tdc environmental

MEMO

TO:	Bill Johnson, RWQCB	**DATE:**	April 29, 2002
FROM:	Kelly D. Moran	**PROJECT:**	33a
SUBJECT:	Pesticide Market Trends and Potential Water Quality Implications—Selection of Pesticides for Detailed Review		

Under contract to the San Francisco Estuary Project, TDC Environmental is reviewing the water quality implications of the new pesticide products entering the marketplace as a result of the phase out of most urban uses of diazinon and chlorpyrifos. This project, which is funded by the San Francisco Bay Regional Water Quality Control Board, is intended to provide information that will support government actions to prevent future incidents of pesticide-related surface water toxicity.

The goal of the first phase of the project was to identify up to ten pesticides that are replacing diazinon and chlorpyrifos in the urban marketplace and that are likely to gain significant market share. On the basis of a review of pesticide usage trend indicators, it was clear that many more than 10 insecticides are gaining meaningful market share. Because budget limitations preclude detailed review of more than about 10 pesticides, the first phase was expanded to include limited review of available surface water quality data, aquatic toxicity data, product formulations, and U.S. Environmental Protection Agency (USEPA) registration documents in order to ensure that those pesticides with greatest potential to be of concern for water quality were included in the detailed review.

The purpose of this memorandum is to summarize the first phase of the project. As the work on this project proceeds, TDC Environmental is preparing memoranda documenting each project phase for two purposes:

- to share information with water quality agencies as soon as it is developed, and
- to provide an opportunity for review and discussion of project elements while the work is in progress.

The information in this memorandum, as modified by comments received,[1] will be incorporated into the final project report, which will be prepared this fall.

<u>SUMMARY</u>

On the basis of projected usage patterns and indicators of environmental importance for 45 identified substitutes for diazinon and chlorpyrifos, ten pesticides and one synergist are recommended for more detailed review as part of this project. Table 1[2] summarizes the factors used to select the 11 recommended chemicals.

[1] Comments can be e-mailed to kmoran@tdcenvironmental.com or mailed or faxed to TDC Environmental (information at the foot of this page).
[2] Tables may be found at the end of this memorandum.

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A. INSECTICIDE CANDIDATE LIST

The initial list of insecticides for review was created from USEPA lists of alternatives to diazinon and chlorpyrifos (USEPA, 2000). All listed chemical products for non-agricultural uses were included, except one veterinary product that is not registered as a pesticide. During the review process, several pesticides identified in pesticide product surveys or found on lists of pesticides related to study list pesticides were added to the study list.

The identified insecticides fall into the following classes:

- Pyrethroids—a family of synthetic insecticides that are chemically similar to the natural insecticide pyrethrins, which come from chrysanthemums.
- Carbamates—a group of synthetic insecticides that are esters of carbamic acids.
- Other organophosphorous pesticides—other synthetic insecticides in the same chemical class as diazinon and chlorpyrifos.
- Other types of pesticides—botanicals, synthetic insecticides in new chemical classes (like chloronicotinyl pesticides), and other miscellaneous insecticides.
- Synergists—substances that enhance the toxicity of the pesticide active ingredient in a product.

B. USAGE TREND INDICATORS

Usage trend indicators were explored for insecticides that control the same target pests on the formerly common urban sites of use for diazinon and chlorpyrifos. The usage investigation relied primarily on two types of data sources:

- California Department of Pesticide Regulation (DPR) pesticide usage data—information reported to the State of California by professional pesticide applicators, whose urban use of insecticides is primarily for structural pest control and landscaping.
- Pesticide product surveys—information from retail shelf surveys, manufacturer product promotion materials and Internet sites, and interviews with those knowledgeable about pesticide sales and use patterns.

The information obtained from these sources is described below.

On the basis of the review of current insecticide products and sales trends, several insecticides and two synergists were added to the study list: acephate, aldicarb, allethrin and related pesticides (d-allethrin, d-trans allethrin, S-bioallethrin, prallethrin, and esbiothrin), clarified hydrophobic extract of neem oil, lambda cyhalothrin, tetramethrin, tralomethrin, n-octyl bicycloheptene dicarboximide, and piperonyl butoxide (PBO).

Professional Applicator Pesticide Use

California requires professional pesticide applicators to report pesticide use to the County Agricultural Commissioners. Each calendar year, DPR compiles pesticide use reports. The most recent data available at the time of this analysis was for calendar year 2000, which is prior to the initiation of regulatory changes for diazinon and chlorpyrifos. To address the problem that available pesticide use reports are unlikely to reflect changes in insecticide use due to diazinon and chlorpyrifos regulatory changes, several interviews were conducted with people working in the field who are familiar with trends in insecticide use.

The major urban reported uses of insecticides fall into two categories in DPR's compilation of pesticide use reports: structural pest control and landscape maintenance.[3] Since previous investigation of the water quality impacts of diazinon and chlorpyrifos found that outdoor structural pest control applications were most likely to release the applied pesticide to surface waters (TDC Environmental, 2001), insecticide use for structural pest control insecticide use was explored in more detail than insecticide use on landscaping.

Structural Pest Control. Table 2 lists pesticides with more than 10,000 pounds of active ingredient reported applied for structural pest control in 1996, 1997, 1998, 1999, and 2000 (DPR, 1999, 2000, and 2001). These data do not show clear trends for most pesticides. Even diazinon and chlorpyrifos usage do not show downward trends within this time period. Of the listed pesticides that are likely alternatives to diazinon and chlorpyrifos, only cypermethrin shows a meaningful trend toward increased use. In 2000, two alternatives to diazinon in chlorpyrifos had more than 100,000 pounds of reported use: cypermethrin and permethrin.

