MEMORANDUM

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DATE: December 19, 2025

SUBJECT: FIPRONIL PET PRODUCTS: POTENTIAL RISKS TO AQUATIC LIFE (DRAFT)

Fipronil is a phenylpyrazole insecticide that is registered for use in pet flea and tick products and structural pest control products. It is not registered for agricultural use in California. The first fipronil pet product was registered with the California Department of Pesticide Regulation (DPR) in 1997. As of October 2024, there were 64 pet products actively registered in California, including 31 dog spot-on, 30 cat spot-on, and three dog and/or cat sprays. Fipronil is used extensively in pet products, which has been identified as a potential concern for both human health and aquatic life. This memo contains DPR's Surface Water Protection Program (SWPP) risk evaluation of fipronil pet products to aquatic organisms and a thorough analysis of DPR's fiprole wastewater monitoring data collected in California.[1] [2]

The use of fipronil pet products presents environmental concerns via the discharge of treated effluent from wastewater treatment plants (WWTPs) to California's surface waters. Previous studies have presented a framework for how pesticides may enter the sewershed (Sutton et al., 2019; Budd et al., 2023). Many of fipronil's use patterns are associated with down-the-drain transport pathways (Xie et al., 2021). Fipronil spot-on

[1] DPR is evaluating the human health risks identified from use of fipronil pet products and the possible mitigation options to address these risks and will issue a separate memo to summarize these findings.
[2] This memorandum does not address the potential ecological risks associated with the outdoor use of products containing fipronil (e.g., structural pest control products). USEPA amended several labels in 2017/2018 to address DPR's concerns with high fipronil concentrations in California urban-area surface water runoff, follow-up investigation by DPR would be necessary to assess current potential risks from surface water runoff. If needed, DPR will issue additional mitigations to address any risk not yet addressed by USEPA.

treatments applied to dogs can wash off during pet bathing (Teerlink et al., 2017), during owner handwashing, and dog bed laundering (Perkins et al., 2024). These activities represent direct pathways by which fipronil can be washed down-the-drain. High concentrations of fipronil (up to 1,400 ng/L) have been detected within wastewater “laterals” (i.e., pipes that connect a structure to a municipal main sewer line) receiving inputs from a pet groomer (Budd et al., 2023). This indicates pet products are a significant source of fipronil in wastewater. In addition, fipronil and its major degradates (collectively known as fiproles) have been detected in WWTP influent and effluent (Sadaria et al., 2016; Supowit et al., 2016; Budd et al., 2023). Teerlink et al. (2017) extrapolated the mass of total fiproles resulting from washing dogs treated with a fipronil spot-on product at 2-,7-, or 28-days post application. It was estimated that if only 20% of the treated dogs were washed within 7 days after application, the mass transferred down-the-drain would account for 100% of the total fiprole loading entering the sewershed (Teerlink et al., 2017).

A key environmental concern surrounding the use of fipronil is the low removal of fiproles during wastewater treatment processes. Estimated removal percentages range from minimal (i.e., no statistically significant difference between influent and effluent concentrations; Supowit et al., 2016) to 36% (Sadaria et al., 2016). Notably, Budd et al. (2023) sampled one WWTP which employed advanced (i.e., tertiary) treatment, yet the average removal of fiproles was only 24%. In addition, Sadaria et al. (2016) sampled eight WWTPs, four of which employed tertiary treatment; however, the authors observed that the various treatment methods did not affect the removal percentages of fipronil at each facility. Many WWTP-impacted inland water bodies in California have minimal dilution flows (Rice & Westerhoff, 2017). Aquatic organisms living in these water bodies may be highly susceptible to organic contaminants present in wastewater discharge, due to lack of dilution (Rice & Westerhoff, 2017). However, there is a lack of available monitoring data regarding the direct impact of fipronil present in effluent to aquatic ecosystems: Currently, fiprole monitoring data in surface water and effluent with concurrent toxicity testing on aquatic species sensitive to fiproles are limited (toxicity testing is typically performed using test species that are not sensitive to fiproles, and WWTPs are typically not required to monitor for fiproles). However, fipronil is a pesticide of concern due to its high toxicity to aquatic life and its environmental persistence. In addition, effluent serves as a continuous pathway for residual pesticide concentrations to enter surface waters. As such, both acute and chronic aquatic toxicity benchmarks are used as screening criteria to evaluate potential risk to sensitive aquatic species.

Concentrations exceeding the U.S. Environmental Protection Agency (USEPA) aquatic life benchmarks have been documented in surface waters of California (Budd et al., 2015; Nowell et al., 2021; Sandstrom et al., 2022). In addition to entering surface waters via discharged WWTP effluent, fipronil applied as pet treatments may also enter surface waters directly via transfer from treated dogs that swim in the water, as this pathway has been demonstrated for other pesticides (Diepens et al., 2023).

