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Agence de réglementation de la lutte antiparasitaire

Regulatory Proposal PRO2005-06

Agricultural Buffer Zone Strategy Proposal

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Table of Contents

1.0 Executive Summary

Since 1995, Health Canada's PMRA has calculated 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. However, in order to reflect the variability between sensitive areas, differing application practices and advances in application technology, the Agency formed the Buffer Zone Working Group to address the need to refine the calculation of buffer zones. It examined various options and proposed a strategy that incorporates information on the sensitive area to be protected, the meteorological conditions under which the spray is applied and the configuration of the pesticide spray equipment.

The buffer zone calculation refinement is done through the use of numeric multipliers based on sensitive area, equipment and meteorological characteristics. In this manner, the observed buffer zone will take into consideration the pesticide and operational conditions.

The PMRA believes that the proposed Strategy is "risk neutral", i.e., it will provide the Agency and the applicator with considerably more flexibility than is presently allowed **without increasing risk to sensitive areas**. The Strategy will encourage applicators to use new technology and sprayer configurations to reduce spray drift. It will increase awareness of the effects of meteorological conditions on spray drift and encourage applicators to spray only under favourable conditions. It will also give applicators the tools they need to customize their spraying program without increasing the risk of harm to the environment.

2.0 Introduction

During and after application, a pesticide can move through the environment by several routes, such as spray drift (particle and vapour), runoff and leaching. Each transportation process presents different problems to sensitive areas[1] and each may require mitigating measures to minimize the adverse effects of the pesticide on these environments. For the purposes of this document, the term "spray drift" [2] will refer **only** to particle drift. In addition, this document does not consider the effects of the following:

- postapplication runoff and leaching;
- forestry pesticide applications, as these applications are complex and very different from agricultural applications; or
- buffer zones for non-target crops.

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[1] In this document, a sensitive area is defined as an area containing or comprised of organisms that are affected by the pesticide product being applied.

[2] Particle (droplet) spray drift is defined as the wind-induced movement of spray particles (droplets) away from the spray swath during application. This definition does **not** include postapplication vapour drift.

During the pesticide evaluation process, the PMRA assesses the risks to non-target organisms posed by the use of a pesticide. It also evaluates the environmental toxicity of the pesticide's active ingredient and identifies 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[3] during application. 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).

Prior to 1995, buffer zones of 15 m and 100 m were imposed for field sprayer and aerial applications, respectively, for those pesticides that were assessed to be of risk to sensitive areas. These buffer zones were arbitrarily selected and did not reflect the differing toxicities of various pesticides to non-target organisms.

Since 1995, the PMRA has used models or empirical data to calculate pesticide buffer zones. The calculation of the buffer zones is based on the following underlying principle: the more toxic the pesticide to a sensitive non-target organism, the larger the buffer zone. The PMRA also believed that refinements to the calculation of buffer zones were needed in order to reflect the variability between sensitive areas, differing application practices and advances in application technology. As a result, the PMRA Buffer Zone Working Group (Appendix I) was formed in 1998 to address these issues.

The following questions represent areas on which the PMRA is seeking input from reviewers. These questions should be seen as food for thought, and reviewers should not constrain themselves to these areas. They are rather encouraged to discuss other areas of interest.

- Do you believe the proposed strategy gives flexibility to applicators while still protecting the environment?

- Is it feasible for applicators to implement the buffer zone approach?

- Are there any "sensitive" aquatic or terrestrial habitats that you would prefer to see added to the list on the buffer zone label? Are there any areas that should be excluded? Please provide your rationale for additions or exclusions.

- Should there be default buffer zones for humans/inhabited areas?

- Do you think the PMRA should also set a minimum buffer zone distance around the listed sensitive habitats, regardless of wind direction at the time of spraying? For example, "This product cannot be applied within five metres of the following

[3] A buffer zone is defined as the distance between the point of direct pesticide application, usually the end of the spray swath, and the nearest **downwind** boundary of a sensitive area.

sensitive habitats, and within X m when these habitats are downwind from the point of application".

- Do growers/applicators have the capability to accurately determine wind speeds on site? Is it feasible to have three windspeed categories?

- What are other possible methods of implementing the buffer zone strategy for currently registered products.

- What other methods of reducing buffer zones should be considered? What data is available to support its use?

- Are you aware of other avenues for training or information distribution other than those presented in this document that the PMRA should use to inform applicators of this strategy?

This document outlines a process and its rationale for a new flexible approach for implementing a buffer zone strategy for agricultural applications of pesticides. The PMRA attempted to develop a practical and transparent approach as well as to prevent any undesirable effects.

3.0 Objectives of the Buffer Zone Working Group

The objectives of the Buffer Zone Working Group are as follows:

- to develop an approach for determining site buffer zones based on sound science for agricultural applications of pesticides that protect sensitive areas (habitats), while remaining flexible enough to meet the needs of growers and applicators;
- to develop a buffer zone policy that will encourage applicators to use new technologies and sprayer configurations to reduce spray drift;
- to increase awareness of the effects of meteorological conditions on spray drift and to encourage applicators to spray only under favourable conditions;
- to increase awareness of the appropriate buffer zones to use when preparing a spray program; and
- to make the process simple and easy for applicators to use, including the development of clear label instructions.

The PMRA Buffer Zone Working Group examined various options with respect to the characteristics of sensitive areas to be protected, the meteorological conditions under which the spray is applied and the configuration of the pesticide spray equipment. It is believed that the proposed policy is "risk neutral", i.e., it will provide the PMRA and the applicator with considerably more flexibility than is presently allowed **without increasing risk to sensitive environmental areas**.

The mechanics of buffer zone modification are complex. The proposed approach, however, allows the applicator to understand the process quickly, to gather the required site information before the spray application, to select an appropriate buffer zone modifier from tables and to apply a multiplier to the labelled buffer zones. The emphasis is to develop a relatively simple process for a quick and effective determination of a buffer zone, but one based on sound science to ensure the protection of sensitive areas. The PMRA recognizes that increased flexibility means increased responsibility for the applicator to gather the required information and, if necessary, to perform the proper calculations. Consequently, an important component of this initiative is to promote awareness among applicators about this new approach. Revised product label statements will also be developed to draw attention to the new buffer zone requirements.

4.0 Overview of Other Approaches to Buffer Zones

Four European countries (Germany, Sweden, the Netherlands and the United Kingdom) as well as the United States have implemented buffer zone guidelines to be followed by their producers. These guidelines are outlined briefly below.

United Kingdom: A scheme called “Local Environmental Risk Assessment for Pesticides” (LERAP) was introduced in March 1999 and is explained in a 17-page booklet. Spray buffer zones of 5 m from water courses are mandatory for all products. For herbicides and fungicides (Category B products), buffer zones can be reduced according to the LERAP scheme. The variables are sprayer drift potential, water course width and application rate. The applicator consults tables that are matched to the drift potential of the sprayer in question. The pesticide dose and water course width are selected, and the corresponding buffer zone distance is recorded. Lower buffer zone distances are awarded for wider watercourses and lower application doses. Drift potential is assessed for nozzles and/or sprayers through a government protocol (paid for by the sprayer manufacturer) and is subsequently placed into one of four categories: a reference sprayer (no drift reduction), a one star rating (25% drift reduction), two star rating (50% drift reduction) and three star rating (75% drift reduction). The applicators need to know which star rating their sprayer has received—this information is available through a United Kingdom government website. The entire LERAP process is documented on a form that must be made available for inspection.

Netherlands: The Dutch system is fairly simple. It sets a standard buffer zone of 14 m for all applications and rewards the use of low-drift nozzles or air assist sprayers with a reduced buffer zone of 1.5 m. The use of both technologies combined results in a buffer zone of 1 m.

