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National Water-Quality Assessment Program

# Prioritizing Pesticide Compounds for Analytical Methods Development

Scientific Investigations Report 2012–5045

U.S. Department of the Interior
U.S. Geological Survey

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By Julia E. Norman, Kathryn M. Kuivila, and Lisa H. Nowell

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## FOREWORD

The U.S. Geological Survey (USGS) is committed to providing the Nation with reliable scientific information that helps to enhance and protect the overall quality of life and that facilitates effective management of water, biological, energy, and mineral resources (*http://www.usgs.gov/*). Information on the Nation's water resources is critical to ensuring long-term availability of water that is safe for drinking and recreation and is suitable for industry, irrigation, and fish and wildlife. Population growth and increasing demands for water make the availability of that water, measured in terms of quantity and quality, even more essential to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) Program in 1991 to support national, regional, State, and local information needs and decisions related to water-quality management and policy (*http://water.usgs.gov/nawqa*). The NAWQA Program is designed to answer: What is the quality of our Nation's streams and groundwater? How are conditions changing over time? How do natural features and human activities affect the quality of streams and groundwater, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues and priorities. From 1991 to 2001, the NAWQA Program completed interdisciplinary assessments and established a baseline understanding of water-quality conditions in 51 of the Nation's river basins and aquifers, referred to as Study Units (*http://water.usgs.gov/nawqa/studies/study_units.html* ).

National and regional assessments are ongoing in the second decade (2001–2012) of the NAWQA Program as 42 of the 51 Study Units are selectively reassessed. These assessments extend the findings in the Study Units by determining water-quality status and trends at sites that have been consistently monitored for more than a decade, and filling critical gaps in characterizing the quality of surface water and groundwater. For example, increased emphasis has been placed on assessing the quality of source water and finished water associated with many of the Nation's largest community water systems. During the second decade, NAWQA is addressing five national priority topics that build an understanding of how natural features and human activities affect water quality, and establish links between sources of contaminants, the transport of those contaminants through the hydrologic system, and the potential effects of contaminants on humans and aquatic ecosystems. Included are studies on the fate of agricultural chemicals, effects of urbanization on stream ecosystems, bioaccumulation of mercury in stream ecosystems, effects of nutrient enrichment on aquatic ecosystems, and transport of contaminants to public-supply wells. In addition, national syntheses of information on pesticides, volatile organic compounds (VOCs), nutrients, trace elements, and aquatic ecology are continuing.

The USGS aims to disseminate credible, timely, and relevant science information to address practical and effective water-resource management and strategies that protect and restore water quality. We hope this NAWQA publication will provide you with insights and information to meet your needs, and will foster increased citizen awareness and involvement in the protection and restoration of our Nation's waters.

The USGS recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for cost-effective management, regulation, and conservation of our Nation's water resources. The NAWQA Program, therefore, depends on advice and information from other agencies—Federal, State, regional, interstate, Tribal, and local—as well as nongovernmental organizations, industry, academia, and other stakeholder groups. Your assistance and suggestions are greatly appreciated.

William H. Werkheiser
USGS Associate Director for Water

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# Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| meter (m) | 3.281 | foot (ft) |
| kilometer (km) | 0.6214 | mile (mi) |
| meter (m) | 1.094 | yard (yd) |
| | Area | |
| square kilometer ($km^2$) | 0.3861 | square mile ($mi^2$) |
| | Volume | |
| liter (L) | 33.82 | ounce, fluid (fl. oz) |
| liter (L) | 0.2642 | gallon (gal) |
| milliliter (mL) | 0.0002642 | gallon (gal) |
| | Mass | |
| gram (g) | 0.03527 | ounce, avoirdupois (oz) |
| kilogram (kg) | 2.205 | pound avoirdupois (lb) |
| | Pressure | |
| kilopascal (kPa) | 0.009869 | atmosphere, standard (atm) |
| kilopascal (kPa) | 0.2961 | inch of mercury at 60°F (in Hg) |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Concentrations of chemical constituents in water are given in micrograms per liter (µg/L).

