Australian Government

Australian Pesticides and Veterinary Medicines Authority

Fipronil Review

Phase 2
Environmental Assessment Report:

Fipronil refined risk assessment

prepared by

Department of the Environment, Water, Heritage and the Arts
Environmental Branch

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1. Refined risk assessment

This risk assessment was undertaken for those organisms where the screening level assessment concluded the potential for a risk. At this stage, additional consideration is given to factors such as multiple applications, persistence and metabolite influence on potential toxicity.

For chemical structures of fipronil and its metabolites, see Attachment 1, Volume 1.

2. Birds, mammals and reptiles

2.1. Group 1 and 2 products

The screening level assessment for these products identified an acute risk to birds, mammals and reptiles at the highest application rate of 800 g ac/ha in the treated zone. In addition, at this rate a chronic risk to birds was also identified. There are insufficient toxicity data to characterise the chronic risk to mammals and reptiles. However, for acute exposure, Q-values were less than those for birds with diet A and the sensitivity of bobwhite quail. Therefore, if the acute and chronic risk to birds at the highest application rate can be mitigated, it should be considered that risk to mammals and reptiles is also acceptable.

When considering dietary exposure, birds with diet A were deemed at risk from rates of 50 g ac/ha and higher, while those with diet B were deemed at risk only at the highest application rate. Use patterns therefore, where a risk was identified at the screening level include brassicas, swede and turnip (50 g ac/ha); sugarcane (75 g ac/ha in the treated area); potatoes and ginger (100 g ac/ha, soil incorporated); and bananas (800 g ac/ha in the treated area). Risk mitigation is considered separately for these use patterns.

2.1.1. Brassicas, swede and turnips

The risk quotient at the screening level assessment for birds with diet A was 0.11. This is only marginally greater than an acceptable Q-value of 0.10 and can readily be mitigated by considering the fraction of area where birds may consume their diet. The screening level Q-values were calculated assuming that birds consume all their food in the newly treated area. In reality, birds in the agricultural landscape may visit a variety of habitats within a single day and may obtain their food from a variety of fields (EFSA 2008). Unfortunately, there are no readily available data to quantitatively base an argument on the amount of time birds may spend in treated brassica, swede or turnip crops feeding. However, any less than 90% of their feeding time would be sufficient to reduce the Q-value in this case to acceptable levels.

DEWHA considers that the dietary risk to birds in these cropping situations is acceptable.

2.1.2. Sugarcane

The risk quotient at the screening level assessment for birds with diet A was 0.16. It is important to further consider the application methodology of fipronil to sugarcane. Where cane is established, the application method is to use hollow cone nozzles as a directed spray to cover the base of the sugarcane stools and up the stalk to a height of 40 cm. This means there will not be significant amounts of foliage contaminated with fipronil. Assuming ground insects within the treated zones remain contaminated, but without residues from grain/long grass as predicted by the Kenaga nomogram (Table V4.1, Section V4.1.1.1), the PEC_{food} is calculated to be 2.7 mg/kg in the consumed diet, assuming the remaining 70% of food intake is uncontaminated. The corresponding Q-value is 0.06, which is indicative of an acceptable risk.

2.1.3. Potatoes and ginger

The risk quotient at the screening level assessment for birds with diet A was 0.22. However, for both these use patterns, fipronil is applied as a broadcast spray to the surface of soil prior to planting, and incorporated to a depth of 15 cm. Given this, there will not be residues on grain/grass for birds to consume, and it is unlikely there will be significant insect exposure. Predictions of residues on small insects at the application rate of 100 g ac/ha are predicted to be 12.1 mg/kg, and birds with diet A are assumed to have a diet consisting of 30% small insects (3.6 mg/kg diet consumed if the remaining 70% of diet is uncontaminated). The Q-value is therefore predicted to be 0.075, which is indicative of an acceptable risk.

2.1.4. Bananas

At an application rate of 800 g ac/ha within the treated zone, acute risk to birds, mammals and reptiles, dietary risk to birds and chronic risk to birds was deemed unacceptable. There are insufficient data to predict dietary and chronic risk to mammals and reptiles.

The Queensland Government advises that bananas are usually grown at densities between 1500–2200 trees/ha, and single rows of bananas (leaving a single sucker) are commonly 5 m apart, with plants spaced 1.2 m apart within the row (http://www2.dpi.qld.gov.au/horticulture/5237.html). Therefore, for refining the risk assessment in bananas:

1) Assume for band application that 50% of the hectare is treated. Therefore, the effective application rate drops to 400 g ac/ha. The Q values for acute birds diet A, birds diet B, birds dietary diet A, birds dietary diet B, birds chronic diet A and birds chronic diet B, mammals acute and reptiles acute then fall to 0.42, 0.15, 0.87, 0.32, 4.2, 1.6, 0.07 and 0.32. The acute risk to mammals is therefore deemed acceptable, but the rest of the risk quotients still show an unacceptable risk.

2) With the band spraying at the base of the rows, it can be assumed that residues on foliage will not occur, but residues on insects may still be found and be a component of the diet. To take into account 50% of the banana plantation remains untreated, residues from Table V4.1, Section V4.1.1.1 are multiplied by 0.5, and the component of the PEC_{food} associated with foliage are not included (for reptiles, where the diet is assumed to come from insects only, this will not change the result from point 1) above).

Birds

Based on this, the PEC_{food} for birds and corresponding Q-values are as follows:

Table V5.1: Avian Q-values for fipronil use in bananas

PEC_{food} (mg/kg diet)		Q-value					
		Birds, acute		Birds, dietary		Birds, chronic	
Diet A	Diet B	Diet A	Diet B	Diet A	Diet B	Diet A	Diet B
14.5	3.74	0.14	0.04	0.3	0.08	1.4	0.4

At this level of analysis, the acute, dietary and chronic risk to birds with diet B is acceptable (assuming they have the sensitivity of galliform species such as bobwhite quail). For birds with a diet similar to diet A, the risk is still not at acceptable levels, but conversely, the Q-values are not excessive.

This potential for risk was made known at the time of the original assessment for fipronil in bananas, and as no additional data for fipronil toxicity to birds is available to lower the originally used end points, the risk can not be refined further. In response to the concerns raised by DEWHA originally, the registrant initiated a grower observation type questionnaire. There were 26 respondents to the questionnaire, 18 in Queensland and eight in New South Wales, with properties ranging from 4–200 ha (average of 41 ha).

Eleven respondents reported having seen scrub turkeys on their plantation. Of those, eight noted no change in their numbers and three noted an increase. Many other bird species were also reported in banana plantations. When asked the question whether they had noticed any change in the number of scrub turkeys, 16 of 17 respondents nominated no change in ‘bird’ numbers.

This study may be suitable as a range finding type study, but can not really have any useful conclusions drawn from it. A second concern noted by DEWHA regarding birds feeding in the trash layer was not addressed. The question of changing foraging behaviour was also not addressed, and growers are unlikely to be able to make these observations with authority. A more appropriate study would be similar to that conducted in the rice growing area. However, in view of the (then Q) calculations and the company’s stewardship program and commitment to Section 161 of the *Agricultural and Veterinary Chemicals Code Act*, further work concentrating on birds in banana plantations, while desirable, was not considered essential.

Reptiles

Acute risk to reptiles was deemed unacceptable when 50% of the field is treated, however the Q-value is not excessive. Reptiles are assumed earlier to have a diet consisting of 100% small insects. However, there are considerable uncertainties with the risk assessment approach used here. First, there is only a very limited number of toxicity data available, and no data are available to consider dietary or chronic risk to reptiles. Secondly, the assumption of a ratio of food intake rate to body weight of 0.2 is not strongly supported. The available toxicity data for reptiles is new since the first application of fipronil to bananas, so this end point should be considered. However, without further data relating to information on the occurrence of native lizards expected to be found in banana plantations, their likely diet, how much of their diet is likely to be consumed from contaminated food, and information on food intake rates, no firmer conclusions about the risk can be determined. Further, if an acute risk is found for these organisms, additional data relating to chronic toxicity should be provided.

3. Aquatic organisms

The refined risk assessment for aquatic organisms may consider refining the ecotoxicity end points and/or estimated exposure concentrations that can arise from spray drift and runoff. Consideration must also be given to the rate of degradation of fipronil in aquatic systems along with the formation and decline of its major metabolites, and how these may in turn impact on aquatic organisms.

3.1. Refinement of ecotoxicity endpoints

Information is available from regulatory studies (not provided to the APVMA) about the persistence of fipronil and the formation of its main metabolites in water/sediment systems following application to the water column (as per spray drift). Results from these studies, as reported in the EFSA review, are summarised in Volume 2. In these studies, the main metabolite found in the water column was the sulphide, MB45950, and levels approached 10% in the water in some systems. Table A2.48 in Volume 3 summarises the ecotoxicity data end points for use in the risk assessment, and it is seen that this metabolite is more toxic than the parent substance for acute exposure to aquatic invertebrates (mysid shrimp), and also for chronic exposure to this organism. Therefore, breakdown to this metabolite does not represent any net gain to the environment.

It may be argued that mysid shrimp are considerably more toxic than other aquatic organisms, including aquatic invertebrates, which were the most sensitive aquatic organisms where test data are available. Mysid shrimp was the most sensitive species tested for both acute and chronic exposure to fipronil, and also to the main metabolites.

To consider whether the results for mysid shrimp can be considered as outliers, the results for aquatic invertebrates were fitted to a species sensitivity distribution using the CSIRO BurrliOz software. In fitting the data, the following rules were applied:

1. Only data from regulatory studies already assessed by DEWHA or from the EFSA review, or new data where studies were rated as 2* (literature) were used.