Sweden: The Swedish system consists of a matrix of variables. There are buffer zone tables for each combination of temperature (10, 15 and 20°C) and wind speed (1.5, 3 and 4.5 m/s) on the day of application, for either a “non-sensitive” (cropped) or “sensitive” (aquatic or ecologically important areas) area. Each temperature/wind speed/area combination has three tables based on either a quarter dose, half dose or full dose application. The table for each dose gives the required buffer zone based on the spray quality used (fine, medium and coarse) and the boom height (15, 40 and 60 cm). The buffer zones in the table range from 2 m to >50 m. Additionally, the applicator is allowed to reduce the buffer zone to a set value if using drift reduction equipment. Buffer zones are not reflective of the toxicity of the pesticide. This information is presented in a 51-page booklet, which also contains other useful information such as spray quality for various nozzles, flow rates and pressures; advice on good management practices; and calibration of sprayers.

Germany: The German system is more rigorous than the other European countries. Germany has published guidelines for good spraying practices, which include prescriptions for application in wind speeds less 5 m/s, at a maximum temperature of 25°C and a relative humidity higher than 60%, with water volume rates 200 L/ha and higher, using large droplets, low pressure, optimum boom heights and working speeds less than 6 km/h.

Buffer zones are set by the Regulatory Authority according to toxicity data for each pesticide. Buffer zones can be adjusted by the applicator in accordance to the drift potential of the sprayer being used as determined in tests conducted by the Federal Biological Research Centre for Agriculture and Forestry (Biologische Bundesanstalt, BBA), the size of the watercourse and the presence of riparian vegetation. Different nozzles and application technologies are classified according to their drift reduction into 3 drift reduction classes: 50%, 75%, and 90%; however, the wind tunnel protocol to determine drift potentials is different and more conservative than the comparable to the United Kingdom protocol. The applicator calculates points based on these parameters as follows:

> Application technology: 50% drift reduction, 3 points; 75% drift reduction, 6 points; 90% reduction, 10 points.
>
> Water type: If the waterway is > 2 m wide and the water is clearly moving, 6 points; if the waterway is < 2 m wide and/or the water is not moving, 0 points.
>
> Buffer vegetation: If the vegetation is a minimum of 1 m wide and 1 m higher than the crop, 3 points; if the vegetation is < 1 m wide and < 1 m higher than the crop, 0 points.

The total sum of points indicates the risk category: A = 20 points, B = 10 points, C = 6 points, D = 3 points. The higher the total number of points "earned", the lower the risk category. Buffer zones for each risk category are published for each product. Compliance is policed, and fines up to $40 000 are authorized for violations.

United States: The United States Environmental Protection Agency (USEPA) released a draft Pesticide Registration Notice entitled *Spray and Dust Label Statements for Pesticide Products* in August 2001 for public comment. This Notice proposed guidance to American registrants on drift mitigation labelling statements for their products, the rationales for the proposed label statements and an implementation plan.

The USEPA intention is to improve the consistency of drift label statements and to move towards drift labelling that reflects the underlying scientific principles of drift and drift management. The basic drift mitigation measure is labelling to help ensure that pesticides are used in a manner that does not result in unreasonable adverse effects on the environment. Although the USEPA has not reproposed guidance for drift labelling, it continues to make labelling decisions as part of its licensing program for pesticide registration.

The USEPA relies on pesticide hazard and use information along with drift deposition estimates from models and studies to make its decision for each pesticide. The USEPA has focussed its attention on the most influential factors in cause and control of spray drift such as wind speed, placement of nozzles, spray quality (droplet size) and application height. The Agency uses available drift models, published studies and studies from registrants in helping to formulate risk assessments with a spray drift component and, when off-target drift is of concern, engage risk managers at the Agency, industry and growers to reach appropriate drift mitigation measures that are flexible and protective for specific pesticides.

The USEPA is also supporting education and training initiatives on drift management for pesticide applicators. It has provided funding for development of training material for commercial aerial applicators and for land grant universities to train private and commercial pesticide handlers and applicators. The USEPA is also engaged with the pesticide industry, including application equipment manufacturers and university researchers, to develop a system for testing the efficiency of new equipment to reduce drift. The goal of this initiative is to encourage purchase and use of drift-reduction equipment by providing incentives of reduced use restrictions to registrants who specify use of such equipment on their labels and applicators who would apply the products with this equipment.

5.0 Human Health Concerns

5.1 Determination of Toxicological Endpoints of Concern

Before any chemical is registered for pest control use in Canada, PMRA toxicologists evaluate an extensive battery of animal studies to determine toxicological endpoints of concern. The toxicological endpoint is based on a no observed adverse effects level (NOAEL) in animal studies where an adverse effect was observed at the next highest dosing level. This NOAEL is compared to the expected exposure levels to humans from the proposed use pattern (i.e., application rate, number of applications, pest to be controlled, area of application, etc.). Quantification of these exposure levels is derived from chemical exposure studies, generic databases based on a number of acceptable studies such as the Pesticide Handlers Exposure Database (PHED) and standard default values (conservative assumptions derived from acceptable scientific studies). Only when the expected exposure levels are at least 100 times less than the NOAEL from the toxicological studies, is the proposed use pattern of the chemical in question considered acceptable for human health. The factor of 100 is based on a 10 times factor for interspecies variation and a 10 times factor for intraspecies variation. In some cases, an additional safety factor may be added, for example, for severity of endpoint, sensitivity to the young or uncertainty in the database.

5.2 Assessment of Exposure to Bystanders

Human exposure from spray drift or spray residues resulting from drift to inhabited areas (e.g., school, daycare, park and residential areas) is not expected to cause an unacceptable health risk; consequently, buffer zones are not usually required for inhabited areas. Exposure to bystanders as a result of spray drift to inhabited areas is assessed qualitatively in the risk assessment for pest control products. Exposure resulting from spray drift to inhabited areas is expected to be less than that of pesticide applicators (mixer/loader/applicator), agricultural workers and others who re-enter treated areas after application and who may be exposed to pesticide residues. This is based on several in-house tools including flagger data in PHED, which suggest that exposure to bystanders resulting from spray drift would be less than mixer/loader/applicator exposure. Flaggers are individuals who are positioned close to the site of aerial application of pesticides in order to direct the pilot and who may be exposed to spray drift[4]. Pesticide exposure to flaggers is expected to be similar to bystanders exposed to spray drift since both individuals would be close to the area of application but would not be directly involved in pesticide application. In the event of an anticipated unacceptable human health risk associated with spray drift (i.e., risk is only acceptable to mixer/loader/applicator with excessive engineering controls such as closed mixing and loading systems), possible mitigation measures may be considered and will be assessed on a case by case basis during the human health assessment. For bystander exposure, mitigation measures may include one of the following:

- label instructions to avoid spraying when people are likely present;
- limit time of day and weather conditions for spraying to reduce drift;
- buffer zone; or
- product stewardship program.

[4] Human flaggers are rarely used in Canada.

5.3 Future Efforts to Reduce Exposure to Bystanders

In the future, a more quantitative approach may be adopted to assess potential human health effects as a result of spray drift to bystanders. The PMRA, in conjunction with the USEPA is currently developing methodologies that will help quantify such potential exposure [e.g., *Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessments* (August 5, 1999)].

