, disposable fume mask with a charcoal filter	Not required
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&A): 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)	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 (handset) – 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: 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)[6]	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 pressurized 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
Veterinary uses					
Ear tags of beef cattle	1.5 g ac/tag 1 tag/animal	Ear tag	Ear tag	PPE (A): rubber gloves. Occupational handler exposure considered negligible	Not applicable

1 EC = emulsifiable concentrate; SR = slow-release generator; 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.

6 For application rates at 70 g ac/ha to 110 g ac/ha, the maximum work rate that does not exceed acceptable risks to applicators occupational handlers (mixing, loading and application) is 125 ha/day.

Table 9: Chlorpyrifos uses that are not supported based on this worker exposure assessment

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
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

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
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 application (spot spray)	EC	MOE < 100 with maximum PPE for mixing/loading and application
Banana	500 to 900 g ac/100 L water or 2.5 to 3.5 g ac/stool	Mechanically pressurised handgun application	EC	MOE < 100 with maximum PPE for mixing/loading and application
	250 g ac/100 L water	Mechanically pressurised handgun application	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 application (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 application (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

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
	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
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 application	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 application (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

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
	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
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	70–1,500 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 g ac/ha	Groundboom (broadacre use)	EC	MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
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]
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 m2	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

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
Ornamental nursery plants	250 to 500 g ac/m3 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 m2	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 m3	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
Termiticide – chemical soil barrier around and under buildings	50 g ac/m2 or 100 g ac/m2 (horizontal barrier)	Soil injection or mechanically pressurized handgun	EC	MOE < 100 with maximum PPE for mixing/loading and application
	1000 g ac/m3 or 2000 g ac/m3 (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

Crop	Rate	Application	Formulation Type [1]	Mixing, loading, application outcome
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.

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). The APVMA does not have sufficient evidence that use of these mixing/loading engineering controls could be feasibly implemented and managed.

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 10 presents the maximum quantities that can be handled with corresponding maximum areas treated based on representative use rates.

Table 10: 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
			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

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)
			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 the first aid instructions (FAI) and warning statements for chlorpyrifos products whose uses are supported are listed in Table 11 and should be included in the relevant product labels.

Table 11: 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 12 to Table 17. The updated safety directions given below should be included in product labels.

Chlorpyrifos ear tag 100 g/kg (or less)

Table 12: Safety directions for chlorpyrifos ear tag 100 g/kg (or less)

Substance	Formulation	Statement codes
Diazinon	Ear tag 300 g/kg with chlorpyrifos 100 g/kg or less	130 133 190 160 162 210 211 380 382 279 283 290 312 350 360 361

The above statement codes translate into the following safety directions:

Safety directions	Code
Hazards	
Poisonous if swallowed	130 133
Repeated minor exposure may have a cumulative poisoning effect	190
May irritate the eyes	160 162
Precautions	
Avoid contact with eyes and skin	210 211
Do not open inner pouch until ready for use	380
Do not allow children to play with tags	382
Mixing or using	
When using the product, wear rubber gloves	279 283 290 312
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.	360 361

Chlorpyrifos SR impregnated plastic film 10 kg (or less)

Table 13: Safety directions for chlorpyrifos SR impregnated plastic film 10 kg (or less)

Substance	Formulation	Statement codes
Chlorpyrifos	SR impregnated plastic film 10 g/kg or less	130 133 190 160 162 210 211 382 279 283 290 295 306 351 360 361

The above statement codes translate into the following safety directions:

Safety Directions	Code
Hazards	
Poisonous if swallowed	130 133
Repeated minor exposure may have a cumulative poisoning effect	190
May irritate the eyes	160 162
Precautions	
Avoid contact with eyes and skin	210 211
Do not allow children to play with bags	382
Mixing or using	
When using the product, wear elbow-length PVC or nitrile gloves and a disposable fume mask with charcoal filter.	279 283 290 295 306
After use	
Wash hands after use.	351
After each day's use wash gloves.	360 361

Chlorpyrifos EC 500 g/L (or less)

Table 14: 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

Safety directions	Code
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 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

Safety directions	Code
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

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, 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 250 g ac/ha
- Groundboom application to cotton crops
- Broadacre groundboom application to all field crops
- Groundboom application to vegetables, field crops and duboisia at rates that exceed 400 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 bananas (except when product is formulated as a slow-release generator)
- Application to turf at, or exceeding, a rate of 1,000 g ac/ha
- Application of granular formulated products
- Seed dressings
- Insect baits

While a number of chlorpyrifos use patterns could be supported from a worker health and safety perspective (see Table 8), 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 11 and the relevant safety directions listed in Table 12 to Table 17 should be included on all product labels.

The following restraints should also be included on all labels (excluding where use of this application equipment would not be relevant, such as products formulated as slow-release generators or ear tags) to mitigate the identified potential risks to product users:

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

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 including establishment of withholding periods (WHPs) and amendment of MRLs including the establishment of temporary MRLs pending the submission of further data.

In 2009, the APVMA published a Preliminary Review Findings (PRF) report (APVMA 2009). The 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 2009 PRF consultation, many international MRLs for chlorpyrifos have been reduced or removed. Codex and the USA 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

A summary of the residues assessment outcomes for various crop groupings are shown in Table 18 and Table 19. No additional data was received in the 2009 PRF 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 (see Table 18 and Table 19).

The approved uses of chlorpyrifos on shallots (equivalent directions to use on onions) and coffee beans have also been considered, as these use patterns were not directly considered in the 2009 PRF report. It was confirmed that 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. Similarly, 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 contemporary assessment of worker health and safety, environment and/or trade risk has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags, a specific

use on oilseeds (except canola and cotton) made prior to emergence at a maximum rate of 110 g ac/ha, and cattle ear tags.

For bananas, there is sufficient residues data to support the banana bag use. in 2 trials reflecting the current banana bag use (one bag per bunch), chlorpyrifos residues in whole banana fruit were <0.05 and 0.08 mg/kg at the 10-week harvest withholding period and a chlorpyrifos MRL for bananas at 0.2 mg/kg is considered appropriate for this use pattern (Farnsworth 2001; Farnsworth 2001a). In one trial where residues were determined separately in skin and pulp, chlorpyrifos residues were detected only in the banana skin and residues were <0.05 mg/kg in the pulp of the fruit.

For oilseeds (except canola and cotton), the specific use pattern that could be supported from an environmental and worker health and safety perspective involves a single application made prior to emergence at a maximum rate of 110 g ac/ha. Residues data which addresses that specific use pattern is not available. 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 2009 PRF. The data indicates that chlorpyrifos residues should be <0.01 mg/kg in seed from this specific use pattern, but that finite residues may be expected in oilseed forage and fodder.

Should it be approved, this specific use on oilseeds (except canola and cotton) would be the only use resulting in chlorpyrifos residues in animal feeds and as it will be driving the maximum feeding level and MRLs required for mammalian animal commodities, it is important that the APVMA have confidence in the level of residues expected in forage and fodder from that use pattern. The rate associated with this specific use pattern (110 g ac/ha) is 0.16× that addressed in the forage and fodder residue 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 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.

Table 18: 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

Parameter	Assessment outcome
Other label statement/restriction	Nil
Banana	
Uses supported by Residues	Bell treatment, foliar treatment, soil/butt treatment, bag dust and treated banana bag
Uses not supported by Residues	Any treatment after the exposure of fingers
MRL[1]	0.5 mg/kg
MRL (based on use patterns for banana bags only)	0.2 mg/kg
WHP	Not required when used as directed, or 10 weeks for the banana bag product.
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
Other label statement/restriction	Critical comments for African black beetle[2], cutworms, mites and vegetable weevil and wingless grasshoppers[2] (application rate up to 450 g ac/ha) – DO NOT apply after 14 days of transplanting. Critical comments for African black beetle (cabbage and cauliflower application rate 1 kg ac/ha) – Restrict to single application within 7 days of transplanting. 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.
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

Parameter	Assessment outcome
Other label statement/restriction	Critical comments for cutworm, wingless grasshopper[2] 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. 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.
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)
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: 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 (e.g. melons, pumpkins, gourds, chokos, marrows and squashes). Cucumber: Any use above 750g ac/ha.

Parameter	Assessment outcome
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)
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

Parameter	Assessment outcome
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
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

Parameter	Assessment outcome
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
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

Parameter	Assessment outcome
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
Other label statement/restriction	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. Rhubarb[2]: Apply no later than 14 days after crown transplant. Asparagus, celery, rhubarb: Remove critical comment "repeat as required". The term 'stalk and stem vegetables (including asparagus, celery and rhubarb)' should be changed to 'asparagus, celery and rhubarb'
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

Parameter	Assessment outcome
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
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 19: 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
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

Parameter	Assessment Outcome
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
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 2009 PRF report. 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 contemporary assessment of worker health and safety, environment, residues and/or trade risk has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags and cattle ear tags. The MRLs recommended above for mammalian livestock and poultry commodities were driven by uses in animal feeds that are not supported by the APVMA. The MRLs for cattle commodities (muscle, fat, offal, milk and milk fat) will be driven by the residues expected from the ear tag use.

Y-TEX Warrior Insecticidal Cattle Ear Tags (P51524) is a cattle ear tag impregnated with chlorpyrifos (100 g/kg) and diazinon (300 g/kg). This assessment has only considered residues of chlorpyrifos that may occur in milk and tissues of treated cattle. It is noted that an assessment of diazinon residues that may result from this product will occur as part of the ongoing review of diazinon. Each ear tag weighs 15 grams and therefore presents an exposure of 1.5 g chlorpyrifos per tag. One tag per animal is permitted, though it is noted that 2 ear tags were administered in 2 Australian tissue residue trials (Tozer 1996a; Tozer 1996b) and 2 Australian milk trials (Tozer 1996c; Tozer 1998). The residues expected in cattle milk (including milk fat), offal, muscle and fat from this ear tag product are summarised below.

Cattle milk and milk fat: The milk residue trials found that following a 2× treatment (2 ear tags per animal), the highest level of residues in milk fat were <0.02–0.046 mg/kg (mean = 0.027 mg/kg, day 1, pm). Given the

treatment was at 2× dose rate, if residues are scaled to the maximum dose rate of 1 ear tag per animal, then the mean and highest residue are 0.014 and 0.023 mg/kg. A MRL for cattle milk fat at 0.05 mg/kg is considered appropriate for this ear tag use. Residues in milk were <0.02 mg/kg. It is considered that a MRL of *0.02 mg/kg is appropriate for cattle milk.

Cattle offal: In one Australian study following 2× dose rate (2 ear tags), chlorpyrifos residues were <LOQ (<0.02 mg/kg) in kidney and liver. This data demonstrates that an MRL for 'cattle, edible offal of' of *0.02 mg/kg is appropriate for this ear tag use.

Cattle muscle: In one Australian study following 2× dose rate (2 ear tags), chlorpyrifos residues were <LOQ (<0.02 mg/kg) in neck muscle and rump muscle. This data demonstrates that an MRL for cattle muscle of *0.02 mg/kg is appropriate for this ear tag use.

Cattle fat: The highest residue in the 2 non-GLP Australian trials in fat was 0.067 mg/kg following a 2× dose rate (2 tags per animal), or 0.0335 mg/kg when scaled for the proposed rate. It is recommended that a MRL of 0.05 mg/kg for cattle fat is appropriate for this ear tag use with a 0-day meat withholding period. It is noted that in each of the 2 available tissue residue studies, chlorpyrifos residues fat peaked at 14 days after the administration of the cattle ear tag but residues were <LOQ (<0.01 mg/kg in one trial, <0.02 mg/kg in the other) after 28–29 days.

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 perspective (Table 18 and Table 19). Given that many uses are not supported by the APVMA review, the chronic and acute dietary exposure assessments have been revised to reflect the use patterns supported by the APVMA chemical review, namely use of chlorpyrifos impregnated banana bags and cattle ear tags.