2. Only results testing the active constituent (no formulation results) were used.

3. For one species (black fly) four results were available, and the geometric mean was used.

4. The lowest result for estuarine copepod was used as results were available for adult males, females and total adults.

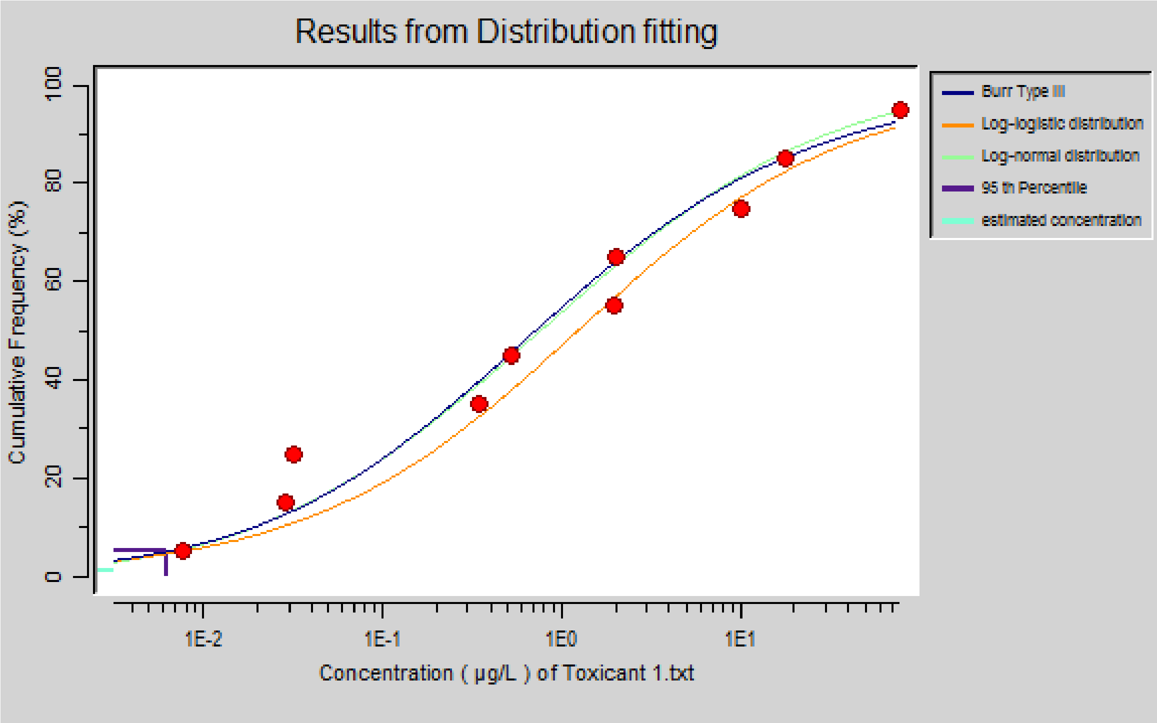
5. An acute to chronic ratio (10:1) was used to convert acute EC/LC50 data to NOECs except where chronic NOECs were already available.

Based on these criteria, the data set was condensed to 10 species as follows:

Table V5.2: Aquatic invertebrate results used in species sensitivity distribution

Species	Acute EC/LC50 (µg/L)	Chronic NOEC (µg/L)	ACR (µg/L)	Final value (µg/L)
Daphnia magna	12.9	10		10
Mysid shrimp	0.14	0.0077		0.0077
Eastern Oyster	770		77	77
Daphniidae	5.3		0.53	0.53
Ceriodaphnia dubia	20.3		2.03	2.03
Black fly	0.19			
	0.19			
	0.29		0.029	0.029
	0.65			
Geometric mean	**0.29**			
White river crayfish	19.5		1.95	1.95
Estuarine copepod	3.5		0.35	0.35
Grass shrimp	0.32		0.032	0.032
Clam	177		17.7	17.7

The following distribution is generated:



This distribution shows a good visual fit of the data and indicates the mysid shrimp results for fipronil and its main metabolites are not outliers, but rather can be considered representative of the more sensitive end of the range of aquatic invertebrates. The 95th percentile protection level from the above distribution was predicted to be 6.3 ng/L, which is close to the chronic mysid shrimp NOEC for fipronil of 7.7 ng/L.

Based on this analysis, a deterministic approach will be maintained in the refined risk assessment and the most sensitive ecotoxicity results remain valid for use in the risk assessment.

This is further supported when considering evidence from non-standard tests. Information reported in Volume 3, Section V3.4.1.1 discusses several aquatic invertebrate toxicity results for black fly, red swamp crayfish and grass shrimp, the LC50 values which are used above in the development of the SSD. However, it is apparent from the recovery phase of the study used to derive these results that they could well underestimate toxicity. For example, with black fly, the 48-hour LC50 was reported as 0.65 µg/L. When this test moved to a recovery stage, even at exposures as low as 0.06 µg/L, mortality increased to >59% (even though it was <2% at the end of the exposure phase). A lack of recovery and continued mortality was also demonstrated for crayfish and adult grass shrimp from this study (Overmyer et al. 2007). In another non-standard study with black fly (Overmyer et al. 2005), the acute LC50 from three replicate tests ranged from 0.19–0.29 µg/L. However, the authors noted sublethal effects at the lowest test concentration of 0.05 µg/L. These findings provide further evidence of the very toxic nature of fipronil to aquatic invertebrates, in the ng/L range.

3.2. Refinement of exposure assessment – spray drift

3.2.1. Aerial application

An aerial spray drift risk assessment is required for Group 1, 2, 3 and 4 products. Group 5 (seed treatment), 6 (turf products, applied as granules) and 7 (termiticides, sprayed using hand-held equipment) do not require an aerial assessment.

Information is available from regulatory studies (not provided to the APVMA) about the persistence of fipronil and the formation of its main metabolites in water/sediment systems following application to the water column (as per spray drift). Results from these studies, as reported in the EFSA review, are summarised in Volume 2. In these studies, the main metabolite found in the water column was the sulphide, MB45950, and levels approached 10% in the water in some systems. The half-life in water of combined residues of fipronil and MB45950 ranged from 17.8 days (r^2 = 0.95) in the system where MB45950 was not produced in significant levels, to 122 days (r^2 = 0.88) in a system where MB45950 was produced in significant levels (>5%). In three systems, MB45950 was produced at levels exceeding 5%, and in these systems, the geometric mean half-life of combined residues was 57.6 days in the water column (r^2 = 0.88–0.95). This long residence time in water makes it difficult to consider time weighted averages as a mitigation option, and also has implications in the event of multiple applications.

3.2.1.1. Group 1 products

- Four products (out of five) have an average water content of 320 g/L, giving a fraction of non-volatiles in the formulation of 0.68 (used to work out total $F_{non\text{-}volatile}$ in tank mix). These products are sub-grouped as group 1a. The remaining product does not contain water so the whole formulation is considered non-volatile. This product is called Group 1b below.

- The aerial buffer zones are calculated using three different spray qualities. The first is coarse (modelled as 'medium to coarse'), but it is highly unlikely fipronil will be applied using a spray with droplets this large.

- The labels in this regard state that "when spraying large droplets (>250 µm), increase the application volume to >40 L/ha to ensure sufficient droplets are produced". A droplet of 250 µm corresponds to 'fine to medium' in AGDISP (mean droplet 254 µm). However, when calculating the fraction of active at the locust control rate of 1.25 g ac/ha and increasing the spray volume to 40 L/ha, AGDISP responds with an error message because the fraction of active (0.000031) is lower than the modelling capability. Therefore, this spray quality was modelled using the standard 20 L/ha. It is important to note that increasing the spray volume to 40 L/ha would likely increase drift distances as there is a greater fraction of non-volatiles in the tank mix so the buffer zones calculated here need to be treated with some caution.

- The third spray quality modelled is ‘very fine to fine’ droplets (mean diameter 137 µm). Again, this was modelled in 20 L/ha spray volume for fixed wing aircraft.

- The standard helicopter application in AGDISP as directed by the APVMA is 50 L spray volume per hectare. At the lowest 1.25 g ac/ha for locust control, the very low fraction of active in the tank mix is outside the capacity of AGDISP. Therefore, buffers calculated for fixed wing aircraft are used as a surrogate for helicopter application.

- **NOTE** the labels state that “aerial application is not recommended for brassica and potato crops”. These rates are not modelled for air as the application rates (50 and 100 g ac/ha respectively) are well in excess of the cotton rate (25 g ac/ha), and at the rate for cotton, buffer zones generally exceeded 2000 m. It should therefore be recommended that labels specifically preclude aerial application to brassicas and potatoes.

- Two of the group 1a products allow use in forestry with plantations up to 2 years old. The standard forestry helicopter settings for a release height of 5 m were considered (as opposed to 3 m for agricultural use settings). However, the standard spray volume of 80 L/ha again meant that the fraction of active constituent in the tank was lower than the model capability, so a volume of 50 L/ha was used. In doing this, the predicted buffer zones were very similar to those derived by the standard agricultural helicopter, so these are used as a surrogate. However, it should be noted for forestry use, if the spray volume is increased, the overall levels of non-volatiles in the tank mix increase and therefore, drift could increase.

The spray drift risk assessment was performed in accordance with the final draft of the APVMA Operating Principles in Relation to Spray Drift (APVMA, 2008). Consequently, the model used is AGDISP (v 8.15). Three wind speeds are modelled (8, 14 and 20 km/h). The model parameters used were:

Table V5.3: AGDISP input parameters

Aircraft type	AT502
Boom height	3 m
Canopy height	0 m
Flight lines	25
Swath width	20 m
Swath displacement	0
Wind speed	8, 14 and 20 km/h
Wind direction	90^{o}
Temperature	30^{o}C
Relative humidity	50%
Spray volume	20 L/ha
Surface roughness	0.0075
Droplet size	Variable

Three aerial applications are considered, namely, application to sorghum/pasture for plague locust control (1.25 g ac/ha), forestry use (2.5 g ac/ha) and use in cotton (25 g ac/ha). The spray drift risk assessment was conducted in line with APVMA principles (APVMA 2008) and uses a standard downwind water body of 3 m wide and 15 cm deep. Due to the persistence of combined residues of fipronil and MB45950 in water, the chronic end point for fipronil to mysid shrimp (NOEC = 7.7 ng/L) was used to establish downwind buffer zones.

The following table provides the output from AGDISP in terms of absolute values for downwind buffers that will not result in an exceedence of the NOEC. In some cases, the model was extended beyond its validated range of 800 m, but was not extended beyond 2000 m downwind.