In the interim, the PMRA will continue to promote best management practises through training initiatives and label statements. The PMRA and provincial authorities have developed national standards for pesticides education, training and certification in Canada (Basic Knowledge Requirements for Pesticide Education in Canada, Applicator Core, Federal/Provincial/Territorial Working Group on Pesticide Education, Training and Certification), which include factors affecting drift and methods to reduce potential for drift to non-target areas during application. Where appropriate, the PMRA will also minimize human exposure from spray drift or from spray residues resulting from drift through qualitative label statements that emphasize the importance of minimizing drift, such as:

> "*Apply only when the potential for drift to inhabited areas or areas of human activity such as houses, cottages, schools and recreational areas is minimal. Take into consideration wind speed, wind direction, temperature, application equipment and sprayer settings.*"

6.0 Current PMRA Methods for Buffer Zone Determination

To support the registration of a pesticide in Canada, the registrant must submit information describing the chemistry, environmental fate, human and environmental toxicity and efficacy of the pesticide as well as its use pattern. The need for buffer zones arise as a result of the risk assessment from the review of the environmental fate and toxicity information. The environmental risk posed by a pesticide is a function of the pesticide's toxicity to non-target organisms and the level of exposure of these organisms to the pesticide. The integration of these two factors, toxicity and exposure, provides an indication of the level of concern for non-target organisms in the environment and whether risk mitigation (e.g., a buffer zone) will be needed.

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 sublethal (e.g., changes in behaviour, changes in reproductive success). Currently, the PMRA uses the no observed 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.

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. For terrestrial plants, the EEC is expressed in terms of the application rate of the active ingredient (g a.i./ha). For aquatic organisms, the EEC is the concentration of the active ingredient in water (g a.i./L). The EEC in water is a determined by calculating the concentration of the pesticide in a field-side pond with a surface area of 1 ha (100 m × 100 m) and a depth of 30 cm. In both cases, the calculations are based on the maximum application rate. 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.

Off-site spray drift and deposition are largely independent of the physical/chemical characteristics of an active ingredient, but may be dependent on the physical/chemical characteristics of a formulation; however, no information is provided to the PMRA on the drift reducing capabilities of the formulation ingredients in the pesticide product. The PMRA uses various information sources to determine the amount of off-site drift for various methods of application. For field sprayer applications, i.e., typically ground rigs pulled behind a tractor or high boom clearance sprayers, the empirical data of Wolf and Caldwell (2001) are used to estimate downwind deposition. For airblast applications, data from Ganzelmeier et al. (1995) are used. For chemigation, basic application is assumed to be a high pressure, impact sprinkler, **not** equipped with an end gun, with a height of 3.5 m. Due to the lack of a suitable drift data for chemigation, the Wolf and Caldwell data are used. The rationale for this is that, even though the droplets are much larger for chemigation, the higher boom height increases the drift potential and these factors roughly compensate for one another. These drift data were used to construct mathematical functions that describe the deposition of a pesticide over distance. For aerial applications, the AGDISP[5] model (Teske et al. 2003) is used to describe deposition.

Buffer zones for aquatic habitats are calculated by using the aquatic EEC and the NOEC for the most sensitive aquatic 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 sensitive aquatic habitat when the pesticide is applied. It should be noted that buffer zones are used when a sensitive aquatic habitat is **downwind** of the spray swath.

5 The acronym AGDISP is derived from AGricultural DISPersal.

Terrestrial buffer zones are calculated by using the terrestrial EEC and the EC_{25} for the most sensitive terrestrial plant 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 sensitive terrestrial habitat when the pesticide is applied. As for aquatic habitats, buffer zones are used when a sensitive terrestrial habitat is **downwind** of the spray swath.

The buffer zones calculated through the use of these functions or the AGDISP model 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.

7.0 Proposed Approach for Site-specific Buffer Zones

7.1 Overview

The PMRA calculates buffer zones using the methods outlined in Section 6.0 and this process results in an aquatic and/or terrestrial buffer zone(s) on the product label. The PMRA believes that the risk assessment scenarios and drift functions used in this process result in buffer zones that are conservative and that the labelled buffer zones could be further refined to accommodate the conditions at the time of application without compromising environmental protection. Consequently, the PMRA proposed a new approach for mitigating the effects of pesticides due to spray drift through the use of buffer zones. This approach was designed to be “risk-neutral”; thus, there would be no additional risk to natural environments from this strategy. The proposed approach is more flexible than the current method and allows for buffer zone reductions depending on the type of sensitive area being protected, the application equipment used as well as the meteorological conditions at the time of spraying.

Under the new approach, the PMRA will continue to calculate buffer zones according to current practices. This buffer zone will be specified on the label according to current practice. The PMRA will also provide the applicator with tables of multipliers which, under specific conditions, can be used to reduce the labelled buffer zone. A full description of these multipliers may be found in Tables in Appendix IV and the rationale for their values is described in the text to follow. Although numerous variables affect drift, the PMRA chose those variables believed to be the most important and operationally achievable in order to simplify the process as much as possible. The multipliers reflect the sensitive area, meteorology and equipment specific to the application site.

The PMRA also envisions that changes in application technology that will assist in reducing spray drift may also be included by this strategy through periodic updates.

7.2 Sensitive Areas

Standard toxicity tests on surrogate species are used to identify habitats which are sensitive to a particular active ingredient. Buffer zones are used to protect sensitive terrestrial and aquatic habitats from spray drift. These habitats vary in their sensitivity and ability to recover from the effects of spray drift; however, few data are available at this time that describe the ability of a habitat to recover from single or multiple exposures to pesticides.

Sensitive area multipliers for those habitats with relatively low risks of incurring adverse effects due to spray drift are presented in Section 8.0. Sensitive areas that contain or are comprised of organisms less able to avoid or withstand the impacts of spray drift do not have multipliers.

7.3 Meteorology

Meteorological conditions have significant impacts on spray drift. Applicators are encouraged to minimize particle spray drift through understanding how weather conditions affect drift and applying pesticides only under favourable weather conditions. The meteorological factors known to be the most important in affecting drift (wind speed, temperature and relative humidity) and their multipliers are given in Section 9.0.

7.4 Application Configuration

The application (sprayer) configuration is under the direct control of the applicator. Applicators are encouraged to minimize pesticide drift through the use of appropriate technology. The application configuration factors known to significantly affect drift, such as spray quality and boom height, and their multipliers are given in Section 9.0.

7.5 Calculation of a Modified Buffer Zone

Appendix II provides detailed examples of modified buffer zone calculations. The applicator must document the reductions in the label buffer zone and a suggested Sample Application Record template is provided in Appendix V. The basic steps in determining the modified buffer zone for a specific application are as follows.

Step 1: The applicator must be familiar with the approach presented in this proposal.

Step 2: The applicator consults the product label to identify the areas requiring protection. The field to be sprayed and the surrounding environment are then surveyed to determine if these sensitive areas are contained within or adjacent to the area of application. This information is recorded on an Application Record (Appendix V).

Step 3: The applicator notes the current meteorological conditions and the configuration of the spray equipment and records these on the Application Record (Appendix V).

Step 4: The applicator adjusts the labelled buffer zone according to the depth of water. As there may be different aquatic areas adjacent to or within the area of application, there may be more than one sensitive area multiplier required per application site.

Step 5: The applicator consults the appropriate tables to ascertain the appropriate site specific modifier for the meteorology and sprayer setup. The configuration of the spray equipment may also be relatively static or may change among two or three different configurations. This value is used to modify those obtained in Step 4 to calculate the final buffer zone(s).

Appendix II provides some example of this process.

8.0 Sensitive Area Categorization and Multipliers

Due to the wide variability inherent in natural environments, some areas may be more sensitive to the effects of particle spray drift than others. Rather than describing and categorising all of the possible areas that may require protection, this proposal attempts to identify the most sensitive components of a particular area. It is the applicator's responsibility to identify the sensitive areas within and adjacent to treated fields.

In general, a sensitive area is considered to be adjacent to a spray area if it is **downwind** from the treated area and within the (unmodified) labelled buffer zone. An area that is upwind or cross-wind to the treated area or that is not within the downwind labelled buffer zone distance is not considered to be adjacent to the spray area.