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 Australian uses and associated MRLs expected to remain as an outcome of this review, the NEDI for chlorpyrifos is equivalent to <30 % of the ADI. 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 maximum estimated acute dietary exposure for the uses supported by the APVMA review of chlorpyrifos was associated with cattle milk and was 5 % of the ARfD for the 2–6 years age group of 2 % for the general population (2+ years).

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 with Codex and international MRLs (current as of October 2023) is detailed below in Table 20.

Table 20: Comparison of proposed Australian and current international chlorpyrifos MRLs for plant commodities

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed)[1]	Codex[2]	USA[3]	EU[4]	Japan[5]	Korea[6]	Taiwan[7]
Cereal grains	T0.1	2	–	–	*0.01	0.5 (wheat and other cereal grains)	0.4 (wheat)	*0.02 (cereal grains)
Sorghum	T3	1	–	–	*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	–	–	*0.01	0.3 (cotton seed)	–	0.5 (other cereals and crops)

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed)[1]	Codex[2]	USA[3]	EU[4]	Japan[5]	Korea[6]	Taiwan[7]
Pulses	T0.05 (vegetables)	0.1	–	–	*0.01	0.3 (beans, dried)	–	0.1 (mung bean and small red beans)
Citrus fruits	T0.5	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	0.5 (apple) 0.3 (pear)	1	*0.01 (vegetables and fruits)
Stone fruit	T1	1 (except peaches which are 0.05)	–	–	*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 assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, 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. Details on this decision 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 websitehttps://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 and the USA 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 expected 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.

It is noted that the only use in plant commodities that is supported by the APVMA review of chlorpyrifos is the banana bag use. Bananas are not considered to be a major export commodity and therefore the trade risk associated with the banana bag use is not considered to be undue and is acceptable.

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 with Codex and international MRLs (current of October 2023) is detailed below in Table 21.

Table 21: Comparison of proposed Australian and current international chlorpyrifos MRLs for animal commodities

Commodity	Chlorpyrifos MRLs (mg/kg)							
	Australia (current)	Australia (proposed)[1]	Codex[2]	USA[3]	EU[4]	Japan[5]	Korea[6]	Taiwan[7]
Mammalian meat [in the fat]	T0.5	2	–	–	*0.01	0.05 (0.01 for pig muscle and fat)	1 (cattle and sheep) 0.02 (pig)	–
Mammalian offal	T0.1	0.02	–	–	*0.01	0.01	0.01 (cattle, sheep and pig)	–
Milk [in the fat]	T0.2	0.5 (whole milk 0.02)	–	–	*0.01	0.01	0.02	–
Poultry meat [in the fat]	T0.1	0.1	–	–	*0.01	0.01	0.01	–
Poultry offal	T0.1	*0.01	–	–	*0.01	0.01	0.01	–
Eggs	T*0.01	*0.01	–	–	*0.01	0.01	0.01	–

1 The Australia (proposed) MRL is reflective of the residue assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, 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. Details on this decision 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 websitehttps://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 2009 PRF report 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 2009 PRF report that are applicable to each species are 56 days for grazing animals (e.g., cattle, sheep and goats) and 7 days for pigs. Given the ESI endpoint of 0.01 mg/kg was used in the 2009 PRF, and that 0.01 mg/kg is the limit of quantification for analytical methods in animal commodities, the previous ESI recommendations in the 2009 PRF should mitigate the risk to trade for animal commodities following use as a pesticide on animal feeds. It is however noted that uses on animal feeds is not supported from a worker health and safety and environment perspective.

Cattle ear tag use is supported by worker health and safety and environment assessments of chlorpyrifos. This use pattern would result in exposure to livestock. Cattle commodities are major export commodities and finite residues in fat are expected to result from the proposed use with a 0-day withholding period. Given that Codex and the USA 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, an Export Slaughter Interval (ESI) of 28 days after administration of the ear tag is recommended to ensure that residues are <LOQ and prevent an undue risk to international trade. Therefore, the following ESI is recommended for Y-TEX Warrior Insecticidal Cattle Ear Tags (P51524):

EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues).

Residues and trade recommendations

The following uses of chlorpyrifos on food crops are not supported based on potential risks identified in the residues 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 applications 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 assessment of worker health and safety and environmental risks has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags, a specific use on oilseeds (except canola and cotton) made prior to emergence at a maximum rate of 110 g ac/ha, and cattle ear tags.

The specific use on oilseeds (except canola and cotton) involving pre-emergent application at 110 g ac/ha cannot be supported from a Residues and Trade assessment due to a lack of residues data relevant to that use pattern.

The uses of chlorpyrifos in banana bags and cattle ear tags are supported from a residues and trade perspective, however the following Export Slaughter Interval should be added to the product label of the cattle ear tag product to prevent an undue risk to international trade:

EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues).

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

Table 22 and Table 23 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 bananas will be driven by the residues expected from the banana bag use while MRLs for cattle commodities (muscle, fat, offal, milk and milk fat) will be driven by the residues expected from the ear tag use.

Table 22: 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	0.2
VB	0040	Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas	T0.5	
VR	0463	Cassava	T*0.02	
MO	0812	Cattle, edible offal of		*0.02
MF	0812	Cattle fat		0.05
ML	0812	Cattle milk		*0.02
FM	0812	Cattle milk fat		0.05
		Cattle muscle		*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	
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	

Code		Commodity	MRL (mg/kg)	
			DELETE	ADD
MM	0095	Meat (mammalian)[in the fat]	T0.5	
ML	0106	Milks [in the fat]	T0.2	
SO	0089	Oilseed, except peanut	T0.01	
SO	0697	Peanut	T*0.01	
FA	0351	Passion fruit	*0.05	
VO	0445	Peppers, sweet [capsicums]	T1	
FI	0353	Pineapple	T0.5	
FP	0009	Pome fruits	T0.5	
VR	0589	Potato	0.05	
PO	0111	Poultry, Edible offal of	T0.1	
PM	0110	Poultry meat [in the fat]	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 [capsicums]; potato; swede; sweet potato; taro; tomato]	T*0.01	

Table 23: 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	
AL	1270	Peanut forage (green)	T10	
		Peanut hay	T2	

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

The current assessment considers the environmental risks of the remaining registered uses of chlorpyrifos; however, many that are not supported based on human health or food safety grounds have not been reconsidered in the interest of efficiency.

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.

The environmental risk assessment scenarios considered in the current assessment are summarised in Table 24. Environmental risks were determined according to the methodology outlined in the APVMA Risk Assessment Manual – Environment.

Table 24: Environmental risk assessment scenarios

Category	Situation	Risk assessment scenario
Treated materials	Ear tags, banana bags, hides/skins	Negligible exposure of the environment
Field crops and pasture	Pasture, lucerne, sugarcane, forage crops, oilseeds (excluding cotton and canola)	2× 350 g ac/ha 7-day retreatment interval
	Duboisia	1× 450 g ac/ha
Tree and vine crops	Avocado (spot application)	1× 500 g ac/ha (25 g ac/100 L, 2000 L/ha)

Category	Situation	Risk assessment scenario
	Grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards	1× 250 g ac/ha (50 g ac/100 L, 500 L/ha)
	Grapevine rootlings	Incorporated granules: 8000 g ac/ha (2 g ac/vine at 4000 vines/ha)
Vegetable crops	Vegetables (band application)	2× 400 g ac/ha 7-day retreatment interval
	Vegetables (broadcast application)	2× 350 g ac/ha 7-day retreatment interval
	Ginger	1× 450 g ac/ha
Seed dressings	Vegetable seeds	25000 mg ac/kg seed
	Cereal seeds	2000 mg ac/kg seed
	Oilseed seeds	400 mg ac/kg seed
Insect baits	Maize, sorghum, soybeans, stone fruit, sunflower, turf	200 mg ac/kg grain bait
	Strawberries, vegetables	50 mg ac/kg grain bait
Ornamentals	Tasmanian blue gum planting hole soil	Planting out: 1500 g ac/ha (1.5 g ac/plant, 1000 plants/ha)
	Potted ornamental soil	Planting out: 4000 g ac/ha (100 mg ac/kg soil, 4 kg soil/plant, 10000 plants/ha)
	Potted ornamentals (beetle larvae)	Soil drench: 4000 g ac/ha (20 g/100 L, 2 L/m^2)
	Potted ornamentals (ant control)	Surface spray: 5000 g ac/ha (125 g ac/25 L, 1000 L/ha)
Crawling insect control	In and around buildings	Surface spray: 5000 g ac/ha
	Ant nests and trails	Surface granules: 1000 g ac/ha
Mosquito control	Vegetation (mosquito adults)	4× 54 g ac/ha 7-day retreatment interval

Category	Situation	Risk assessment scenario
	Polluted water impoundments (mosquito larvae)	105 µg ac/L
Commercial turf	Spot spray to funnel ant mounds	Negligible exposure of the environment
	Control of cockchafer, grub or corbie	1× 450 g ac/ha
	Control of other insect pests	2× 350 g ac/ha 7-day retreatment interval
Termite management	External perimeter treatment (horizontal or vertical) around large buildings	1000 kg ac/ha
	New and existing poles	1000 kg ac/ha
	Chemical barrier (horizontal or vertical) under structure, direct treatment of nest or colony	Negligible exposure of the environment
Combination products containing bifenthrin	Subterrannean clover, clover, lucerne	2× 400 g ac/ha 7-day retreatment interval
	Field tomatoes	2× 250 g ac/ha 7-day retreatment interval

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 B.

Chlorpyrifos is non-persistent in soil under field conditions (geomean DT_{50} 28 days) and is slightly mobile (geomean Kfoc 3572 mL/g). In aquatic systems, chlorpyrifos is moderately persistent (geomean DT_{50} 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 DT_{50} 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 DT_{50} values were also determined for both ground-dwelling species (DT_{50} 4.0 days) and foliage-dwelling species (DT_{50} 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 (Kd = 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 Kd values from the above relationship derived for use in the runoff assessment (Table 26).

Table 25: 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	Fontaine et al. 1987, Old 2002b, Old 2002c, Old 2002d
	1% OC: Kd 67 mL/g 2% OC: Kd 108 mL/g	Damon & Heim 2001
Water	DT_{50} 42 d	Abu 2015b, Kang 2015
Sediment	DT_{50} 42 d	Abu 2015b, Kang 2015
	5% OC: Kp 236 mL/g	Damon & Heim 2001
Air	DT_{50} 1.4 h	Simon 2001

Table 26: Summary of % organic carbon and corresponding Kd for runoff assessments

State	Horticulture		Dryland	
	% organic carbon	Kd (mL/g)	% organic carbon	Kd (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

State	Horticulture		Dryland	
	% organic carbon	Kd (mL/g)	% organic carbon	Kd (mL/g)
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 B.

Chlorpyrifos has high toxicity to mammals (LD_{50} 97 mg ac/kg bw/d, *Rattus norvegicus*) and birds (geomean LD_{50} 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).[4]

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 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 LC_{50} 0.010 mg ac/L, *Leuciscus idus*), aquatic invertebrates (lowest LC_{50} 0.000045 mg ac/L, *Mysidopsis bahia*), and moderate toxicity to algae (lowest E_rC_{50} 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*).

[4] Not required for ear tags, banana bags, or hides/skins situations

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 assessment 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 LD_{50} 0.075 µg ac/bee, *Apis mellifera*) and oral exposure (geomean LD_{50} 0.21 µg ac/bee, *Apis mellifera*), and high toxicity to bee larvae (LD_{50} 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 tanaetafolia* 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).[5]

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 LD_{50} 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 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.[6]

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

[5] Not required for ear tags, banana bags, or hides/skins situations

[6] Not required for ear tags, banana bags, hides/skins, mosquito larvae control, crawling insect control (including ant nests and trails) or termiticides

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 ER_{25} 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 27.

Table 27: 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
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

Group	Exposure	Endpoint	AF	RAL	Reference
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. The summary of outcomes for the wild mammal assessments are reported in Appendix C. No outcomes were identified as acceptable for long-term risk to mammals from these field uses with the exception of oilseeds. Oilseeds were supported up to a seasonal rate of 110 g ac/ha which overlaps the registered rate for control of redlegged earth mite and blue oat mite.