Participants in the Pest Control Operator IPM Evaluation Alliance Team have noted common use of cyfluthrin, deltamethrin, hydramethylnon, permethrin, and various containerized baits for structural pest control. Informally, it was noted that diazinon (which can be used until 2004) continues to be used by structural pest control companies (Brandenburg, 2002). An informal survey of San Mateo County termite control companies found use of fipronil, imidacloprid, and permethrin for control of subterranean termites, which were a common target pest for chlorpyrifos (Moran, April 2002).

Landscape Maintenance. Table 3 lists the reported use for landscape maintenance of diazinon, chlorpyrifos, and alternatives on the study list in 2000 (DPR, 2001). Diazinon and chlorpyrifos use far exceed reported use of any alternative. Of the alternatives on the study list, only three non-traditional pesticides are in the top 10: bifenthrin, imidacloprid, and permethrin.

Since trend analysis was not particularly informative for structural pest control insecticides, only a limited trend analysis of insecticides reported applied for landscape maintenance was conducted. Table 4 shows the reported use from 1996 through 2000 of diazinon, chlorpyrifos, and the alternatives on the study list for which more than 1,000 pounds were reported used in 2000 (DPR, 1999, 2000, and 2001). Again, no clear trend in use of most of these pesticides exists—even for diazinon and chlorpyrifos. Only bifenthrin and boric acid show steady trends of increased use. Given the variability in the data, it is not clear if the significant jump in imidacloprid use in 2000 is meaningful.

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[3] For urban pesticide use, DPR categorizes reported uses in a relatively granular manner that provides the ability to obtain a general understanding of the use location for a pesticide. Public reports do not currently match the more detailed sites of use list used by DPR's registration group.

The Pesticide Distributor Project[4] involves interaction with San Francisco Bay Area pesticide distributors and attendance at trade shows in the region. Common alternatives observed by the technical consultant to that project include bifenthrin, cyfluthrin, deltamethrin, and trans-allethrin (in aerosols). The granular form of deltamethrin is particularly being promoted to professional landscapers (Joseph, 2002).

Pesticide Product Surveys

While California requires pesticide use reporting by professional applicators, no tracking mechanism exists for residential pesticide use. Since unreported use comprises about half of urban pesticide use, it can be very important for water quality. In addition to looking at current unreported urban use of insecticide substitutes for diazinon and chlorpyrifos, the pesticide product survey sought information that would indicate future market trends.

Retail shelf surveys. Surveys of insecticide products displayed for retail sale were conducted at two of the three San Francisco Bay Area retail chains that have previously been documented as selling the largest volumes of home-use insecticides (Cooper, 1996; Scanlin and Cooper, 1997). (The third major retailer only carries large volumes of insecticide products in the summer season, and thus could not be surveyed within the project schedule.) The surveys (Moran, March 2002)[5] found major shifts in insecticide product mix, likely the result of the phase-out of most urban diazinon and chlorpyrifos uses. Pyrethroid products dominated the observed substitutes, which included a wide mix of chemicals.

Retail product surveys. On the basis of current and past retail product surveys, Ortho, Scotts, Bayer Advanced, Spectracide, and Real-Kill were identified as the major product lines for residential-use insecticides. Internet sites for the manufacturers of these products were consulted to identify formulation trends for insecticide products (other than containerized baits and aerosols), with the following results:

- Ortho and Scotts (Ortho is owned by Scotts)—Diazinon and chlorpyrifos products have been replaced by bifenthrin, esfenvalerate, and permethrin. Some new products contain pyrethrum. Carbaryl is more prominently displayed and available in more formulations.
- Spectracide and Real-Kill (both owned by Spectrum Brands)—Spectracide chlorpyrifos products have been replaced by permethrin. (Both stores and the Internet site had these products highlighted by a “Looking for Dursban?” logo.) While Real-Kill products are not described on Spectrum Brand’s Internet site, the shelf survey showed that diazinon and chlorpyrifos products have been replaced with permethrin and, to a lesser extent, tralomethrin. Real-Kill malathion products were also prominently displayed.
- Bayer Advanced—Diazinon and chlorpyrifos products have been replaced primarily by cyfluthrin and imidacloprid. Similar products include one with beta-cyfluthrin and one with trichlorfon.

[4] Managed by the Marin County Stormwater Pollution Prevention Program.
[5] The memorandum presenting retail shelf survey results will be an appendix in the project report.

The following insecticides on the study list were not identified in these retail product surveys: aldicarb, avermectin, diflubenzuron, fenoxycarb, fenthion, fenvalerate, halofenozide, hexaflumuron, lambda cyhalothrin, naled, phosmet, propetamphos, propoxur, pyriproxyfen, spinosad, sulfuramid, taufluvalinate, temephos, tetrachlorvinphos, and trichlorfon.