8.1 Sensitive Aquatic Areas

A sensitive aquatic area is defined as any area adjacent to a spray area consisting of any form of water, such as, but not limited to, a lake, pond, stream, river, creek, slough, canal, prairie pothole or reservoir. Although these habitats are ecologically different, they can be grouped based on broad temporal and spatial similarities.

Aquatic areas may vary over time. Some, such as lakes, are present throughout the season, whereas others, such as sloughs, may be seasonal, temporarily holding water for only part of the season. Seasonal aquatic areas that have no water present at the time of application, i.e., are dry, would not need to have aquatic buffer zones observed. Temporary aquatic areas resulting from flooding of or drainage to low lying areas do not generally need to be buffered (see Appendix III for definitions).

Assuming a closed system and complete mixing of the water body, the risk to aquatic areas is determined by the concentration of the pesticide in the water, which itself is a function of the amount of spray drift, the surface area of the water body, and the depth of water. A sensitivity analysis of water depth and surface area, performed using the AGDISP model, indicated that calculated buffer zones are more sensitive to the depth of the water body than its surface area. Decreased pesticide concentrations due to an increased width of the water body are counter-balanced by the increased amount of spray drift deposited to it. Thus, the average depth of the water body was determined to be the most important characteristic of water bodies for calculating buffer zones. In practice, the average depth of the water body will be visually estimated by the applicator and recorded on the application record.

Depth-dependent multipliers for water bodies were determined using the field, airblast and AGDISP models. To determine the appropriate multipliers, buffer zones for different water depths (0.3, 1 and 3 m), spray qualities (fine, medium and coarse), and toxicological endpoints were calculated. The multipliers were found to be dependent upon the method of application and for aerial application, the spray quality. Consequently, the chosen values attempt to encompass the majority of this variation, but not be overly conservative (Table 1). A buffer zone multiplier of 1.0 was assigned to the basic water depth used in determination of the labelled buffer zone (0.3 m).

Table 1 Buffer Zone Multipliers for Aquatic Areas

Depth (metre) (estimated average depth)	Multiplier		
	Field	Orchard Air Blast	Aerial
< 1	1	1	1
1–3	0.4	0.7	0.5
> 3	0.2	0.3	0.1

8.2 Sensitive Terrestrial Areas

Terrestrial areas vary widely in their characteristics, and there are insufficient data available at this time to group these areas according to their ecological sensitivity to pesticides. Therefore, no additional multipliers are provided to the applicator and the labelled buffer zone distances will apply to all terrestrial areas. The PMRA is, however, consulting with the provinces and territories to determine if a list of excluded terrestrial areas could be included on the label.

8.3 Wetlands and Riparian Areas

Wetlands and riparian zones (the area between a defined aquatic and terrestrial area) possess characteristics of both aquatic and terrestrial habitats and may support both aquatic and terrestrial species. These areas are considered to be ecologically important and require protection. The PMRA will determine the appropriate buffer zone for these areas during its risk assessment process; therefore, no additional multipliers are provided to the applicator and the labelled buffer zone distances will apply to all wetlands and riparian areas.

9.0 Meteorological and Sprayer Configuration Factors

The best way to prevent spray drift is to spray under good atmospheric conditions with a properly adjusted sprayer. This section focuses on strategies to reduce drift focus based on meteorological conditions and sprayer configuration.

The most important variables affecting spray drift for all application methods are droplet size and wind speed. Other factors (which can be specific to a particular application method) include the following:

- atmospheric stability;
- carrier volume;
- discharge height and direction;
- temperature and relative humidity;

- travel speed;
- shrouds;
- adjuvants; and
- crop canopy conditions.

As the inclusion of all possible factors would result in an overwhelmingly complex scheme, only the most important variables were included in this proposal. The major factors affecting drift for specific application methods recognized by this proposal are summarized in Table 2.

Table 2 Major Factors Affecting Spray Drift For Different Application Methods

Application Method	Major Factors
Field sprayers	Spray quality, wind speed and boom height
Aerial	Spray quality and wind speed
Orchard airblast	Sprayer type and wind speed
Chemigation	Sprinkler type and wind speed

The following is a review of variables affecting drift, with specific reference to four main agricultural application methods: field sprayer, aerial, orchard airblast and chemigation.

9.1 Meteorological Conditions

9.1.1 Wind Speed

Wind is an important factor affecting spray drift for all application methods. All other things being constant, airborne spray drift has been found to increase linearly with increasing wind speed for field sprayers (Goering and Butler 1975, Bode et al. 1976, Maybank et al. 1978, Wolf et al. 1993, Grover et al. 1997) and non-linearly with increasing wind speed for aerial applications (AGDISP). Very low wind speeds are, however, often very unpredictable in direction, increasing the risk of non-target impact. As a result, spraying is best done when there is some wind and when the applicator can be sure that wind direction has stabilized. In practice, wind speed is measured at approximately shoulder height using a hand-held anemometer.

The effect of wind speed is a function of several interacting variables. For all application methods, the rate of increase in airborne drift with wind speed decreases with increased droplet size. In other words, coarse sprays are less sensitive to increased wind speeds than fine sprays. For aerial and orchard airblast, where finer sprays are often used, hot and dry conditions may increase the spray’s susceptibility to higher wind speed as a result of rapid evaporation to smaller droplet sizes.

Proposal approach: The proposed scheme reflects the linear nature of the wind speed effect for field sprayers. For all application methods, wind speeds were divided into the following three categories:

- 1–8 km/h, 9–16 km/h, and 17–25 km/h for field sprayers and chemigation applications; and
- 1–5 km/h, 6–10 km/h, and 11–16 km/h for aerial and airblast applications (Appendix IV).

9.1.2 Atmospheric Stability

Under normal sunny daytime conditions, the atmosphere is said to be unstable because the air near the ground is warmer than air above. Under these conditions, there is considerable thermal turbulence in the atmosphere and adjacent air layers mix readily with each other. If the air contains drift particles, these are quickly dispersed upward and downward, becoming diluted with clean air, thereby reducing the downwind impact of airborne drift.

On the contrary, when the atmosphere is stable, inversions occur because the air near the ground is cooler than the air above it. Under temperature inversion conditions, typically on nights with limited cloud cover and light to no wind, turbulence is suppressed and suspended spray may hang over the treated area in a concentrated cloud for a long time. Winds after an inversion are very slow and unpredictable in direction, and, when they occur, a concentrated spray drift cloud can be moved off the treated area and cause considerable damage at its destination. For this reason, drift potential is considered high during a temperature inversion despite calm winds. Fine sprays are particularly sensitive to inversion drift. Applicators should avoid spraying during temperature inversions, regardless of the application method.

Proposal approach: The proposed scheme does not incorporate inversion conditions into drift prediction; instead, spraying during a temperature inversion is not recommended (Goering and Butler 1975, Maybank and Yoshida 1969, Yates et al. 1974).

9.1.3 Air Temperature and Relative Humidity

Small water droplets can rapidly evaporate to a smaller size, predisposing themselves to drift. Spray droplets are assumed to evaporate like water droplets because water is the major component of a spray droplet and is much more volatile than the other ingredients. Temperature and relative humidity affect how quickly droplets evaporate. For example, under warm and humid conditions (20°C and 80% relative humidity), a 100 µm water droplet can evaporate completely in 57 seconds. Under hotter, dry conditions (30°C and 50% relative humidity), the same droplet can evaporate in 16 seconds. This effect is important for aerial application where finer sprays are used and droplet to target distances are generally > 3 m; however, the interactions of various application factors influence the importance of temperature and humidity.

Proposal approach: For field sprayers, where discharge heights rarely exceed 1 m, temperature and relative humidity are not considered important enough to be included (Goering and Butler 1975). An intermediate temperature and relative humidity condition is used for modelling aerial applications: 25°C and 50% relative humidity (Appendix V).