Evaluating Aquatic Risk of Fipronil Pet Products

Pet products are a major source of fipronil applied within California. According to DPR's statewide pesticide product sales data (DPR internal database), of the 73 thousand pounds of fipronil sold yearly between 2020 and 2022, pet products accounted for approximately 56.7%, followed by professional structural applications (42.9%) such as outdoor perimeter or spot treatment and indoor void injection, and other consumer applications (0.35%) such as containerized baits, granules, gel baits, and foams (Figure B-1). Although multiple use patterns such as indoor gel baits and foam applications to floor drains can transport fipronil down-the-drain, pet products account for the greatest contribution to wastewater effluent and thus greatest potential risk to aquatic organisms from down-the-drain transport. Most fipronil pet product labels prescribe application rates, which vary based on the weight of the pet, with greater amounts of fipronil applied to larger pets. The estimated environmental concentrations resulting from the use of fipronil containing pet products can be modeled using SWPP's Pesticide Registration Evaluation Model (PREM). These product registrations were approved prior to SWPP's modeling capabilities of indoor uses. However, the resulting risk quotients shown by the updated PREM analysis for many dogs' spot-on products and sprays (depending on the pet's weight and by extension, the fipronil application rate) are at levels of concern (Appendix C). Cat spot-on products, spot-on products for smaller dogs, and sprays for smaller pets would be supported for registration but would result in fipronil being placed on the watchlist as the risk quotients are only slightly lower than the risk threshold.

The mass of fipronil pet products sold in California has been increasing during the past ten years (2013-2022), especially after the COVID pandemic (Figure D-1). Before 2020, a yearly average of 16.6 thousand pounds of fipronil was sold in pet products between 2013 and 2019, and the number jumped to 41.6 thousand pounds between 2020 and 2022. Each year, dog spot-on products accounted for approximately 4-7 times greater mass sold than cat spot-on. Using the USEPA acute freshwater invertebrate aquatic life benchmark for fipronil (110 ng/L) as a reference point, a daily load over 33.7 µg fipronil per capita in WWTP influent would result in a benchmark exceedance in effluent-dominated water bodies. The calculation (Equation D-1) was based on a removal rate of 21% for fipronil during the wastewater treatment process (Budd et al., 2023) and a daily inflow of 242 L wastewater per capita estimated from a statewide water use report (SWRCB, 2024a). The mass of dog spot-on products sold from 2020 to 2022 equates to an average daily load of 965 µg of fipronil per capita (or 1,317 µg if including cat spot-on products and dog and/or cat sprays). A resulting benchmark exceedance in effluent fipronil concentration would occur if at least 3.5% (= 33.7/965) of the mass sold from dog spot-on, or 2.6% (= 33.7/1,317) from all pet products were transported down-the-drain after application. Research has been conducted to quantify fipronil wash-off from dogs treated with spot-on products. Teerlink et al. (2017) measured the percent of fipronil mass washed off from treated dogs during bathing; values ranged between 21% (2-d post application) and 4% (28-d). A follow-up study (Perkins et al., 2024) estimated a total of 6.14% wash-off from three pet care activities – dog bathing, laundering of pet bedding, and owner handwashing, based on emission data from individual wash-off events up to four weeks post application, together with survey data on the frequency of these activities. The reported percent wash-off for dog spot-on products (between 4 and 21%) is greater than the threshold for benchmark exceedance (3.5%). Therefore, the load of fipronil from dog spot-on products in wastewater is highly likely to result in a benchmark exceedance and pose a potential risk to aquatic organisms in receiving water bodies. Also, a higher estimated risk is expected if the acute freshwater invertebrate benchmark threshold is replaced with a lower value from chronic exposure or using the marine and estuary endpoints. Technical details are presented in Appendix D.

Evaluating Wastewater Monitoring Data

WWTPs are typically not required to monitor for fipronil in effluent. In addition, National Pollutant Discharge Elimination System (NPDES) wastewater discharge permits in California typically do not require whole effluent toxicity testing with species that are sensitive to fipronil. For example, chironomids (midges) are sensitive to fipronil, but this taxonomic group is not included in the list of aquatic toxicity test species that are typically included as NPDES permit requirements (SWRCB, 2021). Therefore, for this analysis, SWPP staff obtained wastewater monitoring data collected as part of DPR's ongoing Wastewater Monitoring efforts (DPR, 2024). In total, 241 influent samples and 241 effluent samples were collected from a total of 33 WWTPs in 10 California counties between June 2019 and May 2024, and were analyzed for fipronil and its degradates (Table E-1). The participating facilities represent a wide range of characteristics, including treatment level, plant capacity (ranging from 0.2 to 450 million gallons per day), and geographic location within California (including Southern California, the San Francisco Bay Area, the Central Coast, and the Central Valley).

Fiproles were detected in 100% of influent samples and 95% of effluent samples, with a median fipronil effluent concentration of 21.7 ng/L (Figure E-1; Tables E-2 and E-3). The 90th percentile concentration of fipronil in effluent was 43.8 ng/L, and the maximum concentration was 411 ng/L (Table E-3). In addition, fipronil concentrations exceeded the minimum freshwater chronic aquatic life benchmark in 81.3% of effluent samples and exceeded the minimum marine acute aquatic life benchmark in 1.2% of effluent samples (Table E-4). Since WWTP effluent represents a continuous pathway for contaminants to enter receiving waters, there is concern that the down-the-drain pathway has deleterious effects on surface water quality and serves as a long-term exposure for downstream aquatic receptors. Therefore, the use of chronic thresholds is appropriate for assessing long-term impacts on aquatic receptors.