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 29. 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.

The same product (50416) is registered for use in ornamental nursery plants and Tasmanian blue gum for use when planting from containers to the field. However, in both cases, direct dietary exposure of birds and mammals is likely to be low as application is by thorough mixing with the container media prior to planting, or by mixing with the soil in the planting hole at the transplanting operation. The following restraint is required for this product.

To protect birds and wild mammals, the product must be entirely incorporated into the soil. Remove spillages.

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 30) or 50 mg ac/kg bait (Table 31). 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 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. 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. An iterative approach to the bioaccumulation assessment has been performed. A maximum seasonal soil exposure rate of 76 g ac/ha was determined to be acceptable to earthworm-eating species. After considering treatment areas are relatively small, ornamental uses (including Tasmanian blue gum planting soil) and adult mosquito control were determined to be acceptable to earthworm-eating mammals. Use in oilseeds is also supported at a maximum seasonal rate of 110 g ac/ha. Seasonal catchment exposure rates for these uses were 76 g ac/ha and below (see Appendix B for details).

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 E).

Table 28: Chlorpyrifos – Summary of risk assessment outcomes for long-term effects on wild mammals

Situation	Rate (g ac/ha)	Number	Interval (d)	Direct dietary assessment	Food chain assessment	Max seasonal rate supported
Pasture, lucerne, sugarcane, forage crops	350	2	7	**Not supported**	**Not supported**	28 g ac/ha
Oilseeds (excluding cotton and canola)	350	2	7	**Not supported**	**Not supported**	110 g ac/ha
Duboisia	450	1	–	**Not supported**	**Not supported**	28 g ac/ha
Ginger	450	1	–	**Not supported**	**Not supported**	92 g ac/ha
Spot application in avocado	250	1	–	**Not supported**	**Not supported**	69 g ac/ha
Other tree and vine crops	250	1	–	**Not supported**	**Not supported**	28 g ac/ha
Macrocarpa hedges around orchards	250	1	–	**Not supported**	**Not supported**	28 g ac/ha
Grapevine rootlings	8000	1	–	**Not supported**	**Not supported**	n/a
Band application in vegetables	400	2	7	**Not supported**	**Not supported**	55 g ac/ha
Broadcast application in vegetables	350	2	7	**Not supported**	**Not supported**	28 g ac/ha
Tasmanian blue gum planting hole soil	1500	1	–	Negligible exposure	Acceptable risk	n/a
Potted ornamentals	5000	1	–	Negligible exposure	Acceptable risk	n/a
Crawling insect control	5000	1	–	Negligible exposure	Negligible exposure	n/a
Control of adult mosquitos in vegetation	54	4	7	**Not supported**	Acceptable risk	28 g ac/ha
Control of cockchafer, grub or corbie in turf	450	1	–	**Not supported**	**Not supported**	28 g ac/ha

Situation	Rate (g ac/ha)	Number	Interval (d)	Direct dietary assessment	Food chain assessment	Max seasonal rate supported
Control of other insect pests in turf	350	2	–	**Not supported**	**Not supported**	28 g ac/ha
Termite protection	100000	1	–	Negligible exposure	Negligible exposure	n/a
Subterrannean clover, clover, lucerne	400	2	7	**Not supported**	**Not supported**	28 g ac/ha
Field tomatoes	250	2	7	**Not supported**	**Not supported**	28 g ac/ha

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

Table 29: 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
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/m2)	12,000	12,000
SPsurface	(no. soil particles/m2)	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 27)

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

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

Table 30: 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 27)

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

Table 31: 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

Focal group	Indicator species	BW (g)	DEE (kJ/d)	FIR (g/d)	DDD (mg ac/kg bw)	RAL (mg ac/kg bw)	RQ
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 27)

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

Table 32: Food chain assessment in terrestrial vertebrates (maximum acceptable threshold)

Exposure	Indicator species	Group	Shortcut	PEC_{media} (mg/kg or mg/L)	DDD (mg/kg/d)	RAL (mg/kg/d)	RQ
Chronic	Earthworm-eating species	Mammals	1.28	0.10	1.0	1.0	1.0
		Birds	1.05	0.10	1.1	2.9	0.40
	Fish-eating species	Mammals	0.142	0.0001	0.020	1.0	0.02
		Birds	0.159	0.0001	0.022	2.9	0.01

Shortcut value from EFSA (2009)

PEC_{medium} is:

PEC_{soil} = predicted environmental concentration in soil (mg/kg) = 76 g ac/ha (maximum acceptable seasonal rate to achieve RQ 1.0)/750

PEC_{water} = aquatic RAL (from Table 27)

PEC_{food} = PECmedium * BCF, where:

$BCF_{earthworm}$ is 8.8 based on [0.84 + 0.012 * 10^(log Kow of 4.9)]/Kd 108 (for 2% OC; from Table 25)

BCF_{fish} is 1374 (Murphy & Luteske 1986)

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

RAL = regulatory acceptable level (from Table 27)

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

Aquatic species

The application rate for polluted water impoundments 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 of the remaining uses are acceptable with the exception of grapevine rootlings and external perimeter treatment for termite protection (Table 33). Assessment details are provided in Appendix D.

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.

Of the acceptable scenarios for runoff, only potted ornamentals, Tasmanian blue gum soil, oilseeds (up to 110 g ac/ha), and non-crop uses have been supported by the terrestrial vertebrate assessment. The following runoff restraint is required for these uses.

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

Table 33: Chlorpyrifos – Summary of runoff risk assessment outcomes for agricultural uses

Situation	Rate (g ac/ha)	Number	Interval (d)	Conclusion
Pasture, lucerne, sugarcane, forage crops, oilseeds (excluding cotton and canola)	350	2	7	Acceptable risk

Situation	Rate (g ac/ha)	Number	Interval (d)	Conclusion
Duboisia, ginger	450	1	–	Acceptable risk
Tree and vine crops	250	1	–	Acceptable risk
Grapevine rootlings	8,000	1	–	Not supported
Vegetable crops (band application)	400	2	7	Acceptable risk
Vegetable crops (broadcast application)	350	2	7	Acceptable risk
Potted ornamentals and Tasmanian blue gum planting hole soil	5,000	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	1	–	Not supported
	500,000	1	–	Not supported
New and existing poles for termite protection	1,000,000	1	–	Acceptable risk
Subterrannean clover, clover, lucerne	400	2	7	Acceptable risk
Field tomatoes	250	2	7	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.

Risks to bees foraging in other treated areas are assessed using a tiered approach. 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. Acceptable risks to foraging bees cannot be concluded at the lowest rate of 54 g ac/ha. 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.

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 34: Screening level assessment of risks to bees

Life stage	Exposure	Rate (g/ha)	Predicted total dose (µg/bee)	RAL (µg/bee)	RQ
Highest maximum single rate					
Adults	Acute contact	500	1.2	0.030	**40**
	Acute oral	500	14	0.084	**170**
Larvae	Acute oral	500	6.1	0.0084	**721**
Lowest maximum single rate					
Adults	Acute contact	54	0.13	0.030	**4.3**
	Acute oral	54	1.5	0.084	**18**
Larvae	Acute oral	54	0.65	0.0084	**78**

Highest maximum single is 500 g ac/ha in spot application in avocado and turf (noting up to 5000 g ac/ha possible in ornamentals)

Lowest maximum single rate is 54 g ac/h for mosquito control

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

RAL = regulatory acceptable level (from Table 27)

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.

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 35: 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
	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 27)

RQ = risk quotient = PEC/RAC, 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 36 with the required protection statements and restraints. Uses that are not supported from the viewpoint of environmental safety are listed in Table 37.

Table 36: Supported uses from the viewpoint of environmental safety

Situation	Protection statements and restraints
All situations	Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.
Ear tags, banana bags, hides/skins, termite nest or colony in wall cavities	(No additional protection statements or restraints are required)
Control of mosquito larvae in temporary water pools	DO NOT use on permanent water bodies for control of mosquito larvae.
Ornamental potting soil and Tasmanian blue gum planting soil	Toxic to birds and wild mammals. To protect birds and wild mammals, the product must be entirely incorporated into the soil. Remove spillages.
Potted ornamentals (soil drench)	DO NOT apply if heavy rains or storms are forecast within 3 days.
Potted ornamentals (surface spray)	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.
Crawling insects in and around buildings	DO NOT apply if heavy rains or storms are forecast within 3 days. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees.
Ant nests and trails	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 effects on bees.
Spot spray to funnel ant mounds in commercial turf	Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees.
Chemical barrier (horizontal or vertical) under structures for termite protection Treatment of new and existing poles for termite protection	To avoid runoff from under-slab termite treatments, the moisture membrane must be installed immediately after treatment.

Situation	Protection statements and restraints
Oilseeds (excluding cotton and canola) up to 110 g ac/ha per season	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. Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds and wild mammals. 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.

Table 37: Uses not supported from the viewpoint of environmental safety

Situation	Basis
Control of adult mosquitos in vegetation	Unacceptable risk to terrestrial vertebrates
Oilseeds (excluding cotton and canola) greater than 110 g ac/ha, Pasture, lucerne, sugarcane, forage crops, Duboisia	
Grapevines, avocado, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards	
Vegetables (band or broadcast applications), ginger	
Seed dressings	
Insect baits	
Commercial turf (excluding spot spray application to funnel ant mounds in commercial turf)	
Combination products (subterrannean clover, clover, lucerne, field tomatoes)	
Grapevine rootlings	Unacceptable risk to terrestrial vertebrates, aquatic species, and soil organisms
Control of mosquito larvae in permanent water bodies	Unacceptable risk to aquatic species

Situation	Basis
External perimeter treatment (horizontal or vertical) around large buildings for termite protection	
Outdoor termite nests or colonies (including trees)	

Efficacy and target safety

Efficacy

The label variations recommended in this Technical Report are within the currently approved use patterns. The use of the 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 38, which is the maximum amount of spray drift exposure that is not expected to cause undue harm to sensitive areas.

Table 38: 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:

- banana bags
- cattle ear tags
- 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.

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. Spray drift requirements are also not relevant to products formulated as solid slow-release generators, such as banana bags and ear tag products. Therefore, no spray drift restraints are required for uses of chlorpyrifos supported by the worker health and safety, residues, trade and environment risk assessments.

Appendices

Appendix A – Summary of assessment outcomes

Table 39: Chlorpyrifos uses that are supported by all risk assessments

Crop/host	Pest	Rate	Amended instructions for use[1]
Horticultural uses			
Banana	Sugarcane bud moth, banana rust thrips, banana scab moth	One bag/bunch *(0.45 g ac/bunch)*	Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. Safety directions for chlorpyrifos SR impregnated plastic film 10 g/kg or less (Table 12).
Veterinary uses			
Ear tags of beef cattle	Buffalo flies *(Haematobia irritans exigua)* Cattle lice *(Bovicola bovis, Linognathus vituli, Haematopinus eurysternus, Solenoptes capillatus)*	One tag/animal *(1.5 g ac/animal)*	Trade advice statement: EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues). Environmental protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos as set out in Table 11).
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	**Restraint:** DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer. **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. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees. **First aid instructions and warnings** for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11). **Safety directions** for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14 or chlorpyrifos EC 700 g/L (or less) in Table 15).

Crop/host	Pest	Rate	Amended instructions for use[1]
Container plants in soil or other growing media (commercial)	Argentine ants	5 g ac/L water	Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer. 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. 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. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos as set out in Table 11). 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).
Hides/skins	Hide beetles	1 g ac/L water *(minimum 15 g ac/skin)*	Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer. Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11). Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14 or chlorpyrifos EC 700 g/L (or less) in Table 15).
Potted ornamentals (commercial)	Scarab beetles – larvae	0.1 – 0.2 g ac/L water	Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer. 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. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11). Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14).