Table V5.4: Downwind aquatic buffer zones (m) for fipronil – coarse spray droplets, group 1a

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	63	80	96	63	80	96
2.5	200	193	195	115	113	122
25	1714	>2000	>2000	1188	>2000	>2000

Table V5.5: Downwind aquatic buffer zones (m) for fipronil – medium spray droplets, group 1a

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	179	177	174	179	177	174
2.5	602	595	451	369	272	242
25	>2000	>2000	>2000	1409	>2000	>2000

Table V5.6: Downwind aquatic buffer zones (m) for fipronil – fine spray droplets, group 1a

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	739	921	742	739	921	742
2.5	1088	1541	1777	786	995	916
25	>2000	>2000	>2000	1864	>2000	>2000

The Group 1b product does not have a forestry use. Different buffer zones will be calculated due to the different level of volatility in the formulation. However, because the application rates are so low, there may not be a great difference in final buffer zones compared with group 1a products. The following aquatic buffer zones were calculated for the Group 1b product:

Table V5.7: Downwind aquatic buffer zones (m) for fipronil – coarse spray droplets, Group 1b

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	70	84	100	70	84	100
25	1625	>2000	>2000	1258	1965	>2000

Table V5.8: Downwind aquatic buffer zones (m) for fipronil – medium spray droplets, Group 1b

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	203	193	190	203	193	190
25	1874	>2000	>2000	1692	>2000	>2000

Table V5.9: Downwind aquatic buffer zones (m) for fipronil – fine spray droplets, Group 1b

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	759	997	957	759	997	957
25	>2000	>2000	>2000	>2000	>2000	>2000

3.2.1.2. Group 2 products

- There are three products in this group. They are solid (wettable granule) formulations and therefore the whole formulation is considered non-volatile for AGDISP modelling.

- Same issue as group 1a products re: spray quality and label instructions relating to droplet size and corresponding spray volume per hectare. There is no forestry use with group 2 products, so the only uses modelled for aerial application are plague locust control in pasture and sorghum, and use in cotton.

Table V5.10: Downwind aquatic buffer zones (m) for fipronil – coarse spray droplets, Group 2

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.20	54	70	87	54	70	87
24	1394	>2000	>2000	1190	1793	1705

Table V5.11: Downwind aquatic buffer zones (m) for fipronil – medium spray droplets, Group 2

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.20	146	133	137	146	133	137
24	1675	>2000	>2000	1389	>2000	>2000

Table V5.12: Downwind aquatic buffer zones (m) for fipronil – fine spray droplets, Group 2

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.20	610	689	528	610	689	528
24	>2000	>2000	>2000	1594	>2000	>2000

3.2.1.3. Group 3 products

The group 3 products contain fipronil at 3 g/L. There is no water in the formulations, so the whole product is considered non-volatile for the purposes of modelling. These products are applied as ultra low volume (ULV) sprays. When modelling these in AGDISP, the DVD size is set to 'ASAE very fine' droplet size of 81 µm. The tank mix is taken to be undiluted product. Therefore, for an application rate of 1.25 g/ha, the amount of product per hectare used is 420 mL and the fraction of active is 0.003 while the fraction of non-volatiles is 1.0.

These products are intended for incremental spray drift application for efficient treatment of large areas. The label states release height should be 8–10 m at 90^{o} to wind blowing 2–8 m/s (7.2 to 29 km/h). However, at wind speeds approaching the high end, the release height is advised to be reduced to 5 m.

It is difficult to perform a spray drift assessment for products designed to be used specifically under drift conditions. The following table shows the buffer zones under the APVMA standard scenarios using three wind speeds and a release height of 3 m:

Table V5.13: Downwind aquatic buffer zones (m) for fipronil – very fine spray droplets, release height 3 m

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	446	667	889	321	442	540

The following table shows indicative buffer zones considered to be more in line with label instructions. Release heights for 8 and 14 km/h wind speeds were set at 10 m. The release height for 20 km/h were set at 8 m and for 29 km/h, at 5 m.

Table V5.14: Downwind aquatic buffer zones (m) for fipronil – very fine spray droplets, release heights of 10, 10, 8 and 5 for 8, 14, 20 and 29 km/h wind speeds respectively

	Fixed wing aircraft				Helicopter			
	Wind speed (km/h)				Wind speed (km/h)			
Rate (g ac/ha)	8	14	20	29	8	14	20	29
1.25	1176	1818	1969	1786	741	1148	1027	973

This analysis indicates that for plague locust control with group 3 products, in accordance with label use instructions, downwind aquatic buffer zones up to 2000 m are required when applying with fixed wing aircraft, and up to 1150 m are required when applying by helicopter.

3.2.1.4. Group 4 products

There is one product in this group. Like the group 3 products, it is only registered for control of plague locusts in pasture and sorghum. It is applied as a ULV. The application rate is 150 mL product/ha. When applied undiluted, this results in a fraction of active constituent of 0.008 and a fraction of non-volatiles in the tank mix of 1.0.

Table V5.15: Downwind aquatic buffer zones (m) for fipronil – very fine spray droplets, release heights of 10, 10, 8 and 5 m for 8, 14, 20 and 29 km/h wind speeds respectively

	Fixed wing aircraft				Helicopter			
	Wind speed (km/h)				Wind speed (km/h)			
Rate (g ac/ha)	8	14	20	29	8	14	20	29
1.25	1170	1808	1958	1775	736	1141	1020	967

Like the group 3 products, this analysis indicates that for plague locust control with group 3 products, in accordance with label use instructions, downwind aquatic buffer zones up to 2000 m are required when applying with fixed wing aircraft, and up to 1150 m are required when applying by helicopter.

3.2.1.5. Groups 5, 6 and 7

Group 5 (seed treatment), group 6 (turf products, applied as granules) and group 7 (termiticides, sprayed using hand-held equipment) do not require an aerial assessment.

3.2.2. Ground application

Spray drift from ground application was performed according to the AGDRIFT model (APVMA 2008). This model is limited in the parameters that can be changed. The downwind limit for this model is 300 m, and cannot be extended. The following provides a summary of the set values used in the modelling:

Tier	Tier 1 Agricultural
Boom height	High/Low – identified individually below
Swath width	13.72 m
Number of swaths	20

3.2.2.1. Group 1, 2, 3 and 4 products

Ground application for broadacre/horticultural cropping situations (spray) – Groups 1, 2, 3 and 4:

Table V5.16: Ground buffer zones (m) for fipronil broadacre/horticultural spraying situations

Crop	Maximum rate (g ac/ha)	Applicable groups	Boom Height	Buffer zone (m)	
				Very fine to fine	Fine to medium/coarse
Pasture /sorghum	1.25	1, 2	High	76	20
Forestry	2.5	1	High	134	50
Wine grapevines	20	1, 2	NA	Unable to model[1]	
Cotton	25	1, 2	High	>300	>300
Asparagus	40	1	High	>300	>300
Brassicas	50	1, 2	High	>300	>300
Swede and turnip	50	1	High	>300	>300
Sugarcane	75	1, 2	NA	Unable to model[2]	
Ginger	100	1	Low	>300	>300
Potatoes	100	1, 2	Low	>300	>300
Bananas	225[3]	1, 2	Low	>300	>300

[1] Application to wine grapevines is limited to hand held equipment. There is no suitable model available to predict spray from these operations, so this use is outside the scope of the spray drift risk assessment.
[2] Application to sugar cane is with hollow cone nozzles as a directed spray to cover the base of the sugarcane stools, or in-furrow application over the top of the plant pieces (setts). There is no model to assess spray drift from this method of application.
[3] Per hectare rate determined by DEWHA at the time of the initial assessment.

In performing the modelling, the 90th percentile data were used except for ginger, potatoes and bananas with fine to medium/coarse spray quality, where the 50th percentile data were used due to the low boom. These lead to a medium and coarse spray respectively.

Group 3 and 4 products are registered for plague locust control with application only by aircraft. There is therefore no requirement for a ground buffer zone on these labels.

Ginger and potatoes were modelled with a low boom as application to these crops is at pre-plant to the bare soil prior to incorporation. Additionally, a low boom was used for bananas as the low boom height in AGDRIFT is 51 cm off the ground, and the height of application for bananas is 30 cm up the stems.

3.2.2.2. Group 5 products

The two products in this group are registered for seed treatment use with rice, canola, sorghum and sunflowers. Spray drift is therefore not expected to be a significant exposure route in the environment.

3.2.2.3. Group 6 products

These products are registered for turf use at rates from 30–75 g ac/ha. Areas where localised runoff may reach aquatic compartments include golf fairways and turf farms. When first registered, the turf products were considered for application rates up to 30 g ac/ha. It is unclear whether DEWHA ever reviewed these products when the application rate was extended to 75 g ac/ha.

However, these products are granular and applied in granular form. Therefore, they are outside the requirements of a spray drift risk assessment (APVMA 2008).

3.2.2.4. Group 7 products

Group 7 products are termiticides. These products can be applied as a soil incorporated application through trenching or rodding around new or existing buildings/structures, or power poles and fence posts. With such application, spray drift will not provide an exposure route to the environment.

These products can also be applied as a soil barrier spray around new or existing buildings and structures, and with this method of application there is the potential for spray drift. However, application is by hand-held equipment and no suitable model exists for estimating likely drift. In any event, use of these products is expected to occur in urban areas and the likelihood of natural aquatic areas being exposed to spray drift is therefore low.

3.3. Refinement of exposure assessment – runoff

There are large uncertainties involved in predicting runoff, and levels of chemical in runoff will be dependent on many site specific parameters including soil characteristics, slopes, distances between edge-of-field and receiving waters and types of buffers in between such distances (for example, vegetative filter strips, bare ground, grassed buffers). Since previous assessments for fipronil registrations DEWHA has established an in-house model for undertaking screening level runoff exposure estimates, and this model is described briefly below.

An estimation of the amount of fipronil in runoff water was calculated using a sub-model of the REXTOX model proposed by the OECD (Probst et al. 2005), which was adopted as a working model by DEWHA. The model considers rainfall and runoff water, topography of the land (slope), degradation of the pesticide, mobility of the pesticide and buffer zones. In addition to the REXTOX sub-model DEWHA considers heterogeneity of fields, interception and retention of the pesticide by crops and weeds and sediment transport of the pesticide.