Currently, there are 14 California waterbodies that have 303(d) impaired waterway listings for fipronil (SWRCB, 2024b). Listing decisions are based on a standardized approach in which all existing and readily available water quality-related data and information are evaluated (SWRCB, 2015). Treatment options for removing fipronil during wastewater treatment processes are limited. For example, although the use of reverse osmosis (RO) may reduce fipronil concentrations, the resulting RO concentrate (which must be discharged) will likely contain fipronil concentrations much greater than what would typically be found in secondary effluent (Lau and Mitch, 2024). Additionally, wastewater treatment technologies do not effectively reduce fipronil concentrations to below aquatic toxicity thresholds; fipronil concentrations above the USEPA minimum chronic freshwater invertebrate aquatic life benchmark of 11 ng/L have been documented in California WWTPs (Sadaria et al., 2016; Budd et al., 2023). Due to the recent increase in fipronil pet product sales and the limited treatment options, the number of fipronil-impaired waterways in California may increase in the future.

Alternatives to Fipronil Pet Products

When evaluating potential strategies to mitigate the identified human health and environmental concerns, it is important to consider the availability of alternative products or practices that may be used in lieu of fipronil products for flea and tick prevention on pets. Many of these alternatives have been discussed in reference materials created by the Bay Area Clean Water Agencies (BACWA), which have been evaluated by DPR's Integrated Pest Management (IPM) Branch (DPR 2025). The IPM Branch found that the IPM claims from BACWA are generally sound and will help support DPR's broader efforts to evaluate potential alternatives to the use of fipronil.

Conclusion and Next Steps

Fipronil is used extensively in pet products, which has been identified as a potential concern for both human health and aquatic life. Pet sprays and spot-on products have been identified as a significant source of fipronil observed in WWTP effluent, as advanced wastewater treatment technologies are not sufficient to remove fiproles below levels of potential ecological concern. Modeling analyses based on product sales data and label information indicate that pet products account for the greatest risk to aquatic organisms among all fipronil indoor uses and are likely to result in aquatic life benchmark exceedances in effluent-dominated water bodies. Monitoring data collected at facilities located throughout California confirms risk estimations, with observed fipronil concentrations detected in treated effluent greater than toxicity thresholds.

As part of next steps, DPR will further engage with registrants and stakeholders to determine options to address and mitigate risks. This will include further analysis on currently available alternatives. Further investigation would be necessary to determine what impacts a shift in product choice would have on human or environmental receptors.

Appendix A: Human Health Risks Associated with Fipronil Pet Products

Table A-1: Single-Route Fipronil Exposure Scenarios from Pet Products with Potential Risk to Humans as Identified in the Fipronil Risk Characterization Document (DPR, 2023).

Target Population	Fipronil Use Scenario	Duration of Exposure	Route of Exposure	MOE
Occupational	Pet spray, Groomer	Acute	Dermal	15
Occupational	Pet spot-on, Groomer	Subchronic	Dermal	28
Occupational	Pet spray, Groomer	Subchronic	Dermal	2
Occupational	Pet spray, Groomer	Subchronic	Inhalation	51
Occupational	Pet spot-on, Groomer	Chronic	Dermal	28
Occupational	Pet spray, Groomer	Chronic	Dermal	2
Occupational	Pet spray, Groomer	Chronic	Inhalation	51
Home user, Adult	Pet spray, Pet owner	Acute	Dermal	41
Post-app, Adult	Pet spray	Subchronic	Dermal	39
Post-app, Child	Pet spray	Subchronic	Oral	91
Post-app, Child	Pet spray	Subchronic	Dermal	21

Table excerpted from the Fipronil Risk Characterization Document (DPR, 2023), "Summary Table 2", page 5.
*Margin of Exposure (MOE) < 100 represents a potential health risk. MOE = point of departure/estimated exposure (i.e., lower MOE values indicate a **greater** risk); **Use Scenarios with MOEs > 100 are not shown in this table.***
"post-app" = post-application (i.e., exposures following application).

Table A-2: Aggregate Margins of Exposure to Fipronil from Pet Products for Occupational Handlers, Home Users, and Adult and Child Residents as Identified in the Fipronil Risk Characterization Document (DPR, 2023).

Target Population	Fipronil Use Scenario	Duration of Exposure	Routes of Exposure	MOE
Occupational	Pet spray, Groomer	Acute	Dermal+Inhalation	14
Occupational	Pet spot-on, Groomer	Subchronic	Dermal+Inhalation	28
Occupational	Pet spray, Groomer	Subchronic	Dermal+Inhalation	1
Occupational	Pet spot-on, Groomer	Chronic	Dermal + Inhalation	28
Occupational	Pet spray, Groomer	Chronic	Dermal+Inhalation	1
home user, adult	Pet spray, Pet owner	Acute	Dermal+Inhalation	40
Post-app, adult	Pet spray	Subchronic	Dermal+Inhalation	39
Post-app, child	Pet spot-on	Subchronic	Oral+Dermal+Inhalation	95
Post-app, child	Pet spray	Subchronic	Oral+Dermal+Inhalation	17

Table excerpted from the Fipronil Risk Characterization Document (DPR, 2023), "Summary Table 3", page 6.
*Margin of Exposure (MOE) < 100 represents a potential health risk. MOE = point of departure/estimated exposure (i.e., lower MOE values indicate a **greater** risk);* ***Use Scenarios with MOEs > 100 are not shown in this table.***
"post-app" = post-application (i.e., exposures following application).