# Acronyms and Abbreviations

| | |
|---|---|
| AAPCO | Association of American Pesticide Control Officials |
| AIC | Akaike Information Criterion |
| AL | Aquatic-life |
| BQ | Benchmark quotient |
| CAS | Chemical Abstract Service (American Chemical Society) |
| CCL | Contaminant Candidate List |
| CCL3 | Third Contaminant Candidate List (USEPA) |
| DEA | Deethylatrazine, an atrazine degradate |
| DEG | Degradate of Parent Pesticide (Numbers after acronym denote Tier of parent pesticide) |
| $EC_{50}$ | 50-percent effective concentration |
| ECOSAR | Ecological Structure Activity Relationships (ECOSAR) Class Program (part of EPI Suite, USEPA) |
| ECOTOX | ECOTOXicology database (USEPA) |
| EPI Suite™ | Estimation Programs Interface Suite (USEPA) |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| GfK | GfK Kynetec |
| GLWQA | Great Lakes Water Quality Agreement |
| HBSL | Health-based screening level (USGS) |
| HPV | High-production volume or high-production-volume chemical |
| $K_{oc}$ | Soil organic carbon-water partitioning coefficient |
| $LC_{50}$ | 50-percent lethal concentration |
| LOC | Level of Concern |
| log $K_{ow}$ | Base-10 logarithm of the octanol-water partition coefficient |
| LT-MDL | Long term-method detection level |
| MAC | Maximum acceptable concentration (Health Canada) |
| MCL | Maximum contaminant level (USEPA) |
| NAWQA | National Water-Quality Assessment (USGS) |
| NDWAC | National Drinking Water Advisory Council |
| NIA | No information available |
| NRC | National Research Council |
| NRWQC | National Recommended Water-Quality Criteria, Office of Water (USEPA) |
| OF | Other Factors |
| OPP | Office of Pesticide Programs (USEPA) |
| p | Probablity |
| PBT | Persistent, bioaccumulative, and toxic |
| PEC | Probable effect concentration |
| PEL | Probable effect level |
| pHBSL | Provisional Health-based screening level (USGS) |
| POPs | Persistent Organic Pollutants |

| | |
|---|---|
| PPDB | Pesticide Properties Database (University of Hertfordshire, UK) |
| $pR^2$ | *pseudo-R*$^2$ |
| $R^2$ | coefficient of determination |
| RED | Reregistration Eligibility Decision, OPP (USEPA) |
| SDWA | Safe Drinking Water Act |
| SFIREG | State FIFRA Issues Research and Evaluation Group |
| SRC | Syracuse Research Corporation |
| SWMI | Surface Water Mobility Index |
| TEC | Threshold effect concentration |
| Toxics Program | Toxic Substances Hydrology Program (USGS) |
| UCMR | Unregulated Contaminant Monitoring Regulation (USEPA) |
| U.S. | United States |
| USEPA | U.S. Environmental Protection Agency |
| USLE | Universal Soil Loss Equation |
| USM | Ultimate Survey Model |
| USGS | U.S. Geological Survey |
| WARP | Watershed Regressions for Pesticides |
| WMPT | Waste Minimization Prioritization Tool |

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## Abstract

The U.S. Geological Survey (USGS) has a periodic need to re-evaluate pesticide compounds in terms of priorities for inclusion in monitoring and studies and, thus, must also assess the current analytical capabilities for pesticide detection. To meet this need, a strategy has been developed to prioritize pesticides and degradates for analytical methods development. Screening procedures were developed to separately prioritize pesticide compounds in water and sediment. The procedures evaluate pesticide compounds in existing USGS analytical methods for water and sediment and compounds for which recent agricultural-use information was available. Measured occurrence (detection frequency and concentrations) in water and sediment, predicted concentrations in water and predicted likelihood of occurrence in sediment, potential toxicity to aquatic life or humans, and priorities of other agencies or organizations, regulatory or otherwise, were considered.

Several existing strategies for prioritizing chemicals for various purposes were reviewed, including those that identify and prioritize persistent, bioaccumulative, and toxic compounds, and those that determine candidates for future regulation of drinking-water contaminants. The systematic procedures developed and used in this study rely on concepts common to many previously established strategies. The evaluation of pesticide compounds resulted in the classification of compounds into three groups: Tier 1 for high priority compounds, Tier 2 for moderate priority compounds, and Tier 3 for low priority compounds.