Other Resources

Three other data sources were explored, but did not provide data that was particularly helpful in distinguishing potential future market leaders among the alternatives to diazinon and chlorpyrifos:

- DPR weekly registration notices—DPR issues two weekly notices: the "Materials Entering Evaluation Process" and the "Notice of Proposed and Final Decisions." These notices list pesticides entering the registration process and pesticides actually registered. No trend toward any specific insecticides was apparent from review of notices from 2001 and early 2002. New and modified registrations for pyrethroids and new types of broad-spectrum insecticides were common.
- Pesticide Sales in California—DPR compiles statewide pesticide sales data based on proceeds of DPR's funding source, the "mill tax." Public data are only available for pesticides for which more than 3 companies have registered products. While statewide sales figures for the years 1997 through 2000 were examined (DPR, 1998, 1999, 2000, and 2001), they did not prove informative primarily because sales for agricultural uses dominate sales of many insecticides, making analysis difficult. (An analysis of the unreported sales of selected pesticides will be included in the next phase of the project.)
- Residential Pesticide Sales and Use Surveys. Previous California residential pesticide sales and use surveys all predate the diazinon and chlorpyrifos regulatory changes (initiated in 2001), and thus do not indicate the market shifts currently underway (Cooper, 1996; Scanlin and Cooper 1997; URS, 2000; Wilen, 2001). The most recent of these surveys (Wilen, 2001) estimated calendar year 2000 retail sales of several insecticides in the San Diego Creek (Orange County) watershed. Because it estimated that sales of clarified hydrophobic extract of neem oil (an insecticide for some of the same target pests as diazinon and chlorpyrifos) were higher than sales of any other insecticide active ingredient in the study watershed, it was added to the study list.

C. INDICATORS OF ENVIRONMENTAL IMPORTANCE

To avoid omitting a particularly environmentally important insecticide from detailed review, three indicators of environmental importance were explored for insecticides on the study list: screening surface water quality data, basic toxicity information, and USEPA classification of pesticides as "botanicals" or "reduced risk" pesticides. The limited data described below were used for screening the study list of insecticides; a more thorough review will be conducted for selected pesticides in the next phase of the project.

Surface Water Quality Data. Data on surface water detections from the U.S. Geological Survey National Water Quality Assessment (USGS NAWQA) and DPR was reviewed. The USGS NAWQA studies, which are currently in progress, provide the most complete available urban surface water data set. The following NAWQA results are particularly relevant to this investigation:

- The insecticides diazinon, chlorpyrifos, carbaryl, and malathion were the ones most commonly detected in urban streams (Gilliom *et al.*, 1999).
- Malathion was found in more than 20% of urban surface water samples; more than 50% of sampled urban streams had at least one sample exceeding a North American aquatic life criterion (Gilliom *et al.*, 1999; Hoffman *et al.*, 2000).
- Carbaryl was found in about 40% of urban stream samples and exceeded a North American aquatic life criterion in 10% of samples from 8 urban streams (Gilliom *et al.*, 1999; Hoffman *et al.*, 2000).
- Early NAWQA investigations did not detect cis-permethrin (Hoffman *et al.*, 2000); however, recent data only available on the Internet shows it was detected in four urban watersheds at concentrations up to 0.011 µg/l (USGS, 2002).
- Aldicarb was not detected (Hoffman *et al.*, 2000)
- Propoxur was found in surface water (Hoffman *et al.*, 2000).
- Piperonyl butoxide (PBO) is frequently found in surface water samples (Pedersen, 2001).

Although an attempt to utilize the DPR Surface Water Quality Database did not provide useful results,[6] search of the DPR internet site identified a presentation summarizing results of a recent DPR-funded surface water study that found diazinon and chlorpyrifos alternatives in surface water (Kim *et al.*, 2001). That study, which explored pesticides used for red imported fire ant control in Southern California, had the following results relevant to this investigation:

- Use of bifenthrin and malathion at nurseries was linked to surface water runoff toxicity measured in the study.
- Malathion in runoff from urban and integrated sites was linked to surface water runoff toxicity measured in the study.
- Fenoxycarb was detected in nursery runoff, but detection itself was not definitely linked to toxicity in surface water runoff.
- Hydramethylnon and pyriproxyfen were detected once each in runoff; neither detection was linked to toxicity in surface water runoff.

[6] Urban runoff and stream studies and data from San Francisco Bay area counties do not appear to be included in the online database. The online interface precludes searches for detections of specific pesticides.

Toxicity Data. The Pesticide Action Network Pesticide Database (PAN Database)[7] contains a compilation of data on pesticide properties and toxicity. This database has a very convenient interface that provides a way to quickly identify and review available aquatic toxicity data for pesticides. It did not, however, contain any aquatic toxicity data for avermectin, clarified hydrophobic extract of neem oil, fipronil, halofenozide, hydroprene, or spinosad. While the National Library of Medicine's Toxnet Hazardous Substances Data Bank (HSDB)[8] was also explored, it contained toxicity data for fewer pesticides than the PAN database and the data format makes focus on aquatic species very inconvenient for a screening review. (HSDB data will be included in the more detailed review of selected pesticides). In general, the aquatic toxicity data confirmed that most of the insecticides on the study list are very toxic to one or more aquatic species. Even some insecticides labeled "reduced risk" by USEPA (*e.g.*, diflubenzuron, hexaflumuron, pyriproxyfen) can be quite toxic to certain aquatic species. For boric acid, the data confirmed the general view that it is a "least toxic" insecticide.