Appendix B: Breakdown of Total Fipronil Use in California by Use Pattern

To generate an overview of fipronil use throughout the state, we retrieved the statewide pesticide sales data from DPR's internal database. The sales data summarized the statewide mass of fipronil sold for each product on a yearly basis. Non-professional applications of pesticide products, such as over-the-counter pet products, are not recorded within the Pesticide Use Reporting (PUR) database. Therefore, we used sales data as a surrogate to estimate the maximum possible use.

Figure B-1 shows a breakdown of fipronil annual mass sold in structural products (used by professional applicators only), pet products and other consumer products such as containerized baits, gel baits, granules, and foams that can be applied to floor drains, based on the statewide product sales data between 2020 and 2022. The mass used in structural pest control is also recorded within PUR, which was 21.1 thousand pounds fipronil per year from 2020 to 2022, compared to 31.4 thousand pounds sold recorded within the sales database.

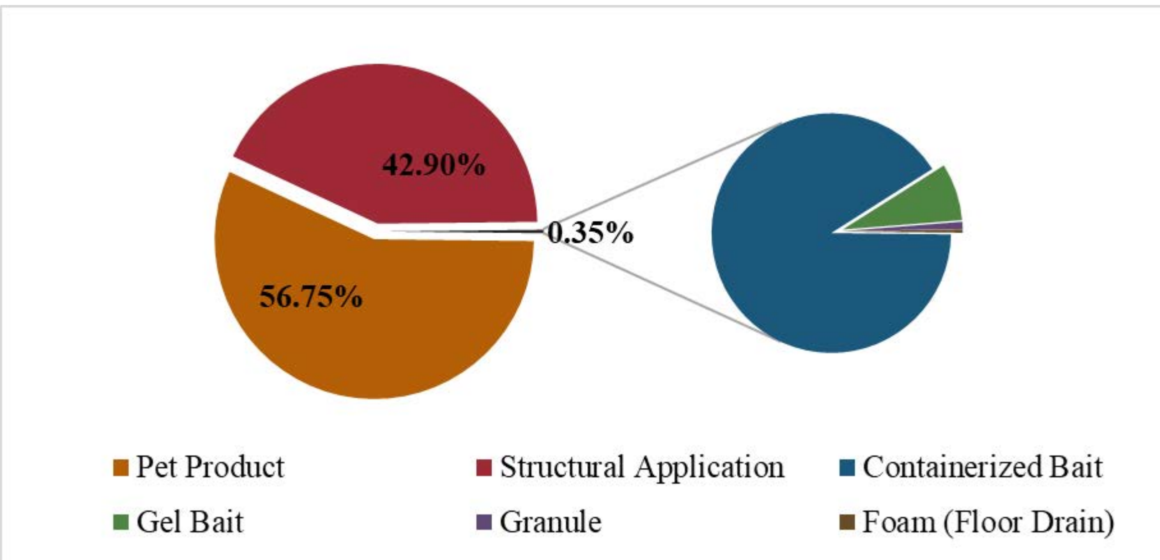

Figure B-1: Breakdown of fipronil mass sold (lbs/year) in California by use pattern based on statewide pesticide product sales data between 2020 and 2022.

Appendix C: Using PREM 6 to Evaluate Aquatic Risk of Fipronil Indoor Products

Pet products, indoor gel baits, and foam applications to floor drains are potential pathways to transport fipronil down-the-drain. The Pesticide Registration Evaluation Model (PREM) version 6 (Luo et al., 2024, Xie & Luo, 2022) was used to evaluate the aquatic risk of each indoor use pattern. For model input, the physicochemical properties and ecotoxicity of fipronil were retrieved from DPR-approved studies or the USEPA report if not available through DPR (Table C-1).

Table C-1: Physicochemical properties, environmental fate, and ecotoxicity of fipronil used in PREM version 6.

Parameter	Description	Unit	Model Input Value	Reference
SOL	Water solubility	mg/L	2.2	DPR chemistry database
KOC	Organic carbon-normalized soil adsorption coefficient	L/kg[OC]	673	USEPA (2011)
HYDRO	Hydrolysis half-life	day	28	DPR chemistry database
AERO	Aerobic soil metabolism half-life	day	128	DPR chemistry database
ANAER	Anaerobic soil metabolism half-life	day	123	DPR chemistry database
FD	Field dissipation half-life	day	131	DPR chemistry database
AERO_W	Aerobic aquatic metabolism half-life	day	14.5	DPR chemistry database
ANAER_W	Anaerobic aquatic metabolism half-life	day	160	USEPA (2011)
MWT	Molecular weight	g/mole	437.14	USEPA (2011)
VP	Vapor pressure	torr	2.8E-09	DPR chemistry database
AQPHOT	Aqueous photolysis half-life	day	0.33	USEPA (2011)
SPHOT	Soil photolysis half-life	day	34	DPR chemistry database
TOX	Lowest toxicity value for water toxicity (acute)	µg/L	0.14	Magliano (2019)
LOGKOW	Log Kow (octanol-water partition coefficient)	-	3.5	DPR chemistry database
HENRY	Henry’s law constant	atm-m3/mol	8.47E-11	DPR chemistry database