The model is based on the following equations:

‘L%runoff = (R/P) × Crsoil_surface ×f1slope × f2bufferzone × f3foliar_application x heterogeneity_factor x 100 + suspended_pesticide.
(Equation 1)

Where L% runoff is the percentage of application dose available in runoff water as dissolved substance, R is the quantity of runoff water (mm/day) and P daily precipitation (mm/day). Currently DEWHA considers a rainfall event of 100 mm with 20 mm of runoff water in its worst case scenario. On a hectare basis, the assumption of 100 mm rainfall with 20% running off results in a runoff water volume of 200 m^3 p/ha, or 200 000 L water.

Topography especially slope is an important consideration in assessing runoff. The model predicts the effect of slope according to

f1slope = 0.02153 × slope + 0.001423 × $slope^2$ for slope <20%. Where slope ≥20%; f1 = 1 **(Equation 2)**

To take into account the many topographical situations in which a pesticide may be applied, DEWHA generally considers the worst case for two scenarios. Most cropping is expected to be performed on gentler slopes ≤12.5% (7º) although some crops may be grown on steeper slopes >12.5% – <20% (>7º – <11º). Solving equation 2 results in a value of ≤0.5 for f1slope with a slope of 12.5% or less, and 1.0 for a slope of 20%. Therefore, with all other factors equalling 1, f1slope will range from 0.5 to 1.0, and results in a prediction of 10% applied chemical in runoff from a 12.5% slope and 20% applied chemical in runoff from a 20% slope based on equation 1. For this exercise, f1slope will be set at 0.5.

The 10% of the applied pesticide in runoff water is likely to be high as this value assumes all areas contribute to runoff. DEWHA estimates that <50% of an area effectively contributes to runoff in most realistic circumstances (based on Dunne & Black 1970). Accordingly, equation 1 is multiplied by 0.5 to reflect the heterogeneity of real fields. This correction lowers the initial estimated amount of chemical in runoff water to 5% as a first tier approach.

The model is further refined by considering the fate of the pesticide. The model assumes that in a worst case, the runoff event occurs 3 days after the application of the pesticide. The mobility of the pesticide is also taken into account. The fraction of the pesticide available for runoff is related by the equation:

Crsoilsurface = $e^{(-3 \ln 2/DT50)}$ X (1/(1+Kd) for three days of degradation **(Equation 3)**

The two critical input values, apart from application rate, in the DEWHA model are the degradation half-life and the Koc (or preferably, Kd where values are available). The model is more sensitive to sorption than half-life. Laboratory soil half-lives described in Volume 2 range from 42 days to 385 days. For this exercise, the geometric mean (155 days) was used.

The choice of Kd will have the largest impact in the DEWHA model. Measured Kd values from laboratory studies (n = 5 soils with measured Kds) range from 3.7– 20.4 L/kg. For this exercise, the geometric mean Kd (10.0 L/kg) will be used.

Applying these values to equation (3), Crsoil_surface = 0.09

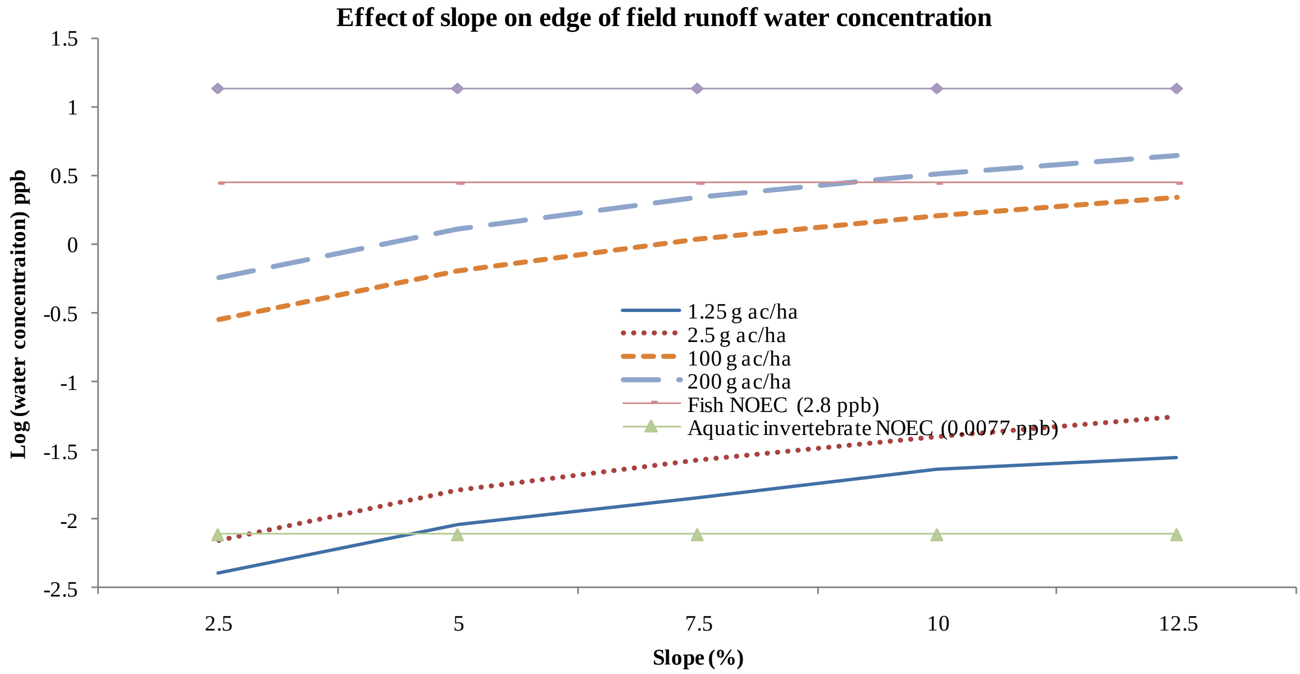
For pesticides applied to crops a portion is retained (F_{ret}) by the crop and not available for runoff during the event. CAS estimates that half of the intercepted (F_{int}) pesticide is retained based on Linders et al., (2000 citing Willis et al. 1994). The value of f3foliar_application is equal to (1-F_{ret}), where $F_{ret} = F_{int} \times 0.5$. For weeds and bare soil $F_{ret} = 0$ and f3foliar_application is consequently = 1. The value of suspended_pesticide = 0 for pesticides with water solubility ≥1 mg/L. Pesticides in solution is the major form of transportation, with only chemicals with a water solubility of <1 mg/L being transported primarily by sediment (Grover 1989). This is due to the volume of runoff water greatly outweighing the mass of sediment transported in a runoff event (ibid: Afyuni et al. 1997). For this modelling exercise, as an initial worst case, no crop interception was assumed at this stage.

The concentration of pesticide in the worst case ‘edge-of-field’ runoff water may be calculated by considering the amount runoff water and amount of pesticide on a hectare basis. The following input values, as described for equation 1 above, are as follows:

R = 20 mm
L = 100 mm
Crsoil_surface = 0.09
f1slope = 0.5
f2bufferzone = 1 (default value)
f3foliar_application = 1 (bare ground, pre-emergent uses)
heterogeneity factor = 0.5
suspended pesticide = 0

Therefore, for an application rate of 50 g ac/ha, equation 1 predicts a percentage runoff of 0.45% if the runoff event occurred 3 days after application. This equates to 0.225 g fipronil p/ha in 200 000 L water/ha, or a concentration of 1.12 µg/L.

The following graph shows the effect of increasing slope (2.5% –12.5%) in the DEWHA model to edge-of-field water concentration, and also for reference, provides the chronic NOECs for fish, aquatic invertebrates and algae/aquatic plants.



At the most conservative runoff assessment level (edge-of-field), it can be seen that at application rates below 100 g ac/ha, even at a 12.5% slope, the risk to fish and algae/aquatic plants is acceptable, while at 200 g ac/ha, the edge-of-field water concentrations exceed the fish NOEC once slopes exceed about 9%.

However, even at the lowest application rate of 1.25 g ac/ha, concentrations in edge-of-field runoff exceed the mysid shrimp NOEC at slopes as shallow as 4.5%.

In undertaking the runoff assessment, the following were used or considered:

1. Q-values were calculated using the chronic NOEC for fipronil to mysid shrimp (7.7 ng/L);

2. Regulatory laboratory aerobic soil studies show the major metabolite formed is the sulfone MB46136 (levels exceeding 30% initial fipronil levels in one soil). Some minor formation of the sulfide MB45950 is also observed. The amide RPA200766 was also a dominant metabolite in one soil, but this is not considered biologically active.

3. The geometric mean soil half-lives (four soils, Fitzmaurice & McKenzie 2002 – not reviewed by DEWHA) using first-order kinetics was 155 days (range of 42–382 days). However, given the biological activity of the main metabolite MB46136 (chronic NOEC to mysid shrimp of 5.1 ng/L), it is appropriate to consider half-lives at least in terms of combined fipronil/MB46136 residues. When this is done, the geometric mean half-life is 304 days (range 136–630 days).

4. There are also field dissipation studies. In one study (four sites, in-furrow application; Wicks & Boussemart 1995 – see Volume 2), the two

dominant, biologically active metabolites, were the MB46136 and MB45950. Based on fipronil alone, the geometric mean field half-life was 122 days (range 96–141 days). However, in terms of total residues the geometric mean half-life increased to 214 days (range 180–267 days).

5. In a second field dissipation study (two sites, surface application; Boussemart, 1993 – see Volume 2), the same major biologically active metabolites were observed along with the desulfinyl MB46513 during the first 2 months. However, the sulphide, MB45950, was only a very small contributor to total residues. From these two sites, it was apparent that the field half-life from surface applications will be lower than those when incorporated, and the fipronil geometric mean half-life was 25 days (range 14–43 days), while that for total residues (fipronil/MB46136/MB45950/MB46513) was 102 days (range 59–175 days).

3.3.1. Impact of half-life on DEWHA runoff estimates

In the following table, the impact on edge-of-field runoff concentrations is considered by keeping application rate constant (50 g ac/ha); slope constant (12.5%) and Kd constant (10 L/kg). The half-lives modelled are the laboratory, field in-furrow and field surface application ‘total’ residue geometric mean half-lives of 304, 214 and 102 days, respectively. The following results are calculated:

Table V5.17: Impact of changing half-life values to edge-of-field runoff water concentration

Half-life (days)	304	214	102
Edge-of-field water concentration (µg/L)	1.11	1.11	1.10

This short analysis shows the lack of sensitivity of the model to half-lives of this magnitude. The DEWHA model considers runoff at 3 days after application, so for any longer half-life, there is going to be little change in initial residues after this time. The impact of half-life is more important in the event of short-lived compounds, or when a longer time delay between application and runoff is considered.

