A *Water Act* for Prince Edward Island,
Department of Communities, Land and Environment,
PO Box 2000,
Charlottetown, PE C1A 7N8

January 15, 2016

RE: CropLife Canada Comments on the Prince Edward Island *Water Act*

On behalf of Canada's plant science industry, CropLife Canada appreciates the opportunity to provide input to the Government of Prince Edward Island's *Water Act.*

CropLife Canada is the trade association representing the manufacturers, developers and distributors of plant science innovations — pest control products and plant biotechnology — for use in agriculture, urban, and public health settings.

CropLife Canada is very supportive of the intent of the proposed *Water Act*. The protection of the quality and quantity of PEI's water to ensure that the water supply is healthy and sustainable now and in the future is an admirable and timely goal.

While CropLife Canada is not in a position to comment on many of the key issues that would be addressed under the proposed Act, we are concerned that pest control products have been unfairly targeted by some individuals during the consultations. These individuals have made claims regarding the potential health and environmental impacts of pest control products in PEI that are simply not supported by the data. As such, we would like to provide some background information on the science-based regulatory process for pest control products in Canada to help inform your deliberations.

In the following pages we have outlined the comprehensive process by which all pesticides in Canada are regulated. The protective nature of this regulatory system is corroborated by real-world monitoring data, which indicate that currently approved pesticide products in Canada do not pose a risk to human health or the environment. These data come from a multitude of different sources, including ongoing water monitoring work on Prince Edward Island that clearly indicate that when pesticides are detected in the water on PEI, they are found at levels far below any known to pose a risk to human health.

In closing, CropLife Canada is supportive of the Government of PEI's plans to consolidate water-related legislation under a single Act. As strong advocates for a transparent, science-based regulatory system, we are a committed stakeholder in this process and look forward to an ongoing dialogue with the Government on this topic.

Sincerely

Maria Trainer, Ph.D.
Managing Director, Science and Regulatory Affairs, Chemistry

Pierre Petelle
Vice President, Chemistry

Executive Summary

Pesticides are one of the most stringently regulated substances in Canadian commerce. Indeed, the pre-market testing and regulatory requirements for a new pest control product are comparable only to those of a new pharmaceutical drug.

In Canada, pesticides are regulated under the federal *Pest Control Products Act* (PCPA) and associated regulations. The PCPA stipulates that before a pesticide can be registered, the dietary, exposure, and environmental risks must all be deemed to be acceptable and the product must have demonstrated value. The PCPA is administered by the Pest Management Regulatory Agency (PMRA) of Health Canada, which employs over 350 scientists for the sole purpose of evaluating pesticides.

Regulatory oversight of pesticides does not end when a product is registered. All pesticides in Canada are subject to post-market regulatory requirements and must also be re-evaluated at least every 15 years. This ensures that regulatory decisions are routinely reviewed to ensure that they are made on the basis of the best available scientific information in order to protect human health and promote environmental sustainability.

The current regulatory framework for pesticides is considered to be extremely conservative and health protective. The PMRA requires the submission of data from a minimum of 200 separate scientific studies on new candidate products. These studies are designed to answer questions about potential risks from short- and long-term exposures and are intended to represent extreme cases rarely expected in real-world conditions in order to be the most protective.

The health-protective nature of the federal regulatory process is corroborated by real-world analyses of incidence rates of health conditions that could be related to pesticide exposures. For example, in 2015 the Chief Public Health Office of PEI released a report reviewing the epidemiological research on human health and pesticide exposures. Following an extensive literature review of published scientific papers in the area of pesticide exposures and human health effects, the Chief Public Health Officer concluded that "*pesticides used in PEI following "labeled-practices" do not pose a significant public health risk*".

Prince Edward Island has routinely monitored pesticide residues in groundwater and surface water for several years now. The data from these monitoring surveys are available online and clearly indicate that, when pesticide residues are detected they are present in quantities far below levels of concern for human health. Indeed, almost all detections were below 1 part per billion (ppb). To put this into context, that is equivalent to one sheet of toilet paper in a roll stretching from New York to London. Indeed, these concentrations are so low that until recently, we lacked the analytical sensitivity to detect them. As such, their presence is more a reflection of our capacity to detect increasingly small concentrations of compounds rather than an indication of a worsening contamination problem.

While it is important to continue to monitor water quality, it is equally important to ensure that the levels of compounds detected are appropriately contextualized to ensure public confidence in both the integrity of the water supply and the rigour of the regulatory system that protects it are preserved.

Overview of the Canadian Pesticide Regulatory Process

Background

Pesticides are one of the most stringently regulated substances in Canadian commerce. Indeed, the pre-market testing and regulatory requirements for a new pest control product are comparable only to those of a new pharmaceutical drug.

Pest control products in Canada are all subject to the federal *Pest Control Products Act* (PCPA) and associated regulations [1]. The PCPA is administered by the Pest Management Regulatory Agency (PMRA) of Health Canada, which employs over 350 scientists – including biologists, epidemiologists, toxicologists, plant pathologists, weed scientists, and entomologists – for the sole purpose of evaluating pesticides.[1]

The PCPA mandates that all pest control products must undergo a thorough review, risk assessment, and efficacy evaluation before they can be registered for sale or use in Canada. To fulfill this mandate, the PMRA requires the submission of data from a minimum of 200 separate scientific studies on new candidate products. Only after the PMRA has thoroughly reviewed the data from these studies and completed a detailed risk assessment is the decision to approve, or reject, a new pesticide made. Furthermore, under the PCPA, all registered pesticides must undergo a re-evaluation at least once every 15 years to ensure that all registered products meet current scientific and regulatory standards.

In the following sections we will provide a high level overview of the rigorous risk assessment process that the PMRA uses to evaluate new and existing pest control products.

[1] For more details on the PMRA, please see: http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php

Risk Assessment

Pesticides, like pharmaceutical drugs and other regulated chemicals, are regulated on the basis of risk. The purpose of a risk assessment is to answer the question "what is the risk that exposure to a particular hazard (in this case, the pesticide) will result in harm?" [reviewed in 2]. As such, risk is a product of both hazard and exposure (Figure 1); if either the hazard or the exposure changes, the risk will also change. To put this into context, a hammer is a hazard to your thumb but as long as the hammer is lying on a table, it poses no risk. When you lift the hammer over your hand, it poses a risk.

