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**Australian Pesticides and
Veterinary Medicines Authority**



Reconsideration of chlorpyrifos

Residential exposure and public space use exposure assessment and risk
characterisation update

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BACKGROUND, SCOPE AND OBJECTIVES

APVMA published a chlorpyrifos interim occupational health and safety assessment in the year 2000. Since this time, the APVMA has made a number of changes to its approach to human exposure assessment approach including:

- historically the APVMA used an older version of the UK Health and Safety Executive predictive operator exposure model (POEM) for exposure assessment and risk characterisation for professional users of pesticides. Currently APVMA uses the US EPA Occupational Pesticide Handler Exposure Calculator (OPHEC; version date: June 2018) to account for such combined exposures¹
- for non-professional residential exposure assessment and risk characterisation APVMA now uses OPHEC for the assessment of mixing, loading and application exposures
- to determine human exposure from hose-end sprayers used in residential/domestic circumstances APVMA now uses the US EPA Standard Operating Procedures for Residential Pesticide Exposure Assessment 2012²
- for professional applicator exposures associated with re-entry into pesticide treated areas, APVMA now uses the US EPA Occupational Pesticide Re-entry Exposure Calculator (OPREC)³
- for re-entry/treated area exposures involving children the APVMA Toddler on Turf exposure model is now used.

The agency has also recently published an update on the toxicology of chlorpyrifos (APVMA 2019). This supplementary evaluation established new human health based guidance values for chlorpyrifos for the Australian population, namely: an acceptable daily intake (ADI) of 0.001 mg/kg bw/day based on point of departure (POD) of 0.1 mg/kg bw/day in rats and a total uncertainty factor of 100; and a new acute reference dose (ARfD) of 0.03 mg/kg bw based on a POD of 0.1 mg/kg bw in humans and a total uncertainty factor of $10 \times 10^{0.5}$.

In light of all the above changes the overall scope of this report was to re-evaluate the exposures and risk characterisations associated with residential and public space (professional and non-professional) uses of chlorpyrifos in Australia. The specific objectives of this report were to:

- Objective 1: Conduct updated exposure assessments and risk characterisations for professional applicators who mix, load and apply chlorpyrifos for use in child-accessible public spaces and domestic/residential areas
- Objective 2: Conduct updated exposure assessments and risk characterisations for professional applicators who re-enter into chlorpyrifos-treated, child-accessible public spaces and domestic/residential areas
- Objective 3: Conduct exposure assessments and risk characterisations for the non-professional uses of chlorpyrifos in child-accessible residential settings.

No new exposure studies were available for, or considered by, this update.

¹[epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data](https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data)

²[epa.gov/sites/production/files/2015-08/documents/usepa-opp-hed_residential_sops_oct2012.pdf](https://www.epa.gov/sites/production/files/2015-08/documents/usepa-opp-hed_residential_sops_oct2012.pdf)

³[epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-post-application-exposure](https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-post-application-exposure)

Out of scope exposure assessments and risk characterisations

Human health risk assessment areas that were not covered by this report were:

- the risks associated with the use of chlorpyrifos emulsifiable concentrate products applied at rates greater than 750 g of chlorpyrifos per ha. Such uses are not supported due to environmental concerns
- spray drift-associated bystander risk and bystander exposures.

Basic parameters used in the exposure assessments and risk characterisations

Table 1: Basic parameters and models used

Parameter	Value(s)
Chlorpyrifos vapour pressure	2.5 x 10 ⁻⁶ kPa Exposure due to inhalation of vaporised chlorpyrifos is considered to be low
Body weight (adult)	70 kg
Body weight (child)	1–2 y = 11 kg 2–3 y = 15 kg
Dermal absorption factor	3% for concentrate, granule, re-entry and Toddler on Turf 10% for spray dilution
Inhalation absorption factor	100%
Gastrointestinal absorption factor	77%
Turf transfer coefficients for children	1–2 years old: 49000 cm ² /h 2–3 years old: 60000 cm ² /hr
Re-entry transfer coefficients for adults	See Appendixes 1 and 2
Re-entry initial foliar residues	See Appendixes 1 and 2
Application rates	See Appendixes 1 and 2; a.c. = Active Constituent
Work rates	See Appendixes 1 and 2
Formulation types evaluated	Aqueous concentrates, emulsifiable concentrates, suspension concentrates, dusts, wettable powders, granular formulations, granular baits, oil in water emulsions, impregnated bags and ultra-low volume formulations