Pesticide classification. Certain classes of pesticides are less likely to be environmentally harmful than ordinary broad-spectrum insecticides. Two possible indicators of lower toxicity were checked:

- USEPA "Reduced Risk" Classification—For registration purposes, USEPA has classified certain pesticides as "reduced risk" due to their potential to be less toxic replacements for common pesticides. While this classification focuses on human health, it may be an indicator of relative environmental importance of a pesticide. The reduced-risk pesticides on the study list are: fipronil, hexaflumuron, pyriproxyfen, spinosad, and tebufenozide.
- Botanicals—Pesticides derived from plants or bacteria are often—but not always—less environmentally problematic than synthetic pesticides. The botanicals on the study list are: avermectin, clarified hydrophobic extract of neem oil, hydroprene, pyrethrins, and spinosad.

D. OTHER FACTORS

Assembled usage trend data showed that diazinon and chlorpyrifos are being replaced with a mix of products, rather than just one or two substitutes. To create a list of products that would be feasible to review in detail within the project budget, additional information needed to be considered that would differentiate among the insecticides on the study list. An evaluation of the potential for each of the insecticides to be released to surface water proved quite useful in differentiating the insecticides, as did considering information developed by USEPA in its pesticide registration and re-evaluation processes.

Potential for release to surface water—Insecticide applications on certain sites of use and using certain formulations are more likely than others to release the insecticide to surface water (TDC Environmental, 2001). Using pesticide product information from DPR's

[7] http://www.pesticideinfo.org
[8] http://toxnet.nlm.nih.gov/

Product/Label database, it was possible to determine that products containing several of the insecticides on the study list are primarily in two types of formulations that are unlikely to release meaningful quantities of the insecticide to surface water:

- Baits—product design prevents most environmental release of the active ingredient. Hydramethylnon and methoprene are primarily formulated into baits.
- Aerosols—low active ingredient concentrations combined with typical application behaviors result in relatively small quantities of insecticide release. The synergist n-octyl bicycloheptene dicarboximide, and the insecticides allethrin (and family), resmethrin, tetramethrin, and tralomethrin are primarily formulated into aerosol products.

Information from USEPA pesticide re-evaluation process. USEPA must review and approve any pesticide before it can be offered for sale in the U.S. This process is called "registration." Many of the currently popular pesticides were first approved for sale decades ago, when scientific understanding of human health and environmental effects of pesticides was far less complete than it is today. In response to concerns about the inadequate environmental review of older pesticides, Congress has put in place two regulatory review requirements for pesticides:

- Reregistration—under 1988 amendments to the nation's primary pesticide law, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), all pesticides initially registered prior to November 1, 1984 must be re-reviewed and reregistered.
- Food Quality Protection Act (FQPA) Review—the 1996 FQPA requires USEPA to review all pesticides with a focus on protecting human health. Reviews, which must be completed by 2011, must consider cumulative human exposures and common modes of action among multiple pesticides. FQPA also requires USEPA to continue to review and reregister all pesticides every 15 years.

The USEPA FIFRA registration and reregistration and the FQPA review processes generate technical documents that contain useful information about the potential for environmentally meaningful releases of a pesticide to surface waters. These documents may include preliminary and revised environmental risk assessments, cumulative risk assessments (for pesticides that are part of a group with a common mode of action) and Registration Eligibility Documents (REDs). For pesticides that are part of a group with a common mode of action, an "Interim RED" (IRED) is generated until the results of the cumulative risk assessment are available to be incorporated into a final RED.

Since passage of FQPA, USEPA has worked to combine FIFRA-required pesticide reregistrations with FQPA reviews, focusing first on the pesticides with the highest potential risks to human health. To facilitate compliance with the requirement to consider cumulative effects of pesticides with common modes of action, USEPA is reviewing pesticides in groups. Currently, the focus of the review is organophosphorous pesticides. In the next year or so, the focus will shift to carbamate pesticides. Future reviews will include pyrethroid pesticides. Table 5 provides the status of insecticides on the study list in USEPA's reregistration and FQPA review processes.

Reregistration documents provided a wealth of information about potential for environmentally important surface water releases from organophosphorous pesticides on the study list. In addition, REDs for pesticides registered in the 1990s and pesticides considered in special reviews during that time period also provided some valuable information. Table 6 presents summary of the relevant findings from these USEPA documents.

For several pesticides, regulatory changes from this process make it unlikely that they will see increased use in response to the diazinon and chlorpyrifos regulatory changes. Specifically, for acephate, fenthion, phosmet, propetamphos, and temephos, regulatory changes proposed in the REDs will greatly reduce future urban uses. For naled and tetrachlorvinphos, findings of significant risks in reregistration risk assessments suggest that uses are likely to be curtailed in the future.

CONCLUSIONS

Table 1 summarizes the information gathered in the investigation described above for the 45 insecticides identified as possible substitutes for urban uses of diazinon and chlorpyrifos. Columns were marked as follows:

- Surveys predict more urban use—Insecticides found frequently in shelf surveys, formulated into most diazinon and chlorpyrifos replacement products by the three major consumer retail product manufacturers, or reportedly frequently used or highly promoted to professional applicators were marked with an "X."
- Documented concern in surface water—If USGS NAWQA found the pesticide above a North American aquatic life criterion or if DPR linked the pesticide to toxicity in urban surface water it received an "X."
- Reported urban use greater than 10K, greater than 100K, or less than 100 pounds—Three columns were used to indicate relatively large or relatively small reported urban use of insecticides (structural pest control, landscaping pest control, and other minor urban uses). If reported urban use exceeded 10,000 (10K) pounds, exceeded 100,000 (100K) pounds, or was less than 100 pounds, the pesticide was marked with an "X" in the appropriate column.
- USEPA may reduce use—This column was marked if a USEPA RED document indicates plans to reduce or eliminate urban uses or if a risk assessment found significant risks that may be mitigated by urban use reductions.
- Primarily in low-release formulations—Insecticides primarily formulated as baits and aerosols were marked.
- Botanical or reduced risk—Insecticides classified by USEPA in either of these groups were marked.