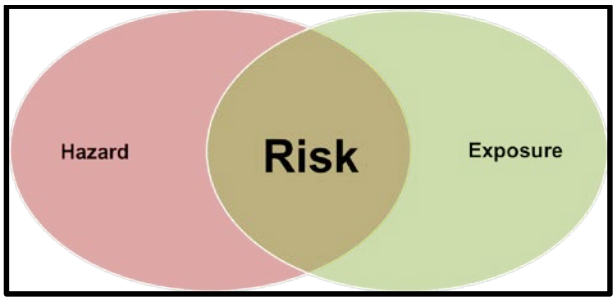

Figure 1. Risk is a function of hazard and exposure

The risk from a pest control product is, therefore, a function of both its inherent toxicity (i.e., its hazard) and the probability of an exposure sufficient to cause an adverse health (or environmental) outcome.

Pesticides are subject to both a human health *and* an environmental risk assessment.

Overview of the human health risk assessment process

Pesticide risk assessments are scenario- and pesticide-specific and take into account route of exposure, duration of exposure, and population-specific exposure (when applicable). The purpose of the human health risk assessment process is to estimate the nature and likelihood of adverse effects to people who could be exposed to pesticides via the food they eat; the air they breathe; their work; or as a result of activities that may lead to contact with pesticide residues on treated surfaces.

The human health risk assessment process was initially codified by the National Research Council of the United States in their 1983 publication, commonly known as the "Red Book" [3]. Since then, that process has been integrated into the risk assessment practices used around the world, including here in Canada. This fundamental process has four distinct steps as shown in Figure 2.

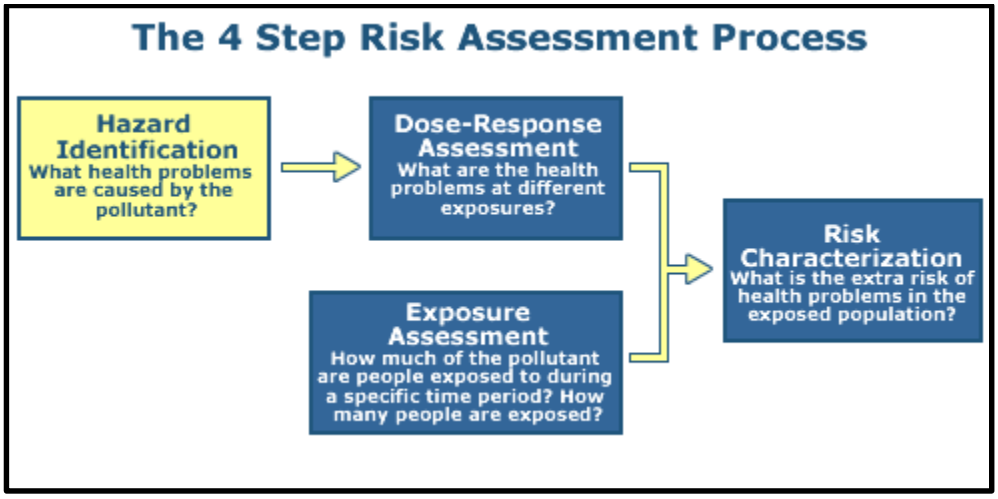

Figure 2. Overview of the four stages of the human health risk assessment for a pesticide [4]

The four steps defined in this process are as follows and described in more detail in the subsequent paragraphs:

- Hazard identification: Determines whether the substance has the potential to cause adverse effects in humans and, if so, under what circumstances.
- Dose-response assessment: Determines the relationship between the adverse effects and dose of the substance.
- Exposure assessment: Measures, or estimates, the frequency and/or duration of exposure to the substance by humans. This step takes into account route of exposure, exposure type (e.g., occupational or residential), and frequency of exposure.
- Risk characterization: Uses the information from the previous steps to estimate the risk of adverse health effects when the substance is used as intended.

Hazard Identification and Dose-Response Assessment

The inherent hazard of a substance is evaluated using a variety of different types of toxicity study. These include acute, short-term, and chronic studies conducted in different species and using different routes

of exposure (e.g., via the skin, mouth, lungs, and eyes). The purpose of these studies is to identify potential effects on human health based on different exposure scenarios.

These studies are conducted in multiple species to determine if effects observed in one organism are common to all or if they are limited only to certain species.

Studies are also conducted to collect metabolic (how the substance is broken down in the body) and toxicokinetic (how a substance gets into the body and what happens to it once it is there) information in order to understand rates of absorption, distribution, and excretion in mammalian systems.

The Canadian data requirements for pesticide registration are similar to those of the United States and other Organisation for Economic Cooperation and Development (OECD) countries [5].[2] These studies must be conducted according to internationally recognized test guidelines published by the US EPA or the OECD.[3; 4]

Required Studies

Acute toxicity studies provide information on adverse health effects that might occur as the result of a short period of high exposure. A typical acute toxicity data package will include studies on the end-use formulation looking at effects resulting from mouth, skin, and lung exposures; eye irritation; skin irritation; and skin sensitization. The data from these studies are used to help establish doses for subsequent longer-term studies. They are also used to help make recommendations on the safe handling of products and to inform hazard warning information on the product label.

Short-term toxicity studies are used to evaluate the effects of a repeated exposure over a short period of time, approximately 10% of the animal's lifespan, via the most common routes of exposure (mouth, skin, and lungs). The data from these studies are used to identify if particular tissues or organs are more susceptible to damage; to determine possible cumulative effects or delayed toxicity; to identify potential variability in species sensitivity; to establish doses that are tolerated by test animals; and to establish the appropriate doses for longer term studies.

Long-term toxicity and carcinogenicity studies are conducted to evaluate the effects of exposure to a substance over the majority of the test animal's lifetime in order to mimic the full lifespan of a human. These studies typically last for 18 months to 2 years (i.e., the full lifespan of a rat or mouse) and provide extensive data on systemic toxicity and carcinogenicity. The doses used in these studies are informed by the acute and short-term studies described above and are chosen to provide a range of responses including the identification of a dose that results in no observable adverse effects (NOAEL) and a dose that results in overt toxicity.