Parameter	Value(s)
Exposure modelling	<p>Professional operators and re-entry into public spaces by children</p> <ul style="list-style-type: none"> • mixing, loading and application: US EPA OPHEC • re-entry: US EPA OPREC • re-entry of children into child-accessible spaces: APVMA Toddler on Turf Model (Appendix 4) <p>Residential (non-professional) operators and children</p> <ul style="list-style-type: none"> • mixing, loading and application US EPA OPHEC • Hose-end spaying US EPA Standard Operating Procedures for Residential Pesticide Exposure Assessment 2012 • re-entry by children: APVMA Toddler on Turf model

1 OBJECTIVE 1

1.1 Conduct updated exposure assessments and risk characterisations for professional applicators who mix, load and apply chlorpyrifos for use in child-accessible public spaces and domestic/residential areas

The risk characterisation findings are shown in Appendix 1. The following assumptions were made:

- professional trained applicators mixed, loaded and applied chlorpyrifos
- professional use in child-accessible public spaces involves regular and repeated occupational exposure to chlorpyrifos over a long period of time. Accordingly the ADI was regarded as the most appropriate human health based guidance value for such uses. The relevant POD was 0.1 mg/kg bw/day which is the no observed adverse effect level (NOAEL) for inhibition of blood cholinesterases in rats following repeated chlorpyrifos exposure (APVMA 2019). A margin of exposure (MOE) of 100 was applied to account for inter and intra-species uncertainties
- professional applicators were assumed to be trained, competent, experienced and compliant users of personal protective equipment
- professional operators were assumed to be trained in, and were competent, experienced and compliant users of relevant application techniques and equipment
- professional applicators were assumed to have a high degree of competence regarding the interpretation of label requirements
- professional operators were assumed to be capable of accurately measuring work rates. A high level of compliance with label-specified mandatory maximum work rates was assumed
- the assessments assumed that amongst professional applicators there would be a high level of compliance with label directed mandatory minimum re-entry intervals
- the exposure and risk characterisation assessments assumed, as a worst case, that a single operator would perform all steps in the use of chlorpyrifos products ie a single operator mixes, loads and applies the pesticide during product use
- the minimum, base-level personal protective equipment was assumed to consist of a long sleeved shirt, long pants, boots and socks or equivalent single layer of clothing (eg coveralls fastened at the neck and wrist). This was assumed to be always used when mixing, loading and applying chlorpyrifos. Personal protective equipment, if required for risk management, was applied in addition to this minimum base level of equipment
- consistent with APVMA's current data on chlorpyrifos use in Australia, the evaluations assumed that 100 per cent closed systems would not be used during mixing, loading and application
- the assessments assumed that 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) did not occur
- the assessments assumed that there was only one single type of use and/or activity per operator per day; for example the same operator would not undertake chlorpyrifos hand wand treatment of a hedge plus performing chlorpyrifos application to lawns using a mechanical spreader on the same work day

- work rates are based on label information and information contained in NOHSC 2001, *Compendium of Farming Practices*, National Occupational Health & Safety Commission, Canberra.

Only the uses shown in Table 2 had acceptable MOEs of ≥ 100 . All other uses had unacceptable risk characterisations (MOEs < 100).

Table 2: Acceptable professional public space uses of chlorpyrifos based on mixing, loading and application exposure modelling using US EPA OPHEC

Crop/use	Application method	Application rate	Work rate	MOE† 	Comments
Child-accessible domestic and child-accessible public space uses (professional use) Container plants Domestic areas Domestic uses	Push type spreader (granules)	0.1 g a.c./m ²	2000 m ² /d	526	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
Duboisia (in domestic and public space uses) Exterior or outdoor areas of domestic buildings Fences Garden beds Garden paths	Push type spreader (granules)	0.2 g a.c./m ²	2000 m ² /d	263	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
Gardens In and around houses and domestic buildings Macrocarpa hedges (in domestic and public space uses) Potted ornamentals and other potted plants	Push type spreader (granules)	0.4 g a.c./m ²	2000 m ² /d	132	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
Public places Public service areas Rockeries Tennis courts	Mechanical (open cab, tractor drawn) spreader (granules)	0.1 g a.c./m ²	5 ha/d	326	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)