Crop/host	Pest	Rate	Amended instructions for use[1]
Treatment of termite nest or colony (in wall cavities)	Termites	5 g ac/L water	Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer. Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11). Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14).
Turf (Commercial)	Funnel ant	2.5 g ac/5L water or 0.015 g ac/per mound (spot spray)	Withholding period: DO NOT graze treated turf or lawn; or feed turf or lawn clippings from any treated area to poultry or livestock Protection statement: 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. First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11). Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14).

1 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 40: Chlorpyrifos uses that are not supported due to safety and/or trade concerns

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

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

Crop/host	Pest	Rate	Assessment outcome[1]
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 *(25 g ac/100 L water applied using 1,000 L water/ha)*	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 *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha *(35 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
Carrots	Light brown apple moth	250 – 350 g ac/ha	Not supported – safety (environment and residues) concerns.
Cabbage, cauliflower	African black beetle	1,000 g ac/ha	Not supported – safety (worker exposure) concerns.
		150 g ac/100 L water *(drench at 100 mL/plant)*	Not supported – safety (worker exposure) concerns.
Chard (silver beet)	Vegetable weevil	400 g ac/ha	Not supported – safety (environment and residues) concerns.
Citrus fruits	California red scale (Citrus red scale)	1,000 – 2,000 g ac/ha *(25 – 50 g ac/100 L water applied using 4,000 L water/ha)*	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 *(50 g ac/100 L water applied using 4,000 L water/ha)*	Not supported – safety (environment and worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Ants	1,000 g ac/ha *(or 100 gac/100 L water applied at 1.5 L spray per butt)*	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 *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – trade concerns.
	Queensland fruit fly	0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)*	Not supported – safety (worker exposure) and trade concerns.
Cole (brassica) crops (including broccoli, brussels sprouts, cabbage, cauliflower)	Cabbage moth, cabbage white butterfly, cabbage aphid, cluster caterpillar, cabbage cluster caterpillar, butterflies	750 or 1,000 g ac/ha *(75 – 100 g ac/100 L water applied using 1,000 L water/ha)*	Not supported – safety (residues, environment and worker exposure) concerns.
	Helicoverpa spp (including corn earworm, native budworm)	750 or 1,000 g ac/ha *(75 – 100 g ac/100 L water applied using 1,000 L water/ha)*	Not supported – safety (residues, environment and worker exposure) concerns.
	Vegetable weevil	500 g ac/ha	Not supported – safety (worker exposure) concerns.
		400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	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; 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[1]
	African black beetle	350 – 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 or 150 g ac/ha	Not supported – safety (environment) concerns.
Cucumbers	Ants, mealybugs	500 g ac/ha	Not supported – safety (worker exposure) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha *(35 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Wingless grasshopper, white flies	250 g ac/ha *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
Cucurbit vegetables or cucurbits (excluding cucumbers)	Wingless grasshopper	250 g ac/ha *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment and residues) concerns.
	Cutworm	350 g ac/ha *(35 g ac/100 L water, applied using 1,000 L water/ha)*	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 *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (residues) concerns.
	Ants, mealybugs	500 g ac/ha	Not supported – safety (residues and worker exposure) concerns.
Custard apple	Ants	1,000 g ac/ha to 10,000g ac/ha *(100 g ac/100 L water to 1,000 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
Ginger	African black beetle, cutworm	350 – 450 g ac/ha *(35 – 45 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
Grapes (grape vines)	Light brown apple moth, grapevine moth	250 g ac/ha *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – trade concerns.
	Grapevine scale	250 g ac/ha or 125 gac/ha + 5 L miscible winder oil *(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)*	Not supported – safety (environment) concerns.
	Mealybug, tuber mealybug	500 g ac/ha *(50 g ac/100 L water applied using 1,000 L water/ha)*	Not supported – safety (worker exposure) and trade concerns.
Green beans, peas	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha *(35 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Wingless grasshopper, white flies	250 g ac/ha *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
Kiwifruit	Common and southern armyworms, light brown apple moth, scale insects	500 g ac/ha *(25 g ac/100 L water, applied using 2,000 L water/ha)*	Not supported – safety (worker exposure) concerns.
Leafy crucifers including chou moullier, kale, mustard, rape	Vegetable weevil	500 g ac/ha	Not supported – safety (residues and worker exposure) concerns.
		400 g ac/ha	Not supported – safety (residues) concerns.
	Redlegged earth mite blue oat mite	70 – 150 g ac/ha	Not supported – safety (residues) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
Lettuce	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
Lettuce and chard (silver beet)	Cutworm	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.
	Redlegged earth mite, blue oat mite	70 or 150 g ac/ha	Not supported – safety (environment) concerns.
Loquats	Queensland fruit fly	0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)*	Not supported – safety (worker exposure) concerns.
Mango	Green tree ant	1,000 g ac/ha *(50 g ac/100 L water applied using 2,000 L water/ha)*	Not supported – safety (environment and worker exposure) concerns.
	Common mango scale	2,000 g ac/ha *(100 g ac/100 L water applied using 2,000 L water/ha)*	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 *(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; 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 *(200 g ac/100 L water applied using 30 L/ha)*	Not supported – safety (worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
Pineapples	White grubs	2,500 g ac/ha (pre-plant, soil-incorporated)	Not supported – safety (worker exposure) concerns.
	Pineapple scale	1,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	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 *(25 g ac/100 L water applied using 1,000 L water/ha)*	Not supported – trade concerns.
	Queensland fruit fly	0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)*	Not supported – safety (worker exposure) and trade concerns.
Potatoes	Wireworm	3,000 g ac/ha	Not supported – safety (worker exposure) concerns.
	African black beetle	1,500 – 3,000 g ac/ha	Not supported – safety (worker exposure) concerns.
		450 – 500 g ac/ha	Not supported – safety (worker exposure) concerns.
	White fringed weevil	3,000 g ac/ha	Not supported – safety (worker exposure) concerns.
		450 – 500 g ac/ha	Not supported – safety (worker exposure) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
	Cutworm	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; 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[1]
Stalk and stem vegetables (including asparagus, celery and rhubarb)	Wingless grasshopper	250 g ac/ha *(25 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Cutworm	350 g ac/ha *(35 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.
Stone fruits	European earwig	750 – 1,000 g ac/ha *(50 g ac/100 L water applied using 1,500 – 2,000 L water/ha)*	Not supported – safety (worker exposure) and trade concerns. *Peaches:* Not supported – safety (residues and worker exposure) and trade concerns.
		100 g ac/ha *(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)*	Not supported – safety (environment and worker exposure) and trade concerns.
	San Jose' scale	750 g ac/ha *(50 g ac/100 L water applied using 1,500 L water/ha, seasonal period)*	Not supported – safety (worker exposure) and trade concerns. *Peaches:* Not supported – safety (residues, environment and worker exposure) and trade concerns.
		250 g ac/ha *(50 g ac/100 L water applied using 500 L water/ha, 2% miscible winter oil may be added, dormant period)*	Not supported – safety (environment) concerns.
	Light brown apple moth	375 g ac/ha *(25 g ac/100 L water applied using 1,500 L water/ha)*	Not supported – safety (worker exposure) and trade concerns. *Peaches:* Not supported – safety (residues and worker exposure) and trade concerns.
		0.0125 – 0.025 g ac/tree *(25 g ac/100 L water applied using 50 – 100 mL/tree)*	Not supported – trade concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Queensland fruit fly	0.1 – 0.2 g ac/tree *(200 g ac/100 L water applied using 50 – 100 mL/tree)*	Not supported – safety (worker exposure) and trade concerns.
Strawberry	Field cricket, mole cricket	50 g ac/ha *(in 10 kg bran bait)*	Not supported – safety (environment and worker exposure) concerns.
Swede, turnip	Vegetable weevil	350 – 500 g ac/ha *(35 – 50 g ac/100 L water – 50 g ac/100 L water applied using 1,000 L water/ha)*	Not supported – safety (residues and worker exposure) concerns.
	Redlegged earth mite, blue oat mite	70 – 150 g ac/ha	Not supported – safety (residues) concerns.
Tomatoes	False wireworm, wireworm	2,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Whitefly *(Trialeurodesvaporariorum)*	1,500 g ac/ha *(60 g ac/100 L water applies using 2,500 L water)*	Not supported – safety (environment and worker exposure) concerns.
	African black beetle	1,000 g ac/ha	Not supported – safety (worker exposure) concerns.
		150 g ac/100 L water *(drench at 100 mL/plant)*	Not supported – safety (worker exposure) concerns.
	Silverleaf whitefly	1,500 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
		750 – 1,000 g ac/ha *(75 – 100 g ac/100 L water – 100 g ac/100 L water, applied using 1,000 L water/ha)*	Not supported – safety (environment and worker exposure) concerns.
	Green vegetable bug, *Helicoverpa* spp. (including tomato grub, native budworm)	750 to/or 1,000 g ac/ha	Not supported – safety (environment and worker exposure) concerns.
	Green peach aphid	500 g ac/ha	Not supported – safety (worker exposure) concerns.
	Vegetable weevil	400 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	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 – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Blue oat mite, pasture webworm	200 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Bryobia Mite	400 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (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 – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
Canola (rapeseed)	False wireworm, wireworms	500 or 750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Balaustium mite	400 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Cutworms	350 to 450 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Bryobia mite	400 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Vegetable weevil	200 to 400 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Blue oat mite, pasture webworm	200 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea	100 to 200 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha (ground spray)	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Lucerne flea	70 to 150 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
		35 g ac/ha	Not supported – safety (worker exposure with broadacre use) and trade concerns.
	Redlegged earth mite	70 g ac/ha	Not supported – safety (worker exposure with broadacre use) and 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 (worker exposure) and trade concerns.
	Blackheaded pasture cockchafer	450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Southern armyworm, common armyworm	350 to 450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Cutworm	350 or 450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Pasture webworm	350 g ac/ha	Not supported – safety (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 – use is not considered practical with the work rate restriction required to mitigate safety (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.
	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 – safety (worker exposure with broadacre use) and trade concerns.
	Lucerne flea	35 g ac/ha	Not supported – safety (worker exposure with broadacre use) and 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.
	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.

Crop/host	Pest	Rate	Assessment outcome[1]
	Seed harvesting ants	40 g ac/100 kg seed	Not supported – safety (environment and worker exposure) and trade concerns.
Coffee beans (non-bearing)	Mealybugs	1,000 g ac/ha *(butt and soil treatment applied at 100 g ac/100 L water using 1,000 L water/ha)*	Not supported – safety (environment and worker exposure) concerns.
Cotton	Spur throated locusts	625 g or 750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Cotton flea beetle, red shouldered leaf beetle	450 or 750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Mites	750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
		300 to 450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Pink spotted bollworm moth (Pectinophora scutigera)	500 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Cutworm	350 or 450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Southern armyworm, common armyworm	350 or 450 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Cotton aphid	150 or 200 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Migratory locusts	175 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Springtails	150 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Blue oat mite, redlegged earth mite	70 to 150 g ac/ha (ground spray)	Not supported – safety (worker exposure) 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–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and trade concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
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)*	Not supported – safety (environment and worker exposure) and trade concerns.
	Earwigs	100 g ac/ha *(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)*	Not supported – safety (environment and worker exposure) and trade concerns.
Field peas, lupins, broad beans, and chickpeas	Redlegged earth mite, blue oat mite	70 to 150 g ac/ha	Not supported – use is not considered practical with the work rate restriction 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	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Blue oat mite	200 g ac/ha	Not supported – use is not considered practical with the application restriction required to mitigate safety (worker exposure with broadacre use) concerns.
	Pasture webworm	200 g ac/ha	Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) 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	450 g ac/ha	Not supported – safety (worker exposure) concerns.
	Cutworms, webspinner, caterpillar	350 g ac/ha	Not supported – safety (environment) concerns.
	Lucerne leafroller	150 to 200 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Blue oat mite, redlegged earth mite	70 to 150 g ac/ha	Not supported – safety (environment) concerns.
Lucerne, medics	Sitona Weevil	175 g ac/ha	Not supported – safety (environment) concerns.
	Bluegreen aphid, spotted alfalfa aphid, pea aphid	100 to 150 g ac/ha	Not supported – safety (environment) concerns.
Lucerne, subterranean clover, 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.
Lucerne pastures, clover seed crops	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	100 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–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m	Not supported – safety (worker exposure) and trade concerns.
Oilseeds (excluding canola and cotton)	Cutworms	450 g ac/ha	Not supported – safety (worker exposure) concerns.
		350 g ac/ha	Not supported – safety (environment) concerns.
	Wingless grasshopper	250 g ac/ha	Not supported – safety (environment) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
	Redlegged earth mite, blue oat mite	70–110 g ac/ha (ground spray)	Not supported – safety (residues) concerns.
		>110–150 g ac/ha (ground spray)	Not supported – safety (environment) concerns.
	False wireworms	125 g ac/310 kg seed	Not supported – safety (environment and worker exposure) concerns.
Pasture and forage crops	Corbie, winter corbie	450 or 750 g ac/ha	Not supported – safety (worker exposure) concerns.
	Spur throated locust	625 or 750 g ac/ha	Not supported – safety (worker exposure) concerns.
	Blackheaded pasture cockchafer	450 g ac/ha	Not supported – safety (worker exposure) concerns.
	Cutworms	450 g ac/ha	Not supported – safety (worker exposure) concerns.
	Underground grass grub	450 g ac/ha	Not supported – safety (worker exposure) concerns.
	Armyworm	350 to 450 g ac/ha	Not supported – safety (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.
	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.