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[2] The PMRA's data requirements are summarized online in data-code (DACO) tables here: http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/prod/_daco-codo/index-eng.php

[3] A full list of approved OECD test guidelines is available for download here: http://www.oecd.org/env/ehs/testing/Full%20list%20of%20Test%20Guidelines%20in%20English%20September%20%202014.pdf

[4] A full list of US EPA test guidelines is available for download here: http://www.epa.gov/sites/production/files/2015-11/documents/ocspp-testguidelines_masterlist-2015-11-19.pdf

Reproductive and developmental toxicity studies are conducted to evaluate possible effects on growth and reproduction. These studies, by necessity, are conducted over at least two generations and look at effects in both males and females. Test animal offspring are exposed to the test substance via the maternal milk supply until weaning, after which they are fed diets containing specific amounts of the same substance.

Teratology studies are conducted to determine whether a substance could cause adverse effects in a developing foetus. Pregnant female test animals are exposed to the test substance during the most sensitive stages of foetal development and the effects on the pregnant animal, developing embryo, and resultant offspring are evaluated.

Genetic toxicity studies are conducted to evaluate whether the substance has the potential to interact with genetic material and, if so, how this interaction might occur. This is key to understanding if the substance could induce mutations or affect normal gene expression. The data from these studies are evaluated in conjunction with the data from carcinogenicity studies in order to help understand possible mechanisms, and modes, of action for any observed effects.

Metabolism and toxicokinetic studies are conducted to help understand how a substance is likely to absorb into the body; how the absorbed dose is then distributed throughout the body; and the rate and routes of excretion from the body. These studies are also used to identify key metabolites and their expected fates.

Additional data requirements

Depending on the outcomes of the studies described above, other studies may be required to further understand and characterize the hazard profile of a substance. These additional studies are described below.

Neurotoxicity and developmental neurotoxicity studies are required for any pesticides that are likely to affect the nervous system. A suite of neurotoxicity studies may be requested in order to fully characterize the pesticide's mechanism of neurotoxic activity.

Immunotoxicity studies may be requested if the data from short- and long-term studies suggests that a pesticide might interfere with normal immune function.

Mechanism of action may be evaluated via the use of ancillary studies in order to better interpret the findings of an animal study. These data may permit a more comprehensive assessment of potential health risks to humans.

Acute studies on a **combination of active ingredients** will be required if an end-use formulation will have more than one active ingredient present. If the combination of active ingredients is suspected to demonstrate additive toxicity, additional toxicity data may also be requested.

Outcome of hazard identification and dose-response analyses

The outcome of the suite of hazard identification and dose-response studies is the identification of numerous NOAELs for the different toxicity endpoints that were studied. These data must be reviewed further in order to select the most appropriate study, endpoint, and NOAEL for use in the risk

assessment. This selection process considers which human subpopulations may be exposed, the route of exposure, and the anticipated duration and/or frequency of exposure.

Exposure assessment

The purpose of the exposure assessment is to quantify the potential route, magnitude, duration, and frequency of exposure to the substance in question.

Exposure estimates consider multiple pathways (food, drinking water, and residential use) and all relevant routes of exposure (oral, dermal, and inhalation) in order to ultimately generate an aggregate exposure assessment [reviewed in 6].

Dietary exposures

Estimates of dietary exposure are derived from two sources of information: the residue level present in or on food and the types and amounts of food that people eat (food consumption) [reviewed in 7].

Consumption data are obtained from the UE EPA's What We Eat in America (WWEIA) - Food Commodity Intake Database, which provides information on what people eat in the United States.[5]

Estimated residue levels in food are derived from crop field trials; US and Canadian government compliance and monitoring programs; total diet studies; storage stability studies; livestock feeding studies; market share data (used to calculate percentage crop treated); and studies on the effects of processing activities that may affect residue levels.

Crop field trials are experimental studies, typically conducted by the registrant in support of their application, to simulate the maximum use scenario of the end-use product. These studies are conducted using the formulated product in accordance with strict PMRA guidelines in order to determine the maximum residue that could be present in fruit, vegetable, grain and other food and feed crops [reviewed in 7, 9, 10].

For those products that are already on the market, government monitoring programs (e.g., CFIA compliance monitoring) and market-based surveys may provide additional data to help refine pesticide residue estimates. When these data are not available (e.g., when evaluating a new active ingredient), the PMRA uses data from the experimental field trials.

Exposure estimates may be further refined to account for the impact of commercial processing, cooking, or in-home food preparation activities on residues (typically a reduction) and available information on the percentage of crop that is treated.

Estimating drinking water exposures

The PMRA includes an evaluation of potential drinking water exposure in the dietary risk assessment [11]. Using a tiered approach, the PMRA identifies those pesticides that might be found in groundwater or surface water and uses established computer models to estimate the concentrations that might be found in these sources of drinking water. The models use conservative assumptions based on worst case scenario use patterns in order to ensure the risk assessment is protective of a range of conditions. The

[5] The PMRA has established that these data are sufficiently representative of Canadian food intake to be used in a risk assessment [8].

models generate an estimated environmental Concentration (EEC), which can then be integrated into the dietary risk assessment.

The PMRA combines both consumption data and residue data for dietary and drinking water exposures to generate an estimate of the potential dietary intake (PDI) for the general population as well as many subpopulations (e.g., infants, children, teenagers, adults, seniors, etc.).

Occupational exposures

The occupational exposure assessment estimates dermal and inhalation exposure in individuals who mix, load, and/or apply pesticides and to post-application workers who work in areas treated with pesticides.

The exposure assessment considers inhalation rates, body weight, and life expectancy in order to determine inhalation exposure estimates, normalized exposures, and lifetime average daily dose respectively [8]. Occupational exposure estimates are calculated for the short-term (1 to 30 days), intermediate-term (1 to 6 months), and long-term (greater than 6 months) depending on the use pattern and hazard profile of the pesticide.

Residential exposures

The residential exposure assessment estimates dermal, inhalation, and incidental oral exposure to pesticides used in homes, parks, on pets, and other areas such as golf courses.

The assessment considers an individual's age and gender attributes; seasonality of use; likelihood of application by professional versus resident; linked uses when two or more products might be used in combination; geographic variations; and demographic considerations [reviewed in 6].