Crop/use	Application method	Application rate	Work rate	MOE† 	Comments
Uses on turf and/or lawns to which children have access	Mechanical (open cab, tractor drawn) spreader (granules)	0.2 g a.c./m ²	5 ha/d	163	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
Professional use products Mosquito adult/larvae control in water bodies	High pressure hand wand	10 g a.c./100 kL water body	20 kL water body/d	>1000	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
	Low pressure hand wand	10 g a.c./100 kL water body	20 kL water body/d	123	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)
	Backpack	10 g a.c./100 kL	50 kL water body/d	591	Required personal protective equipment: Chemical resistant gloves and a double layer of chemical resistant clothing
Professional use products Mosquito adult/larvae control in vegetation	High pressure hand wand	15 g a.c./ha	5 ha/d	266	Required personal protective equipment: Long sleeved shirt buttoned at the neck and wrist, long pants, socks and boots (or coveralls buttoned at the wrist and neck, socks and boots)

Crop/use	Application method	Application rate	Work rate	MOE† 	Comments
	Low pressure hand wand	15 g a.c./ha	5 ha/d	>1000	Required personal protective equipment: Chemical resistant gloves PLUS long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)

* Acceptable MOE ≥ 100 ; POD in rats is 0.1 mg/kg bw/day which was the NOAEL for inhibition of blood cholinesterases.

† Assumes a single professional operator mixes, loads and applies the product.

 The overall MOE accounts for both dermal and inhalation exposures.

2 OBJECTIVE 2

2.1 Conduct updated exposure assessments and risk characterisations for professional applicators who re-enter into chlorpyrifos-treated, child-accessible public spaces and domestic/residential areas

The details of the re-entry exposure assessments and risk characterisations, including the relevant transfer coefficients, are shown in Appendix 2. Re-entry interval modelling was performed using OPREC. The re-entry modelling does not include children (covered by Objective 3, below). The assumptions used were:

- a maximum acceptable re-entry interval of one day was applied to ensure drying of the applied material
- people do not swim in water bodies that have been treated with chlorpyrifos for mosquito control. For this reason re-entry intervals for chlorpyrifos treated water and surface waters were not calculated
- re-entry exposure was assumed to be via dermal exposure. Inhalation exposures under these circumstances were regarded as toxicologically negligible
- only the most exposure-intensive activities for each situation were evaluated (worst case scenario)
- mandatory minimum re-entry intervals for child-accessible public spaces were not regarded as a reliable risk management approach
- multiple re-entries into chlorpyrifos treated, child-accessible public spaces were assumed to occur. Accordingly the most appropriate human health based guidance value for these circumstances was the ADI. This approach is supported by the variable, and potentially long, half-life of chlorpyrifos in some soil types and on non-sun exposed surfaces (NRAAVC 2000)
- all the assumptions made in the Objective 1 evaluations, where scientifically appropriate.
- Based on the outcomes of Objective 1 no spray applications except mosquito control uses were considered acceptable for the child accessible domestic and public space uses with application by back pack, low pressure hand wand or high pressure hand wand.

The results of the assessments based on OPREC are shown in Table 3. Based on these results the only acceptable and practical use was the use of chlorpyrifos for mosquito adult/larvae control in vegetation. However based on APVMA Toddler on Turf modelling this use presents an unacceptable re-entry risk for children (MOE >100).

Table 3: Re-entry risk characterisation based on OPREC

Crop/use	Minimum re-entry interval required to achieve MOE > 100	Comments
<p>Child-accessible domestic and child-accessible public space uses (professional use)</p> <p>Container plants</p> <p>Domestic areas</p> <p>Domestic uses</p> <p>Duboisia (in domestic and public space uses)</p> <p>Exterior or outdoor areas of domestic buildings</p> <p>Fences</p> <p>Garden beds</p> <p>Garden paths</p> <p>Gardens</p> <p>In and around houses and domestic buildings</p> <p>Macrocarpa hedges (in domestic and public space uses)</p> <p>Potted ornamentals and other potted plants</p> <p>Public places</p> <p>Public service areas</p> <p>Rockeries</p> <p>Tennis courts</p> <p>Uses on turf and/or lawns to which children have access</p>	<p>2–34 days depending on plant height, plant foliage density and activity undertaken</p>	<p>A re-entry requirement in child accessible spaces is regarded as impractical, unreliable and unenforceable.</p>
<p>Professional use products</p> <p>Mosquito adult/larvae control in vegetation</p>	<p>0 days</p>	<p>The use is considered to be practical based on re-entry criteria.</p> <p><i>Note: re-entry exposures to children are not acceptable based on APVMA Toddler on Turf (MOE < 100).</i></p>

3 OBJECTIVE 3

3.1 Conduct exposure assessments and risk characterisations for the non-professional uses of chlorpyrifos in child-accessible residential settings

The details of the exposure assessment and risk characterisation are presented in Appendix 3. The assumptions used were:

- non-professional user exposure(s) were assumed to occur occasionally (minimum two chlorpyrifos applications to a maximum of three chlorpyrifos applications per year, with each exposure incident being toxicologically equivalent to an acute exposure incident with no more than one application per month). Accordingly the ARfD was regarded as the most appropriate human health based guidance value for assessment of mixing, loading and application. The relevant POD was 0.1 mg/kg bw/day which was the NOAEL for inhibition of erythrocyte cholinesterase in humans treated with a single oral dose of chlorpyrifos. A MOE of $10 \times 10^{0.5}$ (rounded to 32) was applied to account for intra-species and other uncertainties (APVMA 2019)
- multiple re-entries into chlorpyrifos treated, child-accessible domestic/residential spaces were assumed to occur. As discussed above the most appropriate human health based guidance value for these circumstances was regarded as being the ADI
- where product labels only specified application to a small area (ie a garden, a rockery, or a potted plant) the evaluation assumed that the final application rate on a per unit area basis was ≥ 250 g a.c./ha
- apart from gloves, personal protective equipment was not regarded as a reliable risk management approach for non-professional residential users. This was due to concerns regarding compliance
- post-application re-entry intervals were not regarded as a reliable risk management approach for non-professional residential users due to concerns regarding compliance. Re-entry was assumed to occur on day 0 following application and drying of the applied material
- chlorpyrifos was only applied by people aged 16 years or older (regarded as adults)
- consistent with APVMA's current data on chlorpyrifos use in Australia, the evaluations also assumed that 100 per cent closed systems were not used during the mixing and loading processes
- the exposure assessments and risk characterisations assumed that there were 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)
- the exposure assessments and risk characterisations assumed that there will only one single use type per operator per occasional application instance.

Non-professional residential chlorpyrifos use exposures associated with mixing, loading and application were modelled using OPHEC or the US EPA Standard Operating Procedures for Residential Pesticide Exposure Assessment 2012 (for hose-end spraying only). Re-entry exposure modelling was conducted using the APVMA Toddler on Turf model (Appendix 4). Based on the outcomes of the exposure assessments and risk characterisations there were no acceptable residential (non-professional) chlorpyrifos uses. In most cases this was due to the risks associated with access to chlorpyrifos treated areas by children. In the opinion of APVMA these risks in residential and domestic areas cannot be adequately mitigated.

4 CONCLUSIONS

Based on the criteria stipulated in section 5A of the *Agricultural and Veterinary Chemicals Code Act 1994*, the key overall outcome of the exposure assessments and risk characterisations (based on the data currently available to APVMA) is that there were no acceptable child-accessible domestic, residential and public space chlorpyrifos uses. Accordingly the following domestic, residential and public spaces uses of chlorpyrifos should be discontinued:

- container plants
- domestic areas
- domestic uses
- duboisia (in domestic and public space uses)
- exterior or outdoor areas of domestic buildings
- fences
- garden beds
- garden paths
- gardens
- in and around houses and domestic buildings
- macrocarpa hedges (in domestic and public space uses)
- potted ornamentals and other potted plants
- public places
- public service areas
- rockeries
- tennis courts
- uses on turf and/or lawns to which children have access
- mosquito adult/larvae control in vegetation.

The practical application of the above conclusions means that all home garden and domestic pest-control products containing ≤ 50 g/kg or L chlorpyrifos; and products with domestic and certain non-agricultural uses (that are mentioned above) containing > 50 g/kg or L chlorpyrifos are not supported.

The continued use of chlorpyrifos as a mosquito control agent in non-child accessible domestic, residential and public space water bodies is possible **provided that children do not play in or around the treated body of water or swim in the treated body of water**. Further exposure assessments and risk characterisations of child-accessible, chlorpyrifos-treated recreational water bodies are required to ensure adequate public health protection.



Appendixes

APPENDIX 1

Risk characterisation of professional use of chlorpyrifos in public spaces based on OPHEC

In all OPHEC scenarios considered in this appendix, the combined Mixing/Loading/Applicator scenario is modelled. Scenarios considered are for professional operators (including agricultural workers) and include additional PPE where necessary. The acceptable MOE is ≥ 100 fold the point of departure. Shaded cells indicate an unacceptable MOE.

Table 4: Risk characterisation of professional use of chlorpyrifos in public spaces based on OPHEC

Use	Application method	App rate (ac per ha)	Work rate	Clothing and personal protective equipment	MOE
Mosquito adult/larvae in water bodies	Backpack (all spray formulations)	10g a.c./100 kL	50 kL/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	591
	High pressure hand wand (liquid formulations taken to cover EC and SC)	10g a.c./100 kL	20 kL/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	>1000
	Low pressure hand wand (liquid formulations taken to cover EC and SC)	10g a.c./100 kL	20 kL/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	123
	Backpack (all spray formulations)	15g a.c./ha	1 ha/d	Chemical resistant gloves, boots, socks and a double layer of chemical resistant clothing	92

Use	Application method	App rate (ac per ha)	Work rate	Clothing and personal protective equipment	MOE
Mosquito adult/larvae in vegetation*	High pressure hand wand (liquid formulations taken to cover EC and SC)	15g a.c./ha	5 ha/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	266
	Low pressure hand wand (liquid formulations taken to cover EC and SC)	15g a.c./ha	5 ha/d	Chemical resistant gloves PLUS long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	>1000
Child-accessible domestic and child-accessible public space uses	Belly grinder (granules)	1 kg a.c./ha	1000 m2/d	No acceptable clothing and personal protective equipment combinations	≤70 for all available PPE combinations
Container plants Domestic areas Domestic uses Duboisia	Belly grinder (granules)	2 kg a.c./ha	2000 m2/d	No acceptable clothing and personal protective equipment combinations	≤35 for all available PPE combinations
Exterior or outdoor areas of domestic buildings	Push type spreader (granules)	1 kg a.c./ha	2000 m2/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	526
Fences Garden beds	Push type spreader (granules)	2 kg a.c./ha	2000 m2/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	263
Garden paths Gardens	Push type spreader (granules)	4 kg a.c./ha	2000 m2/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	132

Use	Application method	App rate (ac per ha)	Work rate	Clothing and personal protective equipment	MOE
In and around houses and domestic buildings	Mechanical (open cab, tractor drawn) spreader (granules)	1 kg a.c./ha	5 ha/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	326
Macrocarpa hedges	Mechanical (open cab, tractor drawn) spreader (granules)	2 kg a.c./ha	5 ha/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	163
Potted ornamentals and other potted plants	Mechanical (open cab, tractor drawn) spreader (granules)	4kg a.c./ha	5 ha/d	Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	82
Public places Public service areas	Mechanical (open cab, tractor drawn) spreader (granules)				
Rockerries					≤ 63 for all available PPE combinations
Tennis courts	Low pressure hand wand	350g a.c./ha	3 ha/d	No acceptable clothing and personal protective equipment combinations	
Uses on turf and/or lawns to which children have access	High pressure hand wand	350g a.c./ha	3 ha/d	No acceptable clothing and personal protective equipment combinations	≤ 52 for all available PPE combinations
	Backpack	350g a.c./ha	0.2 ha/d	No acceptable clothing and personal protective equipment combinations	≤ 21 for all available PPE combinations

Scenarios considered are for professional operators (including agricultural workers) and include additional PPE where necessary.

Acceptable MOE = 100 (animal NOAEL).

** These assessments were completed using "Broadcast (foliar)" exposure values, which are expressed in terms of litres of solution handled as per PHED (2018). The calculations were established based on the application rate in g a.c./ha and the work rate so that the volume of solution handled equated in the same level of active constituent exposure.*

APPENDIX 2

Risk characterisation of re-entry following professional use of chlorpyrifos in public spaces based on OPREC

Table 5: Risk characterisation of professional use of chlorpyrifos in public spaces: re-entry using OPREC

Use	App rate a.c./ha#	IFR level µg/cm ²	Scenario		Activity*	TC* cm ² /h	Minimum re-entry interval required to achieve MOE > 100	
			Height	Density				
Child-accessible domestic and child-accessible public space uses	2 kg	5.0	High	Full	Irrigation HS	1900	34 days	
Container plants			Low to high	Full	Tying/training, scouting	1100	28 days	
Domestic areas			Low	Minimum	Transplanting	230	14 days	
Domestic uses			Low	Minimum to full	Scouting	210	13 days	
Duboisia								
Exterior or outdoor areas of domestic buildings								
Fences								
Garden beds								

Use	App rate a.c./ha#	IFR level µg/cm ²	Scenario		Activity*	TC* cm ² /h	Minimum re-entry interval required to achieve MOE > 100
			Height	Density			
Garden paths							
Gardens							
In and around houses and domestic buildings							
Macrocarpa hedges							
Potted ornamentals and other potted plants			Low to high	Full	Weeding, pruning	70	2 days
Public places							
Public service areas							
Rockerries							
Tennis courts							
Uses on turf and/or lawns to which children have access							
Mosquito adult/larvae control in vegetation	15 g	0.038	Low to high	Minimum to full	Scouting	1100	0 days

HS: Handset (hose & manual sprinkler); TC: Transfer coefficient.

IFR: Initial foliar residue, # Application rates are for foliar application by spraying unless otherwise stated; *Only the most exposure-intensive activities are shown.

APPENDIX 3

Risk characterisation of non-professional use of chlorpyrifos in domestic/residential spaces using OPHEC

In all OPHEC scenarios considered in this appendix, the combined Mixing/Loading/Applicator scenario is modelled. The acceptable MOE is ≥ 32 fold the point of departure. Shaded cells indicate an unacceptable MOE.

Table 6: Risk characterisation of non-professional use of chlorpyrifos in domestic/residential spaces using OPHEC

Uses/host	App method‡	App rate (g a.c. per ha or m ² or per L spray)	Work rate	Clothing and personal protective equipment	MOE†
Home and garden (outdoor)	Backpack	25g a.c./10L	10 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	17
	Low pressure hand wand	25g a.c./10L	10 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	10
Gardens (potted ornamentals) (cover spray)	Backpack	20g a.c./100L	50 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	41
	Low pressure hand wand	20g a.c./100L	50 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	24
Gardens (beds/pots/rockeries)	Hand dispersal (granules)	0.2g a.c./m ²	100 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	34

Uses/host	App method‡	App rate (g a.c. per ha or m ² or per L spray)	Work rate	Clothing and personal protective equipment	MOE†
	Hand dispersal (granules)	0.4g a.c./m ²	100 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	17
	Belly grinder (granules)	0.2g a.c./m ²	200 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	169
	Push spreader (granules)	0.2g a.c./m ²	200 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	2635
	Hand dispersal (granules)	0.2g a.c./m ²	200 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	17
Lawn/turf	Hose end sprayer*	4g a.c./10 m ²	200 m ² /d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	22
	Backpack	350g a.c./ha	0.2 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	6
	High pressure hand wand	350g a.c./ha	0.2 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	301
	High pressure hand wand	450g a.c./ha	0.2 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	235

Uses/host	App method‡	App rate (g a.c. per ha or m2 or per L spray)	Work rate	Clothing and personal protective equipment	MOE†
	High pressure hand wand	4000g a.c./ha	0.02 ha/d (min)	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	264
	Low pressure hand wand	350g a.c./ha	0.2 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	4
	Backpack	250g a.c./ha	0.02 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	83
Hedges	Low pressure hand wand	250g a.c./ha	0.02 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	49
	Low pressure hand wand	450g a.c./ha	0.02 ha/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	27
Termite nests	Backpack (Spot treatment)	50g a.c./10L	10 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	59
	Low pressure hand wand	50g a.c./10L	10 L/d	Gloves PLUS Long sleeved shirt buttoned at the wrist and collar plus long pants plus boots and socks (or coveralls buttoned at the neck and wrist plus boots)	5

† acceptable MOE is 32.

‡ formulations are liquid emulsifiable concentrates unless stated otherwise.

* based on US EPA Standard Operating Procedures for Residential Pesticide Exposure Assessment 2012 method

Table 7: APVMA Toddler on Turf day 0 post-application margin of exposure estimates

Application rate (g a.c./ha)	Maximum number of applications/months	Maximum number of applications/year	Total (dermal + oral) mean margin of exposure day 0 post application (after drying)*	
			1-2 years of age	2-3 years of age
≥ 250	1	≥ 2	1	2

*acceptable margin of exposure is 100.

APPENDIX 4

APVMA Toddler on Turf model and input parameters for chlorpyrifos

In the absence of post-application residue and/or exposure studies, the following calculations have been made for exposure to children playing on treated lawn areas, using the Toddler on Turf algorithm. Exposure estimations have been performed for infants (< two year old) and toddlers (two to three year old), using the formula below:

$$E_{(\text{Total}/\text{dayN})} = \left[\frac{\overbrace{([\text{AR} \times (1-\text{DRn})^{\text{dayN}}] \times [\text{DepR} \times \text{Ac}] \times \text{TC} \times \text{ET} \times \text{DA})}^{\text{Dermal}}}{\text{BW}} + \frac{\overbrace{([\text{AR} \times (1-\text{DRn})^{\text{dayN}}] \times [\text{DepR} \times \text{Ac}] \times \text{SAo} \times \text{FQ} \times \text{ET} \times \text{B})}^{\text{Oral}}}{\text{BW}} \right]$$

Where:

AR (Application rate); **B** (oral bioavailability): The oral bioavailability data for the active constituent chlorpyrifos is a factor of 0.77 (ie 77 per cent gastrointestinal absorption).

BW (Bodyweight): One to two year olds = 11 kg, two to three year olds = 15 kg; **DA** (product-specific dermal absorption factor [fraction]): 10 per cent for diluted product (ie 0.10).

DepR (Deposited Residue [fraction]) *and* **Ac** (Accessibility factor [fraction])—together, these factors constitute a transferable residue factor. The default for the accessibility of organics on surfaces is 100 per cent (1.0), and 0.01 per cent (0.0001) for inorganics. For turf, a transferable residue factor (**DepR x Ac**) of five per cent was applied. The default is five per cent (0.05) for all formulation and application types.

DRn (Nominal dissipation/ degradation rate per day) expressed as [fraction]: in the absence of product-specific data to estimate a data-derived nominal dissipation rate, the default 'actual' product-specific dissipation/degradation rate for residues on surfaces (indoors and outdoors) is only equal to the levels lost from transfer to occupants (ie transferred to skin). **For turf**, the default nominal value for dissipation/degradation rate per day is 10 per cent (0.1). This value has been maintained as the default in the absence of additional data. As this default is a conservative factor based on the physical process of blade-growth and subsequent mowing and/or blade turnover, selecting longer dissipation rates (eg due to long environmental half-lives) is inappropriate for estimating post-application exposures to residues on turf. In the cases where a long

environmental half-life for an active constituent (ideally from studies where it was a component of the formulation) has been identified, estimating repeated exposure from soil ingestion of 50 mg soil/day.

ET (Exposure time/duration of mouthing per day): For time spent playing on turf, the default mean values are 1.1h [95th percentile of two hours] and 1h [95th percentile of two hours] for infants (< two) and toddlers (two to three), respectively; **FQ** (Mouthing Frequency): the default mouthing frequency values in outdoor settings are 14/5 contacts per hour for < two/two to three-year olds, respectively.

SAo (Surface area potentially exposed from mouthing activities): The value of 19 cm² per event is used for area mouthed per mouthing event.

TC (Transfer Coefficient): for turf the default dermal TC values for children playing on treated turf are:

- two to three-year olds = 60,000 cm²/h
- one to two-year olds = 49,000 cm²/h.

Values for two to three-year olds are estimated from extrapolating the value to < two-year olds based on a 1.23-fold lower exposed surface area.

Dermal NOAEL: Nil (No suitable study available); **Oral NOAEL:** A NOAEL of 0.1 mg/kg bw/d was selected from a rat study. A MOE of exposure was regarded as acceptable. A dermal absorption factor of three per cent (0.03) was used for route-to-route extrapolation.

REFERENCES

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