- Not found in surveys—insecticides not found in the pesticide product surveys were marked.

Columns on the left side of the table list factors that make an insecticide a priority for more detailed review. Columns on the right side (shaded) list factors that make an insecticide a lower priority for detailed review at this time. Based on the frequency of markings in the left and right columns and information in the "Notes" column, the insecticides were divided into four groups:

- Pesticides and synergist to be reviewed in detail—These substances will be the focus of the remainder of this project. PBO was included in this group because of its frequent appearance in surface water, where it can increase environmental toxicity of pyrethroids other than ones in the product that resulted in the release of the PBO.
- Recommended priorities for future detailed review—These insecticides were separated from the remaining ones because currently available information suggests that they may contribute to urban surface water toxicity in the future. For hydramethylnon, its formulation into uncontainerized bait granules for application around structures is of concern—a concern that is exacerbated by DPR's finding it in nursery runoff (Kim *et al.*, 2001). For n-octyl bicycloheptene dicarboximide, the primary concern is that it (like PBO) has the ability to increase pyrethroid toxicity. For naled and tetrachlorvinphos, the outcome of USEPA reregistration processes are uncertain—USEPA may not select risk management measures that eliminate aquatic toxicity identified in risk assessments.
- Recommended for future screening—The urban insecticide market is still in a state of flux in response to diazinon and chlorpyrifos regulatory changes. Some of the remaining pesticide may gain significant market share as market changes continue. The market should be reviewed in several years to determine if any additional insecticides have developed meaningful market share.
- Least likely to pose future problems—Three pesticides are unlikely to be of future concern to water quality. For boric acid, low aquatic toxicity makes surface water problems unlikely. Phasing out of all urban uses will (in the long term) eliminate future urban releases of fenthion and temephos to surface waters.

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Table 1. Insecticide Replacements for Diazinon and Chlorpyrifos: Summary of Prioritization Review Results[9]

Insecticide	Surveys predict more urban use	Documented concern in surface water	Reported urban use >100K lbs	Reported urban use >10K lbs	Reported urban use <100 lb.	USEPA may reduce use	Primarily in low-release formulations	Botanical or Reduced-Risk	Not found in surveys	Notes
Pesticides and Synergists to be Reviewed in Detail										
Bifenthrin	X	X		X						
Cyfluthrin	X			X						
Cypermethrin and (S)-Cypermethrin	X		X	X						
Deltamethrin	X			X						
Esfenvalerate	X									
Permethrin	X		X	X						
Pyrethrins	X									
Carbaryl	X	X		X						
Malathion	X	X		X						
Imidacloprid	X			X						
Piperonyl Butoxide (PBO)*				X						USGS found frequently in surface water; synergizes pyrethroid toxicity
Recommended Priorities for Future Detailed Review										
Hydramethylnon	X						X			
n-octyl bicycloheptene dicarboximide*							X			Synergizes pyrethroid toxicity
Naled				X		X			X	
Tetrachlorvinphos						X			X	
Recommended for Future Screening										
Allethrin and family* (D-Allethrin, D-Trans Allethrin, S-Bioallethrin, Prallethrin, and Esbiothrin)	X						X			
Beta-Cyfluthrin					X					
Lambda Cyhalothrin*				X					X	

[9] Detailed documentation for each category presented in accompanying memorandum.

Table 1. Insecticide Replacements for Diazinon and Chlorpyrifos: Summary of Prioritization Review Results (Continued)

Insecticide	Surveys predict more urban use	Documented concern in surface water	Reported urban use >100K lbs	Reported urban use >10K lbs	Reported urban use <100 lb.	USEPA may reduce use	Primarily in low-release formulations	Botanical or Reduced-Risk	Not found in surveys	Notes
Fenvalerate									X	
Tau-Fluvalinate									X	
Phenothrin					X					
Resmethrin							X			
Tetramethrin*							X			
Tralomethrin*							X			
Aldicarb*									X	
Fenoxycarb					X				X	
Propoxur									X	
Acephate*				X		X				
Phosmet						X			X	
Propetamphos						X			X	
Trichlorfon									X	
Avermectin					X			X	X	
Clarified Hydrophobic Extract Of Neem Oil*								X		
Diflubenzuron								X	X	
Fipronil	X							X		Growing use is for under-ground injection
Halofenozide					X				X	
Hexaflumuron					X			X	X	
Hydroprene								X		
Methoprene and S-Methoprene				X			X			
Pyriproxyfen					X			X	X	
Spinosad								X	X	
Sulfluramid					X				X	
Pesticides Least Likely to Pose Future Problems										
Boric Acid								X		
Fenthion					X	X			X	
Temephos					X	X			X	

*Not on USEPA lists of alternatives for diazinon and chlorpyrifos

Table 2. Reported Use of Structural Pest Control Pesticides (Pesticides with California Reported Use Greater than 10,000 Pounds)