For example, with the field half-life of 102 days, if the runoff even occurred 2 weeks after application, the DEWHA model predicts a water concentration of 1.02 µg/L. If the fipronil only half-life for surface applied product in the above field studies was used (25 days), at 2 weeks after application the concentration in runoff water is predicted to be 0.76 µg/L.

For this assessment, at three days, there is little influence from the half-life given they are all relatively long. The in-furrow field half-life for total residues of 214 days will be used in the modelling.

3.3.2. Choice of Kd

With the model predicting runoff after 3 days, it is appropriate to use the fipronil Kd as fipronil is still expected to make up the majority of residues available for runoff. In laboratory studies, fipronil accounted for 100% of residues after 3 days. In the field studies, measurements were in terms of months after application, not days, so a direct comparison is not easy. However, after 0.25 months, fipronil still appeared to account for >90% of total residues in most cases for furrow applications. However, at one site for the surface applied spray formulation, fipronil accounted for around 50% of residues with MB46136 and MB46513 each accounting for around 25% of residues. Nonetheless, as a more conservative approach, the fipronil geometric mean Kd of 10 L/kg will be used in the model.

3.3.3. Impact of foliar interception

In most cases, fipronil is not applied to bare soil so crop interception and retention must be taken into account to give an 'edge-of-field' concentration. Data for crop interception and retention is limited but a single comprehensive paper from a reliable source is available (Linders et al. 2000), although most of the fipronil cropping situations are not covered in this European-focused paper. The paper focuses on interception and there are limited data on retention of pesticide on weeds or crops during a rainfall event. The paper alludes to ~50% retention of the intercepted pesticide. Fret = Fint × 0.5 based on Linders et al. (2000). In the DEWHA model, the 'f3foliar_application' is now considered where f3foliar_application = 1-(0.5 X Fint), where Fint is the fraction of interception.

In the worst case exposure calculations above, Fint was set to 0. It is readily observed with this addition to the formula that interception of any level will not translate to a reduction in runoff of an equal proportion. For example, with interception of a crop of 75%, 50% or 25%, the corresponding reduction in runoff (based on f3foliar_application) will be 37.5%, 25% and 12.5% respectively with f3foliar_application equalling 0.625, 0.75 and 0.875 respectively.

With the following refined calculations, a Fint = 50% will be factored into the equation for all cropping situations except potatoes and ginger, where these two will still see application to bare ground (pre-plant).

3.3.4. Group 1 products

The following predicted runoff concentrations in **edge-of-field** runoff waters are predicted based on **a single application only** and considering two different field slopes, namely, 5% and 12.5%, and crop interception.

Table V5.18: Predicted water concentrations (µg/L) in runoff at edge-of-field

Crop	**Maximum rate**	**Runoff water concentration (µg/L)**	
		5% slope	**12.5% slope**
Asparagus	40	0.194	0.666
Bananas	225[1]	1.090	3.744
Brassicas	50	0.242	0.832
Cotton	25	0.121	0.416
Mushrooms	3.2 g ac per 300 L bale[c]	NA	NA
Potatoes	100	0.484	1.664
Wine grapevines	20	0.097	0.333
Pasture / sorghum	1.25	0.006	0.021
Sugarcane	75	0.363	1.248
Forestry	2.5	0.012	0.042
Ginger	100	0.484	1.664
Swede and turnip	50	0.242	0.832

[1] Per hectare rate determined by DEWHA at the time of the initial assessment.

Table V5.19: Acute aquatic risk quotients – 5% slope

	Acute risk quotients				Chronic risk quotients		
	Fish	Aquatic invertebrates	Algae / aquatic plants	Sediment organisms	Fish	Aquatic invertebrates	Algae / aquatic plants
Asparagus	0.002	1.4	0.003	Not considered for edge-of-field water	0.069	25.2	0.005
Bananas	0.013	7.8	0.016		0.389	141.6	0.027
Brassicas	0.003	1.7	0.004		0.086	31.4	0.006
Cotton	0.001	0.9	0.002		0.043	15.7	0.003
Potatoes	0.006	3.5	0.007		0.173	62.9	0.012
Wine grapevines	0.001	0.7	0.001		0.035	12.6	0.002
Pasture / sorghum	0.0001	0.04	0.0001		0.002	0.8	0.0002
Sugarcane	0.004	2.6	0.005		0.130	47.1	0.009
Forestry	0.0001	0.09	0.0002		0.004	1.6	0.0003
Ginger	0.006	3.5	0.007		0.173	62.9	0.012
Swede and Turnip	0.003	1.7	0.004		0.086	31.4	0.006

This analysis of maximum edge-of-field concentrations shows that with a 5% slope, the acute and chronic risk is acceptable for fish and algae/aquatic plants. The acute risk is acceptable to aquatic invertebrates only at rates for pasture/sorghum (1.25 g ac/ha) or forestry (2.5 g ac/ha), while the pasture/sorghum application rate is the only one that results in an acceptable chronic risk to aquatic invertebrates.

Table V5.20: Acute aquatic risk quotients – 12.5% slope

	Acute risk quotients				Chronic risk quotients		
	Fish	Aquatic invertebrates	Algae / aquatic plants	Sediment organisms	Fish	Aquatic invertebrates	Algae / aquatic plants
Asparagus	0.008	4.8	0.010	Not considered for edge-of-field water	0.238	86.5	0.017
Bananas	0.044	26.7	0.055		1.337	486.2	0.094
Brassicas	0.010	5.9	0.012		0.297	108.1	0.021
Cotton	0.005	3.0	0.006		0.149	54.0	0.010
Potatoes	0.020	11.9	0.024		0.594	216.1	0.042
Wine grapevines	0.004	2.4	0.005		0.119	43.2	0.008
Pasture / sorghum	0.0002	0.2	0.0003		0.008	2.7	0.001
Sugarcane	0.015	8.9	0.018		0.446	162.1	0.031
Forestry	0.000	0.3	0.001		0.015	5.5	0.001
Ginger	0.020	11.9	0.024		0.594	216.1	0.042
Swede and turnip	0.010	5.9	0.012		0.297	108.1	0.021

The acute risk to fish and algae/aquatic plants is acceptable for all use patterns. The chronic risk is acceptable to algae/aquatic plants for all use patterns and to fish for all uses except bananas. However, the Q-value in this case is still <2, and the focus for the remainder of the runoff assessment for group 1 products will focus on aquatic invertebrates. With a 12.5% slope, the acute and chronic risk is unacceptable from all uses (although, acute risk is marginal for pasture/sorghum and forestry). Sediment organisms will be considered at the next stage also as this will focus on runoff waters entering receiving water.

Mitigation

Predicting runoff is a complex task, and when applied to national existing chemical assessments such as this, the relevance of the model as anything more than a screening tool is questionable. The above calculations show that in edge-of-field runoff, fipronil concentrations in the water could be sufficiently high to result in acute and chronic risks to aquatic invertebrates following a single application. However, these calculations do not consider important issues such as spatial and temporal scales, which will change risk conclusions.

Several crops registered for use in group 1 labels are horticultural (asparagus, bananas, brassicas, potatoes, ginger, swede and turnip). Such crops are generally more intensive in their nature and are grown over much less land than broadacre crops such as cotton and sugarcane. Consequently, the overall environmental exposure from application to these crops is expected to be significantly less than in other situations such as cotton, sugarcane, forestry and plague locust control in pasture and sorghum, where large areas at a time could be treated. Further, it is unlikely that all crops in a given area will be treated with fipronil at the same time, thereby further reducing overall environmental exposure.

Despite this, current assessment methodology does not exist to allow building in of such considerations into the risk assessment.

The DEWHA model does allow a further dilution step. As a default position, receiving water concentrations are calculated assuming that 200 m^3 of water contaminated with pesticide from each hectare for a total of 10 ha flows into the 1500 m^3 water body resulting in a total water body of 3500 m^3. It can readily be seen that this level of dilution will only result in a decrease in Q-values by around 43%. Revised water concentrations along with calculated sediment concentrations, and revised Q-values for aquatic invertebrates and sediment organisms are shown below.

Sediment concentrations will be calculated following the methodology described in Section V4.1.2.1 above. Risk quotients will be generated only for aquatic invertebrates and sediment organisms. Interception of 50% is assumed for all crops except ginger and potatoes as fipronil can be applied pre-plant here. However, for these crops, pre-plant application is followed by soil incorporation, so an incorporation efficiency of 85% is assumed.

Table V5.21: Predicted water concentrations (µg/L) and sediment concentrations (µg/kg) resulting from modelled runoff by use pattern / application rate

Crop	**Maximum rate**	**Water concentration (µg/L)**		**Sediment (µg/kg)**	
		5% slope	**12.5% slope**	**5% slope**	**12.5% slope**
Asparagus	40	0.11	0.38	1.50	5.16
Bananas	225	0.62	2.13	8.39	28.81
Brassicas	50	0.14	0.47	1.86	6.37
Cotton	25	0.07	0.24	0.93	3.24
Potatoes	15	0.06	0.19	0.74	2.56
Wine grapevines	20	0.06	0.19	0.75	2.53
Pasture / sorghum	1.25	0.003	0.01	0.05	1.62
Sugarcane	75	0.21	0.71	2.80	9.60
Forestry	2.5	0.01	0.02	0.09	0.30
Ginger	15	0.06	0.19	0.74	2.56
Swede and turnip	50	0.14	0.47	1.86	6.37

Q-values are shown below.