9.2 Sprayer Configuration

For all sprayers, drift reducing methods focus on the following two approaches:

- reducing the proportion of small droplets in the spray cloud (spray quality); and
- protecting the spray from wind (boom height and shrouding).

9.2.1 Spray Quality

The most effective way to reduce drift potential is to apply coarse sprays that minimize the proportional contribution of small droplets (< 150 µm). Droplet size can be varied in a number of ways, particularly in the selection of a nozzle and spray pressure.

Nozzle types: Low-drift nozzles use a combination of pressure and flow rate to reduce drift between 50% and 95% from conventional nozzles. Many of these nozzles can be operated at higher pressures without increasing drift potential significantly. This is one of the most important and widely used means of drift reduction for field sprayers. Low-drift nozzles are not widely used in orchard airblast application.

Pressure: For any given nozzle, lower pressures result in coarser sprays. As drift potential can vary by a factor of three within a nozzle’s recommended pressure range, the lowest recommended pressure will minimize drift risk. Applicators should always operate within the nozzles’ recommended pressure range.

Flow Rate: For any given nozzle, a larger orifice (nominal flow rating) will produce a coarser spray. For example, fewer nozzles of higher flow rate on an airblast sprayer will minimize drift. An exception to this rule is high flow rates in fast-moving aircraft (> 225 km/h), where air shear of very coarse sprays can reduce droplet size.

Nozzle fan angle and orientation: With most nozzle types, narrower fan angles produce larger droplets. For aerial sprays, orienting nozzles so that the spray is emitted backwards, parallel to the airstream will produce the coarsest droplets. Droplet size decreases as nozzles are oriented more directly into the airstream.

Low-drift adjuvants: Low-drift adjuvants increase droplet size for most applications, but some products or product rates may alter deposit patterns.

Proposal approach: The proposed scheme recognizes that spray nozzle manufacturers typically report the British Crop Protection Council (BCPC) or American Society of Agricultural Engineers (ASAE) spray quality of their nozzles for each flow rating and pressure, and this information is available to applicators (Southcombe et al. 1997, ASAE 1999). Spray quality categories in this proposal are: fine, medium and coarse (aerial application) and fine, medium, coarse and very coarse (field sprayers). Drift potential varies by about a factor of three between adjacent quality classes. Spray quality is considered as a variable for field sprayer and aerial application only (Appendix IV). Spray quality adjustments are not common in orchard airblast and chemigation applications.

9.2.2 Boom Height and Length

Spray can be protected from wind by lowering the boom to its minimum recommended setting: 45 cm for field sprays with 80º fan angles and 35 cm for 110º fan angles. Higher booms may be required to offset boom movement over uneven terrain. By orienting the spray forward or backward, boom height can be reduced as long as the nozzle to target distance is maintained at its minimum recommended in the direction of spray travel.

For aerial sprays, the appropriate boom length is between one third of semi-wingspan (or half of the active rotor length for helicopters) and one half semi-wingspan (Garry Moffatt, personal communication). Boom length should not exceed three quarters of the wing or rotor length as longer booms increase drift potential. When the boom is too low or too wide, ground effect turbulence or wing tip vortices can elevate small droplets, thereby increasing drift.

Orchard airblast sprays should not be directed to exceed the target height. Drift can be further reduced by shutting off the spray between adjacent trees within a row. Tower or tunnel sprayers, which direct the spray horizontally across the foliage or down from on top, can help target smaller trees or grapevines more effectively.

Proposal approach: The proposed scheme assumes that drift potential is increased by a factor of two when the sprayer boom is raised from 0.6 m to 1.2 m for field sprayers (Goering and Butler 1975, Nordby and Skuterud 1975) (Appendix IV). Although boom height is a very important parameter in aerial applications, it is not considered because flight height decisions are dependent on aircraft size, air speed, terrain and pilot judgement. For orchard airblast applications, spray discharge direction is considered under “Sprayer Type” (Section 9.2.7; Appendix IV). For chemigation, credit is given for lower boom heights and drop tubes (Appendix IV).

9.2.3 Carrier Volume

At any given constant travel speed, higher carrier volumes reduce drift only when they are applied with larger flow-rate nozzles that emit coarser sprays. A “twin” nozzle, which can increase nozzle flow rates without an increase in droplet size, would not reduce drift with higher application volumes.

Proposal approach: In the proposed scheme, no credit is given for increased carrier volume. In cases where a higher volume is applied with a coarser sprays, this effect is captured by the spray quality component in the proposal (Maybank et al. 1978, Wolf et al. 1993)

9.2.4 Travel Speed

Faster travel speeds have two main effects on how spray behaves after it leaves the nozzle. First, faster speeds cause emitted spray droplets to stay aloft longer, because small droplets are not entrained into the downward flow of larger droplets but instead descend more slowly at their terminal velocity. Second, faster travel speeds may be accompanied by higher operating pressures, thereby increasing drift potential. The net result is a finer spray that is more exposed to winds. On the other hand, when maintaining a constant carrier volume and pressure, faster travel speeds require the use of larger flow-rate nozzles (= coarser sprays), reducing drift potential. The net effect of travel speed changes to field sprayers is still not clear. For aerial application, higher air speeds usually increase air shear, which increases drift potential. This is most pronounced with highly deflected sprays.

Proposal approach: In light of the counteracting effects that occur with increasing travel speed, this proposal assumes no net change in drift potential with travel speed.

9.2.5 Shrouds and Cones

In scientific studies, shrouds have been shown to reduced drift by 65% to 85%. Protective cones have been shown to reduce drift by 30% to 50%. An applicator should expect shrouds to become less effective at higher travel speeds. These technologies are usually only used on tractor-drawn sprayers with low boom heights.

Proposal approach: The proposed approach allows an additional 30% drift reduction for cones and 70% for shrouds when used at travel speeds < 12 km/h and boom heights < 60 cm (Edwards and Ripper 1953, Maybank et al. 1991, Wolf et al. 1993) (Appendix IV).

9.2.6 Crop Growth Stage

The stage of the crop to be sprayed may have an influence on spray drift. In general, taller, more mature crops contain more foliage that is capable of intercepting droplets that may otherwise drift. This is of particular importance for orchard airblast sprayers.

Proposal approach: Due to the variable nature of foliation between crops, species and seasons, no adjustment is made for crop growth stage.

9.2.7 Sprayer Type

For field sprayers, aerial application and chemigation applications, the configuration of a sprayer is the sum of the various factors described above. This can result in a large number of possible configurations. For an airblast sprayer, three discrete configurations can be identified. The most common is an axial blower that generates a radial airblast near ground level and discharges the spray up towards the canopy. Spray from this type of equipment can be very prone to drift if the discharge direction is not well matched to the canopy height or condition. An alternative is a tower or cross-flow blower, where the spray originates from a vertical tower that directs it horizontally or downwards towards the tree or grapevine. For grapes or dwarf trees, tunnel sprayers that provide a horizontal discharge direction, completely enclosing the plant from two sides, capturing and recirculating the spray, are available.

Proposal approach: The proposed guideline allows a 50% drift reduction for tower (cross-flow) sprayers, and a 90% drift reduction for recirculating sprayers (Bäcker and Bleifeld 1994) (Appendix IV).

9.3 Determination of Modified Buffer Zones

Buffer zone modifications were based on the best available information from recognized scientific literature or publicly available spray drift models. Buffer zone multipliers of 1.0 were assigned to the basic sprayer configurations and conditions for which the initial risk assessments were conducted. These multipliers were then revised according to the expected drift risk for other application conditions. For field, orchard, and chemigation application, documented or estimated changes in drift amounts resulted in a proportional change in buffer zone (i.e., 50% drift reduction = 50% buffer zone reduction).