Pesticide	Reported Use (Pounds of Active Ingredient)				
	2000	1999	1998	1997	1996
Chlorpyrifos	*428,918*	*526,298*	*462,288*	*506,945*	*521,480*
Diazinon	*519,136*	*345,528*	*291,878*	*308,775*	*286,854*
Bifenthrin	10,728	--	--	--	--
Boric Acid	87,472	84,439	237,071	313,069	143,162
Carbon Dioxide	--	--	--	18,235	--
Copper Sulfate Pentahyd.	--	--	28,022	--	--
Cyfluthrin	14,438		20,505	33,072	31,910
Cypermethrin	126,098	114,130	120,514	88,497	73,708
Deltamethrin	10,607	--	--	--	--
Disodium Octaborate Tetrahydrate	302,046	385,804	402,056	232,198	180,920
Dodecylbenzene Sulfonic Acid	11,379	--	--	--	--
Fenvalerate	--	--	--	27,155	33,929
Formaldehyde	49,336	72,469	244,642	322,435	134,470
Glyphosate, Isopropylamine Salt	--	10,887	30,227	--	--
Imidachloprid	27,473	32,424	--	--	--
Isoparaffinic Hydrocarbons	--	--	--	--	61,556
Lambda Cyhalothrin	10,925	10,543	--	--	--
Limonene	31,034	18,690	17,005	--	--
Malathion	17,607	36,239	22,945	29,999	36,312
Methyl Bromide	275,793	314,749	306,618	504,221	596,830
Nitrogen, Liquified	391,469	392,121	1,003,749	422,101	423,124
Octyl Phenyl Polyethoxyethanol	14,187	--	--	--	--
Permethrin	240,988	158,232	191,700	153,804	168,296
Petroleum Distillates	23,053	12,002	39,626	43,830	60,609
Petroleum Distillates, Aromatic	--	89,497	26,742	--	--
Piperonyl Butoxide	--	--	--	10,305	10,632
Potassium Dimethyldithiocarbamate	--	--	24,795	--	--
Propetamphos	--	--	--	17,280	23,089
Silica Aerogel	10,796	--	--	10,416	16,082
Sodium Chloride	--	11,095	23,706	14,469	--
Sulfur Dioxide	11,290	16,031	--	27,474	13,611
Sulfuryl Fluoride	2,406,133	2,566,707	2,170,746	1,935,677	1,799,946
Xylene Range Aromatic Solvent	--	--	--	16,329	--

"--" indicates less than 10,000 pounds reported used.
Source: DPR Annual Pesticide Use Reports (DPR, 1999, 2000, and 2001).

Table 3. Reported Use of Insecticides for Landscape Maintenance, 2000

Insecticide	Reported Use (Pounds of Active Ingredient)
Chlorpyrifos	*13,566*
Diazinon	*24,665*
Carbaryl	10,096
Acephate	8,425
Imidacloprid	7,999
Naled	7,049
Permethrin	4,329
Boric Acid	4,061
Malathion	3,566
Trichlorfon	2,879
Bifenthrin	1,258
Piperonyl Butoxide	885
Cyfluthrin and Beta-Cyfluthrin	832
Cypermethrin and (S)-Cypermethrin	769
Clarified Hydrophobic Extract Of Neem Oil	322
Propoxur	313
Tau-Fluvalinate	249
Deltamethrin	197
Tetrachlorvinphos	163
Lambda Cyhalothrin	118
Spinosad	109
Pyrethrins	82
Diflubenzuron	55
n-octyl bicycloheptene dicarboximide	44
Hydramethylnon	33
Fenoxycarb	24
Propetamphos	9
Avermectin	7
Methoprene and S-Methoprene	5
Pyriproxyfen	5
Phosmet	3
Allethrin (family)	2
Esfenvalerate	2
Fipronil	2
Hydroprene	2
Phenothrin	2
Resmethrin	1
Tralomethrin	1
Tetramethrin	0.4
Fenvalerate	0.1
Hexaflumuron	0.1
Sulfluramid	0.1
Aldicarb, Fenthion, Halofenozide, and Temephos	No reported use

Note: Table only includes insecticides on study list.
Source: DPR Annual Pesticide Use Reports (DPR 1999, 2000, and 2001).

Table 4. Reported Use of Insecticides for Landscape Maintenance, 1996-2000
(Pesticides with California Reported Use Greater than 1,000 Pounds in 2000)

Insecticide	Amount Reported Used (Pounds of Active Ingredient)				
	2000	**1999**	**1998**	**1997**	**1996**
Chlorpyrifos	*13,566*	*158,187*	*18,725*	*21,560*	*22,926*
Diazinon	*24,665*	*20,566*	*30,155*	*29,770*	*28,810*
Carbaryl	10,096	8,896	11,120	13,694	15,558
Acephate	8,425	5,351	4,577	5,737	5,708
Imidacloprid	7,999	2,252	3,013	3,201	5,696
Naled	7,049	6,425	2,401	6,137	3,999
Permethrin	4,329	2,229	1,937	1,372	3,899
Boric Acid	4,061	251	123	153	402
Malathion	3,566	3,310	4,777	4,078	5,122
Trichlorfon	2,879	1,640	1,576	3,016	2,626
Bifenthrin	1,258	222	90	0.5	1

Source: DPR Annual Pesticide Use Reports (DPR 1999, 2000, and 2001).