Table V5.22: Chronic Q-values to aquatic invertebrates and acute Q-values to sediment dwelling organisms resulting from modelled runoff by use pattern / application rate

Crop	Maximum rate	Q-values, aquatic invertebrates		Q-values, sediment-dwelling organisms	
		5% slope	12.5% slope	5% slope	12.5% slope
Asparagus	40	14.4	49.3	1.7	5.7
Bananas	225	80.7	277.2	9.3	32.0
Brassicas	50	17.9	61.6	2.1	7.1
Cotton	25	9.0	30.8	1.0	3.6
Potatoes	15	7.2	24.6	0.8	2.8
Wine grapevines	20	7.2	24.7	0.8	2.8
Pasture / sorghum	1.25	0.4	1.6	0.06	1.8
Sugarcane	75	26.9	92.4	3.1	10.7
Forestry	2.5	0.9	3.1	0.1	0.3
Ginger	15	7.2	24.6	0.8	2.8
Swede and turnip	50	17.9	61.6	2.1	7.1

Based on these calculations, the risk to aquatic invertebrates and sediment organisms (acute only) remains unacceptable for all uses at a 12.5% slope. At a 5% slope, pasture/sorghum and forestry is acceptable to both aquatic invertebrates and sediment organisms (acute risk only). All other uses result in an unacceptable risk. Further, these risks were calculated **based on a single application**.

Multiple applications

Several cropping situations allow for more than one application. Given the persistent nature of fipronil in aerobic soils, and in both the water column and sediment in water/sediment systems, and the formation of metabolites that exhibit similar or more toxicity than the parent compound, it is important to consider the impact of multiple applications.

Asparagus (six applications), bananas (two applications), brassicas (up to four applications), cotton (two applications) and swede and turnip (four applications) would all result in increases in the risk quotients from those in the above table.

3.3.5. Group 2 products

Group 2 products are registered for use on bananas, brassicas, cotton, mushrooms, potatoes, wine grapevines, pasture/sorghum and sugarcane. The rates are at or similar to those for the same cropping situations for group 1 products.

Consequently, the calculated water and sediment concentrations, corresponding Q-values, and conclusions for these crops for group 1 products will also apply to group 2 products. There is no forestry use registered for group 2 products, so the only situation where risks from runoff are considered acceptable (aquatic invertebrates, and acute risk to sediment organisms) are for plague locust control in pasture or sorghum.

3.3.6. Group 3 and 4 products

The products in these groups are only registered for control of plague locusts and spur throated locusts in pasture and sorghum at a single rate of 1.25 g ac/ha. This is the rate considered for this use pattern in group 1 products above, and resulted in an acceptable risk to aquatic invertebrates and sediment organisms (acute only) arising from exposure through runoff with slopes of 5%, but the risk remained unacceptable on steeper slopes.

3.3.7. Group 5 products

The two products in this group are registered for seed treatment use with rice, canola, sorghum and sunflowers. Based on the assumption that all active is sorbed to the treated seed, and the seed is incorporated at the time of sowing, the likelihood of exposure to aquatic compartments from fipronil or its metabolites dissolved in runoff is considered to be small, and consequently, the risk to aquatic organisms and sediment organisms is considered acceptable for canola, sorghum and sunflowers.

Rice is somewhat different as it is seeded into flooded bays, hence desorption will result in fipronil being released directly to the water column.

As pointed out in the tier 1 assessment (see Section V4.2.2.3), data provided in Stevens and Helliwell (1996), which measured fipronil levels in rice bay water following aerial sowing of fipronil treated rice (12.5 g ac/ha), showed relatively fast dissipation from the water body, with levels at 2.1 µg/L on the day following sowing, declining to <0.005 µg/L after 22 days. In contrast, several water/sediment studies now available as discussed in Volume 2 show fipronil, and its main metabolite found in those tests (sulphide MB46950) had water column half-lives of 18–120 days. DEWHA has calculated the half-life in the rice bay water from Stevens and Helliwell (1996) to be 2.7 days ($r^2 = 0.84$). It may be considered more appropriate to use the Australian data from Stevens and Helliwell in this case for the following reasons:

- This was a study specific to the use pattern in question.
- The application rate was according to the currently registered rate (equivalent to 12.5 g ac/ha), compared with around 200 g ac/ha used in the regulatory water/sediment studies described in Volume 2.
- The dissipation of fipronil was measured in the rice bay water with nine measurements over 22 days.

One of the problems is the lack of data for the metabolites, which are known to be of similar toxicity to the parent compound. In the regulatory studies considered in Volume 2, the sulphide (MB45950) was the main metabolite found in the water column at levels that could approach 10% of parent. These studies showed that when total residues (fipronil + MB45950) were taken into account, dissipation still followed first-order kinetics with good correlation, and the half-lives increased by 25–100% of those for fipronil alone. An increase in the rice water bay half-life of 50% would result in a 'toxic residue' half-life of around 4 days based on the Stevens and Helliwell (1996) data.

Water retention periods vary between the irrigation areas and authorities, but applying the longest generic period of 28 days, using a water half-life of 4 days, and assuming desorption from rice seeds to the surrounding rice bay water will result in an initial fipronil concentration of 2.1 µg/L, a final water concentration at the end of the 28 day withholding period (that is, seven half-lives) would be in the order of 0.03 µg/L.

Once released from the rice bay water, this concentration (prior to dilution in receiving waters) would result in a potential risk to ahalf-lifequatic invertebrates (Q = 0.21, acute; Q = 3.9, chronic). Dilution in the order of 4:1 would be required in receiving waters to reduce the chronic risk quotient to acceptable levels in the best case (more dilution will be needed for shorter retention period).

3.3.8. Group 6 products

These products are registered for turf use at rates from 30–75 g ac/ha. Areas where localised runoff may reach aquatic compartments include golf fairways and farms. The labels state that following application, the chemical is to be incorporated using at least 6 mm overhead irrigation or rainfall.

It is unclear how effective such a mechanism is. Unlike incorporation to bare ground following application, the turf use pattern will see granules applied to established turf prior to watering in. When assessing this use pattern for exposure to birds, DEWHA assumed three levels of incorporation, namely, 50%, 75% and 95%. Using these same assumptions, the DEWHA runoff model calculates the following edge-of-field water concentrations for a 5% and 12.5% slope:

Table V5.22: Runoff water concentrations (µg/L) from turf uses depending on %incorporation

Maximum rate	**Runoff water concentration (µg/L)**	
	5% slope	**12.5% slope**

30 g ac/ha	50% incorporated	0.097	0.333
	75% incorporated	0.048	0.166
	95% incorporated	0.01	0.033
75 g ac/ha	50% incorporated	0.242	0.832
	75% incorporated	0.121	0.416
	95% incorporated	0.024	0.083

It can be seen that even at the best scenario of 5% slope, 30 g ac/ha and 95% incorporation, the chronic risk to aquatic invertebrates remains unacceptable (Q = 1.3).

As noted above, the DEWHA runoff model does allow a further dilution step. As a default position, receiving water concentrations are calculated assuming that 200 m^3 of water contaminated with pesticide from each hectare for a total of 10 ha flows into the 1500 m^3 water body resulting in a total water body of 3500 m^3. For turf uses, given much smaller areas will be treated as opposed to broadacre uses, it is more appropriate to model based on runoff from 1 hectare to a 1-hectare, 15 cm standing body of water, thereby resulting in a total water volume of 1700 m^3. Based on this, the following water and corresponding sediment concentrations are calculated:

Table V5.23: Effects on mitigation measures on water and sediment concentrations, turf uses, runoff

Maximum rate		**Water concentration (µg/L)**		**Sediment (µg/kg)**	
		5% slope	**12.5% slope**	**5% slope**	**12.5% slope**
30 g ac/ha	50% incorporated	0.011	0.039	0.148	0.526
	75% incorporated	0.006	0.019	0.081	0.256
	95% incorporated	0.001	0.004	0.013	0.054
75 g ac/ha	50% incorporated	0.028	0.098	0.377	1.321
	75% incorporated	0.014	0.049	0.189	0.661
	95% incorporated	0.003	0.01	0.040	0.135

The following chronic aquatic invertebrate Q-values and acute sediment organism Q-values are calculated:

Table V5.24: Aquatic invertebrate chronic Q-values and sediment organism acute Q-values, turf runoff scenarios

Maximum rate		**Chronic aquatic invertebrate Q-values**		**Acute sediment organism Q-values**	
		5% slope	**12.5% slope**	**5% slope**	**12.5% slope**
30 g ac/ha	50% incorporated	1.43	5.06	0.16	0.58
	75% incorporated	0.78	2.47	0.09	0.28
	95% incorporated	0.13	0.52	0.01	0.06
75 g ac/ha	50% incorporated	3.64	12.73	0.42	1.47
	75% incorporated	1.82	6.36	0.21	0.73
	95% incorporated	0.39	1.30	0.04	0.15

Where slopes are 5% or less, the risk to aquatic invertebrates is acceptable, and the acute risk to sediment organisms is acceptable at all applications provided at least 75% incorporation is achieved. Where the slope is up to 12.5%, these risks remain acceptable provided incorporation greater than 95% is achieved at the application rate of 30 g ac/ha, but risks are unacceptable at the higher application rate.

Provided at least 95% incorporation is achieved, application could occur on a 10% slope at the highest rate, and the chronic Q-value to aquatic invertebrates would be acceptable (Q = 0.9), as would the risk to sediment organisms (acute, Q = 0.1).

To allow further refinement for this part of the risk assessment, information should be provided relating to the efficiency of incorporation if carried out according to label instructions. Further, the DEWHA model was developed for agricultural applications, and is unlikely to be the best approach for turf situations. A model was developed exclusively for pesticide use in turf (Haith 2001), and includes golf courses (fairways, tees and greens). Subject to the information on efficiency of incorporation, this model will be applied in further refining the risk assessment for group 6 products.

3.3.9. Group 7 products

These products are used as conventional termite soil chemical barrier treatments around existing buildings and structures, with one also registered for pre-construction use. Additionally, the products are registered for treatment of poles and fence posts.

When used around buildings and structures, fipronil is applied either as a surface spray, or incorporated into the soil through trenching or rodding techniques. The latter method is not expected to result in aquatic exposure through runoff, so risk from runoff in these cases is considered acceptable. This is the same for application to poles and fence posts where the chemical is incorporated into the soil through trenching and backfill or soil rodding methods.

Where applied as a barrier treatment around buildings and structures as a spray, there is the potential for runoff to aquatic environments. To perform any meaningful calculations in this regard, it would be useful to have information as to the likely area of a block that may be treated and the expected use at any given time within an urban environment. Such information is not available.