Field Sprayers: Buffer zone multipliers for three wind speed ranges (1–8, 9–16 and 17–25 km/h) and four spray qualities (fine, medium, coarse and very coarse) were tabulated for each of two boom heights (< 60 cm and 60–120 cm) (Appendix IV, Table A IV-2). These tables are used by the applicator to multiply the buffer zone on the pesticide label. For the low boom height field sprayers, additional reduction values were generated for protective cone or shroud equipment.

Orchard Airblast Application: Buffer zone multipliers were tabulated for three sprayer types (axial, cross flow, and tunnel) and three wind speed ranges (1–5, 6–10 and 11–16 km/h) (Appendix IV, Table A IV-3).

Chemigation Application: Buffer zone multipliers were tabulated for two boom heights (< 3 m and > 3 m) with a top-mounted high pressure gun, and a low boom height (< 3 m) with a low-pressure sprinkler (drop tubes) for three wind speed ranges (1–8, 9–16 and 17–25 km/h) (Appendix IV, Table A IV-4).

Aerial Application: Buffer zone multipliers were tabulated using the AGDISP model for three windspeed ranges (1–5, 6–10 and 11–16 km/h) and three spray qualities (fine, medium and coarse) (Appendix IV, Table A IV-5).

10.0 Implementation

10.1 Documentation

Development of standard label statements to support the proposed approach will be required. The label will include the required buffer zone(s), in a tabulated form, as determined from the risk assessment.

As the approach is too complex for inclusion on a pesticide label but is standardized across pesticide labels, the PMRA proposes that the buffer zone modification information be presented in a best management practices booklet detailing operational procedures that are known to reduce spray drift (good application practices) and the buffer zone modifier tables. The use of the booklet would also allow efficient updates of the existing tables and the incorporation of multipliers or tables for new proven drift reducing technologies.

To be eligible for site-specific buffer zone modification, the applicators must document the basis for any changes to the labelled buffer zone and they must retain these documents. Appendix V provides an example of a proposed "Application Record". As additional methods of record keeping become standardized, such as Global Positioning System / Geographic Information System, the PMRA will consult with applicator groups to determine the most efficient method of capturing site-specific modification information.

10.2 Education and Training

The PMRA proposes a voluntary educational component rather than mandatory training. However, to ensure applicators' awareness of these changes, implementation could be accompanied by activities on several fronts such as the following:

1. Enhancement of the basic buffer zone information in the application technology section of the *Standard of Pesticide Education, Training and Certification in Canada*, by referencing the availability of the Best Management Practices for Buffer Zones (which are being developed by the PMRA). The Standard is the basis for certification/education of applicators across Canada, and provinces are moving to incorporate/implement the Standard in their certification programs as resources permits. However, not all provinces have adopted the full extent of the

Standard, and thus growers' certification is not nationwide. The PMRA will develop additional mechanisms to reach all growers.

2. Preparation of media articles in popular regional agricultural publications.

3. Participation of grower and commodity groups, private industry, agricultural or chemical associations at local meetings and/or involvement by educational institutions involved in training/educating on the safe use of pesticides.

4. Development by the PMRA of Standard PowerPoint presentations as basic training tools that can be used by commodity groups, private industry and educational institutions.

10.3 Registration

Although adaptation of the proposal to new registrations (new or re-evaluated products) is fairly straightforward, accommodation to existing registered products is much more complex. The PMRA believes that the buffer zone strategy could be made to accommodate most registrations through a stepwise approach and proposes the following process:

1. New or re-evaluated products, first registered after the effective date of the proposed strategy, would have the buffer zone calculated according to the current practice, and a statement would be placed on the label indicating that the buffer zone on the label could be modified according to the proposed best management practices booklet.

2. Products registered prior to the effective date of the proposed strategy would be updated upon a request from the registrant. The registrant would submit a new Application for Registration for a Category B label amendment for registration. The PMRA would re-calculate the buffer zones using the current approach and update the buffer zone section of the label to current standards.

To avoid marketplace confusion, all products containing the same active ingredient would need to be re-examined at the same time. Eventually, all products will be re-evaluated, and at this time the adequacy of the labelled buffer zones will be assessed.

The PMRA is currently reviewing the approach outlined above as well as other possible options and will consult with stakeholders prior to finalization of a registration strategy.

Appendix I PMRA Buffer Zone Working Group

Current members:
Chair: Ted Kuchnicki—Environmental Assessment Division (EAD)

Shawn Devlin—Health Evaluation Division (HED)
Derek François—EAD
John David Whall—EAD

Former members:
Kristina Curren—EAD
Peter Delorme—EAD
Janine Glaser—EAD
Valerie Hodge—EAD
David Jones—Efficacy and Sustainability Assessment Division
Louis L'Arrivée—HED
Shuhua Liu—EAD
Kristin Macey—HED
Richard Martin—Alternative Strategies and Regulatory Affairs Division
Tom Wolf—Agriculture and Agri-Food Canada

NOTE: The PMRA would like to acknowledge assistance from the Canadian Provincial Representatives for providing comments and suggestions on previous drafts of this proposal.

Appendix II Implementing the Site-specific Buffer Zone—Examples

1. Field Sprayers

An applicator is set to spray a field with a herbicide to treat peas. The product label states that both aquatic and terrestrial areas need to be protected. It also specifies required buffer zone distances of 40 m for aquatic areas and 30 m for terrestrial areas. All buffer zones are downwind between the last spray swath and the sensitive area.

The field is inspected and some temporary potholes, a waterless ditch, a shallow creek about 60 cm deep and a 2-m deep river are found. There is a farmyard in the corner with a shelterbelt around it. This assessment can usually take place well in advance of the anticipated spray event.

From the booklet, the applicator finds that the buffer zone multiplier for aquatic areas less than 1-m deep is 1 (see Table A II-1); therefore, no reduction in the buffer zone is allowed for the shallow creek. For the 2-m deep river, a buffer zone multiplier of 0.4 would be used (see Table A II-1); consequently, the buffer zone would be 16 m (40 × 0.4). The waterless ditch and temporary potholes would not require a buffer zone. No reduction in buffer zone is allowed for the shelterbelt.

Table A II-1 Buffer Zone Multipliers for Aquatic Areas

Depth (metre) (estimated average depth)	Multiplier		
	Field	Orchard Air Blast	Aerial
< 1	**1**	1	1
1–3	**0.4**	0.7	0.5
> 3	0.2	0.3	0.1

The wind speed and sprayer configuration are assessed at the time of application. The pull-type sprayer boom places the nozzles 50 cm above target. The sprayer does not have any shrouds. Charts in the sprayer catalogue say the nozzles, at the flow rate and pressure to be used, produce a “medium” spray. The applicator’s hand-held anemometer reads 15 km/h.

Based on the above information, the applicator then consults the section “*Field Sprayer, low boom (< 60 cm)*” of the table *Field Sprayers Buffer Zone Multipliers* (see Table A II-2) to determine the appropriate operational buffer zone multipliers. Where the row *9–16 km/h* meets the column *Medium* under *Spray Quality*, a buffer zone multiplier of 0.6 is identified. Consequently, when spraying upwind of the shelterbelt, i.e., when the shelterbelt is downwind from the spray equipment, a 18-m (30 × 0.6) buffer zone would be required. For the shallow creek, the 40-m labelled buffer zone can be reduced to 24 m (40 × 0.6) when spraying upwind of the shallow creek. When spraying upwind of the river, the 16-m buffer zone can be further reduced to 10 m (16 × 0.6).