Population groups assessed in residential exposure assessments include adults, youth, children, and females of reproductive age [8]. Residential exposure estimates may be determined over the short-term (1 to 30 days), intermediate-term (1 to 6 months), long-term (greater than 6 months), and the entire life time.

Risk Characterization

Risk characterization integrates the hazard and exposure information in order to determine the level of risk. During this process, the PMRA employs uncertainty factors to ensure that there is a safety margin between the NOAEL observed in animal studies and the anticipated human exposure. This safety margin is intended to provide a reasonable certainty of no harm to human health if the product is used according to the label instructions [reviewed in 12]. Uncertainty factors account for the potential that humans might be more sensitive to a substance than laboratory animals (interspecies extrapolation) and some humans might be more sensitive than others (intraspecies extrapolation). Additional uncertainty factors may also be applied depending on the potential sensitivity of the young, severity of the endpoint, or completeness of the dataset [reviewed in 9]. For any given pesticide, different uncertainty factors may be applied to reflect the relevant toxicological profile and other variables associated with the specific risk assessment.

The PMRA will typically establish a reference dose that represents the level of exposure or intake for which there is reasonable certainty of no harm to human health. This dose is then compared to the estimate of exposure in order to evaluate the acceptability of risk.

Dietary risk assessment

For dietary risk assessments, the PMRA establishes an acute references dose (ARfD) and an acceptable daily intake (ADI). The ARfD is the dose to which an individual could be exposed on any given day and expect no adverse health effects and is typically set 100-1000 times below the NOAEL from the most relevant animal toxicity study; the ADI is the dose to which an individual could be exposed over the course of a lifetime and expect no adverse health effects.[6]

The PMRA will only conclude that the risk is acceptable if the exposure assessment indicates that the potential peak one-day and average lifetime dietary exposures are less than the ARfD and ADI respectively. As such, the PDI (described above) cannot exceed the ADI or the ARfD. This information is summarized graphically in Figure 3.

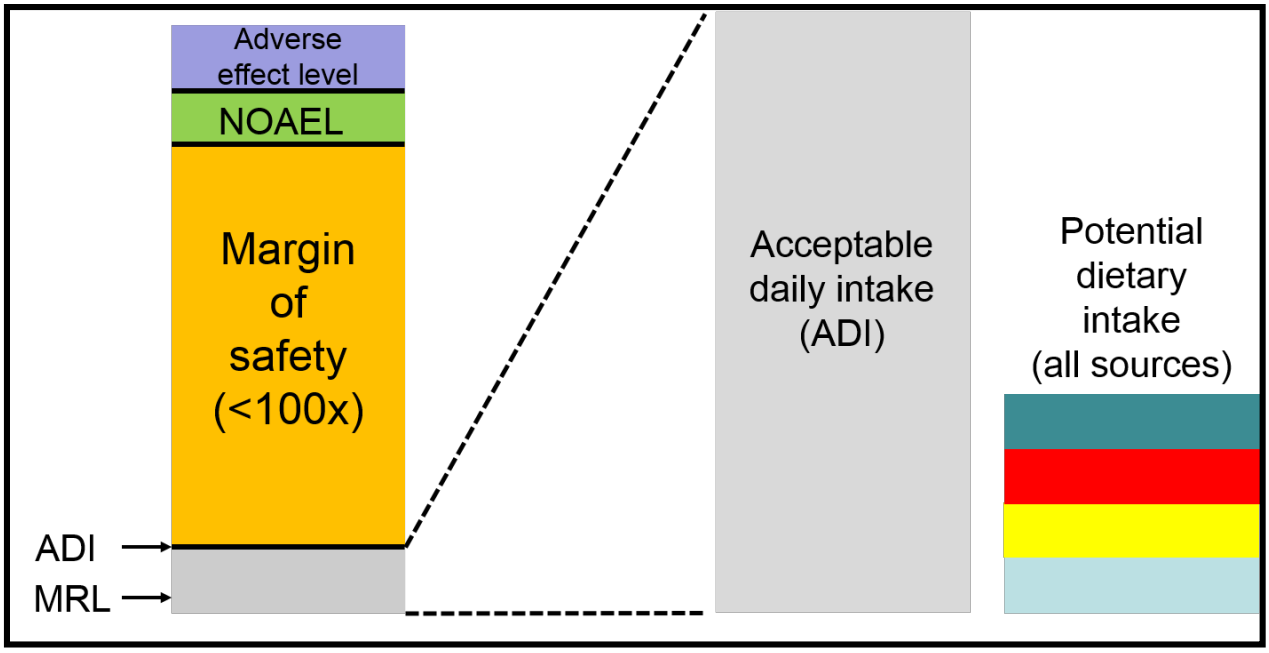

Figure 3. Relationship between NOAEL, ADI, PDI, and MRL

Non-Dietary Risk Assessment

For exposures in the workplace (occupational) or home (residential), the PMRA use a different approach to evaluate risk. For these kinds of exposures, they look at the ratio of the NOAEL to the estimate of exposure. This ratio is commonly referred to as the margin of exposure (MOE). An MOE must be sufficiently large to ensure reasonable certainty of no harm in order to be deemed acceptable.

[6] The ARfD is typically higher than the ADI because people can generally tolerate a higher dose of a substance over a shorter period.

An Aside on Maximum Residue Limits

Maximum residue limits (MRLs) are the maximum amount of pesticide residue legally permitted to remain on or in food commodities or animal feeds. MRLs are derived from crop field trials that have been conducted in accordance with good agricultural practices (GAP). In these trials, the pesticide is applied under the intended conditions of agricultural use and the crop is harvested at an appropriate time interval. The concentration of residues still present in the crop at the end of the field trial are then analysed [reviewed in 13].

MRLs are only established once the dietary risk assessment is complete to ensure that any residues in or on food do not represent a health concern to any subpopulation. Although the MRLs are compared to the ADI and ARfD to ensure that use of the product under field conditions will not result in residues that exceed the ADI or ARfD, the MRL is not based on either of these values. A summary of the relationship of the MRL to the ADI and PDI is shown in Figure 3.

MRLs are not a health-based value. MRLs are an enforcement tool that is used by the Canadian Food Inspection Agency (CFIA) to ensure compliance with the pesticide label.

Overview of ecological risk assessment process

In addition to passing a comprehensive human health risk assessment, a pesticide cannot be approved for sale or use in Canada, unless the PMRA is able to determine that it will not pose an unreasonable risk to plants, wildlife, and the environment.

The PMRA conducts ecological risk assessments to understand what risks might be posed by a pesticide and whether changes to the proposed use (or existing uses in the case of a product under re-evaluation) are needed to protect the environment. Environmental studies are conducted to evaluate:

- Environmental fate and transport of a pesticide in soil, air, and water
- Ecological effects or toxicity of a pesticide, and its breakdown products, to various non-target terrestrial and aquatic plants and animals

The data from these studies are reviewed by scientists at the PMRA to characterize both the potential environmental exposures and potential ecological effects. This information is then integrated into the risk assessment. The risk assessment then describes the ecological risk from the use of the pesticide and/or the likelihood of effects on terrestrial and aquatic animals and plants under different use scenarios.

If the risk assessment indicates that a pesticide could cause harm to plants or wildlife, the PMRA will take additional action.

An ecological risk assessment is conducted for every pesticide active ingredient and its major degradation products. A pesticide is only approved for sale or use if the PMRA is able to conclude that, when used according to label instructions, the product will not cause unreasonable harmful effects to wildlife or the environment.

The ecological risk assessment process for pesticides is summarized in Figure 4 and described in more detail in the subsequent paragraphs.

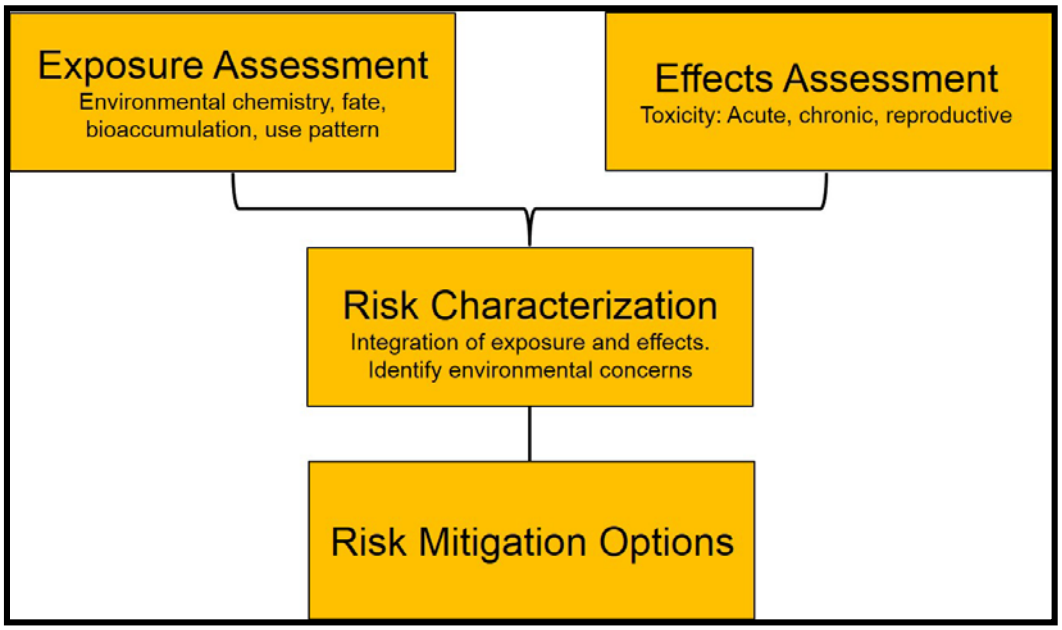

Figure 4. Overview of the ecological risk assessment process

Exposure Assessment

The purpose of the exposure assessment is to estimate the potential exposure of plants and animals to pesticide residues in the environment. The outcome of this assessment is an exposure profile that describes the source(s) of the pesticide and what organisms are exposed; the fate and transport of the pesticide in the environment; potential exposure pathways; an understanding of frequency, duration, and magnitude of exposures to the pesticide and its major breakdown products; an understanding of variability and uncertainty in the exposure estimates; and conclusions about the likelihood of exposures.

To develop this exposure profile, the PMRA use data from a variety of studies, some of which are described in more detail in the subsequent paragraphs.

Fate and transport studies

The PMRA uses data from a large number of laboratory and field studies to understand how a pesticide will behave in the environment. These studies look at the interaction of the pesticide with soil, sunlight, air, surface water, and groundwater and are designed to answer questions such as:

- How does the pesticide active ingredient degrade?
- What compound(s) does the pesticide degrade into?
- How persistent is in the pesticide, and its breakdown products, in the environment?
- How mobile is the pesticide active ingredient, and its degradation products, in the environment?
- How might the pesticide active ingredient, and any degradation products, move away from the initial site of application?
- What is the potential for the pesticide to volatize into the atmosphere?

- What is the potential for the pesticide, and any degradation products, to move into surface water or groundwater?
- What is the potential for the pesticide, and any degradation products, to bind to the soil?
- How much of the pesticide, and its degradation products, will accumulate in the environment?

Collectively this information allows the PMRA to characterize the dissipation processes that will occur when a pesticide is released into the environment and identify the degradation products that will likely result. The PMRA, EPA and OECD guidance documents summarize this in the graphic shown in Figure 5.

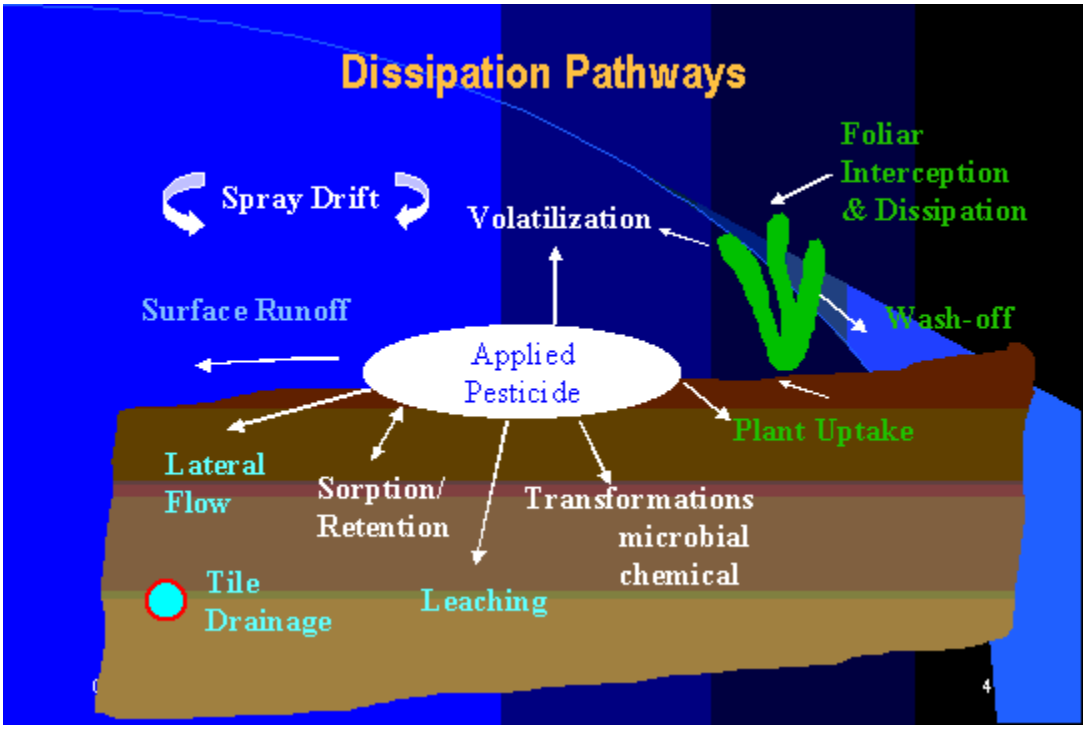

Figure 5. Characterization of dissipation pathways[7]

The results of these analyses are used to develop a preliminary environmental fate and transport profile. If the scientists at the PMRA determine that additional data are needed to further characterize the environmental behaviour of a pesticide, this profile can be used to design additional field studies and provide parameters for additional modelling.

Field studies are also used to provide a more accurate picture of the behaviour of the pesticide and its breakdown products in the environment. These data are used to further refine the environmental fate and transport profile and provide model estimates of potential exposures.

The types of environmental fate studies required by the PMRA depend on the use of the pesticide. For example, certain studies are routinely required for any pesticide intended for outdoor use. Other studies

[7] Source of graphic: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-1#HDPDITE

may be triggered based on the intended use pattern or the basic product chemistry data that registrants must submit. The studies fall into several broad categories:

Physicochemical degradation: These studies evaluate the potential of the pesticide to degrade in water (hydrolysis) and/or in water, soil, and air when exposed to sunlight (photodegradation). Data on the formation, identity, and persistence of breakdown products are also collected in these studies.

Biological degradation: These studies include aerobic and anaerobic metabolism in the soil and in water.

Soil metabolism looks at the persistence of the pesticide when it interacts with soil microorganisms under both aerobic and anaerobic conditions.

Aquatic metabolism looks at the persistence of the pesticide when it interacts with microorganisms in a water/sediment system under both aerobic and anaerobic conditions.

These studies also identify any breakdown products that are produced as a result of biological degradation.

Mobility: These studies include an evaluation of leaching and adsorption/desorption; laboratory volatility; and field volatility.

Field dissipation: Terrestrial field dissipation (TFD) studies are conducted to demonstrate the transformation, transport and fate of pesticides under representative actual use conditions [reviewed in 14]. These field studies are used to substantiate the physicochemical, mobility and biotransformation data from laboratory studies. Environmental fate studies have shown that pesticide dissipation may proceed at different rates under field conditions and may result in degradates forming at levels different from those observed in laboratory studies. The guidance for terrestrial field dissipation studies was harmonized under NAFTA in order to help ensure that TFD studies are conducted in a manner that will provide risk assessors and risk managers with more confidence in the data generated and with a better understanding of the assumptions and limitations of the data and estimated half-lives of the chemical.

Groundwater monitoring: Prospective groundwater studies (PGW) are designed to test whether a pesticide, under certain conditions, can reach groundwater and in what concentrations. These are EPA-mandated studies; however PMRA accepts and has utilized the findings from areas of the US relevant to Canada to more accurately determine the projected concentrations of compounds in groundwater under representative use conditions.

Off-target pesticide movement

Runoff: The PMRA uses exposure models to estimate concentrations of pesticides that may run-off a treated field to adjacent surface water; PMRA uses the linked PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modelling System) models or a newer adaptation called SWCC (Surface Water Concentration Calculator). Pesticide concentrations in a representative wetland are modelled using either 15 cm or 80 cm water depths to account for typical depths of habitation for aquatic life. The PMRA has developed a series of agricultural scenarios that are typical of many of the major crop growing areas across Canada, and inputs for these scenarios include realistic data on the weather, soil, crops and hydrology.

Spray drift: Spray drift is an important process contributing to the off-target movement of a pesticide (together with run-off and leaching). Off-site spray drift and deposition is largely independent of the physical/chemical characteristics of an active ingredient, but may be dependent on the physical/chemical characteristics of the formulation developed by the registrant. For field sprayer applications, the PMRA use the empirical data of Wolf and Caldwell to estimate downwind deposition [reviewed in 15]; for aerial applications, they use the AGDISP model to describe deposition [reviewed in 15].

Exposure evaluation

The PMRA scientists review the environmental fate and transport data and develop an exposure profile that is used to evaluate potential exposures for different organisms.

The approach used to evaluate exposure differs depending on the organisms in question but include the following:

- Exposures to aquatic animals (e.g., fish and invertebrates).
- Dietary exposures for birds and mammals through food items.
- Dietary Exposure for Reptiles and Amphibians through Food Items
- Dietary Exposure of Birds and Mammals through Drinking Water
- Inhalation Exposure for Birds and Mammals
- Dermal Exposure to Birds, Mammals, Reptiles, and Amphibians
- Exposure to non-target aquatic plants (consistent with the approach used for exposures to aquatic animals)
- Run-off and drift estimates for non-target terrestrial plants
- Exposure to non-target insects

The level of exposure of non-target organisms to a pesticide is estimated through the calculation of an Expected Environmental Concentration (EEC) of the pesticide. Calculations are based on the maximum application rate, and if multiple applications of the pesticide are allowed, then the EEC is calculated by considering the maximum single application rate times the maximum number of applications, factoring in the dissipation characteristics of the pesticide, i.e., the half-life or time for 50% of the pesticide to disappear, between applications.

Ecological Effects Assessment

Ecological effects characterization is conducted to understand how toxic a pesticide is to different organisms and/or other ecological entities (such as communities), the effects that it produces, and how those effects change with different levels of exposure.

Toxicity is estimated by evaluating data from acute and chronic lab and (sometimes) field studies in which animals and plants are exposed to different amounts of a pesticide and their responses are measured. The outcome is a dose-response relationship between the amount of pesticide to which an organism is exposed and the effects on that organism.

Since it is not possible (nor ethical) to test every pesticide on every possible species, surrogate organisms are used to represent a group of organisms. Under the auspices of the Organisation for

Economic Cooperation and Development (OECD), leading experts from around the world agree on the representative species and overall data requirements for pesticide assessments.[8] The PMRA is an active participant in these groups and has played a leading role for many years in international regulatory efforts for pesticides.

The PMRA review data from laboratory and field studies in a range of different test organisms from different taxonomic groups in order to characterize the potential toxic response and determine the dose-response relationship with the pesticide and any major breakdown products. The data from these studies are used as predictors for effects on ecosystems.

Impacts and ecological effects studied

The types of data required for an ecological effects characterization may vary depending on the nature of the pesticide in question and when and where it will be used. A full list of all potential studies may be found on the PMRA website.

The toxicity of a pesticide product to non-target organisms is primarily due to the active ingredient(s) (a.i.). This toxicity is expressed as a dose-response relationship between the concentration of the active ingredient and the adverse effects upon the organism, such that increased concentrations of (exposure to) the compound results in increased adverse effects. Adverse effects may be lethal or sub-lethal (e.g., changes in behaviour, changes in reproductive success). Currently, the PMRA uses the No Observable Effect Concentration (NOEC) for fish, *Daphnia* sp., algae or *Lemna* sp. (aquatic organisms) and the EC_{25} (a 25% inhibitory effect in a measurement parameter such as seed germination, seedling emergence, plant height, plant dry weight, shoot length, shoot weight or root weight) for terrestrial plants as the endpoints of concern in its risk assessments. In either case, terrestrial or aquatic, the appropriate endpoint of the most sensitive non-target organism is used for the purpose of calculating a buffer zone.

Some of the impacts or effects measured in ecotoxicity studies include:

- Mortality
- Reduction in growth
- Reproductive impairment
- Change in number of species
- Bioaccumulation of residues in non-target organisms
- Disruption of community and ecosystem-level functions.

Ecotoxicity studies are conducted in many different species, including birds, non-target insects (e.g., honeybees), mammals, fish, amphibians and reptiles, and non-target plants.

For each test and species studied in the ecological effects analyses, the highest concentration at which no effect is observed is recorded. This is known as the no observed effect concentration (NOEC). The lowest NOEC recorded for the most sensitive species is deemed to be the safe environmental concentration.

[8] For more information, see:
http://www.oecd.org/env/ehs/testing/seriesontestingandassessmentadoptedguidanceandreviewdocuments.htm

Risk Characterization

During the risk characterization step, evaluators compare the EECs to the NOECs to determine if any of the anticipated environmental concentrations would approach levels of concern.

In the event that the EECs do represent a concern, the PMRA may look to further refine the risk assessment in order to better understand certain aspects of the anticipated environmental effects and/or examine the potential use of risk mitigation measures.

Risk Mitigation

Examples of potential risk mitigation measures include:

- Reducing the number of applications per season
- Mandating the use of buffer zones to reduce drift
- Restrict applications to non-consecutive years
- Restrict to ground application only (i.e., no aerial use)
- Decreased application rates (in conjunction with an efficacy review)
- Change application conditions (e.g., time of day)
- Modify the formulation type
- Require immediate incorporation into the soil
- Restrict certain uses
- Mandate label advisory statements
- Restrict use of the active ingredient

Risk mitigation example: buffer zones

Spray drift is an important process contributing to the off-target movement of a pesticide (together with run-off and leaching). During the pesticide evaluation process, the PMRA assesses the risks to non-target organisms posed by the use of a pesticide by evaluating the environmental toxicity of the pesticide's active ingredient and identifying aquatic or terrestrial organisms that are sensitive to the compound. If a risk is identified, then various strategies are implemented to reduce it, one of which may be the requirement for a buffer zone during application to reduce spray drift. A sensitive area may be aquatic (including permanent and non-permanent water bodies), terrestrial (e.g., shelterbelts and woodlots) or a combination of both (e.g., wetlands, riparian zones, wet meadows, marshes, swamps, fens and bogs). PMRA calculates pesticide buffer zones based on the following underlying principle: the more toxic the pesticide to a sensitive non-target organism, the larger the buffer zone. Site-specific buffer distances are modified by the sensitive area to be protected, the meteorological conditions under which the spray is applied and the configuration of the pesticide spray equipment.

Buffer zones for aquatic habitats are calculated by using the aquatic EEC and the NOEC or EC_{25} for the most sensitive aquatic/terrestrial organism as input values to the function that describes the deposition of the pesticide over distance. This function is used to determine the appropriate distance, i.e., the buffer zone, in metres that the spray equipment should be from the downwind sensitive habitat when the pesticide is applied.

The buffer zones are specified on the pesticide label. The PMRA believes that the use of conservative drift scenarios and the NOEC or EC_{25} of the most sensitive species results in buffer zones that are upper

bound estimates of those required to protect non-target organisms. By combining information on the amount of drift and exposure with appropriate data on toxicity, it is possible to determine if drift during application is likely to cause adverse effects on non-target organisms. If a risk is identified, i.e., if the EEC is greater than the NOEC or EC_{25} of the most sensitive non-target organism, it is then possible to determine what reduction in drift would be required to reduce the risk, i.e., the EEC equal to or less than the NOEC or EC_{25} of the most sensitive organism. Assuming that the application rate remains unchanged, a reduction in drift to sensitive areas can be achieved by the following:

- Implementing a buffer zone;
- Spraying under more favourable meteorological conditions;
- Changing the sprayer configuration; or
- A combination of the above.

Overview of the value assessment

Under the *Pest Control Products Act*, a pest control product must be of acceptable value in order to be approved for sale or use in Canada [1]. Under the Act, value means the product's actual (or potential) contributions to pest management and includes efficacy; effects on the host organism(s); health, safety, and environmental benefits; and social and economic impact [reviewed in 16]. The PMRA takes a weigh-of-evidence approach to assessing value, integrating data and information across all of these aspects. A broad overview of this approach is summarized in the following paragraphs.

Efficacy

In order to be registered in Canada, a pest control product must demonstrate a level of efficacy that would significantly contribute to the management of the target pest it is registered to treat. The onus is on the registrant to demonstrate to PMRA – through submission of data such as use history information, published papers, scientific rationales, and/or trial studies – that the product is efficacious under the proposed conditions of use in Canada.

Effects on host organisms

The registrant must provide PMRA with data to demonstrate on effects of the pesticide on the host organism. The registrant must explain to the PMRA how they have determined that there is an adequate margin of safety to protect each host and rotational crop. If the product has the potential to cause damage to the host crop, the PMRA will require the addition of warning statements to the product label.

Health, safety, and environmental benefits

The registrant can provide the PMRA with data to demonstrate how, and to what extent, the proposed product (or use pattern) might benefit Canadian users and other direct stakeholders (e.g. consumers or applicators) from a health, safety, and/or environment perspective. Examples of this kind of infloration include control of a poisonous or invasive plant; control of a pest that affects human health (e.g., mosquitoes); control of an invasive species; or control of a plant pathogen that could harm human or animal health.

If the proposed product could replace an existing pesticide that is being phased out or is compatible with integrated pest management (IPM) or resistance management strategies, the PMRA will take that into consideration during the value assessment.

Social and economic impacts

The PMRA will consider factors like the sustainability of the sector, trade implications, acres under crop, influence of the pest on crop quality and marketability, additional costs associated with pest presence, and/or indirect effects of the pest on the crop as part of the value assessment.

If quantitative estimates of the economic impact of the pest, and thus the projected economic benefit of the product, these can also be included in the value assessment.

Outcome of the risk and value assessments

The outcome of the risk and value assessments described in the preceding sections is an integrated science-based decision-making process.

Before a pesticide can be registered, the dietary, exposure, and environmental risks must all be deemed to be acceptable and the product must have demonstrated value to Canada. Using the complete database of information submitted and evaluated, the PMRA must be satisfied that any and all concerns have been identified and addressed before making a final decision.

If the PMRA determines that the health or environmental risks or value are unacceptable, they will deny registration. If they determine that the risks and value are acceptable, they will propose registration of the pesticide, which then triggers a public consultation process. The PMRA publishes a proposed registration decision on their website and the public has 45 calendar days to provide comments that the PMRA takes into consideration before issuing a final registration decision.

Re-Evaluation

Under the *Pest Control Products Act*, a pest control product must be re-evaluated at least once every fifteen years to ensure that they meet the latest health and environmental risk assessment standards [1].

During the re-evaluation process, the PMRA integrates all available and relevant scientific data into their decision-making process [reviewed in 17]. Where applicable, they also collaborate with the US EPA and reviewers from other OECD countries.[9]

At the start of the re-evaluation process, the PMRA conducts a screening review to determine what information and data might be available on the pesticide in question. This includes a scan of the scientific literature and incident reports and outreach to other jurisdictions (including provincial and municipal governments) for any relevant information they may have. They also verify that the conditions of use specified in earlier risk assessments are still reflective of the current use patterns and that nothing major has changed that would impact those earlier decisions. If the PMRA determines that their earlier risk assessments do not meet the current requirements in one or more areas, they may require a new or revised evaluation for each affected area.

The outcome of the re-evaluation could be continued registration with no changes; label amendments; removal of certain formulations and uses from the registration; or cancellation of the registration if the risks are deemed unacceptable.

In the event that the PMRA has reasonable grounds to conclude, prior to completion of the re-evaluation, that the product poses an imminent risk to human health or safety or the environment, they can cancel or amend the registration at any time.

[9] More information on the PMRA's Re-Evaluation Program can be found here: http://www.hc-sc.gc.ca/cps-spc/pest/part/protect-proteger/regist-homolog/_re-eval/index-eng.php

Pesticides and Prince Edward Island

The health-protective nature of the federal regulatory process is corroborated by real-world analyses of incidence rates of health conditions that could be related to pesticide exposures. For example, in 2015 the Chief Public Health Office of PEI released a report reviewing the epidemiological research on human health and pesticide exposures. Following an extensive and literature review of published scientific papers in the area of pesticide exposures and human health effects, the Chief Public Health Officer concluded that "*pesticides used in PEI following "labeled-practices" do not pose a significant public health risk*".

Prince Edward Island has routinely monitored pesticide residues in groundwater and surface water for several years now and should be commended for its proactive approach to protecting its precious water supply. The data from these programs are important for registrants and regulators alike to ensure that there are no unintended or unexpected drinking water exposures as a result of pesticide use in the province. A review of the most recent report [18] indicates that the number of groundwater sites recording pesticide detections has remained mostly constant over the past decade, with the increase recorded in the past two years entirely attributable to an increase in detection sensitivity.

Detection sensitivity is a key factor to be considered when interpreting any environmental monitoring data. Over the past several decades, we have witnessed a tremendous improvement in our capacity to detect increasingly small concentrations of substances in the environment. As such, it is imperative that ensure that if and when compounds are detected, the concentrations are appropriately contextualized to ensure public confidence in both the integrity of the water supply and the rigour of the regulatory system that protects it are preserved. For example, a review of the PEI groundwater monitoring data indicate that, when pesticide residues are detected, they are present in quantities far below levels of concern for human health. Indeed, almost all detections were below 1 part per billion (ppb). To put this into context, that is equivalent to one sheet of toilet paper in a roll stretching from New York to London. Indeed, these concentrations are so low that until recently, we lacked the analytical sensitivity to detect them. As such, their presence is more a reflection of our capacity to detect increasingly small concentrations of compounds rather than an indication of a worsening contamination problem.

In conclusion, CropLife Canada is supportive of the Government of PEI's plans to consolidate water-related legislation under a single Act. As strong advocates for a transparent, science-based regulatory system, we are a committed stakeholder in this process and look forward to an ongoing dialogue with the Government on this topic.

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