Crop/host	Pest	Rate	Assessment outcome[1]
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)*	Not supported – safety (environment and worker exposure) and trade concerns.
Rice	Brown plant hopper	750 g ac/ha	Not supported – safety (worker exposure) and trade concerns.
	Bloodworm	30 or 75 g ac/ha	Not supported – trade concerns.
Safflower	Wireworm, false wireworm	2.5 g–7.5 g ac/100 m row or 250–750 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–7.5 g ac/100 m row or 250–750 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 (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 (worker exposure) concerns.
	Spur throated locust	625 or 750 g ac/ha	Not supported – safety (worker exposure) concerns.
	Southern armyworm, common armyworm	450 g ac/ha	Not supported – safety (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.

Crop/host	Pest	Rate	Assessment outcome[1]
Sunflower	Wireworm, false wireworm	2.5 g–7.5 g ac/100 m row or 250–750 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 *(pre-plant, soil incorporated)*	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 *(horizontal barrier)* 1000 g ac/m^3 or 2000 g ac/m^3 *(vertical barrier)*	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 *(horizontal barrier)*	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 *(horizontal barrier)* 1000 g ac/m^3 or 2000 g ac/m^3 *(vertical barrier)*	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.
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.

Crop/host	Pest	Rate	Assessment outcome[1]
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.
	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 *(applied in in 2.5 kg bran bait)*	Not supported – safety (environment and worker exposure) concerns.

Crop/host	Pest	Rate	Assessment outcome[1]
		50 g ac/ha *(with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)*	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.

1 Many uses that were not supported based on human health or food safety grounds have not been reconsidered in the environment assessment. Additional environmental concerns not indicated in this table may therefore exist for some uses.

Appendix B – Listing of environmental endpoints

Table 41: 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 3.4×10^{-3} Pa at 20°C	Shubha 2015a
		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 λmax ε (L/mol/cm)	
		Acidic 285 nm 5377 Neutral 285 nm 5274 Alkaline 285 nm 5206	Shubha 2014c
		Acidic 289 nm 6167 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	Singh 2009

Substance	Study	Result	Reference
TMP	Vapour pressure	1.3×10^{-3} Pa at 25°C 0.9×10^{-3} Pa at 20°C	Comb 2002
	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 λmax ε (L/mol/cm) 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	Madsen & Humfleet 2004
TCP	Vapour pressure	3.3 mPa at 25oC	Meikle & Hamaker 1981
	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 42: 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

Study	Substance	Result	Reference
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	Jackson 2015, Kang 2014a

Study	Substance	Result	Reference
		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	
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	Soil %OC Kf Kfoc 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 Kfoc 3572 mL/g, mean 1/n 0.92	Damon & Heim 2001
Adsorption/ desorption	TMP	Soil %OC Kf Kfoc 1/n 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	Heim & Damon 2001
	TCP	Soil %OC Kf Kfoc 1/n	
		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	Damon & Sarff 2001
		Clay loam 2.5 2.0 77 0.78	Racke & Lubinski 1992

Study	Substance	Result					Reference
		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 Michigan: DT_{50} 38 d California: DT_{50} 66 d					Abu 2015c, Fontaine et al. 1987
		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 43: 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 44: 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

Study	Substance	Result	Reference
	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 & Rüdel 1993

Table 45: Effects on mammals

Exposure	Species	Test substance	Toxicity value	Reference
Acute	*Rattus norvegicus*	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
	Mus musculus	Chlorpyrifos	LD_{50} >50 mg ac/kg bw/d	Verma 2013b
Chronic	*Rattus norvegicus*	Chlorpyrifos	NOEL 1.0 mg ac/kg bw/d	Breslin et al. 1991

Table 46: Effects on birds

Test substance	Exposure	Species	Toxicity value	Reference
Chlorpyrifos	Acute	*Quiscalus quiscula*	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	
		Phasianus colchicus	LD_{50} 12 mg ac/kg bw	Hudson et al. 1984
		Agelaius phoeniceus	LD_{50} 13 mg ac/kg bw	Schafer & Brunton 1979

Test substance	Exposure	Species	Toxicity value	Reference
		Columba livia	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	
Chlorpyrifos	Acute	*Coturnix japonica*	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	
		Passer domesticus	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	
		Gallus gallus	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	
		Grus canadensis	LD_{50} 38 mg ac/kg bw	Hudson et al. 1984
		Colinus virginianus	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

Test substance	Exposure	Species	Toxicity value	Reference
			LD_{50} 128 mg ac/kg bw	Lloyd et al. 1989b
			Geomean LD_{50} 46 mg ac/kg bw	
		Brania canadensis	LD_{50} 60 mg ac/kg bw	Hudson et al. 1984
		Alectoris chukar	LD_{50} 61 mg ac/kg bw	Hudson et al. 1984
		Callipepla californica	LD_{50} 68 mg ac/kg bw	Hudson et al. 1984
		Agelaius phoeniceus	LD_{50} 75 mg ac/kg bw	Schafer & Brunton 1979
		Anas platyrhynchos	LD_{50} 95 mg ac/kg bw	Hudson et al. 1972
	Dietary	*Colinus virginianus*	LD_{50} 75 mg ac/kg bw/d	Gallagher & Beavers 2007
		Anas platyrhynchos	LD_{50} 71 mg ac/kg bw/d	Roberts & Phillips 1987
	Chronic	*Colinus virginianus*	NOEL 11 mg ac/kg bw/d	Beavers & Fink 1978a
		Anas platyrhynchos	NOEL 2.9 mg ac/kg bw/d	Beavers & Fink 1978b
TCP	Acute	*Colinus virginianus*	LD_{50} >2000 mg/kg bw	Campbell et al. 1990
	Dietary	*Anas platyrhynchos*	LD_{50} >1027 mg/kg bw/d	Long et al. 1990

Table 47: 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

Test substance	Crop	Exposure	Effect	Reference
	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 48: Effects on fish

Exposure	Species	Test substance	Toxicity value	Reference
Acute	*Oncorhynchus mykiss*	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
	Leuciscus idus	Chlorpyrifos	LC_{50} 0.010 mg ac/L	Douglas & Bell 1985a
	Cyprinus carpio	Chlorpyrifos	LC_{50} 0.024 mg ac/L	Bopanna 2014a
	Cyprinodon variegatus	Chlorpyrifos	LC_{50} >0.076 mg ac/L	Surprenant 1989a
	Rutilus rutilus	Chlorpyrifos	LC_{50} 0.25 mg ac/L	Douglas & Bell 1985b
	Pimephales promelas	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
	Lepomis macrochirus	TCP	LC_{50} 12 mg/L	Gorzinski et al. 1991b
	Menidia menidia	TCP	LC_{50} 58 mg/L	Graves & Smith 1991

Exposure	Species	Test substance	Toxicity value	Reference
Chronic	*Oncorhynchus mykiss*	Chlorpyrifos	NOEC 0.00051 mg ac/L	Adema 1990
		TCP	NOEC 0.081 mg/L	Marino et al. 1999
	Menidia peninsulae	Chlorpyrifos	NOEC 0.00038 mg ac/L	Goodman et al. 1985
	Pimephales promelas	Chlorpyrifos	NOEC 0.00057 mg ac/L	Mayes et al. 1993
	Menidia beryllina	Chlorpyrifos	NOEC 0.00075 mg ac/L	Goodman et al. 1985

Table 49: Effects on aquatic invertebrates and sediment dwellers

Exposure	Species	Test substance	Toxicity value	Reference
Acute	*Daphnia magna*	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
	Mysidopsis bahia	Chlorpyrifos	LC_{50} 0.000045 mg ac/L	Surprenant 1989b
	Hyalella azteca	Chlorpyrifos	LC_{50} 0.00014 mg ac/L	Brown et al. 1997
	Crassostrea virginica	Chlorpyrifos	EC_{50} 0.084 mg ac/L	Surprenant 1989c
Chronic	*Daphnia magna*	Chlorpyrifos	NOEC 0.000056 mg/L	Adema & de Ruiter 1990
		TCP	NOEC 0.029 mg/L	Machado 2003
	Mysidopsis bahia	Chlorpyrifos	NOEC 0.0000046 mg ac/L	Sved et al. 1993
	Chironomus riparius	DCP	NOEC 33 mg/L	Putt 2005
	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 50: Effects on algae and aquatic plants

Group	Species	Test substance	Toxicity value	Reference
Algae	*Pseudokirchneriella subcapitata*	Chlorpyrifos	E_rC_{50} 1.0 mg ac/L	Bopanna 2014c
		EC 480 g/L	E_bC_{50} 0.064 mg/L	van der Kolk 1995b
		TMP	E_rC_{50} 3.3 mg/L	Biester 2010

Group	Species	Test substance	Toxicity value	Reference
		TCP	E_rC_{50} 1.1 mg/L	Kirk et al. 1999
	Scenedesmus subspicatus	Chlorpyrifos	E_bC_{50} 0.48 mg/L	Douglas et al. 1990
	Anabaena flos-aquae	TCP	EC_{50} 1.4 mg/L	Kirk et al. 2000a
	Navicula pelliculosa	TCP	E_rC_{50} 8.9 mg/L	Sayers 2003
		DCP	E_rC_{50} 12 mg/L	Hoberg 2006
Aquatic plants	*Lemna gibba*	TCP	EC_{50} 8.8 mg/L	Kirk et al. 2000b

Table 51: 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
Apis mellifera	Adult	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 52: Semi-field studies on bees

Test substance	Crop	Application	Effect	Reference
WG 750 g/kg	*Phacelia tanacetafolia* 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	*Phacelia tanacetafolia* 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 53: 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 54: Effects on soil macro-organisms

Exposure	Species	Test substance	Toxicity value	Reference
Acute	*Eisenia fetida*	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

Exposure	Species	Test substance	Toxicity value	Reference
		TCP	LC_{50corr} 9.8 mg/kg dry soil	Ward & Boeri 1999
Chronic	*Eisenia fetida*	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
	Hypoaspis aculeifer	TCP	EC_{10} >50 mg/kg dry soil	Vinall 2011a
	Folsomia candida	TCP	NOEC 50 mg/kg dry soil	Vinall 2011b

Table 55: 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 56: Effects on non-target terrestrial plants (pre-emergent exposure)