For water, a total of 247 pesticide compounds were classified as Tier 1 and, thus, are high priority for inclusion in analytical methods for monitoring and studies. Of these, about three-quarters are included in some USGS analytical method; however, many of these compounds are included on research methods that are expensive and for which there are few data on environmental samples. The remaining quarter of Tier 1 compounds are high priority as new analytes. The objective for analytical methods development is to design an integrated analytical strategy that includes as many of the Tier 1 pesticide compounds as possible in a relatively few, cost-effective methods.

More than 60 percent of the Tier 1 compounds are high priority because they are anticipated to be present at concentrations approaching levels that could be of concern to human health or aquatic life in surface water or groundwater. An additional 17 percent of Tier 1 compounds were frequently detected in monitoring studies, but either were not measured at levels potentially relevant to humans or aquatic organisms, or do not have benchmarks available with which to compare concentrations. The remaining 21 percent are pesticide degradates that were included because their parent pesticides were in Tier 1. Tier 1 pesticide compounds for water span all major pesticide use groups and a diverse range of chemical classes, with herbicides and their degradates composing half of compounds. Many of the high priority pesticide compounds also are in several national regulatory programs for water, including those that are regulated in drinking water by the U.S. Environmental Protection Agency under the Safe Drinking Water Act and those that are on the latest Contaminant Candidate List.

For sediment, a total of 175 pesticide compounds were classified as Tier 1 and, thus, are high priority for inclusion in analytical methods available for monitoring and studies. More than 60 percent of these compounds are included in some USGS analytical method; however, some are spread across several research methods that are expensive to perform, and monitoring data are not extensive for many compounds. The remaining Tier 1 compounds for sediment are high priority as new analytes. The objective for analytical methods development for sediment is to enhance an existing analytical method that currently includes nearly half of the pesticide compounds in Tier 1 by adding as many additional Tier 1 compounds as are analytically compatible.

About 35 percent of the Tier 1 compounds for sediment are high priority on the basis of measured occurrence. A total of 74 compounds, or 42 percent, are high priority on the basis of predicted likelihood of occurrence according to physical-chemical properties, and either have potential toxicity to aquatic life, high pesticide useage, or both. The remaining 22 percent of Tier 1 pesticide compounds were either degradates of Tier 1 parent compounds or included for other reasons. As with water, the Tier 1 pesticide compounds for sediment are distributed across the major pesticide-use groups; insecticides and their degradates are the largest fraction, making up 45 percent of Tier 1. In contrast to water, organochlorines, at 17 percent, are the largest chemical class for Tier 1 in sediment, which is to be expected because there is continued widespread detection in sediments of persistent organochlorine pesticides and their degradates at concentrations high enough for potential effects on aquatic life. Compared to water, there are fewer available benchmarks with which to compare contaminant concentrations in sediment, but a total of 19 Tier 1 compounds have at least one sediment benchmark or screening value for aquatic organisms. Of the 175 compounds in Tier 1, 77 percent have high aquatic-life toxicity, as defined for this process.

This evaluation of pesticides and degradates resulted in two lists of compounds that are priorities for USGS analytical methods development, one for water and one for sediment. These lists will be used as the basis for redesigning and enhancing USGS analytical capabilities for pesticides in order to capture as many high-priority pesticide compounds as possible using an economically feasible approach.

# Introduction

To ensure that the U.S. Geological Survey (USGS), and specifically, the National Water-Quality Assessment (NAWQA) Program is prepared to address future pesticide monitoring needs, a strategy for prioritizing pesticide compounds for analytical methods development is needed that considers a very broad range of pesticides that can be important in either streams or groundwater. When characterizing pesticides in streams, the more water-soluble pesticide compounds are most readily determined by sampling the water column, whereas the more hydrophobic pesticide compounds are more likely to be detected in sediment. Some persistent, hydrophobic pesticide compounds that tend to accumulate in sediment also can bioaccumulate in the tissues of fish and other aquatic organisms, though prioritization for fish tissue methods was not included in the scope of this report.