If multiple values were reported in the DPR chemistry database, the median was used for model input. The lowest toxicity value submitted by registrants and approved by DPR was used in PREM evaluation. The 0.14 µg/L value was derived from mysid shrimp (Americamysis bahia) for acute toxicity (96 hours). The ratio of estimated environmental concentration (EEC) to the lowest toxicity value, i.e. risk quotient (RQ), was compared to the RQ threshold of 0.5. The threshold of 0.5 accounts for a safety factor of 2, which is equivalent to the safety factor built into the USEPA acute aquatic life benchmark for estuarine/marine invertebrates (0.07 µg/L).

The application rate and interval were determined from an extensive label review for actively registered fipronil products conducted by SWPP staff. For pet spot-on products, label rate is in the unit of fl oz product per application, which is converted to the model-compatible unit by using Equation C-1.

$$Q_{\mu g} = Q_{fl\,oz} \times 2.95 \times 10^{7} \times SpecGravity \times (\%AI/100) \quad \text{[Equation C-1]}$$

$Q_{\mu g}$ is the rate in the unit of µg active ingredient (AI)/pet, $Q_{fl\,oz}$ is the rate in the unit of fl oz product/pet, 2.95×10^{7} is the conversion factor converting volume of wet formulation products to weight, $SpecGravity$ is the specific gravity of the product, and $\%AI$ is the percent AI of the product.

There is one label rate for the three actively registered dog and/or cat sprays, which is 2 seconds/pumps of spray per pound of animal body weight. Following the product package information sheet, we assume one pump action delivers 0.5 ml product. Model-input rate is calculated by using Equation C-1 with a conversion from ml to fl oz. Although all three products may be applied to either animal with the same application rate on a per-pound basis, other PREM inputs (e.g., subject per capita conversion factor) are different for dogs and cats. Therefore, we performed separate model runs for the use of sprays on dogs and on cats.

The rate of foam application to floor drains was determined based on a previous SWPP product registration evaluation report (Burant & Xie, 2021). Label rate of indoor gel baits is in the unit of gram product per square yard and converted to µg/ft^2 for model input. In some cases, the label rate is vague, such as in the unit of “dime-sized spots” bait per square yard. Since there is no additional information on the weight of product per dime-sized spot, products with vague label rates were omitted when determining the maximum application rate for indoor gel baits.

Table C-2 summarizes the maximum application rate and minimum interval for each of the indoor use patterns, and the corresponding risk quotient (RQ) and registration recommendation. The dog spot-on and dog spray were evaluated with the PREM “dog treatment (except shampoo)” scenario, and cat spot-on and cat spray were evaluated with the PREM “cat treatment (except shampoo)” scenario. The RQs are estimated based on the application rate and interval. For the monthly treatment to pets, the model predicted that an application rate of greater than 1.88E+05 and 2.23E+05 µg fipronil/pet to dogs and cats, respectively, would result in a RQ greater than the risk threshold of 0.5. Based on current label language, a denial of registration is recommended for dog spot-on products when applied to dogs in weight categories over 41 pounds and for dog sprays when applied to dogs over 75.5 pounds. The risk threshold for cats is 93.5 pounds, so the registration of cat sprays will be supported in most situations, and on watchlist if RQ ≥ 0.1 based on the weight of a cat. Cat spot-ons, indoor gels, and foams to floor drains are expected to cause a risk slightly lower than the risk threshold (RQ = 0.5); therefore, product registration would be supported, but placed on the watchlist for further investigation.

Table C-2: Summary of maximum application rate and minimum interval of actively registered products, model-estimated risk quotient and recommendation of registration for fipronil indoor products.

Use Pattern	Number of Actively Registered Products	Maximum Rate in a Single Application	Minimum Application Interval (day)	Risk Quotient (RQ)	Model Recommendation
Dog Spot-On	31	4.26E+05 (µg AI/dog ≥ 81 lbs)	30	1.132	*Not Support*
		2.85E+05 (µg AI/dog between 41 and 80 lbs)	30	0.758	*Not Support*
		1.41E+05 (µg AI/dog between 21 and 40 lbs)	30	0.375	Support (Watchlist)
		7.21E+04 (µg AI/dog ≤ 20 lbs)	30	0.192	Support (Watchlist)
Dog Spray	3	≥ 1.88E+05 (µg AI/dog ≥ 75.5 lbs)	30	0.5	*Not Support for Dogs Over 75.5 lbs*
		< 1.89E+05 (µg AI/dog < 75.5 lbs)	30	< 0.5	Support and/or Support (Watchlist)
Cat Spot-On	30	5.90E+04 (µg AI/cat ≥ 1.5 lbs)	30	0.127	Support (Watchlist)
Cat Spray	3	≥ 2.32E+05 (µg AI/cat ≥ 93.5 lbs)	30	0.501	*Not Support for Cats Over 93.5 lbs*
		< 2.32E+05 (µg AI/cat < 93.5 lbs)	30	< 0.501	Support and/or Support (Watchlist)
Foam to Floor Drain	2	1.80E+03 (µg AI/drain)	30	0.214	Support (Watchlist)
Indoor Gel	22	1.67E+02 (µg AI/ft^2)	30	0.342	Support (Watchlist)

The label-allowed application rate for pet products is related to the body weight of a pet. The application rate for dog spot-on products is binned in 4-5 categories based on dog weight. The table shows the maximum rate for each weight category. For cat spot-on products, there is only one rate for all cats regardless of the weight of a cat. The application rate for dog sprays and cat sprays is determined as a continuous number based on the weight of a pet. The threshold rate that would cause a risk of concern (i.e., RQ ≥ 0.5) is shown. For forms and indoor gels, the maximum rate for the actively registered products is shown to present the worst-case scenario for the use pattern. The application interval is 30 days for all pet products and 30-90 days for foams and indoor gels.

Appendix D: Risk of Benchmark Exceedance Estimated from Statewide Mass Sold

Figure D-1 shows the annual mass of fipronil sold in various types of pet product such as dog spot-ons, dog and/or cat sprays, and cat spot-ons from 2013 to 2022, based on the statewide pesticide product sales data.

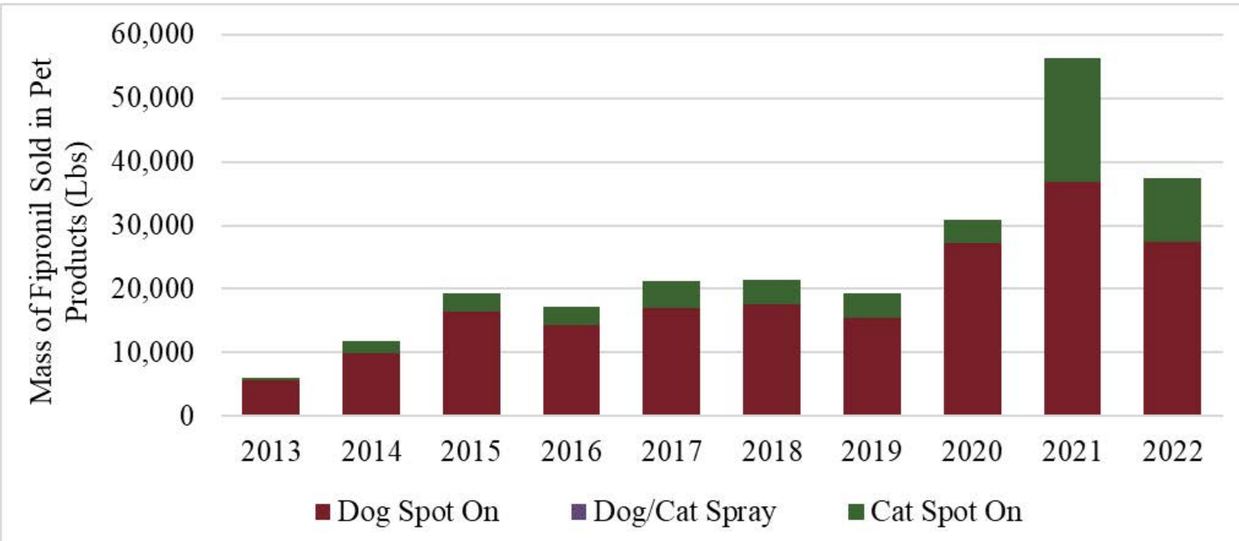

Figure D-1: Mass of fipronil sold in pet products from 2013 to 2022. The raw data was corrected for outliers. The mass of two dog spot-ons sold in 2020 and 2021 were over 10,000 pounds and unusually higher than the mean of all other years by two orders of magnitude. The two data points were identified as outliers and replaced by the average mass of the previous and following years. The correction reduced the mass sold for dog spot-on from 4,128,113 to 27,203 pounds in 2020 and from 51,868 to 36,831 pounds in 2021.

To evaluate the level of aquatic risk resulting from fipronil pet products, we used the USEPA aquatic life benchmark of acute toxicity to freshwater invertebrate species (0.11 µg/L for fipronil) as a reference point. In the most conservative case where WWTP effluent is a dominant source of flow in the receiving water body, a concentration of 0.11 µg/L fipronil in WWTP effluent would result in a benchmark exceedance and pose a potential risk to aquatic organisms. Note that the acute benchmark is lower for marine and estuarine species, but since many freshwater waterways have little to no dilution from streamflow, using freshwater endpoints represent a worst-case scenario for analysis compared with marine and estuary environment where the dilution factor would lower the overall risk. The average removal rate for fipronil during wastewater treatment process is 21% based on samples from a tertiary plant in California (Budd et al., 2023). The volume of wastewater is 242 L per capita per day based on the statewide water use report in the wettest month (January) from 2015 to 2020 published by the California State Water Resources Control Board (SWRCB, 2024a). Combining all factors, a daily load over 33.7 µg (Equation D-1) fipronil per capita in WWTP influent would result in a benchmark exceedance in the receiving water body.

$$Benchmark\ Load = (0.11\mu g/L \times 242\ L/p/d)/(1 - 21\%) = 33.7\mu g/p/d \quad \text{[Equation D-1]}$$

Table D-1a shows the daily load of fipronil based on the statewide annual sales data normalized by population of California in the corresponding year from 2020 and 2022, and the three-year average. Taking the ratio of threshold load for benchmark exceedance (33.7 µg/person/day) to the loading based on mass sold (Table D-1a), we calculated the threshold percent wash-off that would result in a benchmark exceedance (Table D-1b). Note that due to the lack of use data on pet products, we use the sales data to represent the maximum possible use and assume 100% of the mass sold is applied to pets.

Table D-1: (a) Loading of fipronil to pets from mass sold (µg/person/day) and (b) the corresponding threshold percent wash-off necessary to result in a benchmark exceedance (0.11 µg/L), from 2020 and 2022, and the three-year average.

Product Type(s)	2020	2021	2022	Average
(a) Dog Spot-On Only	856	1,169	870	965
(a) All Pet Products	973	1,786	1,192	1,317
(b) Dog Spot-On Only	3.9%	2.9%	3.9%	3.5%
(b) All Pet Products	3.5%	1.9%	2.8%	2.6%

Appendix E: Wastewater Monitoring Data

Statistical analyses of monitoring data were carried out using the *EnvStats*, *NADA*, and *NADA2* packages in RStudio (version 4.2.1), using procedures appropriate for environmental data sets with censored observations, also known as "non-detects" (Helsel, 2012).

Table E-1. Information regarding DPR's wastewater monitoring data used in this memorandum. Data were obtained from DPR Study 322: Monitoring Pesticides in Wastewater Influent and Effluent (DPR, 2024).

Total Sample Count	Number of WWTPs Sampled	Number of Counties Represented	Sample Date Range	Treatment Level of Effluent	Plant Capacity (Median and Range)
241 Influent, 241 Effluent	33	10	June 2019 to May 2024	16 secondary, 17 tertiary.	**Median:** 25 million gallons per day (MGD) **Range:** 0.2 to 450 MGD

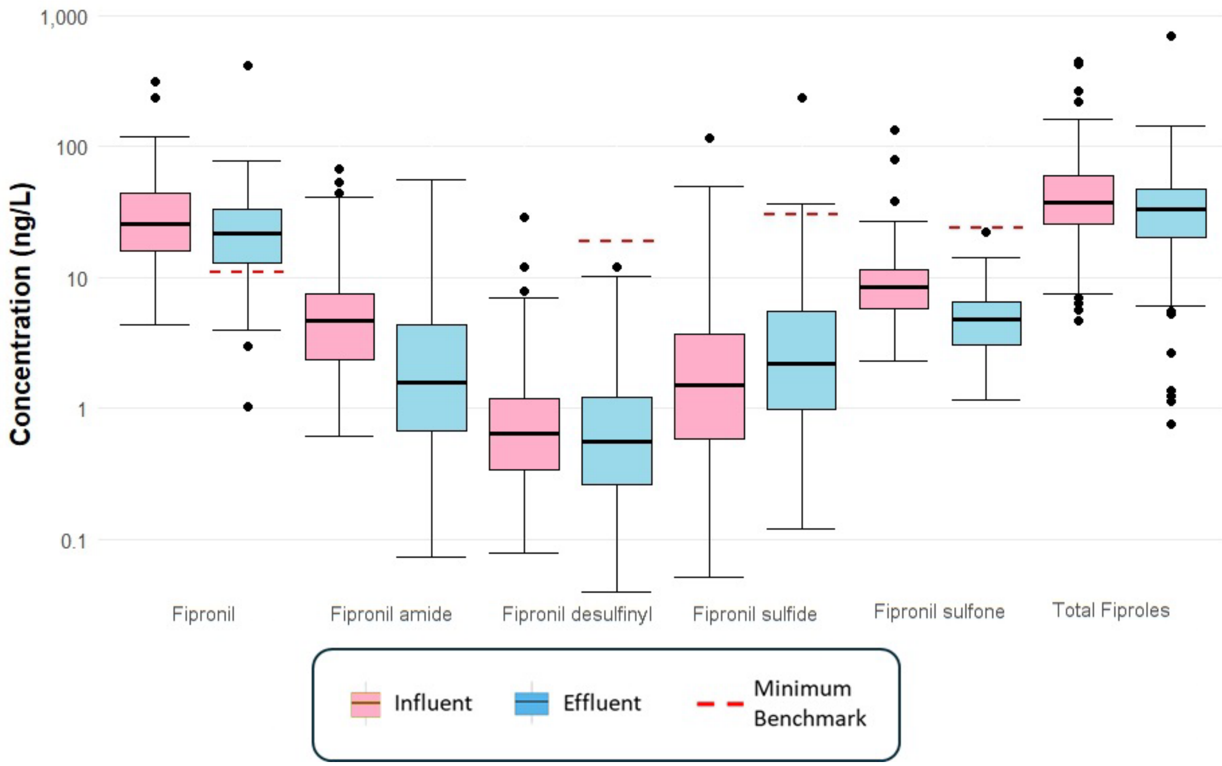

Figure E-1: Fiprole concentrations in influent and effluent samples from DPR's Wastewater Monitoring Program, plotted on a logarithmic y-axis. Statistics were calculated using the Kaplan-Meier method to incorporate non-detects and unquantified "trace" observations; therefore, the boxplots reflect imputed estimates of concentrations below method detection limits and reporting limits, in addition to quantified detections. Dashed lines indicate the minimum available USEPA aquatic life benchmark for the given compound, when applicable (for more details, please refer to Table E-4). Fipronil desulfinyl amide is not plotted, because its detection frequencies were very low (1.2% in influent and 0.4% in effluent). Black points ***above*** *boxplots indicate measurements greater than the 75th percentile + 1.5 x IQR (interquartile range; 75th–25th percentile) for the given compound. Black points* ***below*** *boxplots indicate measurements less than the 25th percentile – 1.5 x IQR for the given compound.*

Table E-2. Fiprole concentrations in influent samples from DPR's Wastewater Monitoring Program.

Analyte	DF	Median Conc.	75th Percentile Conc.	90th Percentile Conc.	Max. Conc.
Fipronil	100%	25.8	44.2	61.2	311
Fipronil amide	44%	4.71	7.59	12.5	67
Fipronil desulfinyl	30%	<0.4	1.18	1.93	29
Fipronil desulfinyl amide	1.2%	<3.71	<3.71	<3.71	55
Fipronil sulfide	44%	<2.16	3.56	11.1	116
Fipronil sulfone	89%	8.52	11.8	14.2	135
Total Fiproles	**100%**	**37.3**	**59.9**	**87.2**	**448**

DF = detection frequency (including unquantified "trace" observations).
Statistics were calculated using the Kaplan-Meier method to incorporate non-detects and unquantified "trace" observations. All concentration units are ng/L. Results are reported to DPR by the laboratory in units of µg/L, and were mathematically converted to ng/L for this memorandum.

Table E-3. Fiprole concentrations in effluent samples from DPR's Wastewater Monitoring Program.

Analyte	DF	Median Conc.	75th Percentile Conc.	90th Percentile Conc.	Max. Conc.
Fipronil	93%	21.7	34.0	43.8	411
Fipronil amide	47%	<0.4	4.39	9.15	56
Fipronil desulfinyl	56%	0.555	1.22	2.40	12
Fipronil desulfinyl amide	0.4%	N/A	N/A	N/A	53
Fipronil sulfide	46%	<2.16	5.91	10.8	238
Fipronil sulfone	93%	4.75	6.61	8.12	22
Total Fiproles	**95%**	**33.1**	**48.5**	**61.1**	**694**

DF = detection frequency (including unquantified "trace" observations).
Statistics were calculated using the Kaplan-Meier method to incorporate non-detects and unquantified "trace" observations. All concentration units are ng/L. Results are reported to DPR by the laboratory in units of µg/L, and were mathematically converted to ng/L for this memorandum.
Fipronil desulfinyl amide had <2 uncensored observations in effluent. Therefore, the NADA2 software was not able to calculate summary statistics.

Table E-4. Minimum aquatic life benchmarks and exceedance frequencies for fiproles in effluent samples from DPR's Wastewater Monitoring Program.

Analyte	Minimum Freshwater Endpoint Acute Benchmark (Exceedance Frequency)	Minimum Freshwater Endpoint Chronic Benchmark (Exceedance Frequency)	Minimum Marine Endpoint Acute Benchmark (Exceedance Frequency)	Minimum Marine Endpoint Chronic Benchmark (Exceedance Frequency)
Fipronil	110 ng/L (0.4%)	11 ng/L (81.3%)	70 ng/L (1.2%)	240 ng/L (0.4%)
Fipronil desulfinyl	10,000 ng/L (0%)	530 ng/L (0%)	750 ng/L (0%)	19 ng/L (0%)
Fipronil sulfide	15,400 ng/L (0%)	830 ng/L (0%)	38 ng/L (0.4%)	30 ng/L (0.8%)
Fipronil sulfone	12,500 ng/L (0%)	220 ng/L (0%)	28 ng/L (0%)	24 ng/L (0%)

Fipronil amide and fipronil desulfinyl amide are omitted because there are no available aquatic life benchmarks.

For each combination of water type (i.e., freshwater or marine) and exposure type (i.e., acute or chronic), the lowest available benchmark value was chosen based on the data available. Typically, benchmarks were available for multiple taxonomic groups within each combination (e.g., vertebrates, invertebrates); in these cases, the lowest value was chosen and is presented in this table. The taxonomic group for each benchmark shown in the table is as follows:

Freshwater Acute: Invertebrates
Freshwater Chronic: Invertebrates
Marine Acute: Invertebrates
Marine Chronic: Vertebrates

Note that for marine invertebrates, only acute values were available. The two marine benchmarks presented in this table for fipronil are from different taxonomic groups, and this explains why the minimum marine endpoint chronic benchmark presented in the table (240 ng/L) is greater than the minimum marine acute benchmark (70 ng/L).

Appendix F: References

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