Test substance	Species	ER_{25}	ER_{50}	Reference
EC 480 g/L	*Abutilon theophasti*	>2400 g ac/ha	>2400 g ac/ha	Paterson & Toft 2007a
WG 750 g/kg	*Alopecurus myosuroides*	>2400 g ac/ha	>2400 g ac/ha	
CS 200 g/L	*Avena fatua*	>2400 g ac/ha	>2400 g ac/ha	
	Beta vulgaris	>2400 g ac/ha	>2400 g ac/ha	
	Chenopodium album	>2400 g ac/ha	>2400 g ac/ha	
	Digitaria sanguinalis	>2400 g ac/ha	>2400 g ac/ha	
	Echinochloa crus-galli	>2400 g ac/ha	>2400 g ac/ha	

Test substance	Species	ER_{25}	ER_{50}	Reference
	Euphorbia heterophylla	>2400 g ac/ha	>2400 g ac/ha	
	Glycine max	>2400 g ac/ha	>2400 g ac/ha	
	Helianthus annus	>2400 g ac/ha	>2400 g ac/ha	
	Ipomoea hederacea	>2400 g ac/ha	>2400 g ac/ha	
	Oryza sativa	>2400 g ac/ha	>2400 g ac/ha	
	Sorghum bicolour	>2400 g ac/ha	>2400 g ac/ha	
	Triticum aestivum	>2400 g ac/ha	>2400 g ac/ha	
	Zea mays	>2400 g ac/ha	>2400 g ac/ha	
EW 450 g/L	*Lactuca sativa*	2670 g ac/ha	>6400 g ac/ha	Bergfield 2011a, 2012a
	Cucumis sativus	5720 g ac/ha	>6400 g ac/ha	
	Allium cepa	>6400 g ac/ha	>6400 g ac/ha	
	Avena sativa	>6400 g ac/ha	>6400 g ac/ha	
	Brassica oleraca	>6400 g ac/ha	>6400 g ac/ha	
	Daucus carota	>6400 g ac/ha	>6400 g ac/ha	
	Glycine max	>6400 g ac/ha	>6400 g ac/ha	
	Lolium perenne	>6400 g ac/ha	>6400 g ac/ha	
	Lycopersicon esculentum	>6400 g ac/ha	>6400 g ac/ha	
	Zea mays	>6400 g ac/ha	>6400 g ac/ha	

Table 57: Effects on non-target terrestrial plants (post-emergent exposure)

Test substance	Species	ER_{25}	ER_{50}	Reference
EC 480 g/L	*Abutilon theophasti*	>2400 g ac/ha	>2400 g ac/ha	Paterson & Toft 2007b
WG 750 g/kg	*Alopecurus myosuroides*	>2400 g ac/ha	>2400 g ac/ha	
CS 200 g/L	*Amaranthus retroflexus*	>2400 g ac/ha	>2400 g ac/ha	
	Avena fatua	>2400 g ac/ha	>2400 g ac/ha	
	Beta vulgaris	>2400 g ac/ha	>2400 g ac/ha	
	Brassica napus	>2400 g ac/ha	>2400 g ac/ha	
	Chenopodium album	>2400 g ac/ha	>2400 g ac/ha	
	Cirisum arvensis	>2400 g ac/ha	>2400 g ac/ha	
	Digitaria sanguinalis	>2400 g ac/ha	>2400 g ac/ha	
	Echinochloa crus-galli	>2400 g ac/ha	>2400 g ac/ha	
	Euphorbia heterophylla	>2400 g ac/ha	>2400 g ac/ha	
	Glycine max	>2400 g ac/ha	>2400 g ac/ha	
	Helianthus annus	>2400 g ac/ha	>2400 g ac/ha	
	Ipomoea hederacea	>2400 g ac/ha	>2400 g ac/ha	
	Oryza sativa	>2400 g ac/ha	>2400 g ac/ha	
	Polygonum convolvulus	>2400 g ac/ha	>2400 g ac/ha	
	Setaria faberii	>2400 g ac/ha	>2400 g ac/ha	
	Sorghum bicolour	>2400 g ac/ha	>2400 g ac/ha	
	Stellaria media	>2400 g ac/ha	>2400 g ac/ha	
	Triticum aestivum	>2400 g ac/ha	>2400 g ac/ha	
	Viola tricolor	>2400 g ac/ha	>2400 g ac/ha	
	Zea mays	>2400 g ac/ha	>2400 g ac/ha	
EW 450 g/L	*Allium cepa*	>6400 g ac/ha	>6400 g ac/ha	Bergfield 2011b, 2012b
	Avena sativa	>6400 g ac/ha	>6400 g ac/ha	
	Brassica oleraca	>6400 g ac/ha	>6400 g ac/ha	
	Cucumis sativus	>6400 g ac/ha	>6400 g ac/ha	
	Daucus carota	>6400 g ac/ha	>6400 g ac/ha	
	Glycine max	>6400 g ac/ha	>6400 g ac/ha	
	Lactuca sativa	>6400 g ac/ha	>6400 g ac/ha	
	Lolium perenne	>6400 g ac/ha	>6400 g ac/ha	
	Lycopersicon esculentum	>6400 g ac/ha	>6400 g ac/ha	
	Zea mays	>6400 g ac/ha	>6400 g ac/ha	

Appendix C – 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.

The chronic assessment assumes 50% of food items are obtained from the treatment area for the first 21 days after the last application (PT 0.5). In the 2019 assessment, a long-term time-weighted average (TWA) factor of 0.53 was applied (based on default foliar DT_{50} 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, the use patterns were divided up into groups which consist of crop species that have similar growing patterns (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.

Acceptable risks of long-term effects on wild mammals could not be concluded for any of the use patterns assessed, which could not be mitigated by restricting the timing of application (Table A2).

Table A1: Seasonal exposure estimates for various environmental matrices

Use pattern	EFSA 2009 crop group	Situation	Application rate and frequency	Fraction Field treated	Seasonal exposure rate (g/ha)	
					Insects (DT_{50} 3.5 d)	Foliage (DT_{50} 4.0 d)
Field crops and pasture	Grassland	Pasture, sugarcane	2× 350 g ac/ha 7d interval	1	438	454
	Legume forage	Lucerne, forage crops	2× 350 g ac/ha 7d interval	1	438	454
	Oilseed rape	Oilseeds (excluding cotton and canola)	2× 350 g ac/ha 7d interval	1	438	454
	Ornamentals/nursery	Duboisia	1× 450 g ac/ha	1	450	450

Use pattern	EFSA 2009 crop group	Situation	Application rate and frequency	Fraction Field treated	Seasonal exposure rate (g/ha)	
					Insects (DT_{50} 3.5 d)	Foliage (DT_{50} 4.0 d)
Tree and vine crops	Vineyards	Grapevines	1× 250 g ac/ha	1	250	250
	Orchards	Apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards	1× 250 g ac/ha	1	250	250
	Orchards	Avocado (spot treatment)	1× 500 g ac/ha	0.40	200	200
Vegetable crops	Leafy vegetables	Vegetables (band application)	2× 400 g ac/ha 7d interval	0.50	250	259
	Leafy vegetables	Vegetables (broadcast application)	2× 350 g ac/ha 7d interval	1	438	454
	Root and stem vegetables	Ginger	1× 450 g ac/ha	1	450	450
Mosquito control	Ornamentals/nursery	Vegetation (mosquito adults)	4× 54 g ac/ha 7d interval	1	72	76
Commercial turf	Grassland	Control of cockchafer, grub or corbie	1× 450 g ac/ha	1	450	450
		Control of other insect pests	2× 350 g ac/ha 7d interval	1	438	454
Combination products	Legume forage	Subterrannean clover, clover, lucerne	2× 400 g ac/ha 7d interval	1	500	519
	Fruiting vegetables	Field tomatoes	2× 250 g ac/ha 7d interval	1	313	324

Risk assessment scenarios as described in section 2; foliar interception values are based on EFSA (2020) defaults for similar situations; seasonal exposure rates based on indicated application rate, frequency, DT_{50}, fand fraction of field treated (40% for spot treatment, 50% for band application)

Table A2 Long-term risks of chlorpyrifos to wild mammals (RAL 1.0 mg/kg bw/d)

Crop group	Crop stage	Generic focal species	Shortcut value	Exposure rate (g/ha)	DDD (mg/kg bw/d)	RQ
Pasture, sugarcane, commercial turf						
Grassland	All season	Small herbivore	72.3	450	16	**16**
	All season	Large herbivore	17.3	450	3.9	**3.9**
	All season	Small omnivore	6.6	450	1.5	**1.5**
	Late season	Small insectivore	1.9	450	0.43	0.43
Lucerne, forage crops, combination products (subterranean clover, clover, lucerne)						
Legume forage	BBCH 40–49	Small herbivore	72.3	454	16	**16**
	BBCH ≥50	Small herbivore	21.7	454	4.9	**4.9**
	BBCH 21–49	Large herbivore	14.3	454	3.2	**3.2**
	BBCH 10–49	Small omnivore	7.8	454	1.8	**1.8**
	BBCH 10–19	Small insectivore	4.2	438	0.92	0.92
				500	1.1	**1.1**
	BBCH ≥50	Small omnivore	2.3	500	0.60	0.60
	BBCH ≥20	Small insectivore	1.9	500	0.48	0.48
Oilseeds (excluding cotton and canola)						
Oilseed rape	BBCH ≥40	Small herbivore	18.1	454	4.1	**4.1**
	All season	Large herbivore	14.3	454	3.2	**3.2**
	BBCH 10–29	Small omnivore	7.8	454	1.8	**1.8**
	BBCH 10–19	Small insectivore	4.2	438	0.92	0.92
	BBCH 30–39	Small omnivore	2.3	454	0.52	0.52

Crop group	Crop stage	Generic focal species	Shortcut value	Exposure rate (g/ha)	DDD (mg/kg bw/d)	RQ
	BBCH ≥40	Small omnivore	1.9	454	0.43	0.43
	BBCH ≥20	Small insectivore	1.9	438	0.42	0.42
Duboisia, adult mosquito control						
Ornamentals/nursery	BBCH 40–49	Small herbivore	72.3	76	2.7	**2.7**
	BBCH ≥50	Small herbivore	36.1	76	1.4	**1.4**
	BBCH 10–49	Small omnivore	7.8	76	0.30	0.30
				450	1.8	**1.8**
	BBCH ≥50	Small omnivore	3.9	450	0.88	0.88
	All season	Small insectivore	1.9	438	0.42	0.42
Grapevines						
Vineyards	Ground directed	Small herbivore	72.3	250	9.0	**9.0**
	BBCH 10–19	Small herbivore	43.4	250	5.4	**5.4**
	BBCH 20–39	Small herbivore	36.1	250	4.5	**4.5**
	BBCH ≥40	Small herbivore	21.7	250	2.7	**2.7**
	Ground directed	Large herbivore	11.1	250	1.4	**1.4**
	Ground directed	Small omnivore	7.8	250	0.98	0.98
	BBCH 10–19	Large herbivore	6.7	250	0.84	0.84
	BBCH 20–39	Large herbivore	5.5	250	0.69	0.69
	BBCH 10–19	Small omnivore	4.7	250	0.59	0.59
	BBCH 10–19	Small insectivore	4.2	250	0.53	0.53
	BBCH 20–39	Small omnivore	3.9	250	0.49	0.49