The prioritization strategy described in this report includes screening procedures for water and sediment, with the goal of identifying the highest priority compounds to include in future analytical methods. The "universe" of more than 600 compounds considered includes 447 pesticide compounds for which agricultural pesticide use information was available, selected degradates, and other pesticide compounds currently on USGS analytical methods for pesticides in water and sediment. Pesticide degradates included primarily those that have been analyzed by USGS methods and do not represent all possible degradates of the agricultural pesticides evaluated. Criteria incorporated into the prioritization strategy include measured detection frequency and concentration in streams, groundwater, and sediment; predicted concentrations in streams and groundwater; agricultural and non-agricultural pesticide use estimates; physical-chemical properties; aquatic-life benchmarks and toxicity data; human-health benchmarks; and priorities of other agencies or organizations.

## Background

Past assessments of pesticides by NAWQA have provided comprehensive national- and regional-scale analyses of pesticide occurrence and concentrations in streams and groundwater. Previous approaches for prioritizing pesticide compounds for analytical methods development for NAWQA Program studies have focused on selected pesticides, and their degradates, with high agricultural or urban uses (Gilliom and others, 2001). Pesticide use is constantly changing, however, with new pesticides being registered and introduced into use, while other pesticides are restricted or banned from use. When pesticides are applied in the environment, there are concerns for toxicity to non-target organisms, including aquatic life and humans. It is important to monitor and assess compounds that could occur at concentrations of potential concern to aquatic organisms, humans, or both, particularly those that are most likely to occur and persist in the environment. In addition to parent pesticide compounds, pesticide degradation products also need to be considered because these compounds can persist in the environment and also can be toxic to non-target organisms.

## Other Chemical Prioritization Approaches

Chemical prioritization or ranking systems provide a means to synthesize information about the relative exposures, hazards, and risks posed by chemicals to assist in the allocation of monitoring or other resources. Ranking and scoring systems have been developed for many purposes, including regulatory action, priority setting, and impact evaluations (Davis and others, 1994). When the National Research Council reviewed 10 existing chemical prioritization schemes, they characterized them using a common framework shown in *figure 1* (National Research Council, 1999). "Selection of Contaminant Pool" refers to the universe of chemicals considered in each of the prioritization schemes; "Determination of Exposure" refers to the factors, such as occurrence in the environment, considered in evaluating the potential exposure to a contaminant; and "Determination of Toxicity" refers to the factors considered in evaluating the potential health effects of a contaminant. Finally, "Prioritization Scheme" refers to

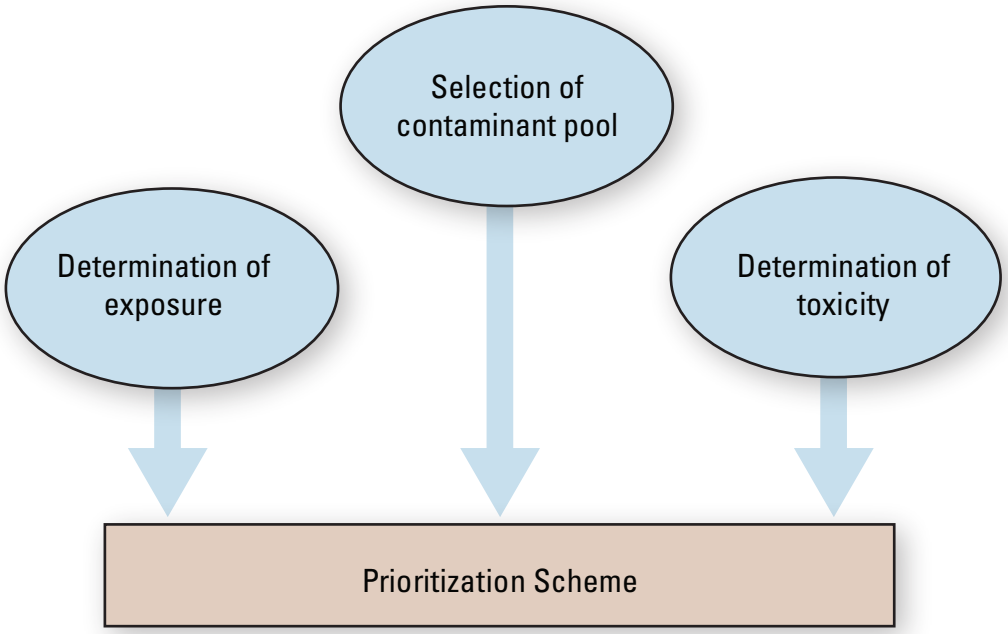



**Figure 1.** National Research Council framework for evaluating chemical ranking schemes (National Research Council, 1999).

the algorithm by which exposure and toxicity are combined to provide a metric for ranking or prioritizing contaminants.

Prioritization efforts undertaken in the United States and internationally have included those that focus on persistent, bioaccumulative, and toxic (PBT) chemicals, contaminants for potential regulation in drinking water, high production-volume chemicals, and emerging contaminants. PBT programs include the U.S. Environmental Protection Agency's (USEPA's) PBT Chemical Program, which has relied upon tools to prioritize chemicals, such as the PBT Profiler, an online risk-screening tool that predicts a chemical's potential to persist, bioaccumulate, and be toxic to humans or aquatic organisms (U.S. Environmental Protection Agency, 2010b), and the Waste Minimization Prioritization Tool (WMPT), a tool developed to prioritize chemicals on the basis of persistence, bioaccumulation potential, toxicity, and quantity (U.S. Environmental Protection Agency, 2000a). Other PBT prioritization efforts were conducted by the 2001 Stockholm Convention on Persistent Organic Pollutants (POPs, *http://chm.pops.int/default.aspx*); the Canadian government, as part of its Chemicals Management Plan "Challenge" program for high-priority chemical substances (*http://www.chemicalsubstanceschimiques.gc.ca/challenge-defi/index-eng.php*); and the state of Oregon, which recently created a prioritized list of persistent pollutants to guide the state's pollution prevention efforts (Oregon Department of Environmental Quality, 2009). One recently published prioritization effort identified new persistent and bioaccumulative organic chemicals that are not included in current monitoring programs but are present in the environment (Howard and Muir, 2010), and other studies have prioritized emerging or trace environmental contaminants in freshwater, including potential endocrine-disrupting chemicals (Kumar and Xagoraraki, 2010; Murray and others, 2010).

USEPA's Contaminant Candidate List (CCL) program prioritizes chemicals for regulation in drinking water by using a detailed classification approach developed through recommendations from the National Research Council (NRC) of the National Academy of Science (National Research Council, 2001) and the National Drinking Water Advisory Council (U.S. Environmental Protection Agency, 2009b). Every 5 years the USEPA is required to publish a list of unregulated contaminants that are known or anticipated to occur in public water systems and which may require future regulations under the Safe Drinking Water Act (SDWA). USEPA is required to develop the CCL by using specific data sources and criteria and must consider health effects and occurrence information to identify contaminants of greatest concern to public health from exposure to drinking water. The most recent list is the Third Contaminant Candidate List (CCL3), which was finalized in August 2009 (U.S. Environmental Protection Agency, 2009b).

None of these approaches completely meet USGS needs for prioritizing pesticide compounds. Many of the approaches rely on separate scoring techniques for exposure and toxicity components and then apply algorithms to combine component scores into an overall score for a chemical. The USGS prioritization strategy for pesticide compounds described herein follows the general framework illustrated in *figure 1* to meet the goals of creating systematic procedures for water and sediment that are objective, semi-quantitative (to the extent possible), and absolute (not relative rankings). For example, the availability of modeling tools for water made it possible to combine potential exposure and toxicity components to express predicted environmental pesticide concentrations, or predicted exposure, relative to toxicity as a fraction of potentially toxic levels.

# Purpose and Scope

This report describes the process of prioritizing pesticide compounds for methods development to identify those compounds that are most likely to occur frequently or be present at concentrations potentially harmful to humans or aquatic organisms in the environmental matrix of interest: water or sediment. Separate screening procedures were developed to prioritize pesticide compounds for water and sediment because of differing availability of data. In both media, compounds were prioritized into three levels of relative importance, and the highest priority group of compounds for water and sediment are the main focus for analytical methods development and inclusion in future monitoring programs.

The more than 600 pesticide compounds screened include pesticides for which recent agricultural pesticide-use data were available, selected degradates, and other pesticide compounds currently included in USGS analytical methods for pesticides in water and sediment. The prioritization strategy reflected the fact that pesticide studies may have a number of different goals. Pesticide compounds that are known, or anticipated, to occur frequently in the environment, regardless of their concentrations, can, for example, be important to monitor for trends or studies of fate and transport. Additionally, pesticide compounds can be important to consider for potential effects on human health or aquatic life if they have been measured, or are anticipated to occur, at concentrations approaching relevant threshold concentrations for organisms with potential exposure. Because this was a screening process, thresholds for occurrence and concentrations, and decisions for prioritizing pesticide compounds into tiers, were intentionally conservative.

## Water

The goal of the prioritization for water was to identify pesticides and degradates that are likely to occur widely in streams or groundwater, or that are anticipated to occur at concentrations potentially relevant to the health of humans, in streams and groundwater, or aquatic organisms in streams. The 619 pesticides and degradates screened for water were evaluated by considering (1) measured pesticide concentration and detection-frequency data from NAWQA Program studies of streams and groundwater; (2) predicted pesticide concentrations in streams and groundwater, which incorporated pesticide-use estimates and physical-chemical properties; and (3) potential toxicity to humans and aquatic organisms. Pesticide compounds were further evaluated for their regulatory and non-regulatory importance to other agencies or organizations.

Pesticide compounds analyzed in previous NAWQA studies were evaluated in terms of both detection frequency and measured concentrations. Modeling procedures were used to predict concentration statistics for current-use pesticides, and selected degradates, for which recent agricultural-use estimates were available. Pesticide compounds with data from previous NAWQA studies that also have current agricultural-use data were evaluated for both measured and predicted occurrence. Pesticide concentrations, either predicted or measured, were placed in the context of toxicity to humans and aquatic life by using benchmarks and toxicity information.

## Sediment

The goal of the prioritization for sediment was to identify pesticides and degradates that frequently occur, or are likely to occur in sediment, and that could be toxic to aquatic organisms. The universe of pesticide compounds in sediment started with the list of 619 compounds from the screening for water, which was completed first. Pesticides and degradates included in USGS analytical methods, both approved and research, for sediment that are not included in any water methods were added to the list. The list was further refined to exclude constituents such as mixtures, microbial pesticides, and inorganic compounds, which resulted in a list of 611 pesticides and degradates to be screened for sediment.

The screening for sediment considered (1) measured occurrence in stream bed, suspended, and lake sediments from prior USGS studies; (2) predicted likelihood of occurrence in sediment on the basis of physical-chemical properties; (3) potential toxicity to aquatic organisms; and (4) pesticide-use levels. As with water, pesticide compounds also were evaluated according to the priorities of other agencies or organizations.

Pesticide compounds analyzed in previous USGS studies were evaluated for their detection frequency. For pesticide compounds without occurrence data, physical-chemical property data were examined to determine the likelihood of the compound occurring in sediments. When possible, measured pesticide concentrations were evaluated relative to toxicity to aquatic organisms by comparing concentrations to screening values for sediment. Aquatic toxicity also was incorporated into the sediment prioritization by classifying pesticides that occur, or are likely to occur, in sediment according to their relative degrees of toxicity to identify the most toxic compounds.

# Methods

The prioritization strategy incorporated the same general data elements in the screening procedures for water and sediment. This section first describes the common data elements used and then separately describes the tiering processes for water and sediment. Specifics about measured occurrence data for water and sediment, details about models used to estimate predicted concentrations in water, and agency and organization priorities considered are given under the water and sediment tiering process subsections.

## Data Types and Sources

Several types and sources of data were used to prioritize pesticide compounds for water and sediment. The following subsections discuss physical-chemical properties, pesticide use information, aquatic-life benchmarks and toxicity information, sediment benchmarks and toxicity information, and human-health benchmarks.

### Physical-Chemical Properties

Physical-chemical property data for pesticides were compiled from several sources, including the Pesticide Properties DataBase (2009) from the UK FOOTPRINT project (PPDB), a literature compilation of property data from primary sources conducted by the NAWQA Pesticide National Synthesis group (various sources cited in tables), and experimental and estimated values from USEPA's Estimation Programs Interface (EPI) Suite™ software program (U.S. Environmental Protection Agency, 2009a). Three properties were used to predict pesticide concentrations in streams by using the multi-compound Watershed Regressions for Pesticides (WARP) model: vapor pressure, the organic carbon-water partitioning coefficient ($K_{oc}$), and aerobic soil degradation half-life (+). When property data were available from more than one source, a priority of existing sources was used to select the value for each property in order to obtain the greatest consistency in the type of value selected and to rely on values compiled from the literature. The priority of sources for selected property values were as follows:

- Vapor pressure—(1) PPDB or (2) EPI Suite™ experimental or estimated value.
- $K_{oc}$—(1) literature value, (2) PPDB, or (3) EPI Suite™ experimental or estimated value.
- Soil half-life—(1) PPDB "typical" (the "typical values" are those given in the general literature and are often a mean of all studies, field and laboratory), field study, or lab study, or (2) field or lab study value compiled from literature.

Selected properties also were used to determine the predicted likelihood of occurrence of pesticide compounds in sediment: aerobic soil degradation half-life, to indicate persistence; octanol-water partitioning coefficient ($K_{ow}$) or water solubility, to indicate hydrophobicity; and $K_{oc}$, to indicate soil sorption (*appendix 1*). As with water, with the exception of soil half-life, when property data were available from more than one source, a priority of available sources was used to select the value for each property. The priority of sources for selected $K_{ow}$ values was (1) PPDB, (2) literature value, or (3) EPI Suite™ experimental or estimated value. The priority of sources for selected water solubility values was (1) literature value at 25 degrees Celsius (°C), (2) EPI Suite™ experimental or estimated value at 25°C, or (3) PPDB value at 20 or 25°C. Water solubility values from the PPDB were given lowest priority because most are given at 20°C, compared to the standard 25°C used in most other sources. The priority of sources for $K_{oc}$ values selected was the same as for water. A conservative decision was made to choose the maximum, or longest, of the available soil degradation half-life values, using the same sources as those listed for water, because a compound's persistence was the primary factor in predicting the likelihood of occurrence in sediments. For a limited number of compounds for which measured soil half-life values were not available as a measure of persistence in sediment, but for which other properties that were required to determine predicted likelihood of occurrence in sediment, estimates of persistence were relied upon. These estimates also are listed in *appendix 1* and were of two types: (1) a "Persistence score" (see *appendix 2* for the scoring methodology), determined from output of the BIOWIN model, a component of EPI Suite™ (U.S. Environmental Protection Agency, 2009a), and (2) estimated soil half-life from the PBT Profiler, a property estimation screening tool developed to screen chemicals lacking experimental data, to identify chemicals that potentially persist, bioaccumulate, and are toxic to aquatic life (U.S. Environmental Protection Agency, 2010b).

### Pesticide-Use Data

Estimates of agricultural pesticide use for 2007 were obtained from unpublished proprietary data from GfK Kynetec (GfK), for 331 pesticides (GfK Kynetec, 2007). The data from GfK include pesticide-use estimates for active ingredients collected through annual surveys of more than 80 crops, including major field crops, some fruit and specialty crops, and other agricultural land use, such as pasture and rangeland. Annual crop surveys are based on a statistical sample of commercial farm operations distributed throughout crop reporting districts (Thelin and Stone, 2010). Of the 447 pesticide compounds in the database of use estimates for the years 1992 to 2007, 331 compounds had agricultural use for the most recent year, 2007. These data were used in the screening procedure for water in models used to estimate pesticide concentrations in streams and groundwater. Estimates of non-agricultural pesticide-use ranges were based on information collected during 2000–07 obtained from the USEPA (Gail P. Thelin, U.S. Geological Survey, written commun., 2009); these estimates, along with 2007 agricultural pesticide-use estimates, were used qualitatively in the screening procedure to prioritize pesticide compounds in sediment. Agricultural pesticide-use trends—increasing or decreasing—from the most recent 5 years of unpublished proprietary data, 2003–07, from GfK Kynetec also were considered.

## Aquatic-Life Benchmarks and Toxicity Information for Water

Aquatic-life benchmarks for water used in this prioritization effort included USEPA Office of Pesticide Programs' (OPP) aquatic-life benchmarks for freshwater (U.S. Environmental Protection Agency, 2009d); USGS aquatic-life benchmarks, developed using the same methods used to develop OPP benchmarks as well as aquatic-life toxicity data compiled from OPP Reregistration Eligibility Decision (RED) and ecological risk assessment documents for individual compounds, which are available at *http://www.epa.gov/oppsrrd1/reregistration/status.htm* (U.S. