Re-evaluation Note REV2018-01

Special Review of Dichlorvos and Its Associated End-use Products: Proposed Decision for Consultation

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1.0 Introduction

Pursuant to subsection 17(2) of the *Pest Control Products Act*, Health Canada's Pest Management Regulatory Agency (PMRA) initiated a special review of pest control products containing dichlorvos, based on the 2007 and 2012 European Union regulatory decisions. The initiation of the special review of dichlorvos was announced in December 2013 (Canada, 2013).

Pursuant to subsection 18(4) of the *Pest Control Products Act*, the PMRA has evaluated the aspects of concern that prompted the special review of dichlorvos. The aspects of concern are relevant to human health (potential carcinogenicity of dichlorvos and potential occupational and residential risks) and the environment (potential risk to non-target organisms).

2.0 Uses of Dichlorvos in Canada

Dichlorvos is a broad spectrum, organophosphate insecticide used for the control of various insect pests (for example, mosquitoes, gnats, flies) in a number of sites (outdoor, greenhouse, indoor). Outdoor sites include outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking areas, and other areas around buildings. Greenhouse uses include food (cucumber and tomato) and non-food (ornamentals) uses. Other registered uses include indoor and outdoor structural sites (such as animal houses/barns, warehouses, processing plants, storage facilities, and outdoor recreational areas).

Dichlorvos end use products are formulated as a liquid (emulsifiable concentrate and solution) or slow-release generator (pest strip). The liquid products are applied indoors by handheld sprayers, automatic sprayers, or ultra-low volume applicators (automatic foggers). The liquid products can also be applied outdoors by ground equipment (mechanical fogger or ultra-low volume applicator, handheld sprayer). The commercial pest strips are placed into insect traps by hand (with gloves), which are placed in vegetable and fruit crops outdoors. There is also a registered ready-to-use domestic product, formulated as pest strip (package contains one resin vaporizer strip impregnated with dichlorvos in a foil-lined and sealed pouch). The users remove the strip from the pouch and suspend the strip with the accompanying hook in enclosed spaces to be treated. All registered pest control products containing dichlorvos (Appendix I) are considered for the special review.

Dichlorvos is currently under re-evaluation in Canada. The PMRA published the proposed re-evaluation decision for dichlorvos in October 2017 (PRVD2017-16).

3.0 Aspects of Concern that Prompted the Special Review

Dichlorvos was registered in the European Union Member States for use as a plant protection product (fogging during indoor flower bulb storage; no food uses) and as a biocide (pest strips in cupboards, non-occupied rooms, barns). These uses were re-evaluated, and based on the assessment, uses of dichlorvos were not approved in the European Union.

For the plant protection product use, the European Commission in 2007 (European Commission, 2007) indicated that "the information available is insufficient to satisfy the requirements set out in Annex II and Annex III Directive 91/414/EEC in particular with regard to

- *Lack of data on toxicity of breakdown products*
- *A finalised assessment of operators, workers and bystanders exposure"*,

and noted that "the risk assessment is inconclusive due to the uncertainties of the genotoxic and carcinogenic properties of the substance". Based on this, all uses of dichlorvos as plant protection product were not authorized in the European Union. The PIC Circular (Rotterdam Convention, 2011) also indicated similar information. As European Commission (2007) indicated that the available information was insufficient and the risk assessment was inconclusive, conclusions from this decision were not considered as aspects of concern.

However, as part of the special review, the PMRA considered the European Decision (2012) on biocide use (pest strips) based on the review by the European Chemical Agency (ECHA, 2011). The review indicated that "The scenarios evaluated in the human health risk assessment, as well as in the environmental risk assessment, showed a potential and unacceptable risk". The review also noted that dichlorvos "may exert its own toxicity through a non-threshold or a threshold carcinogenic mechanism", and indicated non-cancer risk of concern for certain exposure scenarios (for example, potential post-application inhalation exposure in treated warehouses/storage, animal buildings, and in treated cupboards). Based on this, all biocide uses of dichlorvos were not authorized in the European Union. ECHA did not conduct a dietary risk assessment from indirect exposure of the biocide uses of dichlorvos.

Based on a review of the European Commission (2012) decision, the PMRA has identified the following aspects of concern that prompted the special review:

- Human Health
  - Potential carcinogenicity of dichlorvos
  - Potential occupational and residential risks

- Environment
  - Potential risk to non-target organisms

4.0 PMRA Evaluation of the Aspects of Concern that Prompted the Special Review

Following the initiation of the special review, the PMRA requested information related to the aspects of concern from provinces and other relevant federal government departments and agencies in accordance with the subsection 18(2) of the *Pest Control Products Act*.

In order to evaluate the aspects of concern for dichlorvos, the PMRA considered currently available relevant scientific information, which includes information considered for the re-evaluation of dichlorvos (Canada, 2017), information on the toxicity of dichlorvos, information from the European Commission decisions, and any relevant information obtained since then (for example, information from the Canadian incident report database).

4.1 Potential Carcinogenicity of Dichlorvos

As part of the assessment, the PMRA considered available genotoxicity, carcinogenicity and epidemiological studies (Canada 2017). Within the genotoxicity database, dichlorvos was mutagenic in numerous bacterial assays. Positive results were also observed in in vitro mammalian mutagenicity assays. These assays included DNA strand break, viral transformation and gene mutation assays. In vitro mammalian clastogenicity assays, including sister chromatid exchange and chromosomal aberrations, also produced positive results. An in vitro micronucleus assay demonstrated aneuploidy with dichlorvos exposure. An in vitro unscheduled DNA synthesis assay gave conflicting results. In summary, dichlorvos was considered an in vitro mutagen and clastogen.

In vivo mutagenicity and clastogenicity assays in mammals were generally negative, although positive results were obtained in some in vivo genotoxicity studies. These positive in vivo results were obtained in a sister chromatid exchange assay, a micronucleus test, a supplemental Comet assay for DNA damage as well as DNA damage and crossover recombination in Drosophila melanogaster. Another positive result was obtained in a supplemental in vivo micronucleus test in mouse keratinocytes when dichlorvos was dermally administered. In in vivo mammalian studies, dichlorvos produced some positive results, though the weight of evidence suggests that it is neither mutagenic nor clastogenic in vivo.

Published in vitro and in vivo literature studies investigated the potential of dichlorvos to induce low levels of DNA alkylation in mice and rats. Based on the results of these studies, it was determined that dichlorvos has a weak potential to induce low levels of DNA alkylation in rodents which could result in damage to DNA.

The potential carcinogenicity of dichlorvos has been extensively studied. Most studies have deficiencies and therefore were not used for the re-evaluation. This re-evaluation relied on the 2-year gavage National Toxicology Program (NTP) studies in both the rat and mouse while a non-NTP 2-year rat inhalation study was considered supplemental.

In a 2-year gavage study in the mouse, a dose-related increase in forestomach squamous cell carcinoma and/or papilloma was observed in males and females. Conclusions regarding the toxicological relevance of these carcinogenicity findings were difficult to reach for several reasons. Repeated bolus administration of dichlorvos would result in high sustained concentrations of dichlorvos in the mouse forestomach. Although humans have no organ similar to the forestomach, it is uncertain whether the rapid transit of dichlorvos through the human esophagus would result in sustained tissue levels prior to dichlorvos breakdown.

The use of a corn oil vehicle may have impacted the toxicokinetics of dichlorvos as well as the lipid nutritional profile, thereby further confounding the results. A further limitation of this study was that only two dose groups were tested, thus making it difficult to identify true dose-response relationships.

Although arguments have been advanced that the irritating properties of dichlorvos may have contributed to the induction of these forestomach tumours, it is worth noting that no increases in other non-proliferative lesions (for instance erosions and thinning of gastric lining) were observed. The registrant suggested that dichlorvos had a similar mode of action (MOA) as butylated hydroxyanisole, a non-genotoxic promotor of forestomach tumours, which causes focal hyperplasia and induced replicative DNA synthesis. The MOA was unsubstantiated because no increase in focal hyperplasia of the stomach was observed in the dichlorvos mouse study. It is possible that the chronic effects of dichlorvos on mouse forestomach epithelium in the oral gavage bioassay were mediated via enhanced cell proliferation rather than by a genotoxic mechanism, but the evidence for this was inconclusive.

The 2-year gavage study in the F344 rat suffered from limitations similar to those identified in the mouse study (that is, use of a corn oil vehicle and only two dose groups). Equivocal treatment-related findings in the study included increased incidences of alveolar/bronchiolar adenoma in males, mammary fibroadenoma, adenoma and carcinoma in females and leukemia (lymphocytic, monocytic, mononuclear or undifferentiated) in males. The incidence of pulmonary tumours in males was statistically significant for trend analysis, but not statistically significant in pairwise comparison. The response for combined mammary tumours was also unclear as it lacked a classical dose-response pattern, was statistically significant in pair-wise analysis at the low-dose only, and fell within the historical control incidence of the testing laboratory.

The observed mononuclear cell leukemia (MCL) incidence was statistically significant in trend and pairwise comparisons. However, the incidence of MCL fell within the historical control range of the testing laboratory and was less than the maximum incidence of the historical controls from the NTP. Additionally, dichlorvos did not alter the latency to MCL development. Furthermore, the higher incidence of MCL in treated groups did not result in higher mortality, which generally would be expected since MCL is a rapidly progressive and uniformly fatal tumour. In an experimental MCL transplant study, dichlorvos was shown to accelerate the progress of MCL in MCL-inoculated animals; however, this study method has not been validated. Long-term studies in rats involving trichlorfon, which is metabolized to the biologically active metabolite dichlorvos, did not result in elevated incidences of MCL, though trichlorfon did increase the incidence of other tumour types at excessive doses (PRVD 2008-14, *Trichlorfon*).

An increased incidence of pancreatic exocrine tumours in male rats in the 2-year gavage study was the most robust carcinogenic response as it was statistically significant in trend and pairwise comparisons and exceeded the range of historical control data for the performing laboratory. Since corn oil has been shown to increase the rate of proliferative pancreatic lesions in male F344 rats, comparison to control data with corn oil vehicle was considered appropriate. However, even the control incidence for pancreatic tumours in males was high, exceeding the mean (but

not the range) of the corn oil vehicle historical control data for both the testing laboratory and the NTP. A dose-related increase in pancreatic exocrine tumours was also seen in females. Though this increase in females was not statistically significant, the incidence in the high-dose group exceeded the range of the corn oil vehicle historical control data for both the testing laboratory and the NTP.

A 2-year inhalation study with dichlorvos revealed no evidence of carcinogenicity in rats. This study had numerous limitations such as whole-body exposure, uncertainties regarding achieved dose (exposure from contamination of food, drinking water, dermal contact and grooming), the number of tissues examined was limited or not stated, low survival in male control animals and a lack of report details. Therefore, this study was considered to provide supplementary information for the re-evaluation of dichlorvos.

In summary, the PMRA concluded that the available evidence is insufficient to rule out the possibility that dichlorvos may be carcinogenic. Although available cancer studies have limitations, the risk assessment has an adequate margin to protect against these effects by ensuring that the level of exposure to humans is well below the lowest dose that resulted in tumours in test animals.

The PMRA also considered available epidemiology studies (Canada, 2017) investigating the association between dichlorvos exposure and cancer development (including prostate cancer, lymphohematopoietic cancer, and childhood cancer). Overall, the findings in the epidemiological studies were often limited by small numbers, self-reporting and/or the lack of reproducibility. The lack of reliable characterization of exposure was considered an important weakness in most studies. Of the positive associations noted, most showed a weak response. In conclusion, the available epidemiology data for dichlorvos did not further inform the current risk assessment.

The results of extensive investigations of the genotoxicity of dichlorvos indicate that it is an in vitro mutagen and clastogen. In in vivo mammalian studies, dichlorvos produced some positive results; however, the overall weight of evidence suggested that it is neither mutagenic nor clastogenic in vivo. The potential carcinogenicity of dichlorvos has been extensively studied; however, the available evidence is insufficient to rule out the possibility that dichlorvos may be carcinogenic. Although available cancer studies have limitations, there is a large margin (~40,000) between the proposed reference values for repeat-exposure and the lowest dose resulting in tumours in the available dichlorvos studies. In view of this, additional cancer studies are not required at this time, nor will an additional database factor be applied in the risk assessment.

4.2 Potential Occupational and Residential Risk

Toxicology Endpoint Selection for Occupational and Residential Risk Assessment

Dermal Exposure

For short-, intermediate- and long-term dermal exposure, there were no suitable repeat-dose dermal toxicity studies upon which to base the risk assessment for dichlorvos. An 8-day dermal cholinesterase inhibition study in the guinea pig was considered supplemental due to the lack of details on the application method and the histopathological examination. A 117-day dermal cholinesterase inhibition study in the rat was also insufficient as animals were dosed only once every 72 hours and a 10-day dermal study in the monkey was outdated and did not establish a no observed adverse effect level (NOAEL). In the absence of a suitable dermal study, the 7-day repeat-dose oral cholinesterase inhibition study in neonatal and young adult rats was deemed appropriate for this endpoint. A benchmark dose lower confidence limit ($BMDL_{10}$) of 0.011 mg/kg bw/day was derived for brain cholinesterase inhibition in males from this study. Standard uncertainty factors of 10-fold for intraspecies variability and 10-fold for interspecies extrapolation were applied resulting in a target MOE of 100. For residential scenarios the *Pest Control Products Act* factor was reduced to 1-fold as discussed in the *Pest Control Products Act* Hazard Characterization section below.

Inhalation Exposure

For short-, intermediate- and long-term inhalation exposure, there were no suitable repeat-dose inhalation toxicity studies upon which to base the risk assessment. Inhalation developmental toxicity studies in the rat and rabbit were considered supplemental based on numerous conduct and reporting deficiencies. A 90-day inhalation study in the monkey was only available as a draft document and was therefore considered supplemental. In the absence of a suitable inhalation study, the 7-day repeat-dose oral cholinesterase inhibition study in neonatal and young adult rats was deemed appropriate for these scenarios. A $BMDL_{10}$ of 0.011 mg/kg bw/day was derived for brain cholinesterase inhibition in males from this study. Standard uncertainty factors of 10-fold for intraspecies variability and 10-fold for interspecies extrapolation were applied resulting in a target MOE of 100. For residential scenarios the *Pest Control Products Act* factor was reduced to 1-fold as discussed in the *Pest Control Products Act* Hazard Characterization section below.

Non-Dietary Incidental Oral Exposure

For short-term incidental oral exposure, the most suitable study was the 7-day repeat-dose oral cholinesterase inhibition study in neonatal and young adult rats. A $BMDL_{10}$ of 0.011 mg/kg bw/day was derived for brain cholinesterase inhibition in males in this study. Standard uncertainty factors of 10-fold for intraspecies variability and 10-fold for interspecies extrapolation were applied resulting in a target MOE of 100. For residential scenarios, the *Pest Control Products Act* factor was reduced to 1-fold as discussed in the *Pest Control Products Act* Hazard Characterization section.

Dermal Absorption

A dermal absorption value of 30% was used for dichlorvos based on a chemical-specific *in vivo* dermal absorption study.

***Pest Control Products Act* Factor**

For assessing risks from potential residues in food or from products used in or around homes or schools, the *Pest Control Products Act* requires the application of an additional 10-fold factor to threshold effects to take into account completeness of the data with respect to the exposure of, and toxicity to, infants and children, and potential prenatal and postnatal toxicity. A different factor may be determined to be appropriate on the basis of reliable scientific data.

With respect to the completeness of the toxicity database as it pertains to the toxicity to infants and children, extensive data were available for dichlorvos. The database contains a 2-generation reproductive toxicity study in rats, oral developmental toxicity studies in mice (supplemental), rats and rabbits, as well as supplemental inhalation developmental toxicity studies in rats and rabbits. A series of developmental neurotoxicity studies and comparative cholinesterase inhibition studies in rats were also available. Overall, the database for dichlorvos was considered adequate for determining potential sensitivity of the young. With respect to potential pre- and post-natal toxicity, no evidence of sensitivity of the young was noted in guideline studies. Slightly decreased mean pup weight and pup survival were noted in the offspring in the rat reproductive toxicity study at a dose level higher than that which resulted in inhibition of cholinesterase activity in parental animals. In rats, mice and rabbits, no evidence of teratogenicity or fetal sensitivity was noted in any of the developmental toxicity studies. Fetal effects, when present, were limited to reductions in body weight. Rats were exposed to dichlorvos in a series of acute and repeat-dose cholinesterase inhibition studies. The results of benchmark dose analyses for the acute studies revealed no evidence of age-related sensitivity for young (PND 8, PND 15 and PND 22) and adult rats. In the 7-day repeat-dose cholinesterase inhibition study, no evidence of age-related sensitivity was noted in males or females for brain cholinesterase inhibition or in males for erythrocyte cholinesterase inhibition; significant variation with respect to erythrocyte cholinesterase inhibition in females precluded a determination of age-related sensitivity. Overall, the available information did not demonstrate sensitivity of the young, and as a result, the *Pest Control Products Act* factor has been reduced to 1-fold for dichlorvos.

Appendix II lists toxicological endpoints used in occupational and residential risk assessment.

4.2.1 Potential Occupational Risks

Occupational risk is estimated by comparing potential exposures with the most relevant endpoint from toxicology studies to calculate an MOE. This is compared to a target MOE incorporating uncertainty factors protective of the most sensitive subpopulation. If the calculated MOE is less than the target MOE, it does not necessarily mean that exposure will result in adverse effects, but mitigation measures to reduce risk would be required.

There is potential for exposure to dichlorvos in occupational scenarios from workers handling dichlorvos products during the application process (e.g., mixing/loading liquid products and applying using handheld sprayers, mixing/loading liquid products for automatic application equipment, application of pest strips) and potential for postapplication exposure from workers entering areas previously treated with dichlorvos.

4.2.1.1 Mixers, loaders and Applicators Exposure

For commercial-class products, there are potential exposures to mixers, loaders and applicators (M/L/A) for spray solutions and for applicators of pest strips. Dichlorvos is used up to 2 times per week for as often as necessary for the liquid formulations. Exposure in indoor (greenhouse or structural uses) and outdoor environments is expected to be intermittent long-term (≥6 months) and short-to-intermediate-term (<6 months) in duration, respectively. The following scenarios were considered in the assessment:

- Mixing/loading of liquids for automatic application equipment in greenhouse tomatoes, greenhouse cucumbers, and greenhouse ornamentals; tobacco storage; dairies, piggeries, poultry houses, and barns; food processing plants, industrial plants, and warehouses; theaters; and for outdoor mosquito control.
- Mixing/loading and applying (M/L/A) using handheld sprayers (mechanically pressurized hand wand, backpack, manually pressurized hand wand, and backpack) for greenhouse tomato, greenhouse cucumbers, greenhouse ornamentals, sheds, stables, barns, loafing sheds, pigpens, outdoor areas, poultry barns, outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking and refuse areas, and other areas around buildings.
- M/L/A using truck mounted equipment for mosquito abatement.
- Application of impregnated pest strips for use in insecticidal traps in outdoor areas.

For the spray applications, the assessment indicated that the combined dermal and inhalation margin of exposure (MOE) for M/L/As exceeded the target MOE only when automated application equipment was used with an extra layer of personal protective equipment (chemical-resistant coveralls). In addition, for some uses, restrictions on the maximum amount handled per day (1.14 kg active ingredient per person) were required. The results of the mixer/loader and applicator assessment are presented in Appendix III, Table 1-3. Uses where automatic application equipment is not agronomically feasible, are proposed for cancellation including for outdoor mosquito control or outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking and refuse areas, and other areas around buildings.

Based on the use pattern, the commercial pest strips are placed into the insect traps by hand with gloves. As the strips only need to be replaced every 12 weeks, and the number of pest strips is limited around vegetable and fruit crops, occupational applicator exposure from use of pest strips in outdoor areas was expected to be minimal, and was not assessed quantitatively. Based on a qualitative assessment, the exposure is expected to be minimal and potential risk is not expected to be of concern.

4.2.1.2 Postapplication Worker Exposure

Potential occupational dermal and inhalation postapplication scenarios include workers entering the treated sites. Postapplication exposure was assumed to be intermittent long-term (>6 months) in duration for greenhouses and structural sites, and intermittent short-to-intermediate term in duration for outdoor pest strips in agricultural areas. Potential exposure doses for postapplication workers were assessed using the best available data, including chemical-specific dislodgeable

foliar residue (DFR) and air monitoring or modelling data (Canada 2017). Due to the high vapour pressure of dichlorvos, inhalation exposure is expected. The degree of dermal exposure would be dependent on the deposition of dichlorvos following spray application, the rate of volatilization, dissipation of dislodgeable residues and potential worker activities involving contact with treated surfaces. Using the endpoints, and dermal absorption value descripted in Section 4.2.1, the following postapplication exposure scenarios were assessed:

- Greenhouse cucumbers, tomatoes, and ornamentals
- Structural sites (tobacco storage, food processing plants, barns, industrial plants, theaters, and warehouses)
- Outdoor pest strips in insecticidal traps in agricultural areas

Greenhouse uses
Potential exposure to postapplication workers was estimated using updated activity-specific transfer coefficients (TCs), and chemical-specific dislodgeable foliar residue (DFR) and air monitoring data. The DFR refers to the amount of residue that can be dislodged or transferred from a surface, such as leaves of a plant. The TC is a measure of the relationship between exposure and DFRs for individuals engaged in a specific activity, and is calculated from data generated in field exposure studies. The TCs are specific to a given crop and activity combination (for example, harvesting cut flowers) and reflect standard agricultural work clothing worn by adult workers. Activity-specific TCs from the Agricultural Re-Entry Task Force (ARTF) were used. Postapplication exposure activities for agricultural crops include (but are not limited to): harvesting, pruning and scouting. For more information about estimating worker postapplication exposure, refer to PMRA's Regulatory Proposal PRO2014-02, *Updated Agricultural Transfer Coefficients for Assessing Occupational Postapplication Exposure to Pesticides*.

A chemical-specific study in greenhouses that measured dichlorvos DFR and air concentrations was used to assess postapplication dermal and inhalation exposure from activities in greenhouses producing cucumbers, tomatoes, and ornamentals. In this study, exposure to greenhouse workers was examined following application of dichlorvos using an automatic cold fog generator. Dichlorvos was applied to two greenhouses containing roses at a rate of 8.3 to 50 mg/m^3.

For workers entering a treated site, restricted-entry intervals (REIs) are calculated to determine the minimum length of time required before workers can safely enter after application to perform tasks involving hand labour. An REI is the duration of time that must elapse in order for air concentrations and residues to decline to a level at which there are no risks of concern for postapplication worker activities (for example, in the case of dichlorvos, performance of a specific activity that results in exposures above the target MOE of 100).

The calculated combined inhalation and dermal MOEs for agricultural worker postapplication exposure to dichlorvos in greenhouses exceeded target MOEs (Appendix IV, Table 1) with REIs ranging from 4 to 20 days. As REIs greater than 4 days are considered to be agronomically unfeasible, the PMRA proposes to cancel the use of dichlorvos in greenhouse cucumbers, tomatoes and cut flowers. For potted greenhouse ornamentals (non-cut flowers), risks are not of concern with a 4-day REI.

Structural sites (tobacco storage, food processing plants, barns, industrial plants, theaters, and warehouses)
Postapplication exposure estimates for individuals entering theaters and animal barns commercially treated with dichlorvos were based on an air model developed by the USEPA. The decay constant and initial air concentration used in the model were based on a chemical-specific food processing plant study described in the USEPA Revised Preliminary HED Risk Assessment for Dichlorvos (August, 2000) and a revision document (June, 2000). In the study, dichlorvos was applied at a rate of 25.8 mg a.i./m^3 by multiple wall-mounted fogging units and, in one area, a portable electric fogger.

The predominant route of postapplication exposure is expected to be inhalation due to the method of application and volatility of dichlorvos. Although dermal exposure is possible, since the results from the food processing study suggested that dermal exposure would be less than 3% of the total exposure and contact with potentially contaminated surfaces in structural sites is expected to be minimal, a quantitative dermal risk assessment was not conducted.

Calculated inhalation MOEs exceeds the target MOE with a REI of 4 days and following ventilation (Appendix IV, Table 2). Therefore, risks are not of concern from the use of dichlorvos in structural sites provided that worker entry occurs 4 days after application and full ventilation has occurred.

Outdoor Pest Strips in Agricultural Areas
Postapplication exposure following use of outdoor pest strips in insecticidal traps is expected to be minimal since the traps are usually placed in isolated areas and any dichlorvos released into the outdoor air would be expected to quickly dissipate. Therefore, the use of dichlorvos-impregnated pest strips in outdoor insecticidal traps in agricultural areas is not of concern.

4.2.2 Potential Residential Exposure

There is one domestic product registered. In addition, pest control products containing dichlorvos can be used in residential areas. Therefore, residential exposure could occur when the products are applied in residential areas or entering areas previously treated with dichlorvos.

4.2.2.1 Residential Applicator Exposure and Risk

The registered domestic product is a pest strip that may be used in garages, attics, crawl spaces, and sheds, occupied for less than 4 hours per day, or in areas that are continuously unoccupied for a minimum of 4 months. Each domestic product package contains one resin vaporizer strip impregnated with dichlorvos in a foil-lined and sealed pouch. The users remove the strip from the pouch and suspend the strip with the accompanying hook in an enclosed space to be treated.

Based on the use pattern and the current label directions, the potential residential applicator exposure from the use of the pest strips in residential areas is expected to be minimal, and the potential risk is not expected to be of concern.

4.2.2.2 Postapplication Exposure and Risk

Residential postapplication exposure occurs when an individual is exposed through dermal, inhalation and/or incidental oral (non-dietary ingestion) routes as a result of being in a residential environment that has been previously treated with a pesticide. Pesticide treatment could be by a residential applicator using a domestic-class product, or a commercial applicator applying in residential areas.

While exposure may occur for people of all ages, adults (≥16 years old), youth (11<16 years old), and children (1<2 years old), were chosen as the index life stages to assess, based on behavioural characteristics and the quality of the available data. Children 2 years old to < 11 years old are not assessed separately, for most scenarios, because their exposure is expected to be less than that of children 1 < 2 years old. Children (1<2 years) are expected to have a greater exposure because of additional routes of exposure (incidental oral) as well as a greater body surface area (cm^2) to body-weight (kg) ratio.

Postapplication residential exposure to dichlorvos is expected to be intermittent short-to-intermediate-term (up to 6 months) in duration, with the exception of indoor structural uses (that is, pest strips, theaters and animal barns) which is assumed to result in intermediate-to-long-term (1-12 months) exposure. The main route of postapplication exposure is expected to be via inhalation. Potential dermal exposure is expected to be negligible.

Pest strips

Postapplication exposure is expected from the use of impregnated pest strips in areas of the home that are occupied up to 4 hours a day, as well as, the use of pest strips in animal and other farm buildings, milk rooms, motels, restaurants, food processing plants (non-food areas only), industrial and commercial locations, kennels, garbage storage areas, and containers that are occupied up to 4 hours per day. Pest strips may also be used in cottages, cabins and trailers, in areas that are to be continuously unoccupied for a minimum of 4 months following placement of the strips; postapplication exposure from this use is expected to be minimal. Consequently, potential postapplication risks are not expected to be of concern (Canada, 2017).

Exposure estimates were based on a chemical-specific study submitted by the registrant. The objective of the study was to measure dichlorvos concentrations following use of the pest strip in a treated space (closet) and the room adjacent to the closet under the extremes of high and low environmental conditions of air exchange rate, temperature, and humidity. The study also measured weight loss from the pest strip, and transferable residues from deposition onto surfaces. The study conditions did not capture the Canadian use scenario exactly in that the pest strip used in the study was smaller than the pest strip registered in Canada (16 g versus 65 g, respectively), and the pest strip was placed in a closet in the study whereas the pest strip is used in garages, attics and crawl spaces in Canada. Nonetheless, as this is the best available data, the study results were used for the risk assessment. Mean air concentration values were selected based on the time weighted average mean air concentration data measurements in the adjacent room as well as the treated closet. The adjacent room data was selected to represent areas adjacent to rooms where the pest strip is placed (for example, bedroom above garage containing the pest strip). The closet data were selected to represent a scenario where the pest strip is placed in an open area, such as a

garage or an attic, where individuals may be directly exposed. It was assumed that exposure would be similar across use sites. Therefore, the postapplication exposure assessment is also considered to be representative of exposure to individuals present in commercial locations such as motels and restaurants.

Both inhalation and dermal exposures are possible; however, since the data indicated that the predominant route of exposure would be inhalation, a quantitative exposure assessment was conducted for the inhalation route only.

The calculated inhalation MOEs did not meet the target MOE for all age groups, and therefore, risks are of concern (see Appendix V, Table 1). The use of impregnated pest strips in inhabited homes, and in commercial locations, such as animal and other farm buildings, milk rooms, motels, restaurants, food-processing plants, industrial and commercial locations, kennels, garbage storage areas and containers, and similar enclosed spaces, are proposed for cancellation. Since exposure from the use of pest strips in structures (for example, cottages, cabins and trailers) continuously unoccupied for at least 4 months following placement of the pest strips is considered to be minimal, risks are not of concern for this scenario.

Outdoor Mosquito Control in Residential Areas

Postapplication exposure estimates for individuals entering an area that had been previously treated with dichlorvos were generated using the USEPA Standard Operating Procedures (SOPs) (2012). The USEPA has generated standard default assumptions for developing residential exposure assessments for both applicator and postapplication exposures when chemical- and/or site-specific field data are limited. The assumptions and algorithms may be used in the absence of, or as a supplement to, chemical- and/or site-specific data, and generally result in high-end estimates of exposure. The assumptions and algorithms relevant to the dichlorvos re-evaluation are outlined in the SOPs for Residential Pesticide Exposure Assessments 2012, under “Section 5: Outdoor Fogging/Misting Systems”.

Multiple applications were not assessed for outdoor aerosol space sprays and outdoor residential misting systems, since exposure on the day of application without any dissipation was assumed for the entire duration of exposure (for several months). This is considered to be a highly conservative assumption (that is, resulting in upper bound exposure estimates), when combined with the other exposure inputs in the Residential SOPs.

Both inhalation and dermal exposures are possible. The predominant route of exposure is expected to be inhalation due to the method of application and volatility of dichlorvos.

The calculated inhalation MOEs did not meet the target MOE for all age groups, and therefore, risks are of concern (see Appendix V, Table 2). Therefore, all mosquito control uses for dichlorvos in outdoor residential areas are proposed for cancellation. Although dermal exposures are also possible following use of dichlorvos for mosquito control, as there were risks of concern from the inhalation route, which is expected to be the predominant route, a quantitative dermal risk assessment was not conducted.

Theatres and Animal Barns

Postapplication exposure estimates for individuals entering theaters and animal barns commercially treated with dichlorvos were based on an air model developed by the USEPA using an exposure study from a food processing plant (USEPA, 1993). For further details on this study and assessment, see Postapplication Worker Exposure and Risk Assessment Section.

The predominant route of exposure is expected to be inhalation due to both the method of application and volatility of dichlorvos. Although dermal exposure is possible, since the results from the food processing study suggested that dermal exposure would be less than 3% of the total exposure (USEPA, 1993), and contact with potentially contaminated surfaces in theaters and animal barns would be expected to be minimal, a quantitative dermal risk assessment was not conducted.

The calculated inhalation MOEs met the target MOE for all age groups (see Appendix V, Table 3), when the required mitigation measures (that is, entry is not permitted until 4 days after application and after full ventilation has occurred) are considered. Therefore, risks are not of concern from the use of dichlorvos in theatres and animal barns.

Aggregate Exposure and Risk Assessment

In an aggregate risk assessment, the combined potential risk associated with food, drinking water and various residential exposure pathways is assessed. A major consideration is the likelihood of co-occurrence of exposures. Additionally, only exposures from routes that share common toxicological points of departure are aggregated.

An aggregate risk assessment was conducted for individuals entering commercially treated theaters and animal barns. As there were risks of concern associated with use of pest strips in inhabited areas and outdoor mosquito control, these uses are proposed for cancellation, and thus, an aggregate assessment was not conducted for these uses. In addition, as minimal exposure would be expected from the use of pest strips in areas that are continuously unoccupied for at least 4 months after pest strip placement, such as cottages, cabins, and trailers, an aggregate risk assessment was not conducted for this use.

The calculated aggregate MOEs met the target MOE for all age groups (see Appendix VI, Table 1) with the proposed risk mitigation measures. Therefore, aggregate risks are not of concern from use of dichlorvos in theaters and animal barns.

Cumulative Assessment

The *Pest Control Products Act* requires the Agency to consider the cumulative effects of pest control products that have a common mechanism of toxicity. Dichlorvos belongs to a group of chemicals classified as organophosphates. Organophosphates have a common mechanism of toxicity wherein they all possess the ability to interact with the cholinesterase enzyme ultimately leading to neurotoxicity. A cumulative assessment will be undertaken upon completion of the re-evaluation of the individual chemicals in the organophosphate group with all relevant chemicals and scenarios of the common mechanism group.

4.3 Potential risk to Non-target Organisms

The PMRA assessed potential risks to non-target aquatic and terrestrial organisms resulting from application of dichlorvos using available information. Environmental fate characteristics of dichlorvos and toxicity to non-target organisms were considered as part of the assessment.

Dichlorvos is readily soluble in water. It has intermediate to high volatility from dry surfaces. Based on Henry's law constant, however, it is only slightly volatile from moist soil or water surfaces. Dichlorvos is expected to degrade rapidly in air as it is susceptible to photochemical oxidative reactions, half-life was estimated to be less than 0.5 to 2 days. In the terrestrial environment, hydrolysis is an important route of transformation; half-life was 0.88 to 30 days (pH 5-9; 15-25°C). Direct phototransformation is not expected to be an important route of abiotic transformation in soil. Laboratory aerobic biotransformation dissipation time (DT_{50}) values for dichlorvos in a wide range of soils (1 hour to 19.3 days) indicated that it is non-persistent to slightly persistent in soil. A high level of transformation occurred rapidly, with the production of transient, intermediate transformation products including desmethyldichlorvos, 2,2-dichloroacetaldehyde, and dichloroethanol. Studies indicated high CO_2 capture in non-sterile soils and very little capture in sterile treatments. Dichlorvos transformed under anaerobic soil conditions with a DT_{50} of 6.3 days in sandy loam soil, which would classify it as non-persistent. The major transformation products were 2,2-dichloroacetic acid (DCA), 2,2-dichloroacetaldehyde, and 2,2-dichloroethanol. Therefore, in addition to hydrolysis, biotransformation is an important route of transformation of dichlorvos in soil and, overall, dichlorvos is not expected to persist in soil.

Dichlorvos is predicted to have high (K_{oc} 50-150) to very high (K_{oc} 0-50) mobility in soil based on K_{oc} values alone. Consideration of the criteria by Cohen and the Gustafson equation indicates that dichlorvos may leach. However, laboratory studies of column leaching indicated that no dichlorvos was found in leachate, and it was likely that extensive transformation (hydrolysis and microbial transformation) of dichlorvos occurred during leaching and prior to measurement. Results from field studies varied. One finding indicated that up to 20% of dichlorvos applied to soil penetrated to a depth of 30 cm within 5 days of application while other field studies indicated that dichlorvos was not detectable at any soil level. The transformation product DCA was detected in the 0 to approximately 10 cm soil layer further indicating that degradation of dichlorvos is likely occurring in the upper soil layers. Based on the available evidence, dichlorvos may be mobile in soil under certain conditions but it is unlikely to leach significantly and reach groundwater or persist because of its rapid rate of degradation through hydrolysis and microbial activity in the soil column.

The UV-absorption spectrum indicates that direct photolysis of dichlorvos should not occur under normal environmental conditions at the earth's surface. There is some evidence, however, that indirect photolysis may occur in the presence of sensitizers in water.

Aquatic biotransformation studies in water/sediment systems indicated that transformation of dichlorvos (whole system DT_{50} <1 d) was rapid and that it would be classified as non-persistent. Similar intermediate transformation products were identified to those found in soil studies and a high degree of mineralization occurred rapidly. Aerobic biotransformation is, therefore, an important route of transformation of dichlorvos in aquatic systems. No data were available to determine the anaerobic aquatic biotransformation of dichlorvos.

Dichlorvos has a log K_{ow} of 1.47 at 20°C, which would indicate that it has a low potential for bioaccumulation. In a bioaccumulation study with fish, low concentrations of dichlorvos in tissues decreased rapidly during the depuration phase and were below the limit of detection within 6 hours. Thus, dichlorvos is not expected to bioaccumulate in fish exposed to residues in water.

Environmental Risk Characterization

The environmental risk assessment integrates the environmental exposure and ecotoxicology information to estimate the potential for adverse effects on non-target species. This integration is achieved by comparing exposure concentrations with concentrations at which adverse effects occur. Estimated environmental concentrations (EECs) are concentrations of pesticide in various environmental media, such as food, water, soil and air. The EECs are estimated using standard models which take into consideration the application rate(s), chemical properties and environmental fate properties, including the dissipation of the pesticide between applications. Ecotoxicology information includes acute and chronic toxicity data for various organisms or groups of organisms from both terrestrial and aquatic habitats including invertebrates, vertebrates, and plants. Toxicity endpoints used in risk assessments may be adjusted to account for potential differences in species sensitivity as well as varying protection goals (that is, protection at the community, population, or individual level).

Initially, a screening level risk assessment is performed to identify pesticides and/or specific uses that do not pose a risk to non-target organisms, and to identify those groups of organisms for which there may be a potential risk. The screening level risk assessment uses simple methods, conservative exposure scenarios (for example, direct application at a maximum cumulative application rate) and sensitive toxicity endpoints. A risk quotient (RQ) is calculated by dividing the exposure estimate by an appropriate toxicity value (RQ = exposure/toxicity), and the risk quotient is then compared to the level of concern (LOC). If the screening level RQ is below the LOC, the risk is considered negligible and no further risk characterization is necessary. If the screening level RQ is equal to or greater than the LOC, then a refined risk assessment is performed to further characterize the risk. A refined assessment takes into consideration more realistic exposure scenarios (such as drift to non-target habitats) and might consider different toxicity endpoints. Refinements may include further characterization of risk based on exposure modelling, monitoring data, results from field or mesocosm studies, and probabilistic risk assessment methods. Refinements to the risk assessment may continue until the risk is adequately characterized or no further refinements are possible.

Minimal exposure to the environment is expected through uses of dichlorvos such as pest strips, stored food and feed, and when used indoors. Therefore, EECs were not calculated for these uses and a risk assessment was not conducted. Exposure to non-target organisms as a result of uses for greenhouse food and non-food crops and other outdoor sites (for example, fogging and space spray for human habitat and recreational areas) cannot be quantified but was considered where relevant. Risk to non-target organisms from these uses was, therefore, assessed qualitatively.

Fogging for mosquitoes requires that dichlorvos be dispersed into the air as very small droplets, to allow the pesticide to remain suspended for longer periods of time to contact the target. Ultra-low volume applications are only conducted under environmental conditions that ensure optimal product movement. Droplets containing dichlorvos are, therefore, not expected to deposit in significant amounts in the environment and any residues of dichlorvos will breakdown or dissipate quickly. Therefore, the amount of spray that deposits on soil and water is expected to be minimal, and persistence in these media is low. Some residues may deposit on vegetation; however, it is expected that dichlorvos will dissipate rapidly from plant surfaces through volatilization and other degradation pathways under most environmental conditions. Fine droplets are expected to evaporate while suspended in the air and dichlorvos will be degraded by atmospheric photochemical reactions. In addition, fogging programs will be conducted in the early morning and late evening, which will further minimize the potential for exposure of non-target organisms.

Surface spray applications are relatively small, localised treatments, using hand-held equipment, over areas such as outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking areas, refuse areas and other areas around buildings. Spray drift is minimal when using such equipment and interception of the spray by the vegetation will reduce the amount reaching soil. Runoff is not expected to be a significant source of entry to aquatic systems because treated areas are targeted and relatively small, and dichlorvos breaks down quickly in soil and water. Volatilisation from plants and inert surfaces, followed by subsequent breakdown in air, is also expected to occur rapidly, and will minimise any residues left after treatment.

Effluent from greenhouses may be a route of exposure of dichlorvos to aquatic systems. Exposure to terrestrial systems is not expected from this use. A qualitative assessment of this use was conducted for aquatic organisms.

Risks to Terrestrial Organisms

Earthworms: The 14-d lethal concentration to 50% (LC_{50}) of dichlorvos to the earthworm *Eisenia fetida* ranged from 14 to 80.9 mg/kg dry soil, with a no observed effect concentration (NOEC) stated to be < 12.3 mg/kg. Fogging, surface spray, and applications in greenhouses are not expected to result in significant residues of dichlorvos in soil. Therefore, risk to earthworms from these uses is not expected to be of concern.

Bees and other non-target arthropod species: Laboratory tests show that dichlorvos is highly toxic to honey bees (*Apis mellifera*), via topical application or oral dosing resulting in LD_{50} values ranging from 0.052 µg per bee to approximately 0.9 µg per bee. Although no toxicity studies were available for other non-target arthropod species, effects are expected as dichlorvos is an

insecticide. If bees and other non-target arthropods are present at the time of treatment or are foraging on flowers shortly after a surface spray has occurred, effects are expected. However, mosquito fogging programs are conducted in the evening, at night or early morning, when honeybees and other beneficial insects are less likely to be active. It is expected that populations will not be affected and any losses will be mitigated by recolonization of insects from untreated areas. Similarly, potential impacts to bees due to exposure through surface spray and fogging applications can be mitigated by avoiding application of dichlorvos around blooming plants. This will also reduce potential for exposure of other beneficial insects. Therefore, statements are proposed on the label to advice users that exposure to bees may be harmful, and application should occur during times of minimal foraging and to avoid application around blooming plants. Precautionary label statements for greenhouse uses are also proposed to inform users of the potential for toxicity to insects used for pollination and biocontrol.

Birds and mammals: The potential exposure of birds and mammals to dichlorvos is primarily through the ingestion of food items that have received spray from the product either from fogging or a direct spray; spray drift from hand-held application equipment is not expected to be significant.

As a surface spray, dichlorvos is applied to small, localised areas in and around human habitation and recreational areas which may include vegetation used as food sources by birds and wild mammals. It is not expected that birds and mammals will be grazing recently treated areas extensively or as a sole source of food. In addition, dichlorvos transforms rapidly in the environment; under certain conditions, this may occur within a few hours to a few days. Therefore, the likelihood that an animal would consume enough food contaminated with dichlorvos to cause an acute or reproductive effect is limited and risks of concern to birds and wild mammals are not expected. However, due to the inherent toxicity of dichlorvos to birds and mammals, label statements informing users of the toxicity to birds and mammals are proposed.

For the fogging use, if any dichlorvos deposits on vegetation or other food items for birds and mammals, it is expected to dissipate rapidly. In addition, fogging occurs at times when many non-target organisms are less active. As a result, risks of concern to birds and mammals are not expected. Precautionary label statements will, however, be proposed to inform users of the inherent toxicity of dichlorvos to birds and mammals.

Plants: No studies were available addressing the toxicity of dichlorvos to vascular plants. Risk to plants is not expected to be a concern due to the insecticidal mode of action of dichlorvos and long history of use on plants. In addition, direct spray applications are small and localized, and no incident reports involving effects of dichlorvos on plants have been submitted to the PMRA.

Risks to Aquatic Organisms

Dichlorvos can be very highly toxic to freshwater and marine fish and invertebrates (Canada 2017). Information regarding the toxicity of dichlorvos to algae and aquatic vascular plants was not available, although risk to plants is not expected due to the insecticidal mode of action of dichlorvos.

As exposure to aquatic environments through spray drift and runoff is expected to be minimal due to the methods of application (fogging with small droplets or hand-held equipment for outdoor surfaces) and small areas receiving direct application as a surface spray, no risks of concern to aquatic organisms were identified from these uses.

A qualitative assessment was conducted to assess the effects to aquatic organisms potentially exposed to discharge of greenhouse process water that may contain residues of dichlorvos and its transformation products. Estimating levels of residues in effluent under this use pattern is difficult, as water used in greenhouses is reused throughout day to day processes prior to discharge at a later time. In addition, there are multiple applications at different times throughout the crop production process, and for different crops. Based on laboratory studies, however, dichlorvos is highly toxic to fish and very highly toxic to aquatic invertebrates. Therefore, it is important to mitigate potential release of effluent containing residues of dichlorvos to aquatic systems through this use. Precautionary label statements are proposed to inform users of the toxicity to aquatic organisms. In addition, label statements are proposed stating that effluent containing this active ingredient, from use of dichlorvos in greenhouses, should not be discharged into waterbodies.

5.0 Incident Reports

As of 12 June 2017, 19 human incident reports involving dichlorvos have been submitted to the PMRA. Eighteen of these human incident reports involved dichlorvos-impregnated pest strips used to control flies and mosquitos in homes and farms. The strip is hung in an enclosed space and is effective for up to four months.

All incidents were minor or moderate in severity. The incidents related mostly to the location and/or way in which the product was applied, and misuse of the product was frequently reported. More than half of the people affected were exposed to areas in which the pest strip was situated. Similar trends were observed in the US, in which the use of pest strips in homes that were occupied for more than 4 hours a day (a misuse) was the most frequently reported type of exposure.

Based on the incident data, the primary panel on dichlorvos-impregnated indoor pest strip products is proposed be modified to more clearly indicate allowed areas of use.

There were no environmental incident reports involving dichlorvos submitted to the PMRA. The USEPA’s EIIS was queried for dichlorvos incidents that were available in the database as of 5 October 2015; there were six cases. According to a previous USEPA assessment, the incidents were associated with exposure through ingestion of treated feed (mallard duck), exposure due to industrial operations (unspecified organisms), unspecified exposure to birds causing mortality (bluebirds), exposure from secondary poisoning (red-tailed hawk), exposure due to drift from an unincorporated broadcast application (fox), and unspecified exposure to bees in China (honeybees).

Where it was possible to determine a means of exposure for reported incidents (ingestion of treated feed, industrial operations, secondary poisoning, and drift from a broadcast application), the Canadian use patterns would not fall within these methods based on the information provided. For the incidents associated with an unspecified means of exposure, it is unknown if these would have been a result of use patterns similar to those in Canada.

6.0 Proposed Special Review Decision for Dichlorvos

Evaluation of available relevant scientific information related to the aspects of concern for human health and environment, indicate that dichlorvos does not pose unacceptable risks to human health and the environment, taking into account the implementation of the proposed conditions of use (Appendix VII). On this basis, Health Canada's Pest Management Regulatory Agency, under the authority of the *Pest Control Products Act*, is proposing to confirm the current registration of dichlorvos products for sale and use in Canada pursuant to subsection 21(1) of *the Pest Control Product Act*.

This proposed special review decision is a consultation document.[1] The PMRA will accept written comments on this proposal up to 45 days from the date of publication of this document. Please forward all comments to Publications (please see contact information on the cover page of this document).

7.0 Next Steps

Before making a special review decision on dichlorvos, the PMRA will consider all comments received from the public in response to this consultation document. A science-based approach will be applied in making a final decision on dichlorvos. The PMRA will then publish a special review decision document, which will include the decision, the reasons for it, a summary of the comments received on the proposed decision, and the PMRA's response to these comments.

[1] "Consultation statement" as required by subsection 28(2) of the *Pest Control Products Act*.

Appendix I Registered Products Containing Dichlorvos as of 1 January 2018

Registration Number	Marketing Class	Registrant	Product Name	Formulation Type	Guarantee
19723	Technical	Amvac Chemical Corporation	Dichlorvos (DDVP) Technique	Liquid	97.7%
11819	Commercial	Gardex Chemicals Ltd.	Gardex Vapona Insecticide Industrial Fogging Solution	Emulsifiable Concentrate	4.65%
16476	Commercial	Gardex Chemicals Ltd.	Gardex Vapona-20 ULV Concentrate	Emulsifiable Concentrate	20%
19680	Commercial	Premier Tech Brighton Ltd.	Pro Professional DDVP-20 Ultra-Low Volume Insecticide	Solution	20%
21222	Commercial	AbAberdeen Road Company d/b/a HERCON ENVIRONMENTAL	Vaportape II Insecticidal Strips	Slow-Release Generator	10%
21824	Commercial	Plus (9021-7993 Quebec Inc.)	DICHLORVOS PLUS #1 READY TO USE INSECTICID	Solution	1.8%
23915	Commercial	LOVELAND PRODUCTS CANADA INC.	DDVP 20% Insecticide	Emulsifiable Concentrate	20%
22027	Domestic	Scotts Canada Ltd..	Ortho® Home Defense Max No-Pest Insecticide Strip	Slow-Release Generator	19.2%

Appendix II Toxicology Endpoints for Use in Occupational and Residential Risk Assessment for Dichlorvos

Exposure Scenario	Endpoint	Study	CAF[a] or Target MOE
Dermal[b] Short-, Intermediate- and Long-term	$BMDL_{10}$ = 0.011 mg/kg bw (BChE inhibition)	7-day Repeat-dose Oral ChE Inhibition Study - PND 18 and 48 rats	100
Inhalation[c] Short-, Intermediate- and Long-term	$BMDL_{10}$ = 0.011 mg/kg bw (BChE inhibition)	7-day Repeat-dose Oral ChE Inhibition Study - PND 18 and 48 rats	100
Incidental Oral, Short-term	$BMDL_{10}$ = 0.011 mg/kg bw (BChE inhibition)	7-day Repeat-dose Oral ChE Inhibition Study - PND 18 and 48 rats	100
Aggregate Short-, Intermediate- and Long-term, Oral, Dermal[b] and Inhalation[c]	$BMDL_{10}$ = 0.011 mg/kg bw (BChE inhibition)	7-day Repeat-dose Oral ChE Inhibition Study - PND 18 and 48 rats	100
Cancer Oral, Dermal and Inhalation	Dichlorvos is an in vitro mutagen and clastogen; however, the overall weight of evidence suggested that it is neither mutagenic nor clastogenic in vivo. The available evidence is insufficient to rule out the possibility that dichlorvos may be carcinogenic. Although a data gap remains in the dichlorvos database with respect to carcinogenicity, there is a large margin (~40,000) between the proposed reference values for repeat-exposure and the lowest dose resulting in tumours in the available dichlorvos studies.		

[a] CAF (composite assessment factor) refers to a total of uncertainty and *Pest Control Products Act* factors for dietary assessments; MOE refers to a target MOE for occupational and residential assessments.
[b] Since an oral NOAEL was selected, a dermal absorption factor was used for route-to-route extrapolation
[c] Since an oral NOAEL was selected, an inhalation absorption factor of 100% (default value) was used for route-to-route extrapolation

Appendix III Commercial Mixer/Loader/Applicator Risk Assessment

Table 1 Mixer/Loader/Applicator Exposure and Risk Assessment of Dichlorvos in Greenhouses

Crop	Application Equipment	Application rate	ATPD[A]	Amount handled per day (kg a.i./day)	Dermal Exposure[B] (mg/kg bw/day)	Inhalation Exposure[C] (mg/kg bw/day)	Dermal MOE[D]	Inhalation MOE[D]	Combined MOE[E]
Personal Protective Equipment: Coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves and a respirator[F].									
Greenhouse cucumber, tomato, ornamentals	MPHW	0.00113 kg a.i./L	150 L/day	0.1695	4.67×10^{-4}	9.58×10^{-6}	20	1100	23
	Backpack	0.00113 kg a.i./L	150 L/day	0.1695	1.65×10^{-3}	1.32×10^{-5}	10	840	7
	MPHG	0.00113 kg a.i./L	3800 L/day	4.2940	3.95×10^{-2}	8.10×10^{-4}	< 1	14	< 1
	Automated Application	0.00005658 kg a.i./m^2	10000 m^2	0.5658	6.65×10^{-5}	4.46×10^{-7}	170	25000	170
Personal Protective Equipment: Chemical-resistant coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves and a respirator[F].									
Greenhouse cucumber, tomato, ornamentals	MPHW	0.00113 kg a.i./L	150 L/day	0.1695	4.41×10^{-4}	9.58×10^{-6}	25	1100	24
	Backpack	0.00113 kg a.i./L	150 L/day	0.1695	1.29×10^{-3}	1.32×10^{-5}	8.5	840	8
	MPHG	0.00113 kg a.i./L	3800 L/day	4.2940	2.94×10^{-2}	8.10×10^{-4}	< 1	14	< 1

ATPD = area treated per day, MOE = margin of exposure, MPHW = manually pressurized handwand, MPHG = mechanically pressurized hand-gun

[A] The value for automated fogger is based on the use information received for dichlorvos for greenhouses. Other values are defaults based on the ATPD memo.

[B] Dermal exposure (mg/kg bw/day) = (dermal unit exposure × ATPD × maximum application rate × DA (30%))/80 kg body weight

[C] Inhalation exposure (mg/kg bw/day) = (inhalation unit exposure × ATPD × maximum application rate)/80 kg body weight.

[D] Based on a short, intermediate and long-term oral NOAEL of 0.011 mg/kg bw/day, and a target MOE of 100 for the dermal endpoint and inhalation endpoint.

[E] Combined MOE = NOAEL (0.011 mg/kg bw/day, target MOE of 100)/(Dermal Exposure + Inhalation Exposure).

[F] 90% protection factor was used for the respirator.

Current PPE on the label states: Mid-level PPE + respirator. MOEs of concern (shaded) do not meet the target MOE even with the max-level PPE.

Table 2 Mixer/Loader/Applicator Exposure and Risk Assessment of Dichlorvos in Structures

Site	Application equipment	Max Application Rate (kg a.i./m^2 or m^3)	Area Treated Per Day (m^2 or m^3)[A]	Amount handled per day (kg a.i./day)	Dermal Exposure[B] (mg/kg bw/day)	Inhalation Exposure[C] (mg/kg bw/day)	Dermal MOE[D]	Inhalation MOE[D]	Combined MOE[E]	Restriction on Amount Handled (kg)
Personal Protective Equipment: Coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves, and a respirator[F].										
Tobacco Storage	Automated Fogger/ULV	0.000066	21000	1.39	1.63×10^{-4}	1.09×10^{-6}	68	10000	**68**	0.93
Dairies, piggeries, poultry houses, barns	Automated Fogger	0.0000174	610	0.01	1.25×10^{-6}	8.36×10^{-9}	8824	1300000	8741	0.93
Sheds, stables, barns, loafing sheds, pigpens, outdoor areas, poultry houses	MPHW	0.00472	150	0.71	1.95×10^{-3}	4.00×10^{-5}	5.64	275	**5**	0.039
	Backpack	0.00472	150	0.71	6.89×10^{-3}	5.49×10^{-5}	1.60	200	**2**	0.011
	MPHG	0.00472	3800	17.92	1.65×10^{-1}	3.38×10^{-3}	0.07	3.25	**< 1**	0.012
Food processing plants, industrial plants, warehouses, theaters	Automated Fogger/ULV	0.0000330	350000	11.55	1.36×10^{-3}	9.10×10^{-6}	8.11	1209	**8**	0.93
Personal Protective Equipment: Chemical-resistant coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves, and a respirator[F].										
Tobacco Storage	Automated Fogger/ULV	0.000066	21000	1.39	1.33×10^{-4}	1.09×10^{-6}	83	10000	**82**	1.14
Sheds, stables, barns, loafing sheds, pigpens, outdoor areas, poultry houses	MPHW	0.00472	150	0.71	1.84×10^{-3}	4.00×10^{-5}	**6**	280	**6**	0.041
	Backpack	0.00472	150	0.71	5.38×10^{-3}	5.49×10^{-5}	**2**	200	**2**	0.014
	MPHG	0.00472	3800	17.92	1.23×10^{-1}	3.38×10^{-3}	**< 1**	**3.3**	**< 1**	0.016
Food processing plants, industrial plants, warehouses, theaters	Automated Fogger/ULV	0.0000330	350000	11.55	1.10×10^{-3}	9.10×10^{-6}	10	1200	**10**	1.14

ATPD = area treated per day, MOE = margin of exposure, MPHW = Manually pressurized handwand, MPHG = Mechanically pressurized hand-gun

[A] Volumes are based on the use information received for dichlorvos. Other values are defaults based on the ATPD memo.

[B] Dermal exposure (mg/kg bw/day) = (dermal unit exposure × ATPD × maximum application rate × DA (30%))/80 kg body weight

[C] Inhalation exposure (mg/kg bw/day) = (inhalation unit exposure × ATPD × maximum application rate)/80 kg body weight.

[D] Based on a short, intermediate long-term oral NOAEL of 0.011 mg/kg bw/day, and a target MOE of 100 for the dermal endpoint and inhalation endpoint.

[E] Combined MOE = NOAEL (0.011 mg/kg bw/day, target MOE of 100)/ Dermal Exposure + Inhalation Exposure

[F] 90% protection factor was used for the respirator.

Table 3 Mixer/Loader/Applicator Exposure and Risk Assessment of Dichlorvos in Human Habitat and Residential Outdoors

Site	Application equipment	Max Application Rate (kg ai/ha or kg ai/L)[A]	Area Treated Per Day[B]	Amount handled per day (kg ai)	Dermal Exposure[C] (mg/kg bw/day	Inhalation Exposure[D] (mg/kg bw/day)	Dermal MOE[E]	Inhalation MOE[E]	Combined MOE[F]
Personal Protective Equipment: Coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves and a respirator[G].									
Outdoor mosquito control	Automated Fogger	0.112	1200 ha	134.40	1.58×10^{-2}	1.06×10^{-4}	0.70	100	**< 1**
	Truck Mounted ULV	0.113	1200 ha	135.60	9.63×10^{-2}	1.65×10^{-3}	0.11	6.68	**< 1**
Outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking and refuse areas, and other areas around buildings	MPHW	0.00472	150 L	0.71	1.95×10^{-3}	4.00×10^{-5}	5.64	275	**5**
	Backpack	0.00472	150 L	0.71	6.90×10^{-3}	5.50×10^{-5}	1.60	200	**2**
	MPHG	0.00472	3800 L	17.94	1.65×10^{-1}	3.39×10^{-3}	0.07	3.25	**< 1**
Personal Protective Equipment: Chemical-resistant coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves and a respirator[G].									
Outdoor mosquito control	Automated Fogger	0.112	1200 ha	134.40	6.67×10^{-2}	1.63×10^{-3}	0.17	6.74	**< 1**
	Truck Mounted ULV	0.113	1200 ha	135.60	6.73×10^{-2}	1.65×10^{-3}	0.16	6.68	**< 1**
Outdoor living areas, picnic grounds, backyard areas, patios, latrines, loading docks, parking and refuse areas, and other areas around buildings	MPHW	0.00472	150 L	0.71	1.84×10^{-3}	4.00×10^{-5}	5.97	275	**5.87**
	Backpack	0.00472	150 L	0.71	5.38×10^{-3}	5.50×10^{-5}	2.04	200	**1.98**
	MPHG	0.00472	3800 L	17.94	1.23×10^{-1}	3.39×10^{-3}	0.09	3.25	**< 1**
Personal Protective Equipment: Closed Cab, Chemical-resistant coveralls over a long-sleeved shirt and long pants, chemical-resistant gloves and a respirator[G].									
Outdoor mosquito control	Truck Mounted ULV	0.113	1200 ha	135.60	1.96×10^{-2}	1.61×10^{-4}	0.56	68.31	**< 1**

ATPD = area treated per day, MOE = margin of exposure, MPHW = Manually pressurized handwand, MPHG = Mechanically pressurized hand-gun

[A] Application rates for outdoor living areas are expressed in units of kg ai/L. Application rates for outdoor mosquito control are expressed in units of kg ai/ha.

[B] Based on the ERS Area Treated Per Day Memo.

[C] Dermal exposure (mg/kg bw/day) = (dermal unit exposure × ATPD × maximum application rate × DA (30%))/80 kg body weight

[D] Inhalation exposure (mg/kg bw/day) = (inhalation unit exposure × ATPD × maximum application rate)/80 kg body weight.

[E] Based on a short- and intermediate-term oral NOAEL of 0.011 mg/kg bw/day, and a target MOE of 100 for the dermal endpoint and inhalation endpoint.

[F] Combined MOE = NOAEL (0.011 mg/kg bw/day, target MOE of 100)/(Dermal Exposure + Inhalation Exposure)

[G] 90% protection factor was used for the respirator.

Appendix IV Postapplication Worker Risk Assessment

Table 1 Combined Postapplication Greenhouse Risk Assessment

Crop	Transfer Coefficient (cm^2/hr)	Target DFR (ng/cm^2)[A]	Dermal REI[B] (days)	Inhalation REI[C] (days)	Req REI[D] (days)	DFR on REI Day (ng/cm^2)[E]	AC on REI Day (mg/m^3)[F]	Dermal Exposure (mg/kg bw/day)[G]	Inhalation Exposure (mg/kg bw/day)[H]	Combined Exposure (mg/kg bw/day)[I]	Combined MOE[F] (Target = 100)[J]
Cut Flower Ornamentals	4000	0.92	20	4	20	0.94	4.45×10^{-13}	1.13×10^{-4}	4.45×10^{-17}	1.13×10^{-4}	**98**
Potted Greenhouse Ornamentals	230	15.94	3	4	4	8.24	6.40×10^{-1}	5.69×10^{-5}	6.40×10^{-5}	1.21×10^{-4}	**91**
Greenhouse Cucumbers, Tomatoes	1400	2.62	9	4	9	2.76	1.02×10^{-4}	1.16×10^{-4}	1.02×10^{-8}	1.16×10^{-4}	**95**

[A] Target DFR is the DFR value required to have worker exposure for a specific-crop activity combination reach the target MOE of 100. It is calculated using the following formula: Target DFR (ng/cm^2) = [NOAEL (11 µg/kg bw/day) * Body Weight (80 kg) * Conversion Factor (1000 ng/µg)] ÷ [TC (cm^2/hr) * Duration (8 hrs) * Target MOE (100) * Dermal Absorption (30% or 0.3)]

[B] Time to reach target DFR was calculated using the equation of the line of DFR (ng/cm^2) versus time (hrs) of $y = 3908.65x^{-1.35}$ (Manninen et al. 1996), Time (hrs) = (Target DFR (ng/cm^2)/3908.65)$^{-1/1.35}$

[C] Time required to reach the target air concentration using air concentration data from Manninen et al., 1996.

[D] The REI required to reach the target DFR or target air concentration.

[E] Dislodgeable foliar residue on the required REI day calculated using the DFR equation from Manninen et al. 1996, DFR (ng/cm^2) = 3908.65 (time in hours)$^{-1.35}$.

[F] Air Concentration on the DFR day calculated using the natural log transformed linear regression of air concentration data from greenhouse (50 mg/m^3) in Manninen et al., 1996, air concentration (mg/m^3) = $e^{-0.0729(\text{time in hours}) + 6.5515}$.

[G] Calculated using the following formula: Dermal Exposure (mg/kg bw/day) = [TC (cm^2/hr) × Duration (8 hours/day) × DFR (ng/cm^2) × Dermal Absorption (30%) × Conversion Factor (1.0×10^{-6} mg/ng)] ÷ Body Weight (80 kg)

[H] Calculated using the following formula: Inhalation Exposure (mg/kg bw/day) = [Air Concentration (µg/m^3) × Light Inhalation Rate (1 m^3/hr) × Duration (8 hrs/day) × Conversion Factor (0.001 mg/µg)] ÷ Body Weight (80 kg)

[I] Combined Exposure at required REI (mg/kg bw/day) = Dermal Exposure (mg/kg bw/day) + Inhalation Exposure (mg/kg bw/day)

[J] Margin of Exposure at required REI (target = 100), calculated using the following formula: MOE = NOAEL (oral value = 0.011 mg/kg bw/day) ÷ Combined Exposure (mg/kg bw/day).

Table 2 Postapplication Risk Assessment for Structural Sites based on the USEPA Model in Food Processing Plants

Time (hr)	Estimated Concentrations[A] (mg/m^3)			Inhalation Exposure[B] (mg/kg bw/day)			Margin of Exposure[C]		
	Tobacco (66.0 mg/m^3)	Barn[D] (17.4 mg/m^3)	Warehouse[E] (33.0 mg/m^3)	Tobacco (66.0 mg/m^3)	Barn[D] (17.4 mg/m^3)	Warehouse[E] (33.0 mg/m^3)	Tobacco (66.0 mg/m^3)	Barn[D] (17.4 mg/m^3)	Warehouse[E] (33.0 mg/m^3)
24	25.1	6.61	12.5	3.13×10^{-1}	8.26×10^{-2}	1.57×10^{-1}	**< 1**	**< 1**	**< 1**
48	1.79	4.71×10^{-1}	8.94×10^{-1}	2.24×10^{-2}	5.89×10^{-3}	1.12×10^{-2}	**< 1**	**2**	**1**
72	1.28×10^{-1}	3.36×10^{-2}	6.38×10^{-2}	1.60×10^{-3}	4.21×10^{-4}	7.98×10^{-4}	**7**	**26**	**14**
96	9.11×10^{-3}	2.40×10^{-3}	4.55×10^{-3}	1.14×10^{-4}	3.00×10^{-5}	5.69×10^{-5}	97	367	193

[*] Application rate in parenthesis.

[A] Estimated concentrations were based on the following equation: $C_o = {}^{t2}I_{t1}(C_i) * e^{-kt}$ where: C_o = Predicted air concentration (mg/m^3), C_i = Initial air concentration, which is equal to the application rate, k = decay constant (0.11) (USEPA 2000a), t = time (hours) representing an 8 hour work period postapplication

[B] Inhalation Exposure (mg/kg bw/day) = Air concentration (mg/m^3) × IR (1 m^3/hour) × 1/BW body weight (80 kg for adult). Since the air model estimates the air concentration that a worker is exposed to over an 8 hour period, the exposure time was not considered in the equation.

[C] MOEs = NOAEL (oral value of 0.011 mg/kg bw/day) / Inhalation Exposure (mg/kg bw/day), Target MOE is 100.

[D] Includes dairies, piggeries, and poultry houses.

Appendix V Non-Occupational Risk Assessment

Table 1 Postapplication Inhalation Exposure and Risk Assessment for Pest Strips

Scenario	AC[A] (mg/m^3)	IR (m^3/hr)	ET[B] (hr/day)	Inhalation Exposure[C] (mg/kg bw /day)	Inhalation MOE[D] (Target = 100)
Exposure from Areas Occupied for up to 4 hours per Day (for example, attics, garages, etc.)					
Adult	0.035	0.64	4	1.10×10^{-3}	**10**
Youth (aged 6 to < 11 years)		0.63		1.53×10^{-3}	**7**
Children (aged 3 to < 6 years)		0.42		3.05×10^{-3}	**4**
Children (aged 1 to < 2 years)		0.33		4.14×10^{-3}	**3**
Exposure from Areas Adjacent to an Area with Pest Strip					
Adult	0.004	0.64	10	3.13×10^{-4}	**35**
Youth (aged 6 to < 11 years)		0.63	11	4.94×10^{-4}	**22**
Children (aged 3 to < 6 years)		0.42	12	1.04×10^{-3}	**11**
Children (aged 1 to < 2 years)		0.33	13	1.58×10^{-3}	**7**

IR = Inhalation Rate, MOE = Margin of Exposure, BW = Body Weight

[A] AC = Air Concentration. Air concentration value was calculated based on a registrant submitted study (PMRA No. 2586571). A time-weighted average (TWA) value from the closet data (closet contained pest strip) was used to represent exposure from areas that could be occupied for up to 4 hours per day, such as, attics and garages. The TWA of air concentrations from the room adjacent to the closet was used to represent potential exposures to a room adjacent to an attic or crawl space that contains the pest strip.

[B] Exposure Time. A value of 4 hours was chosen based on label statement indicating the use in areas occupied for less than 4 hours/day . Exposure times for exposure from areas adjacent to an area where a pest strip is used in based on the amount of time spent in bedrooms from the USEPA Exposure Factors Handbook (USEPA, 2011). Bedroom was chosen to represent a worst-case scenario.

[C] Inhalation Exposure (mg/kg bw/day) = Air concentration (mg/m^3) × IR (m^3/hour) × ET (hr/day) × 1/BW where body weight (80 kg for adults, 57 kg for youth (11 < 16 years old), 19 kg for children 3 < 6 years old) and 11 kg for children (1 < 2 years old)

[D] Adult, youth and children long-term MOEs are based on an oral NOAEL of 0.011 mg/kg bw/day with a target MOE of 100

Table 2 Postapplication Inhalation Exposure and Risk Assessment for Outdoor Mosquito Control in Residential Areas

Scenario	IR (m^3/hr)	Inhalation Exposure[A] (mg/kg bw /day)	Inhalation MOE[B] (Target = 100)
Outdoor Aerosol Space Spray			
Adult (80 kg)	0.64	0.039	**< 1**
Youth (aged 6 to < 11 years) (57 kg)	0.63	0.053	**< 1**
Children (aged 1 to < 2 years) (11 kg)	0.33	0.144	**< 1**
Outdoor Residential Misting Systems			
Adult (80 kg)	0.64	0.002	**7**
Youth (aged 6 to < 11 years) (57 kg)	0.63	0.002	**8**
Children (aged 1 to < 2 years) (11 kg)	0.33	0.006	**2**

IR = Inhalation Rate, MOE = Margin of Exposure, BW = Body Weight, AR = Application Rate.

[A] Inhalation exposure calculated based on algorithms from the USEPA Residential SOPs (2012). For outdoor aerosol space sprays: Inhalation Exposure (mg/kg bw/day) = AR (26.31 g a.i./day) × IR (m^3/hour)/Q (5400 m^3/hour) × 1/BW

For outdoor residential misting systems:
Inhalation Exposure (mg/kg bw/day) = $\left(\frac{IR \times C_0 \times V}{Q} \text{int}(ET \cdot PR) + \frac{(1 - R^{\text{fract}(ET.PR)})}{(1 - R)} \right)$

Where C_0 is the initial concentration calculated above, V is the volume of treated space of 90.6 m^3, Q is the airflow through the treated area value of 5400 m^3/hour, ET is exposure time in hr/day of 2.3, 1.9, and 2.3 for adults, youth, and children respectively, PR is the pulse rate of 1 spray event/hr, and T_{BA} is the time between application events (that is, the inverse of the pulse rate, or 1/PR).
[B] Adult, youth and children short-term MOEs are based on an oral NOAEL of 0.011 mg/kg bw/day with a target MOE of 100.

Table 3 Postapplication Inhalation Exposure and Risk Assessment for Theaters and Animal Barns

Scenario	AC[A] (mg/m^3)	IR (m^3/hr)	ET[B] (hr/day)	Inhalation Exposure[C] (mg/kg bw /day)	Inhalation MOE[D] (Target = 100)
Theaters (33 mg/m^3)					
Adult (80 kg)	0.00086	0.64	3	2.05×10^{-5}	540
Youth (aged 6 to < 11 years) (57 kg)		0.63		2.84×10^{-5}	390
Children (aged 3 to < 6 years) (19 kg)		0.42		5.68×10^{-5}	200
Children (aged 1 to < 2 years) (11 kg)		0.33		7.70×10^{-5}	140
Animal Barns (17.4 mg/m^3)					
Adult (80 kg)	0.00045	0.64	4	1.44×10^{-5}	762
Children (aged 3 to <6 years) (19 kg)		0.42	2	1.99×10^{-5}	551

IR = Inhalation Rate, AC = Air Concentration, MOE = Margin of Exposure, BW = Body Weight.
[A] Air concentration value was calculated based on a USEPA air model after 96 hours, reflective of a 4 day restricted entry interval
[B] Exposure Time. A value of 3 hours was chosen for theaters to represent the longest duration for a theater visit. The exposure time for animal barns is from the USEPA Residential SOPs (2012).
[C] Inhalation Exposure (mg/kg bw/day) = Air concentration (mg/m^3) × IR (m^3/hour) × ET (hr/day) × 1/BW
[D] Adult, youth and children MOEs are based on an oral NOAEL of 0.011 mg/kg bw/day with a target MOE of 100

Appendix VI Aggregate Risk Assessment

Table 1 Aggregate Risk Assessment for Theaters and Animal Barns

Scenario	Inhalation Exposure[A] (mg/kg bw/day)	Dietary Exposure[B] (mg/kg bw/day)	Aggregate Exposure[C] (mg/kg bw/day)	Aggregate MOE[D] (Target = 100)
Theaters (33 mg/m^3)				
Adult (80 kg)	2.05×10^{-5}	8.00×10^{-6}	2.95×10^{-5}	385
Youth (aged 6 to < 11 years) (57 kg)	2.84×10^{-5}	1.30×10^{-5}	4.14×10^{-5}	266
Children (aged 3 to < 6 years) (19 kg)	5.68×10^{-5}	1.90×10^{-5}	7.58×10^{-5}	145
Children (aged 1 to < 2 years) (11 kg)	7.70×10^{-5}	2.40×10^{-5}	1.01×10^{-4}	109
Animal Barns (17.4 mg/m^3)				
Adult (80 kg)	1.44×10^{-5}	8.00×10^{-6}	2.34×10^{-5}	490
Children (aged 3 to <6 years) (19 kg)	1.99×10^{-5}	1.90×10^{-5}	3.89×10^{-5}	282

[A] Inhalation Exposure, See Appendix VII, Table 3.
[B] Chronic dietary exposure values including drinking water. Dichlorvos exposure was estimated using residues of dichlorvos from all sources, that is, residues of dichlorvos from use of dichlorvos, as well as, residues of dichlorvos resulting from use of naled.
[C] Aggregate Exposure (mg/kg bw/day) = Inhalation Exposure (mg/kg bw/day) + Dietary Exposure (mg/kg bw/day)
[D] Adult, youth and children MOEs are based on an oral NOAEL of 0.011 mg/kg bw/day with a target MOE of 100

Appendix VII Label Amendments for Products Containing Dichlorvos

The label amendments presented below do not include all label requirements for individual end-use products, such as first aid statements, disposal statements, precautionary statements and supplementary protective equipment. Information on labels of currently registered products should not be removed unless it contradicts the following label statements.**Note:** The following information is divided according to product type. Each section should be read carefully and appropriate changes should be made to product labels.

I) TECHNICAL GRADE AND COMMERCIAL CLASS PRODUCTS

a. Based on the toxicological assessments, the both of technical and commercial class product label text should be expanded and/or standardized as follows:

Toxicology Information

“Dichlorvos is a cholinesterase inhibitor. Typical symptoms of overexposure to cholinesterase inhibitors include headache, nausea, dizziness, sweating, salivation, runny nose and eyes. This may progress to muscle twitching, weakness, tremor, incoordination, vomiting, abdominal cramps and diarrhea in more serious poisonings. A life-threatening poisoning is signified by loss of consciousness, incontinence, convulsions and respiratory depression with a secondary cardiovascular component. Treat symptomatically. If exposed, plasma and red blood cell cholinesterase tests may indicate degree of exposure (baseline data are useful). Atropine, only by injection, is the preferable antidote. Oximes, such as Pralidoxime Chloride, may be therapeutic if used early; however, use only in conjunction with atropine. In cases of severe acute poisoning, use antidotes immediately after establishing an open airway and respiration. With oral exposure, the decision of whether to induce vomiting or not should be made by an attending physician”.

b. For the technical grade active ingredient product label, include the following:

Under ENVIRONMENTAL PRECAUTIONS, add the following:

“TOXIC to aquatic organisms.”

Under PRECAUTIONS, add the following:

“DO NOT discharge effluent containing this product into sewer systems, lakes, streams, ponds, estuaries, oceans or other waters.”

Under DISPOSAL, add the following:

“Canadian manufacturers should dispose of unwanted active ingredients and containers in accordance with municipal or provincial regulations. For additional details and clean-up of spills, contact the manufacturer or the provincial regulatory agency.”

II) DOMESTIC-CLASS PRODUCTS

a. The following statement must be added to the primary panel of all domestic pest strip products:

"DO NOT USE in inhabited homes, including in attics, crawl spaces, and garages."

"DO NOT USE in commercial areas, including animal and other farm buildings, milk rooms, motels, restaurants, food processing plants, industrial and commercial locations, kennels, garbage storage areas and containers, and similar enclosed spaces."

"For use only in unoccupied structures, provided that they are continuously unoccupied for at least 4 months immediately following placement of the pest strip, such as vacation homes, cabins, mobile homes, and boats."

b. Based on the toxicological assessments, the label text should be expanded and/or standardized as follows:

Toxicology Information

"This product contains a pesticide that is a cholinesterase inhibitor (anti-cholinesterase compound). Symptoms of human poisoning may include headache, weakness, sweating, blurred vision, nausea and diarrhea. Obtain medical attention or call a poison control centre at once. Atropine is antidotal."

c. Under a new or existing heading titled ENVIRONMENTAL PRECAUTIONS, add the following:

"Toxic to aquatic organisms

Toxic to birds and small wild mammals"

d. Under a STORAGE heading, add the following:

"To prevent contamination store this product away from food or feed."

e. Under DISPOSAL, add the following:

"DO NOT reuse the empty containers. Dispose in household garbage.

Unused or partially used products should be disposed at provincially or municipally designated hazardous waste disposal sites."

III) COMMERCIAL-CLASS PRODUCTS

1. As the following uses are proposed for cancellation or not supported by the registrant, all references to these uses would be removed from all end-use product labels:

- greenhouse cucumbers and tomatoes
- greenhouse cut flower ornamentals
- outdoor mosquito control
- outdoor residential living area
- mushroom houses.

2. PRECAUTIONS

Personal Protective Equipment

a. For greenhouse potted ornamentals (that is, non-cut flowers) and animal buildings, the following label statements must be added:

"For use with automatic application equipment only. Individuals MUST not be present in the entire enclosed area during application. DO NOT APPLY with handheld equipment or handheld foggers."

"Wear coveralls over a long-sleeved shirt, long pants, chemical-resistant gloves, and chemical-resistant footwear during mixing, loading, clean-up and repair. In addition, a respirator with a NIOSH approved organic-vapour-removing cartridge with a prefilter approved for pesticides or a NIOSH approved canister approved for pesticides, MUST be worn."

b. For tobacco storage, the following label statements must be added:

"For use with automatic application equipment only. Individuals MUST not be present in the entire enclosed area during application. DO NOT APPLY with handheld equipment or handheld foggers."

"Limit the amount handed per day to 1.14 kg ai per person."

"Wear chemical-resistant coveralls over a long-sleeved shirt, long pants, chemical-resistant gloves, socks, and chemical-resistant footwear during mixing, loading, clean-up and repair. In addition, a respirator with a NIOSH approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH approved canister for pesticides, MUST be worn."

c. For food processing plants, industrial plants, warehouses, theaters, the following label statements must be added:

"Limit the amount handled per day to 1.14 kg ai per person."

"Wear chemical-resistant coveralls over a long-sleeved shirt, long pants, chemical-resistant gloves, socks, and chemical-resistant footwear during mixing, loading, clean-up and repair. In addition, a respirator with a NIOSH approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH approved canister for pesticides, MUST be worn."

d. For outdoor commercial pest strips (that is, insecticidal traps in fruit and vegetable crops), the following statements must be added:

"Wear chemical-resistant gloves, and a respirator with a NIOSH approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH approved canister approved for pesticides when opening insect traps and for disposal of the pest strip."

3. DIRECTIONS FOR USE

a For all product labels <u>(excluding pest strips)</u>, add the following:

"DO NOT contaminate irrigation or drinking water supplies or aquatic habitats by cleaning of equipment or disposal of wastes.

DO NOT apply by air."

b. For greenhouse potted ornamentals, the following label statement must be added:

i. Use Precautions

"For use on potted ornamentals only. DO NOT use on cut flowers."

ii. Under ENVIRONMENTAL PRECAUTIONS:

"Greenhouse use: Toxic to bees and other beneficial insects. May harm bees and other beneficial insects, including those used in greenhouse production. Do not apply when bees or other beneficial insects are foraging in the treatment area."

iii Under DIRECTIONS FOR USE:

"DO NOT allow effluent or runoff from greenhouses containing this product to enter lakes, streams, ponds or other waters."

4. Restricted-Entry Interval

a. For greenhouse potted ornamentals, tobacco storage, animal buildings, food processing plants, industrial plants, warehouses, and theaters, the following label statement must be added:

"Do not enter or allow workers or other individuals to enter during the restricted entry interval of 4 days. Entry into treated areas MUST only occur after full ventilation. Ventilation is defined as:

- 10 air exchanges are completed; or
- 2 hours of ventilation using fans or other mechanical ventilating systems; or
- 4 hours of ventilation using vents, windows or other passive ventilation; or
- 11 hours with no ventilation followed by 1 hour of mechanical ventilation; or
- 11 hours of no ventilation followed by 2 hours of passive ventilation."

"Due to inhalation risk concerns, entry before 4 days is not permitted, including for non-hand labour tasks or short tasks such as turning on a light switch."

5. Under a new or existing heading titled ENVIRONMENTAL PRECAUTIONS, add the following:

"Toxic to aquatic organisms"

"Toxic to birds and small wild mammals"

To reduce runoff from treated areas into aquatic habitats avoid application to areas with a moderate to steep slope, compacted soil, or clay.

Avoid application when heavy rain is forecast.

Contamination of aquatic areas as a result of runoff may be reduced by including a vegetative strip between the treated area and the edge of the water body.

6. Under a STORAGE heading, add the following:

"To prevent contamination store this product away from food or feed."

7. OTHER REQUIREMENTS

a. For all products containing aromatic petroleum distillates, add the following:

This product contains (an) active ingredient(s) and aromatic petroleum distillates which are toxic to aquatic organisms.

b. Should the uses for outdoor surface spray and fogging remain registered after public consultation, the following statements would be required.

i. For all product labels with outdoor uses, add the following:
Under a new or existing heading titled ENVIRONMENTAL PRECAUTIONS, add the following:

Outdoor areas: Toxic to bees. Avoid application around blooming plants. Toxic to beneficial insects. Minimize exposure to non-target areas.

ii. And for products with outdoor ULV/fogging uses, add this additional information:
ULV / fogging: Toxic to bees and beneficial insects. Applications are typically made during the cooler hours of the night or early mornings which will minimize exposure to foraging bees and beneficial insects.

c. Should the uses for greenhouse tomato, cucumber or cut flowers remain registered after public consultation, the following statements would be required.

i. Under ENVIRONMENTAL PRECAUTIONS:

“Greenhouse use: Toxic to bees and other beneficial insects. May harm bees and other beneficial insects, including those used in greenhouse production. Do not apply when bees or other beneficial insects are foraging in the treatment area.”

ii. Under DIRECTIONS FOR USE:

“DO NOT allow effluent or runoff from greenhouses containing this product to enter lakes, streams, ponds or other waters.”

References

A. Studies/Inofrmation Submitted by the Registrant

PMRA Number	Reference
2502268	2002. Data Evaluation Record, Health Effects Division, Office of Pesticide Programs, United States Environmental Protection Agency, March 31st, 2003. Dichlorvos (DDVP): Acute Cholinesterase Inhibition Study in Pre-weaning rats. Laboratory Report No.: CTL/AR7147/ Regulatory/Report, Study No.: AR7147. November 22nd, 2002. MRID No. 45842301. Unpublished Study. DACO: 4.5.12.
2502260	2003. Dichlorvos: Repeat Dose Cholinesterase Inhibition Study in Pre-weaning and Young Adult Rats. Laboratory Report No. CTL/KR1490/Regulatory/Report, Study No. KR1490. October 24th, 2003. Unpublished Study. DACO 4.5.12.
2502261	2002. Dichlorvos (DDVP): Second Acute Cholinesterase Inhibition Study in Rats. Laboratory Report No. CTL/AR7126/ Regulatory/Report, Study No. AR7126. June 19th, 2002. Unpublished Study. DACO 4.5.12.
2502262	2002. Dichlorvos (DDVP): Third Acute Cholinesterase Inhibition Study in Rats. Laboratory Report No. CTL/AR7138/Regulatory/Report, Study No. AR7138. June 26th, 2002. Unpublished Study. DACO 4.5.12.
2502264	2002.Dichlorvos (DDVP): Acute Cholinesterase Inhibition Study in Pre-weaning rats. Laboratory Report No.: CTL/AR7147/ Regulatory/Report, Study No.: AR7147. November 22nd, 2002. Unpublished Study. DACO 4.5.12.

B. Additional Information Considered

i) Published Information

PMRA Number	Reference
2405939	Canada, 2013. Re-evaluation Note REV2013-06, Special Review Initiation of 23 Active Ingredients
2767433	Canada, 2017. Proposed Re-evaluation Decision PRVD2017-16, Consultation on a Proposed Re-evaluation Decision for Dichlorvos and Its Associated End-use Products
2812845	European Commission, 2007. COMMISSION DECISION of 6 June 2007 concerning the non-inclusion of dichlorvos in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing that substance
2812848	European Commission, 2006. Review report for the active substance dichlorvos

2480295 EFSA, 2006. Conclusion regarding the peer review of the pesticide risk assessment of the active substance dichlorvos

2813814 Rotterdam Convention, 2011. Database of Notifications of Final Regulatory Action

2813815 European Commission, 2012. COMMISSION DECISION of 10 May 2012 concerning the non-inclusion of dichlorvos for product type 18 in Annex I, IA or IB to Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market

2813817 ECHA, 2011, Directive 98/8/EC concerning the placing biocidal products on the market Non-inclusion of active substances in Annex I or IA to Directive 98/8/EC, Assessment Report Dichlorvos Product-type 18 (Insecticide) 9th December 2011

ii) Unpublished Information

PMRA Number	Reference
2502265	2002. Data Evaluation Record, Health Effects Division, Office of Pesticide Programs, United States Environmental Protection Agency, May 19th, 2003. Dichlorvos (DDVP): Second Acute Cholinesterase Inhibition Study in Rats. Laboratory Report No.: CTL/AR7126/ Regulatory/Report, Study No.: AR7126. June 19th, 2002. MRID No. 45805702. Unpublished Study. DACO: 4.5.12.