Crop group	Crop stage	Generic focal species	Shortcut value	Exposure rate (g/ha)	DDD (mg/kg bw/d)	RQ
	BBCH ≥40	Large herbivore	3.3	250	0.41	0.41
	BBCH ≥40	Small omnivore	2.3	250	0.29	0.29
	BBCH ≥20	Small insectivore	1.9	250	0.24	0.24
Avocado, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards						
Orchards	BBCH <10	Small herbivore	72.3	200	7.2	**7.2**
	BBCH 10–19	Small herbivore	57.8	200	5.8	**5.8**
	BBCH 20–40	Small herbivore	43.4	200	4.3	**4.3**
	BBCH 71–79	Frugivore	22.7	200	2.3	**2.3**
	BBCH ≥40	Small herbivore	21.7	200	2.2	**2.2**
	BBCH <10	Large herbivore	14.3	200	1.4	**1.4**
	BBCH 10–19	Large herbivore	11.5	200	1.2	**1.2**
	BBCH 20–40	Large herbivore	8.6	200	0.86	0.86
				250	1.1	**1.1**
	BBCH <10	Small omnivore	7.8	250	0.98	0.98
	BBCH 10–19	Small omnivore	6.2	250	0.78	0.78
	BBCH 20–40	Small omnivore	4.7	250	0.59	0.59
	BBCH ≥40	Large herbivore	4.3	250	0.54	0.54
	BBCH ≥40	Small omnivore	2.3	250	0.29	0.29
	BBCH <10	Small omnivore	1.9	250	0.24	0.24
Vegetables (band or broadcast application)						
Leafy vegetables	BBCH 40–49	Small herbivore	72.3	259	9.4	**9.4**

Crop group	Crop stage	Generic focal species	Shortcut value	Exposure rate (g/ha)	DDD (mg/kg bw/d)	RQ
	BBCH ≥50	Small herbivore	21.7	259	2.8	**2.8**
	All season	Large herbivore	14.3	259	1.9	**1.9**
	BBCH 10–49	Small omnivore	7.8	259	1.0	1.0
				454	1.8	**1.8**
	BBCH 10–49	Small insectivore	4.2	438	0.92	0.92
	BBCH ≥50	Small omnivore	2.3	454	0.52	0.52
	BBCH ≥20	Small insectivore	1.9	438	0.42	0.42
Ginger						
Root and stem vegetables	BBCH ≥40	Small herbivore	21.7	450	4.9	4.9
	BBCH 10–39	Small omnivore	7.8	450	1.8	1.8
	BBCH 10–19	Small insectivore	4.2	450	0.95	0.95
	BBCH ≥40	Small omnivore	2.3	450	0.52	0.52
	BBCH ≥20	Small insectivore	1.9	450	0.43	0.43
Combination products (field tomatoes)						
Fruiting vegetables	BBCH 10–49	Small herbivore	72.3	324	12	12
	BBCH 71–89	Frugivore	25.2	324	4.1	4.1
	BBCH ≥50	Small herbivore	21.7	324	3.5	3.5
	BBCH 10–49	Small omnivore	7.8	324	1.3	1.3
	BBCH 10–19	Small insectivore	4.2	313	0.66	0.66
	BBCH ≥50	Small omnivore	2.3	324	0.37	0.37
	BBCH ≥20	Small insectivore	1.9	313	0.30	0.30

Crop groups as indicated in Table A1; generic focal species and shortcut values for indicated crop groups from EFSA (2009)
Seasonal exposure rates selected from Table A1 for the indicated crop groups represent worst-case scenario (if acceptable) or best-case scenario (if not acceptable). A threshold of unacceptable risk was reached within the range of registered rates for a few species/timing combinations for which both bounds are presented.
DDD = daily dietary dose (mg/kg bw/d) = shortcut value * rate (kg ac/ha) * PT 0.5
RAL = regulatory acceptable level = NOEL 1.0 mg/kg bw/d (Breslin et al. 1991)
RQ = risk quotient = DDD/RAL, where acceptable RQ ≤1

Appendix D – Runoff assessments

Assessment scenarios

Runoff has been modelled following the methodology described in Appendix B, 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 PERAMA[7] 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 addition, it is assumed that no more than 50% of the catchment is treated at once, with a few exceptions as described below.

For ornamentals, it is conservatively assumed that 0.1% of the catchment is treated. This is 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).

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 m^2 per building and 0.26 m^2 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.

Table B1: Soil exposure rates assessed for the runoff assessments of chlorpyrifos

Use pattern	Situation	Application rate and frequency	Foliar interception fraction	Fraction catchment treated	Seasonal catchment exposure rate (g/ha)
Field crops and pasture	Pasture, lucerne	2× 350 g ac/ha 7d interval	0.90	0.5	177
	Sugarcane	2× 350 g ac/ha 7d interval	0	0.5	322
	Forage crops, oilseeds (excluding cotton and canola)	2× 350 g ac/ha 7d interval	0.30	0.5	274

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Use pattern	Situation	Application rate and frequency	Foliar interception fraction	Fraction catchment treated	Seasonal catchment exposure rate (g/ha)
	Oilseeds (excluding cotton and canola)	1× 110 g ac/ha	0.30	0.5	47
	Duboisia	1× 450 g ac/ha	0.25	0.5	197
Tree and vine crops	Avocado, grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards	1× 250 g ac/ha	0.60	0.5	88
	Grapevine rootlings	1× 8000 g ac/ha	0	0.5	4000
Vegetable crops	Vegetables (band or broadcast application)	2× 350 g ac/ha 7d interval	0.25	0.5	282
	Ginger	1× 450 g ac/ha 1× 92 g ac/ha	0.25 0.25	0.5 0.5	197 40
Ornamentals	Potted 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
Combination products	Subterrannean clover, clover, lucerne	2× 400 g ac/ha 7d interval	0.85	0.5	212
	Field tomatoes	2× 250 g ac/ha 7d interval	0.25	0.5	201

Risk assessment scenarios as described in section 2; foliar interception values are based on EFSA (2020) defaults for similar situations; seasonal catchment exposure rates based on indicated application rate, frequency, soil DT_{50} 28 days, foliar interception (with 50% wash-off) and fraction of catchments treated.

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 ornamentals, crawling insect control and termite pole protection at the Tier 1 level of assessment (Table B2).

Table B2: Tier 1 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

Situation	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Potted ornamentals, 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

Seasonal catchment exposure rates from Table B1

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 B3.

Acceptable risks could not be determined for external perimeter treatment (horizontal or vertical) around large buildings (Table B4). In-stream analyses cannot be undertaken for urban scenarios; thus, no further refinement can be undertaken and the use pattern is not supported.

Table B3: Tier 2 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Pasture and lucerne							
Queensland and Northern Territory	177	17	1.10	108	2.48	0.02	0.20
Victoria	177	24	3.87	108	2.78	0.06	0.65
South Australia	177	25	2.87	88	2.85	0.06	0.55
Western Australia	177	39	3.17	108	3.35	0.04	0.37
Sugarcane							
Burdekin	322	14	1.84	108	2.20	0.07	0.74
Forage crops and oilseeds (excluding cotton and canola)							
Queensland and Northern Territory	274	19	1.97	67	2.79	0.10	1.0
New South Wales and ACT	274	27	1.89	88	2.92	0.05	0.52
Victoria	274	27	1.18	67	2.92	0.04	0.42
Tasmania	274	21	2.59	194	2.74	0.04	0.39
South Australia	274	28	2.49	77	2.92	0.08	0.79
Western Australia	274	44	2.46	67	3.54	0.07	0.68
Duboisia							
Burdekin	197	17	1.84	108	2.39	0.04	0.38
Mary Burnett	197	17	3.59	108	2.39	0.08	0.82
SE Queensland	197	17	3.88	108	2.39	0.09	0.90
Avocado, grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards, adult mosquito control							
Queensland and Northern Territory	88	17	4.27	108	2.39	0.04	0.42
New South Wales and ACT	88	27	4.27	108	2.99	0.03	0.32

Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
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
Vegetable crops (band or broadcast application)							
Victoria	282	21	2.85	108	2.59	0.08	0.80
South Australia	282	22	2.81	88	2.66	0.10	0.96
Western Australia	282	34	3.78	108	3.20	0.08	0.82
Burdekin	282	14	1.84	108	2.20	0.06	0.64
Ginger							
Burdekin	197	14	1.84	108	2.20	0.04	0.43
Mary Burnett	197	14	3.59	108	2.20	0.09	0.93
SE Queensland	197	14	3.88	108	2.20	0.10	1.0

Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Commercial turf							
Queensland and Northern Territory	253	24	4.27	108	2.98	0.06	0.57
New South Wales 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
Subterranean clover, clover, lucerne (combination products)							
Queensland and Northern Territory	212	17	1.97	108	2.43	0.07	0.71
New South Wales and ACT	212	26	1.89	108	2.96	0.05	0.52
Victoria	212	26	1.18	108	2.96	0.03	0.31
Tasmania	212	20	2.59	194	2.75	0.05	0.51
South Australia	212	27	2.49	88	2.95	0.08	0.84
Western Australia	212	42	2.46	108	3.39	0.05	0.49
Field tomatoes (combination products)							
New South Wales and ACT	201	21	4.27	108	2.58	0.09	0.89
Victoria	201	21	2.85	108	2.59	0.06	0.55

Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
South Australia	201	22	2.81	108	2.66	0.05	0.53
Western Australia	201	34	3.78	108	3.20	0.06	0.57
Burdekin	201	14	1.84	108	2.20	0.04	0.44
Mary Burnett	201	14	3.59	108	2.20	0.09	0.95
SE Queensland	201	14	3.88	108	2.20	0.10	1.0

Seasonal catchment exposure rates from Table B1; sugarcane scenario in Burdekin assumes no trash blanket is present

Table B4: Tier 2 scenarios showing unacceptable runoff risks of chlorpyrifos to aquatic species – Termite protection

Region	Seasonal catchment exposure rate (g/ha)	Rainfall (mm)	Slope (%)	Kf (mL/g)	Runoff (mm)	PEC (µg/L)	RQ
Queensland and Northern Territory	790	7.00	4.02	108	1.20	0.94	9.4
	395	7.00	4.02	108	1.20	0.46	4.6
New South Wales 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

Tier 3 assessments

This highest tier of assessment applies long term rainfall data for representative weather stations in the different regions, which has been obtained from the Bureau of Meteorology. Further, the receiving water characteristics are based on long term stream flow monitoring data and this tier therefore allows assessments to be undertaken on both spatial and temporal scales.

The high tier assessment approach for runoff has been used for a number of years and through this experience, scope for additional refinements have become apparent. There are 2 areas where significant improvement has been made.

The first relates to fraction of catchment treated at a given time. The current approach in the APVMA manual assumes for in-stream analysis that 20% of a catchment is treated at a given time, and all treated area contributes to runoff. This has been shown to potentially underestimate exposure for some situations such as cereals and pasture, and overestimate exposure for cropping situations where growing occurs over smaller areas such as horticultural crops. The updated MCAS-S data on a 1 km^2 scale have been assessed for major land uses and proportions of catchments grown to a particular land use have now been assessed. These values, while stated in MCAS-S as being "Catchment" are probably more appropriate to be considered a basin level so may underestimate exposure in smaller catchments. However, overall, the results are considered applicable as a general indication of the dominance of a particular land use within a catchment scale assessment. In order to identify a fraction of catchment for a particular land use, catchments where ≥90% of the land use in a region was found were used for the analysis. The fraction of catchment was then taken as the 90th percentile value from this range of catchments. This value was lower than the highest catchment but tended to be higher than the majority of catchments. Nonetheless, it is considered sufficiently conservative to include situations where higher contributions in sub-catchment areas are found and these data are not available.

The second area for improvement relates to the time over which the rainfall event is assumed to occur (currently 1 h for the 25th percentile rainfall value and 2 h for the 75th percentile rainfall value). The 25th and 75th rainfall values are based on daily rainfall (24 h) data from different weather stations within the growing regions. These results have now been compared to a 1 in 10 year rainfall intensity for a 24 hour duration to better allocate a duration of the rainfall event being assessed. The rainfall intensity values are obtained from the Intensity Frequency Distribution (IFD) data available from the Bureau of Meteorology (BOM). The coordinates for the town/weather station assessed are used. As an example, in Cairns, the 25th percentile rainfall value in January is 16 mm, and the 1 in 10 year 24 h rainfall intensity is 16.1 mm/h. Therefore, the use of a 1 h duration for this is appropriate. However, in Richmond, Tasmania, the 25th percentile rainfall value in summer is 11.7 mm, and the 1 in 10 year 24 h rainfall intensity is 2.98 mm/h. Therefore, with this intensity, the 25th percentile rain event will occur over a duration of 3.9 hours. This method, while increasing realism, still does not address temporal rainfall trends in the different areas because the BOM value is an annual result irrespective of the time of year the result was obtained. However, this methodology is considered a significant improvement to the modelling in PERAMA.

Acceptable risks could be concluded for all uses in the remaining regions except for grapevine rootlings. Please refer to the tables below for a summary of the critical outcomes.

Table B5: Tier 3 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
Pasture and lucerne									
NSW and ACT	2.54	0.53	188	Summer	25	16.9	1.3	0.0025	97
Tasmania	3.59	0.35	124	Summer	75	23.9	3.0	0.014	>99

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)		Waters protected (%)
Sugarcane										
Wet tropics		2.97	0.057	37	Mar	75	64.7	2.91	0.030	>99
Mackay Whitsunday		2.02	0.279	180	Sep	75	31.8	1.5	0.009	98
Mary Burnett		1.56	0.092	59	May	75	49.4	3.5	0.012	>99
SE Queensland		1.68	0.046	30	Jan	75	36.0	3.6	0.009	97
Northern NSW		3.36	0.042	27	Jun	75	38.9	3.1	0.022	>99
Duboisia										
Wet tropics		2.97	0.057	22	Mar	75	64.7	2.91	0.031	>99
Mackay Whitsunday		2.02	0.279	110	Sep	25	12.2	0.6	0.003	96
Northern NSW		3.36	0.042	17	Jun	75	38.9	3.1	0.026	>99
Grapevine rootlings										
NSW and ACT		1.85	0.076	608	Summer	25	16.9	1.3	0.020	96
Tasmania		5.38	0.067	536	Winter	25	11.5	1.3	0.0048	96
Western Australia		1.64	0.020	160	Summer	75	27.6	2.9	0.0009	>99
Wet tropics		2.97	0.057	456	Nov	25	13.7	0.62	0.005	90
Fitzroy		1.89	0.007	56	Apr	75	43.4	1.9	0.014	91
Northern NSW		3.36	0.042	336	Oct	75	28.1	2.2	0.017	93
Vegetables (band or broadcast application)										
NSW and ACT		1.85	0.076	43	Winter	75	45.9	2.8	0.012	>99
Tasmania		5.38	0.067	38	Summer	75	23.2	3.0	0.031	>99
Wet tropics		2.97	0.057	32	Nov	25	13.7	0.62	0.006	99

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)		Waters protected (%)
Mackay Whitsunday		2.02	0.279	157	Nov	25	12.2	0.60	0.003	90
Fitzroy		1.89	0.007	3.9	Apr	75	43.4	1.9	0.011	98
Mary Burnett		1.56	0.092	52	May	75	49.4	3.5	0.010	>99
SE Queensland		1.68	0.046	26	Jan	75	36.0	3.6	0.009	97
Northern NSW		3.36	0.042	24	Jun	75	38.9	3.1	0.020	>99
Ginger										
Wet tropics		2.97	0.057	22	Feb	75	63.7	2.85	0.021	>99
Mackay Whitsunday		2.02	0.279	110	Aug	25	11.0	0.5	0.002	95
Fitzroy		1.89	0.007	2.8	Apr	75	43.4	1.9	0.011	98
Northern NSW		3.36	0.042	17	Jun	75	38.9	3.1	0.020	>99
Commercial turf										
Tasmania		5.38	0.01	5.1	Summer	75	23.2	3.0	0.004	>99
Northern NSW		3.36	0.01	5.1	Jun	75	38.9	2.5	0.006	>99
Field tomatoes (combination products)										
Tasmania		5.38	0.067	27	Summer	75	23.2	3.0	0.030	>99
Wet tropics		2.97	0.057	23	Nov	25	13.7	0.62	0.009	99
Mackay Whitsunday		2.02	0.279	112	Aug	25	11.0	0.5	0.002	95
Fitzroy		1.89	0.007	2.8	Apr	75	43.4	1.9	0.018	98

Only worst-case scenarios are presented for each region; seasonal catchment exposure rates from Table B1 have been readjusted to account for the refined fractions catchment treated; sugarcane scenarios assume a trash blanket is present; risks are considered acceptable where ≥90% of receiving waters are protected.

Table B6: Regions showing unacceptable runoff risks of chlorpyrifos to aquatic species – Grapevine rootlings

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
Victoria	1.24	0.092	736	Autumn	75	31.7	2.9	0.0048	**96**
					25	18.1	1.3	0.0015	**84**
				Spring	75	27.7	2.6	0.0039	97
					25	17.4	1.3	0.0014	90
				Summer	75	34.0	3.4	0.0053	**96**
					25	19.5	1.4	0.0019	**69**
				Winter	75	29.6	2.1	0.0043	99
					25	17.4	1.2	0.0014	94
South Australia	2.33	0.098	784	Autumn	75	30.8	3.0	0.0084	**93**
					25	18.8	1.4	0.0026	**78**
				Spring	75	28.0	2.7	0.0070	**95**
					25	19.2	1.3	0.0028	**83**
				Summer	75	33.7	3.0	0.0097	**85**
					25	19.1	1.3	0.0027	**63**
				Winter	75	26.4	2.7	0.0063	99
					25	17.9	1.3	0.0022	92
Burdekin	0.80	0.132	1056	Jan	25	16.5	1.0	0.002	>99
					75	49.5	2.9	0.006	>99
				Feb	25	15.8	0.9	0.002	>99
					75	53.4	3.2	0.006	>99
				Mar	25	14.8	0.9	0.001	>99
					75	50.0	3.0	0.006	>99
				Apr	25	13.8	0.8	0.001	>99
					75	38.6	2.3	0.005	>99

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
				May	25	12.4	0.7	0.001	>99
					75	28.0	1.7	0.004	>99
				Jun	25	12.7	0.8	0.001	>99
					75	28.5	1.7	0.004	>99
				Jul	25	12.6	0.7	0.001	96
					75	29.3	1.7	0.004	>99
				Aug	25	12.7	0.8	0.001	94
					75	29.2	1.7	0.004	>99
				Sep	25	14.6	0.9	0.001	**84**
					75	33.8	2.0	0.004	**>99**
				Oct	25	12.7	0.8	0.001	**72**
					75	36.1	2.1	0.005	**>99**
				Nov	25	13.5	0.8	0.001	**89**
					75	32.9	2.0	0.004	**>99**
				Dec	25	14.4	0.9	0.001	>99
					75	41.9	2.5	0.005	>99
Mackay Whitsunday	2.02	0.279	2232	Jan	25	14.2	0.7	0.003	**83**
					75	57.8	2.8	0.018	**97**
				Feb	25	15.8	0.8	0.004	93
					75	50.7	2.4	0.016	99
				Mar	25	16.2	0.8	0.004	94
					75	49.2	2.4	0.016	>99
				Apr	25	13.2	0.6	0.003	**88**
					75	39.1	0.9	0.014	**>99**
				May	25	11.9	0.6	0.002	**84**
					75	24.0	1.1	0.008	**93**

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
				Jun	25	13.7	0.7	0.003	**79**
					75	33.0	1.6	0.012	**92**
				Jul	25	11.6	0.6	0.002	**79**
					75	31.4	1.5	0.011	**88**
				Aug	25	11.0	0.5	0.002	**72**
					75	30.0	1.4	0.010	**76**
				Sep	25	12.2	0.6	0.002	**66**
					75	31.8	1.5	0.011	**73**
				Oct	25	14.0	0.7	0.003	**52**
					75	23.0	1.1	0.008	**71**
				Nov	25	12.2	0.6	0.002	**53**
					75	38.2	1.8	0.013	**72**
				Dec	25	14.0	0.7	0.003	**65**
					75	39.6	1.9	0.014	**93**
Mary Burnett	1.56	0.092	736	Jan	25	13.6	1.0	0.002	**97**
					75	39.5	2.8	0.010	**88**
				Feb	25	13.8	1.0	0.002	>99
					75	42.1	3.0	0.011	97
				Mar	25	13.4	0.9	0.002	96
					75	34.1	2.4	0.009	91
				Apr	25	12.4	0.9	0.002	**93**
					75	31.6	2.2	0.008	**84**
				May	25	13.2	0.9	0.002	**92**
					75	49.4	3.5	0.012	**78**
				Jun	25	12.5	0.9	0.002	**98**
					75	33.2	2.4	0.009	**89**

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
				Jul	25	17.0	1.2	0.004	**92**
					75	38.7	2.7	0.010	**85**
				Aug	25	11.8	0.8	0.002	**93**
					75	29.8	2.1	0.008	**83**
				Sep	25	14.4	1.0	0.008	**89**
					75	32.0	2.3	0.008	**81**
				Oct	25	14.4	1.0	0.003	**80**
					75	35.0	2.5	0.009	**65**
				Nov	25	12.4	0.9	0.002	**89**
					75	36.9	2.6	0.010	**72**
				Dec	25	13.5	1.0	0.002	**93**
					75	38.3	2.7	0.010	**79**
SE Queensland	1.68	0.046	368	Jan	25	14.0	1.4	0.003	**89**
					75	36.0	3.6	0.010	**78**
				Feb	25	13.8	1.4	0.003	**95**
					75	36.2	3.5	0.010	**88**
				Mar	25	13.2	1.3	0.002	**93**
					75	32.3	3.2	0.009	**86**
				Apr	25	12.6	1.3	0.002	**93**
					75	32.5	2.9	0.008	**86**
				May	25	12.6	1.3	0.002	**94**
					75	32.5	3.3	0.009	**86**
				Jun	25	12.2	1.2	0.002	**96**
					75	31.8	3.1	0.009	**89**
				Jul	25	12.7	1.3	0.002	96
					75	28.4	2.8	0.008	91

Region	Slope (%)	Fraction catchment treated	Catchment exposure (g/ha)	Timing	Stream flow (%)	Rainfall (mm/d)	Rain duration (h)	Runoff (%)	Waters protected (%)
				Aug	25	11.9	1.2	0.002	**95**
					75	24.0	2.4	0.007	**89**
				Sep	25	11.5	1.2	0.002	**91**
					75	22.7	2.3	0.006	**83**
				Oct	25	12.7	1.3	0.002	**89**
					75	28.4	2.8	0.008	**75**
				Nov	25	12.9	1.3	0.002	**91**
					75	29.5	3.0	0.008	**80**
				Dec	25	13.3	1.3	0.002	**90**
					75	32.5	3.2	0.009	**78**

Seasonal catchment exposure rates from Table B1 have been readjusted to account for the refined fractions catchment treated; risks are considered acceptable where ≥90% of receiving waters are protected.

Appendix E – 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
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
DES	desethyl-chlopyrifos
ds	dry soil
DT_{50}	period required for 50 percent dissipation
EC	Emulsifiable concentrate
EC_X	concentration causing X% effect (E_rC_x is used for growth rate; E_bC_x is used for biomass)
EFSA	European Food Safety Authority
EngC	Engineering controls
ER_x	rate causing X% effect
ESI	Export Slaughter Interval

Shortened term	Full term
EU	European Union
EW	emulsion, oil in water
ExpE	exposure estimate
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
max	maximum
mg	Milligram
mL	Millilitre
mm	millimetre(s)
MOE	Margin of Exposure
MRL	Maximum residue limit
NEDI	National Estimated Daily Intake
NESTI	National Estimated Short-Term Intake
nm	nanometre(s)

Shortened term	Full term
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
PHED	Pesticide Handler Exposure Database
PERAMA	Pesticide Environmental Risk Assessment Model for Australia
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
POPRC	Persistent Organic Pollutants Review Committee
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
SDRAM	spray drift risk assessment manual
SR	Slow-release generator
TCP	3,5,6-trichloropyridinol

Shortened term	Full term
TMP	3,5,6-trichloro-2-methoxypyridine
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	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: • 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 An estuary through which water flows.
wetland	An area of land where water covers the soil—all year or just at certain times of the year. They include: • 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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