Table A II-2 Field Sprayers Buffer Zone Multipliers

Low boom (< 60 cm)

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	0.8	0.2	0.1	0
9–16	1.2	**0.6**	0.3	0
17–25	1.6	1	0.6	0.2

Although not applicable to this application, if the boom were equipped with shrouds, the original buffer zones for the shelterbelt, shallow creek and river would be reduced by 0.2 (see Table A II-3) to 6 m (30 × 0.2), 8 m (40 × 0.2) and 3 m (16 × 0.2), respectively.

The applicator fills out an application record to document weather conditions, sprayer configuration and observed buffer zone distance.

Table A II-3 Field Sprayers Buffer Zone Multipliers for Drift Reducing Equipment

Low boom, shrouds

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	0.2	0.1	0	0
9–16	0.4	**0.2**	0.1	0
17–25	0.5	0.3	0.2	0.1

2. Aerial Application

A wheat field is to be sprayed by air with a fungicide product to control leaf spot diseases. The label states that a buffer zone of 160 m is required from all aquatic areas, but none is required for terrestrial habitats. According to the label, the product should be applied with a “medium” spray. From the booklet, the applicator would select the table for adjusting the buffer zone based on the water depth (see Table A II-4) and the appropriate table detailing the multipliers for aerial application by fixed wing aircraft (see Table A II-5).

Table A II-4 Buffer Zone Multipliers for Aquatic Areas

Depth (metre) (estimated average depth)	Multiplier		
	Field	Orchard Air Blast	Aerial
< 1	1	1	1
1–3	0.4	0.7	**0.5**
> 3	0.2	0.3	0.1

Table A II-5 Fixed Wing Aircraft Sprayer Buffer Zone Multipliers Based on Labelled Spray Quality

Medium Spray Quality:

Wind Speed (km/h)	Spray Quality		
	Fine	Medium	Coarse
1–5		0.3	0
6–10		**0.8**	0.1
11–16		1	**0.2**

A survey of the field reveals a deep pond (2.5 m) and a dry ditch on one side of the field. A shelterbelt runs the length of the field. Since no terrestrial buffer zone is identified on the label, only the deep pond needs to be protected according to the label.

As the pond is 2.5 m, the buffer zone can be reduced from 160 m to 80 m (160 × 0.5) (see Table A II-4).

The applicator determines with a portable anemometer that the wind speed is 10 km/h. As the label specifies that a “medium” spray quality is required, the *Medium Spray Quality* table (see Table A II-5) is consulted and reading the *6–10 km/h* wind speed results in a buffer zone multiplier of 0.8. Therefore, the buffer zone for this pond is 64 m (80 m × 0.8). If the label had specified that a “coarse” spray should be used, then the *Coarse Spray Quality* table would be consulted for the appropriate multiplier.

As the applicator nears finishing the field, winds increase to 15 km/h and a new buffer zone must be calculated for the last tank load. The pond remains in the unsprayed part of the field. The applicator decides to change to a “coarse” spray because of the higher wind. The *Medium Spray Quality* table is again consulted and at the intersection of *Coarse* column and *11–16 km* row a multiplier of 0.2 is obtained and the buffer zone for the pond can be reduced to 16 m (80 × 0.2).

The applicator fills out an application record to document the weather conditions, sprayer configuration and observed buffer zone distance.

Appendix III Definitions

Buffer zone: A buffer zone is defined as the distance between the point of direct pesticide application and the nearest **downwind** boundary of a sensitive habitat, unless otherwise specified on a product label. A buffer zone is also referred to as a setback or a no-spray area.

Ditch: Sunken or low area beside roads or facilities used for the purpose of drainage. It can be either artificial or natural. Widths range from 2 to 20 m and slopes range from gradual to sharp drops adjacent to the bank. Depths vary from less than 1 m to several metres.

Forest: A wooded area larger than 500 hectares.

Grassland: An area with herbaceous plants dominated by grasses rather than large shrubs or tress. Grasslands may make up hay lands, pastures and prairies.

Hedgerows: Lines or groups of trees, shrubs, perennial forbs and grasses planted along field edges or other unused areas.

Non-permanent water body: An area holding water for only part of the year. These areas can be seasonal or temporary.

Permanent water body: An aquatic area holding water all year round. Most lakes, ponds, rivers and the oceans are examples of this kind of aquatic area.

Seasonal water body: A seasonal water body is an area covered with water only part of the year **and** for which flooding occurs in subsequent years on a regular basis. This will depend on climatic conditions and patterns. An example of this kind of water body is an aquatic area with water in the spring and summer but that dries out in the fall and winter.

Sensitive aquatic area: A sensitive aquatic area is defined as any area adjacent to a spray area which consists of any form of water, such as, but not limited to, a lake, pond, stream, river, creek, slough, canal, prairie pothole, marsh, reservoir or wetland.

Sensitive area: A “sensitive area”, in the context of this document, is defined as an area containing or comprised of organisms that are affected by the pesticide product being applied. A sensitive area may be aquatic (including both permanent and non-permanent aquatic areas), terrestrial (e.g., shelterbelts and woodlots) or a combination of both (e.g., wetlands, riparian zones, wet meadows, marshes, swamps, fens and bogs).

Sensitive terrestrial area: A sensitive terrestrial area is defined as any area within or adjacent to a spray area that consists of vegetation at risk, such as, but not limited to, a forest, woodlot, shelterbelt, meadow, hedgerow, riparian vegetation or rangeland.

Shelterbelt: A barrier consisting of one to a few rows of trees or shrubs on agricultural fields. The purpose of a shelterbelt is to reduce soil erosion by wind, to increase moisture for crop growth due to snow trapping and reduced moisture loss through evaporation, to reduce wind damage to crops and to provide wildlife habitat and shelter.

Shrubland: An area covered by shrubs, defined as perennial woody plants usually less than 10 m tall with branches near ground level but with no distinct trunk. Shrubs may be deciduous (e.g., hawthorn) or evergreen (e.g., holly).

Spray drift: Particle (droplet) spray drift is defined as the wind-induced movement of spray particles (droplets) away from the spray swath during application. This definition does not include postapplication vapour drift. For the purposes of this document, the term “spray drift” refers **only** to particle drift.

Temporary water body: An area covered with water only some of the time and the water-holding period is not regular or seasonal. An example of the kind of water body is a lower part of a field flooded after a heavy rain or runoff.

Wetlands and riparian zones: Wetlands and riparian zones (the area between a defined aquatic and terrestrial area) possess characteristics of both aquatic and terrestrial habitats. These types of areas also include wet meadows, marshes, swamps, fens and bogs. The primary characteristic of these areas is water covering, at, or near the surface of the soil for part or all of the year. Wetlands and riparian areas may support both aquatic and terrestrial species.

Woodlot: A wooded area smaller than 500 hectares. Examples of woodlots include Christmas tree plantations, regenerating tree stands as well as tree areas such as parklands and private woodlots.

Appendix IV Multipliers Used to Adjust Buffer Zone on the Product Label [6]

Table A IV-1 Buffer Zone Multipliers For Aquatic Areas

Depth (metre) (estimated average depth)	Multiplier		
	Field	Orchard Air Blast	Aerial Spray
< 1	1	1	1
1–3	0.4	0.7	0.5
> 3	0.2	0.3	0.1

Table A IV-2 Buffer Zone Multipliers For Field Sprayers

Low boom (< 60 cm)

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	0.8	0.2	0.1	0
9–16	1.2	0.6	0.3	0.1
17–25	1.6	1	0.6	0.2

High boom (60–120 cm)

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	1.6	0.3	0.2	0.1
9–16	2.3	1.1	0.6	0.2
17–25	3.1	1.9	1.1	0.4

6 The PMRA is continually refining the buffer zone multipliers; consequently, the content of the following tables may change.