Table 5. USEPA Registration Status for Diazinon and Chlorpyrifos Alternatives

Pesticide	USEPA Registration Status
Pyrethrins and Pyrethroids	*Pyrethroids that are candidates for reregistration are likely to be evaluated cumulatively as well as individually. USEPA has not announced a timeline for pyrethroid reregistrations.*
Allethrin and family (D-Allethrin, D-Trans Allethrin, S-Bioallethrin, Prallethrin, and Esbiothrin)	Allethrin family will be reviewed for reregistration (except prallethrin, which is not subject to reregistration*)
Bifenthrin	Not subject to reregistration*
Cyfluthrin and Beta-Cyfluthrin	Not subject to reregistration*
Lambda Cyhalothrin	Not subject to reregistration*
Cypermethrin and (S)-Cypermethrin	Will be reviewed for reregistration
Deltamethrin	Not subject to reregistration*
Esfenvalerate	Not subject to reregistration*
Fenvalerate	Will be reviewed for reregistration
Permethrin	Will be reviewed for reregistration
Phenothrin	Will be reviewed for reregistration
Pyrethrins	Will be reviewed for reregistration
Resmethrin	Will be reviewed for reregistration
Tau-Fluvalinate	Will be reviewed for reregistration
Tetramethrin	Will be reviewed for reregistration
Tralomethrin	Not subject to reregistration*
Carbamates	*A cumulative risk assessment for carbamate pesticides is planned; it must be completed before the final REDs for the carbamates below can be completed.*
Aldicarb	Preliminary risk assessment not yet prepared; Candidate for 2002 IRED
Carbaryl	Preliminary risk assessment in preparation; IRED must be completed by June 30, 2003 in accordance with NRDC lawsuit settlement
Fenoxycarb	Preliminary risk assessment not yet prepared
Propoxur	RED completed in 1997.
Organophosphorous Pesticides	*A cumulative risk assessment for organophosphorous pesticides is in progress; it must be completed before the final REDs for the organophosphorous pesticides below can be completed.*
Acephate	IRED completed 2001
Fenthion	IRED completed 2000
Malathion	Revised risk assessment completed 2000; IRED in preparation
Naled	Revised risk assessment completed 1999; IRED in preparation
Phosmet	IRED completed 2001
Propetamphos	IRED completed 2000
Temephos	IRED completed, apparently in 2000 (undated)

Table 5. USEPA Registration Status for Diazinon and Chlorpyrifos Alternatives (Continued)

Pesticide	USEPA Registration Status
Tetrachlorvinphos	RED completed 1995; revised risk assessment completed 2000; IRED in preparation
Trichlorfon	RED completed 1995; reregistration revised risk assessment 2000; IRED in preparation
Other pesticides	
Avermectin	Not subject to reregistration*
Boric Acid	RED completed 1993
Clarified Hydrophobic Extract Of Neem Oil	Not subject to reregistration*
Diflubenzuron	RED completed 1997
Fipronil	Not subject to reregistration*
Halofenozide	Not subject to reregistration*
Hexaflumuron	Not subject to reregistration*
Hydramethylnon	RED completed 1998
Hydroprene	Not subject to reregistration*
Imidacloprid	Not subject to reregistration*
Methoprene and S-Methoprene	Methoprene RED completed 1991; S-Methoprene not subject to reregistration*
Pyriproxyfen	Not subject to reregistration*
Spinosad	Not subject to reregistration*
Sulfluramid	Not subject to reregistration*

*Pesticides originally registered after November 1, 1984 are not subject to reregistration
Source: USEPA registration status information (USEPA, April 2002).

Table 6. Summary of Relevant Information from USEPA Documents

Pesticide	Notes
Acephate	The 2001 IRED indicates that acephate has relatively low aquatic toxicity and explains that aquatic risks are low. The IRED calls for ending all residential indoor uses, prohibiting application via low-pressure handwand for perimeter treatment by professional applicators, for trees, shrubs, and outdoor floral, and for the control of wasps' and terminating all turf grass uses (except golf course, sod farm, and spot or mound treatment for ant control). The IRED also says turf application rates for sod and golf courses will be reduced (USEPA, September 2001). In a product cancellation notice, USEPA noted that the vast majority of acephate usage is on agricultural and commercial ornamental plant use sites. Use in and around the home is a small fraction of total acephate usage. Acephate use in the home and on lawns is apparently somewhat self-limiting due to the pesticide's objectionable odor (USEPA, November 2001).
Boric Acid	The 1993 RED concludes that available studies indicate that technical boric acid is practically nontoxic to birds, fish and aquatic invertebrates, and relatively nontoxic to beneficial insects. The RED says that boric acid rights-of-way herbicide use pattern poses a potential risk to aquatic invertebrates (including some that are endangered); however, USEPA believes that risk probably is mitigated by the practice of limiting treatment to small strips of land, thereby limiting the amount of contaminated runoff into adjacent aquatic environments (USEPA, September 1993).
Diflubenzuron	The USEPA summary of the 1997 RED states "the results indicate that diflubenzuron is very highly toxic to freshwater aquatic invertebrates, including marine/estuarine crustacea, while it is highly toxic to marine/estuarine mollusks. The results indicate that diflubenzuron affects reproduction, growth and survival in freshwater invertebrates as well as reproduction in marine/estuarine invertebrates." The RED concludes that it is "expected to cause some adverse chronic effects to estuarine/marine fish at the highest application rate (forestry), these effects are not as widespread as those associated with freshwater and estuarine/marine invertebrates. The use of diflubenzuron is expected to cause adverse acute and chronic effects to both freshwater and estuarine/marine invertebrates, including endangered species. The risk to aquatic invertebrates is also expected to be substantial when diflubenzuron is applied to control mosquito larvae. Since this use involves direct application to water and/or near water, no mitigation is currently proposed" (USEPA, August 1997).
Fenthion	The summary of the 2000 IRED states that there are no homeowner uses for fenthion and that the only uses are to control adult mosquitoes in Florida only and dragonfly larvae in contained ornamental fish ponds in Arkansas, Florida, and Missouri. All other uses are being phased out (USEPA, January 2001).
Hydramethylnon	A summary of the 1998 RED says, "the Agency concludes that the overall acute impact on freshwater and terrestrial non-target organisms from the use of hydramethylnon for insect control will be minimal" (USEPA, December 1998).

Table 6. Summary of Relevant Information from USEPA Documents (Continued)

Pesticide	Notes
Malathion	According to the summary of the 2000 revised risk assessment, "[m]alathion runoff in urban areas has resulted in relatively high aquatic malathion concentrations. Malathion is toxic to aquatic organisms at concentrations which have been monitored or are predicted to occur as a result of registered uses. There is potential for acute and chronic risk to aquatic invertebrates and some fish." Some uses are being phased out because they are not being considered in reregistration—these uses include all pet uses; all indoor uses (except for some stored commodities and storage facilities, and mushroom houses); all greenhouse uses; and all pressurized can formulations (USEPA, November 2000).
Methoprene	While the RED was completed in 1991, additional studies on aquatic toxicity were conducted in the 1990s. In 2001, USEPA concluded that there will be "minimal acute and chronic risk to freshwater fish freshwater invertebrates and estuarine species from exposure to Methoprene mosquito products." Special studies found toxicity to chironomid (midge) larvae at normal application rates, but studies on other non-target species showed adequate safety factors (USEPA, June 2001).
Naled	In 1999, a revised risk assessment was completed. An addendum to the revised risk assessment says "[t]he acute and chronic [levels of concern] LOCs were exceeded for freshwater invertebrates. The acute high risk was exceeded for estuarine/marine fish. Chronic estuarine/marine fish LOC could not be determined due to lack of data." (USEPA, March 1999).
Phosmet	The 2001 IRED summary says that few urban uses are to remain. All uses in or around homes are to be cancelled, including uses on domestic pets, household ornamental plants and household fruit trees. Remaining urban uses will be few—evergreen trees, fire ants, and ornamental nursery stock. USEPA states that "on certain crops, where there is a high application rate and frequent application of phosmet, expected environmental concentrations can lead to acute risk for mammals; chronic risk for birds and mammals; and acute and chronic risks to invertebrates" (USEPA, October 2001).
Propetamphos	According to the 2000 IRED, all residential uses are being cancelled, as are all uses in structures children and the elderly occupy, including homes, schools, day-cares, hospitals, nursing homes (except for areas of food service when food is covered or removed prior to treatment) and all spot, broadcast, and termiticide treatments. Propetamphos may still be applied at indoor commercial, and industrial buildings and equipment, such as offices and factories. It may also be used in food service establishments where there is no contact with food, and where no processing, packing, or warehousing of food occurs. According to the RED summary, all uses are indoors and so "exposure to the environment is not expected, and therefore, ecological risks are not of concern to the Agency" (USEPA, October 2000).

Table 6. Summary of Relevant Information from USEPA Documents (Continued)

Pesticide	Notes
Propoxur	USEPA summary of 1997 RED indicates that there was "very limited outdoor use of propoxur." "Outdoor applications are limited to exteriors of buildings, on and immediately around patios, sidewalks and building foundations, and boat mooring lines, water lines and utility supply lines.... Minimal aquatic exposure from runoff or drift is expected from propoxur outdoor bait products. Although the toxicity is high, the aquatic risk does not exceed the Agency's LOCs [levels of concern]. Based on the limited outdoor bait applications of propoxur, minimal to no risk is expected to aquatic organisms." Broadcast use on lawns and turf was eliminated in 1992. The 1997 RED added label language prohibiting landscape treatment. (USEPA, 1997).
Temephos	According to the USEPA summary of the 2000 RED, temephos' main use is as a mosquito larvicide. There are no residential, commercial, or agricultural uses of temephos (USEPA, July 2001).
Tetrachlorvinphos	USEPA completed a RED for tetrachlorvinphos in 1995 and is now conducting the FQPA review. According to the revised risk assessment, the only registered uses are for livestock and pets. The revised risk assessment found significant risks associated with pet uses (USEPA, December 1999).
Trichlorfon	A summary of the 1995 RED states that "[a]cute toxicity testing on aquatic invertebrates indicate that trichlorfon is very highly toxic to all test species except crayfish, to which it was found to be moderately toxic. Chronic toxicity testing with aquatic invertebrates indicate that the MATC for trichlorfon is between 5.6 and 8.6 ng/L….The registrant has agreed to require buffer strips from aquatic habitats, mandatory watering-in for turf sites to reduce surface run-off, the prohibition of aerial application which can result in spray drift and the prohibition of residential lawn use with the bait formulations….The Agency has determined that although levels of concern are exceeded for non-target organisms, the exposure has been adequately mitigated" (USEPA, January 1997). Use information from the 2000 human health risk assessment says that residential uses of trichlorfon include perimeter treatment around dwellings and application to residential lawns (USEPA, April 2000). In September 2001, USEPA completed a review of trichlorfon to meet FQPA requirements. That review did not consider additional information that USEPA had received suggesting that trichlorfon use may pose risks to certain non-target species (USEPA, September 2001).

Source: USEPA registration and FQPA review documents (each cited in table).