It is apparent however, that runoff from such uses does occur as confirmed by recent data from California. As described by Moran (2007), in California, all registered uses of fipronil products are urban. It is commonly used by professionals for underground injection to control termites. In 2003, the California Department of Pesticide Regulation (DPR) agreed to allow application of fipronil outdoors around structures to control ants, which could therefore expose it to runoff. Almost all fipronil used in 2004 and 2005 (latest data reported in Moran 2007) was for structural pest control. In 2005, some 21 700 pounds (~10 000 kg) was sold in California.

Haver et al. (2008) then report pesticide detections in dry and wet weather surface runoff from single family residences in California. This monitoring program included eight single-family residential drainsheds (four in Sacramento County and four in Orange County) with 150–450 parcels (presumably house blocks) per site. Pesticide sampling was undertaken for various OPs, synthetic pyrethroids and fipronil. Weekly grab samples were taken from October 2006–December 2007 in Orange County, and from July 2006–December 2007 in Sacramento. In addition, biweekly grab samples were taken in both counties from January 2008–September 2008. In the Orange Country samples, for dry weather runoff, fipronil was detected in 98.5% of samples (194/197). The maximum level was 10 µg/L, although the median concentration found was much lower at 91 ng/L. In wet weather runoff (26 samples), fipronil was found in all samples with a median concentration of 183 ng/L and a maximum concentration of 1.1 µg/L.

These fipronil detections can really only have come from surface application around building structures and are of concern given the median concentrations in both wet and dry runoff are well in excess of the chronic fipronil NOEC to mysid shrimp, and Q-values from wet and dry runoff median concentrations are 12 and 24 respectively.

Lao et al. (2010) report on the occurrence of fipronil in sediments from the Ballona Creek estuary. This creek is described as a nine mile-long (14.4 km) flood-control channel that drains a highly urbanised 329 km^2 watershed within the city of Los Angeles. Given the information from Moran (2007) above, it must be assumed that fipronil exposed to sediments in this region is the result of runoff from urban uses as a pest control. Six sampling stations along a 4 km tidally-influenced stretch of this water way were utilised and sediment samples collected during three dry season events (September 2007, June 2008 and October 2008). Samples were collected to a depth of 5 cm. Fipronil desulfinyl (MB46513), sulphide (MB45950) and sulfone (MB46136) were detected in samples from each of the three sampling events. In contrast, parent fipronil was detected infrequently (4 of 18 samples). MB46136 was the most abundant metabolite (100% of samples) at concentrations ranging up to 9.8 µg/kg. The other two metabolites were found in all 2008 samples but at lower concentrations, generally <1 µg/kg. For the September 2007 event, these metabolites were found at a maximum concentration of 6.2 µg/kg (MB45950) and 1.5 µg/kg (MB46513). MB46136 accounted for >50% total residues compared with around 20% each for MB45950 and MB46513, and <10% total residues was attributed to the parent compound.

MB46136 is as toxic to sediment organisms as the parent compound based on data described in Appendix 2. The 10-day LC50 to *Chironomus tentans* was determined to be 0.83 µg/kg, well below some of the levels detected in the above study.

While runoff is not considered an important exposure route for termiticide use of fipronil when thoroughly incorporated into soil through trenching or rodding, this is not the case when sprayed as a surface barrier. Since the initial environmental assessment for this use of fipronil in Australia, new data have become available relating to the chronic toxicity of fipronil and its metabolites to aquatic invertebrates, and the acute toxicity of fipronil and its metabolites to benthic organisms. In addition, monitoring data from California for runoff waters and sediments has found fipronil at levels consistently above the now known toxicity limits. The findings of fipronil and its metabolites in the Californian monitoring are attributed to its use as a surface spray in urban areas for pest control.

In light of this new information, the use of fipronil as a surface barrier spray for termite and ant control around new and existing buildings and structures may no longer be able to be supported unless additional information is provided to the APVMA for the fipronil review. Such information should include volumes of use of fipronil for this use pattern over the last 5 years, the main geographical areas of use and characterisation of areas of use (for example, the amount of treated area around ‘typical’ buildings; number of likely treated buildings in a wider location) to allow a better modelling approach to estimating runoff concentrations. It is highly desirable that monitoring of urban runoff and associated sediments be provided as undertaken in fipronil use areas to allow validation or otherwise of any modelling later undertaken for this use pattern.

3.4. Potential for endocrine disruption effects

Some non-standard data are reported in Volume 3 showing the potential for endocrine disruption impacts on aquatic invertebrates at sub-ppb concentrations. The marine copepod *A. tenuiremis* had inhibition of reproduction approaching 90% when males exposed to fipronil at 0.63 µg/L mated even though no significant mortality was observed at this concentration. This same species, when exposed to 0.16, 0.22 and 0.42 µg/L in a full life-cycle test showed >90% adult survival at all rates. However, delayed development was observed at the two highest concentration, and at 0.22 µg/L fipronil halted female egg extrusion by 71%. Even at 0.16 µg/L, there was a 58% reduction in gravid females.

In further testing with this species, strong reproductive (52–88%) and net production (40–80%) depressions for fipronil and MB46513 at 0.25 µg/L and MB45950 at 0.15 µg/L were found compared with controls. Spiked sediment exposures of 65–300 µg/kg of fipronil yielded significantly reduced production rates per female that were 50–67% of control production.

In the 28-day mysid shrimp study reported in the EFSA review, reproduction was almost halted (92% reduction) at 0.057 µg/L, and was reduced by over 30% at 0.015 µg/L. The NOEC from this study was 0.0077 µg/L, and at this concentration, inhibition in reproduction was 8.6% compared with control organisms.

Given the most sensitive available data still relate to the chronic mysid shrimp NOEC, the aquatic assessment for spray drift and runoff is expected to also cover potential risks to endocrine impacts, based on the relatively small amount of data available.

4. Other terrestrial organisms

4.1. Bees

In previous assessments of risk of fipronil to exposed bees, assessments were performed using a contact LD50 of 5.93 ng/bee. However, there is now significant new data indicating this level is too high. It was derived through a standard 48-hour contact toxicity test while later data show a lag time between exposure and subsequent death from both oral and contact exposure of 3 and 5 days respectively. The standard test could not account for such a lag time. The new data suggest the LD50 to honey bees is somewhere between 0.01 ng/bee and 0.1 ng/bee. In one study, at 0.1 ng/bee through both oral and contact toxicity, mortality was 100% after 7 and 10 days respectively. This compared with 25% mortality in the oral exposure group and 0% mortality in the contact exposure group at this dose level after 48 hours, the time for standard toxicity testing.

4.1.1. Group 1 and 2 products

Residues on fruits/seeds/pods/large insects were calculated using the Kenaga nomogram in the screening risk assessment (see Table V4.1, Section V4.1.1.1). In the absence of other information, it will be assumed these residues equate to those in pollen (mg/kg) or nectar (mg/L).

Information from Rortais et al. (2005) indicates in the bee colony, nurses are the highest consumers of pollen (65 mg over 10 days). The 10-day PEC_{pollen} (ng/65 mg pollen, which equates to a dose of ng/bee over 10 days) is calculated in the following table.

In terms of nectar, Rortais et al. (2005) observes that nectar can contain up to 80% sugar, and nectar foragers can consume up to 899 mg sugar over 7 days of foraging. The 7 day PEC_{nectar} (ng/899 mg sugar, which equates to a dose of ng/bee over 7 days) is calculated in the following table.

Table V5.25: Bee exposure (µg ac/bee) following different spray rates of fipronil

	Application rates (g ac/ha)						
Dietary component	1.25	25	40	50	75	100	800
Pods with seeds; large insects	0.02	0.33	0.54	0.67	1.0	1.34	10.7
PEC_{pollen} (ng/nurse bee)	1.3	214	35.1	43.6	65	87.1	695
PEC_{nectar} (ng/foraging bee)	22.5	370	610	750	1120	1500	12000

With an LD50 to bees expected to be somewhere from 0.1–0.01 ng/bee, it can be seen this approach results in an assumption of risk to bees at all application rates.

There are few data to enable such an assessment to be validated at this stage. In one study reported (Taylor et al. 2007 – see Volume 3), fipronil present at 0.01 mg/L sugar syrup, placed in bait stations in a 4 km^2 grid, resulted in the complete mortality of 20 colonies within 13 days of poisoning. After 6 weeks, the effect of poisoned hives on the survival of newly introduced colonies also showed complete mortality of colonies introduced into the initial eradication zone, presumably through ‘robbing’ the honey in the contaminated hives. This indicates very high potency of fipronil to bee colonies. The concentration of fipronil in this experiment was in the order of the highest residues predicted in nectar in the above table with an application rate of 800 g ac/ha.

However, this process is still conservative in that it assumes bees obtain all their diet from the contaminated area, and the levels of fipronil/metabolites remain in pollen and nectar at these levels during the whole period of foraging.

At this stage, no further refinement of the risk assessment is considered possible, and the scoping assessment concludes the risk to bees is not acceptable from spray uses of fipronil. To further refine this in any further fipronil review, the new bee toxicity data detailed in the Recommendations section, Volume 1 should be provided. Further, registrants/industry should address in some detail the following issues:

- Except for the literature study of Mayer and Lunden (1999) which looked at bee mortality only, there are no data available on the toxicity to bees in the field following spray application (as opposed to seed dressings – see

Section V5.4.1.2). Given new concerns about the toxicity of fipronil to bees, a field trial should be provided/undertaken addressing this data gap. Suggested methodology is available from the European and Mediterranean Plant Protection Organisation (EPPO) activities related to honeybees[1]. with the following observations being required:

  - The number of foraging bees in the crop, behaviour of bees on crop and around hives, mortality of bees (using dead-bee traps).
  - An estimation of pollen collection (using pollen traps) and pollen in collected honey. Given the likely persistence of fipronil in honey and potential impacts on the colony, it is considered necessary to estimate the number of bees on frames, brood status in frames, and to study residues in dead bees, pollen, wax and honey. Brood status should always be assessed at test initiation and test termination.