Low boom, drift-reducing cones

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	0.6	0.1	0.1	0
9–16	0.8	0.4	0.2	0.1
17–25	1.1	0.7	0.4	0.2

Low boom, drift reducing shrouds

Wind Speed (km/h)	Spray Quality			
	Fine	Medium	Coarse	Very Coarse
1–8	0.2	0.1	0	0
9–16	0.4	0.2	0.1	0
17–25	0.5	0.3	0.2	0.1

Table A IV-3 Buffer Zone Multipliers For Airblast Application

Wind Speed (km/h)	Sprayer Type		
	Axial Fan, No Deflectors	Cross Flow	Tunnel
1–5	0.7	0.2	0.1
6–10	1	0.5	0.2
11–16	1.3	0.8	0.2

Table A IV-4 Buffer Zone Multipliers Used For Chemigation

Wind Speed (km/h)	Sprinkler Type		
	Top Mounted (> 3 m)	Top Mounted (< 3 m)	Drop Tubes (< 3 m)
1–8	0.3	0.1	0
9–16	1	0.3	0
17–25	3	1	0.1

Table A IV-5 Aerial Buffer Zone Multipliers Based on Labelled Spray Quality

Fine Spray Quality

Wind Speed (km/h)	Spray Quality		
	Fine	Medium	Coarse
1–5	0.4	0.1	0
6–10	0.7	0.2	0
11–16	1	0.2	0

Medium Spray Quality

Wind Speed (km/h)	Spray Quality		
	Fine	Medium	Coarse
1–5		0.3	0
6–10		0.8	0.1
11–16		1	0.2

Coarse Spray Quality

Wind Speed (km/h)	Spray Quality		
	Fine	Medium	Coarse
1–5			0.2
6–10			0.6
11–16			1

Appendix V Sample Application Record

APPLICATION RECORD

Applicator and Business Name			
Land Legal Description			
Application Date		Crop	
Product Name		Use rate	L/ha or g/ha
Buffer Zone (from product label) **(A)**	Aquatic m	Terrestrial	m

Sprayer Configuration

Nozzle type (circle)	e.g., flat fan, low-drift, air-induced, hollow cone, CP-03, CP Straight Stream				
Nominal fan angle and flow rating	e.g., 8003, 11005, etc.				
Nozzle deflection (aerial only)	degrees	Air Speed (aerial only)	knots		
Boom pressure	psi	Boom height	m	Carrier volume	L/ha
Spray quality (select from manufacturer catalogue) **(D)**	Fine, Medium, Coarse, Very Coarse				
Sprayer type **(E)**	Axial Fan (no deflectors), Cross Flow, Tunnel				
Sprinkler type **(F)**	Top mounted (< 3 m or > 3 m), Drop Tubes (< 3 m)				

Meteorological Conditions

Start Time		Wind Speed **(G)**	km/h	Direction	deg	Temp. (aerial)		Relative Humidity (aerial)	
End Time		Wind Speed	km/h	Direction	deg	Temp. (aerial)		Relative Humidity (aerial)	

Calculator

Using the **Buffer Zone Multipliers for Aquatic Areas** table from the Best Management Practices Booklet, find the **Aquatic Area** multiplier: _________(**B**)_______.

Using the values **D**, **E**, **F** and **G**, determine the **Application** multiplier from buffer zone multiplier tables in the Best Management Practices Booklet for the appropriate **Type of Application**: ________(C)__________

Sensitive Area (depth m)	**Type of Application (field, airblast, chemigation, aerial)**	**Buffer Zone from Product Label (m) (A)**	**Multipliers (from the buffer zone multiplier tables in the Best Management Practices booklet)**		**Application Specific Buffer Zone (m) (A × B × C)**
			Aquatic Area (B)	**Application (C)**	
Creek (0.5 m)*	Field	10	1	0.2	2
Lake (5 m)	Field	10	0.5	0.2	1
Shelterbelt	Field	5	—	0.2	1

*Values in the table are for demonstration purposes only.

Field Map

Sketch map of field, identifying wind direction and any sensitive areas within the largest label buffer zone from the field edge. Identify the nature of each sensitive area.

References

American Society of Agricultural Engineers. 1999. *Spray Nozzle Classification by Droplet Spectra*. ASAE S-572. St. Joseph, Michigan.

Bäcker, G. and H. Bleifeld. 1994. *The status of recycling technology in the application of crop protection agents in grape and fruit production*. Mitteilungen aus der Biologischen Bundesanstalt, 49. Deutsche Planzenschutztagung, Heft 301. 460 p.

Bode, L.E., B.J. Butler and C.E. Goering. 1976. Spray drift and recovery as affected by spray thickener, nozzle type, and nozzle pressure. *Transactions of the ASAE*. 19:213–218.

Edwards, C.J. and W.E. Ripper. 1953. Droplet size, rates of application and the avoidance of spray drift. *Proc. Brit. Weed Control Conf*., p. 348–367.

Ganzelmeier, H., D. Rautmann, R. Spangenberg, M. Streloke, M. Herrmann, H.-J. Wenzelburger and H.-F. Walter. 1995. *Studies on spray drift of plant protection products*. Results of a test program carried out throughout the Federal Republic of Germany. BBA, Heft. Report Number 305.

Goering, C.E. and B.J. Butler. 1975. Paired field studies of herbicide drift. *Transactions of the ASAE*. 18:27–34.

Grover, R., B.C. Caldwell, J. Maybank and T.M. Wolf. 1997. Airborne off-target losses and ground deposition characteristics from a Spra-Coupe using “low drift” nozzle tips. *Can. J. Plant Sci*. 77:493–500.

Maybank, J. and K. Yoshida. 1969. Delineation of herbicide-drift hazards on the Canadian Prairies. *Transactions of the ASAE* 12:759–762.

Maybank, J., S.R. Shewchuk and K. Wallace. 1991. The use of shielded nozzles to reduce off-target herbicide spray drift. *Can. Agric. Eng*. 32(2):235–241.

Maybank, J., K. Yoshida and R. Grover. 1978. Spray drift from agricultural pesticide applications. *J. Air Poll. Control Assoc*. 28(10):1009–1014.

Nordby, A. and R. Skuterud. 1975. Effects of boom height, working pressure and wind speed on spray drift. *Weed Res*. 14:385–395.

Southcombe, E. S. E., P. C. H. Miller, H. Ganzelmeier, J. C. Van de Zande, A. Miralles and A. J. Hewitt. 1997. The international (BCPC) spray classification system including a drift potential factor. *Proc. Brighton Crop Prot. Conf. - Weeds*. 5:371–390.

Teske M.E., H.W. Thistle and G.G. Ice. 2003. Technical Advances in Modeling Aerially Applied Sprays. *Transactions of the ASAE*. Vol. 46 #4 pp. 985–996.

Wolf, T.M. and B.C. Caldwell. 2001. Development of a Canadian spray drift model for the determination of buffer zone distances. In: *Expert Committee on Weeds - Comité d'experts en malherbologie (ECW-CEM). Proceedings of the 2001 National Meeting, Québec City. Sainte-Anne-de-Bellevue, Québec: ECW-CEM*. Eds. D. Bernier, R.A. Campbell and D. Cloutier. p. 60.

Wolf, T.M., R. Grover, K. Wallace, S.R. Shewchuk and J. Maybank. 1993. Effect of protective shields on drift and deposition characteristics of field sprayers. *Can. J. Plant Sci.* 73(4):1261–1273.

Yates, W.E. 1974. Criteria for minimizing drift residues on crops downwind from aerial applications. *Transactions of the ASAE.* 17:627–632.

United States Environmental Protection Agency. *Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment*. Presented to FIFRA Scientific Advisory Panel on 21 September 1999. Office of the Pesticide Program. Washington, D.C. 116 p.