- The likelihood that foraging bees will be exposed through the identified use pattern, including likelihood of weeds flowering during treatment.
- For uses where bees may be exposed, a detailed characterisation of exposure is important, and should consider such factors of the spatial scale of application compared with foraging area of bees.
- For use patterns where bees could be exposed, the likely residues of fipronil/metabolites in nectar and pollen following application.
- Persistence of fipronil and its metabolites in nectar or pollen contaminated by spray drift.
- Toxicity of the main metabolites to bees (in the absence of such data, it will be assumed they are as toxic as the parent molecule).

4.1.2. Group 3 and 4 products

These products are only registered for plague locust control at rates of 1.25 g ac/ha. This rate is included in the analysis in Section V5.4.1.1 above for group 1 and 2 products. At this rate, a risk is still predicted for bees, and the data requirements to address this issue are outlined above.

4.1.3. Group 5 products

The original risk assessment for use of fipronil in seed dressing formulations concluded a low risk to bees due to limited exposure. As shown in the screening risk assessment, new studies appear to support this conclusion. However, due to concerns in general about bee/pollinator decline, the issue is to be explored further in this refined risk assessment.

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[1] Available at http://www.eppo.org/PPPRODUCTS/ppp_standards/pp1-170-3-e.pdf

The new studies addressing bee effects exposed to sunflowers grown from treated seed (see Section V3.8.1.1.3, Volume 3) showed no adverse effects on mortality, behaviour and colony development to bees exposed to sunflowers grown from treated seed, or to sunflowers grown in soil treated with fipronil. These findings appear to support a conclusion of low risk to bees when exposed to plants where fipronil was applied as a seed dressing.

Part of these studies included measuring residues of fipronil and three metabolites, being MB45950, MB46136 and MB46513 in leaf stalks, dead bees, pollen, flowers, honey and bumble bee nectar. No traces of fipronil or the metabolites were found in any substrate from the studies with sunflower grown from fipronil-treated seeds. However, the limit of quantification is given as 2 µg/kg, and this may not be sensitive enough to detect these substances at levels that may cause biological effects (see below).

Another systemic insecticide seed dressing, imidacloprid, has been implicated in bee mortality, and has been the subject of developing a new risk assessment approach for systemic insecticides to bees (Halm et al. 2006). Imidacloprid is applied as a seed dressing to sunflowers in Australia at a rate around 3.5 times that of fipronil. Research presented by Rortais et al. (2005) report imidicloprid present in sunflower pollen at 3.4 µg/kg and in nectar at 1.9 µg/kg. If fipronil were present at the same levels relative to its application rate, it could be found at around 1 µg/kg in pollen and 0.54 µg/kg in nectar.

In terms of the pollen concentration, Rortais et al. (2005) calculate that in the bee colony, nurses (which consume the highest amounts of pollen) could be exposed to 0.2 ng of imidacloprid after 10 consecutive feeding days (or around 0.057 ng of fipronil if found in the same relative quantities). Similarly, nectar forages may be exposed to 1.1–4.3 ng imidacloprid in a week of foraging, or 0.3–1.2 ng fipronil if available in relative amounts. Of the new toxicity data available (Decourty et al. 2005 – see Volume 3), levels of 0.3 ng/bee resulted in over 90% mortality while 0.075 ng/bee still resulted in 41% mortality.

The lag time between exposure and death means colonies could be exposed with contaminated food then fed to larvae as well. It is clear from other new data that fipronil remains active in honey for extended periods of time and at a concentration of 10 ng/L in honey, 100% mortality of adult bees was found after 24 hours of exposure following storage of the honey at temperatures up to 20^{o}C for over 2 years.

To properly assess this aspect of risk to bees, the full reports for the specific field/semi-field studies described in Section V3.8.1.1.3 (Volume 3) need to be provided. It is possible a more refined risk assessment for this issue may be required at that stage.

It is also necessary to have data provided on fipronil concentrations in nectar and pollen where fipronil is used as a seed treatment in canola, sorghum and sunflowers in Australia. These data should be generated with a suitably low limit of quantification.

4.2. Other non-target terrestrial arthropods

Risk to soil-dwelling organisms was deemed acceptable. The following pertains to off-field exposure of other terrestrial non-target arthropods. It should be noted that the following calculations are not to provide terrestrial buffer zones, as it is not practical to do so for such organisms as flying insects. Rather, they provide a guide as to how far of the edge of the treated field these insects may be impacted if exposed to spray drift.

4.2.1. Group 1 and 2 products

At the screening level assessment, in-field Q-values for ground dwelling invertebrates was acceptable at all application rates except the highest rate for bananas. This was using an application rate of 800 g ac/ha in the treated area. Refining this to 400 g ac/ha to account for band spraying, the Q-value is reduced to 6.5 (still unacceptable). At 1-metre downwind at this rate, AGDRIFT predicts that 15% of the application rate will be deposited, or 60 g ac/ha. If mixed in the top 10 cm soil (density of 1500 kg/m^3), the soil concentration is 0.04 mg/kg, which results in a Q-value of 1 and an acceptable risk. It can therefore be concluded that the off-field risk to soil-dwelling non-target invertebrates from fipronil applications from group 1 and 2 products is acceptable for all uses.

Off field impacts on above ground non-target invertebrates is addressed by considering spray drift. Ground modelling was performed in accordance with methods described in Section V5.3.2.2.1.

Table V5.26: Downwind distance required from ground application to obtain acceptable risk (downwind deposition of 0.21 g ac/ha or less) for non-target terrestrial arthropods

Crop	**Maximum rate (g ac/ha)**	Applicable groups	Boom Height	Buffer zone (m)	
				Very fine to fine	Fine to medium / coarse
Pasture / sorghum	1.25	1, 2	High	4	0
Forestry	2.5	1	High	8	1
Wine grapevines	20	1, 2	NA	Unable to model[1]	
Cotton	25	1, 2	High	82	23
Asparagus	40	1	High	121	43
Brassicas	50	1, 2	High	144	56
Swede and turnip	50	1	High	144	56
Sugarcane	75	1, 2	NA	Unable to model[2]	
Ginger	100	1	Low	151	35
Potatoes	100	1, 2	Low	151	35
Bananas	400[3]	1, 2	Low	>300	167

[1] Application to wine grapevines is limited to hand held equipment. There is no suitable model available to predict spray from these operations, so this use is outside the scope of the spray drift risk assessment.

[2] Application to sugar cane is with hollow cone nozzles as a directed spray to cover the base of the sugarcane stools, or in-furrow application over the top of the plant pieces (setts). There is no model to assess spray drift from this method of application.
[3] Assumes 50% of the hectare is treated as application is either directly to the tree butt, or as a band application.

This analysis indicates that where medium droplets are used, the risk to non-target terrestrial invertebrates off-field should be acceptable within around 50 m from the edge of the field for all uses except bananas. Where a fine droplet spray is used, this downwind area of potential risk extends to around 150 m, but remains <10 m for pasture/sorghum and forestry.

A similar exercise was conducted use patterns where aerial application is expected, and the following buffer zones were obtained from AGDISP:

Table V5.27: Downwind terrestrial buffer zones (m) for fipronil – medium spray droplets, group 1a

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	6	10	15	6	10	15
2.5	12	21	27	15	22	30
25	627	456	407	458	248	185

Table V5.28: Downwind terrestrial buffer zones (m) for fipronil – fine to medium spray droplets, group 1a

	Fixed wing aircraft			Helicopter		
	Wind speed (`)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	8	14	20	8	14	20
2.5	26	39	48	21	34	43
25	1104	1542	1267	823	1150	716

Table V5.29: Downwind terrestrial buffer zones (m) for fipronil – medium spray droplets, Group 1b

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25	6	10	15	6	10	15
25	640	516	441	448	292	204

Table V5.30: Downwind terrestrial buffer zones (m) for fipronil – fine to medium spray droplets, Group 1b

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.25 25	8 1093	14 1603	20 1774	8 756	14 1140	20 804

Table V5.31: Downwind terrestrial buffer zones (m) for fipronil – medium spray droplets, Group 2

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.20 24	6 370	9 336	14 294	6 221	9 168	14 158

Table V5.32: Downwind terrestrial buffer zones (m) for fipronil – fine to medium spray droplets, Group 2

	Fixed wing aircraft			Helicopter		
	Wind speed (km/h)			Wind speed (km/h)		
Rate (g ac/ha)	8	14	20	8	14	20
1.20 24	7 856	12 896	19 917	7 898	12 513	19 441

It is generally observed that the downwind area of potential risk to non-target terrestrial arthropods is limited for pasture/sorghum (<20 m from the treated area) and forestry uses (<50 m from the treated area). However, for cotton application the downwind area from the edge of the treated area increases significantly where insects may be at risk.

4.2.2. Group 3 and 4 products

Table V5.33: Downwind terrestrial buffer zones (m) for fipronil – very fine spray droplets, release heights of 10, 10, 8 and 5 m for 8, 14, 20 and 29 km/h wind speeds respectively, Group 3

	Fixed wing aircraft				Helicopter			
	Wind speed (km/h)				Wind speed (km/h)			
Rate (g ac/ha)	8	14	20	29	8	14	20	29
1.25	206	297	296	240	120	173	143	146

Table V5.34: Downwind aquatic buffer zones (m) for fipronil – very fine spray droplets, release heights of 10, 10, 8 and 5 m for 8, 14, 20 and 29 km/h wind speeds respectively, Group 4

	Fixed wing aircraft				Helicopter			
	Wind speed (km/h)				Wind speed (km/h)			
Rate (g ac/ha)	8	14	20	29	8	14	20	29
1.25	198	285	284	228	115	166	137	139

For group 3 and 4 products, maximum downwind areas where insects could be at risk is around 300 m from the edge of the treated area.

The calculations performed for broadacre agricultural spraying of fipronil products (groups 1 and 2) indicates that off-field risks to non-target terrestrial invertebrates should be limited with the lower application rates for pasture/sorghum or forestry. However, it is observed that once application rates exceed these (>2.5 g ac/ha), downwind areas where these organisms may be at risk increases dramatically, and even at 25 g ac/ha, such organisms may be at risk for up to 600 m even where a medium droplet is used.

Due to the nature of spraying for plague locust control (group 3 and 4 products), even at the low application rate of 1.25 g ac/ha, non-target terrestrial arthropods may be at risk for several hundred m downwind of the sprayed zone.

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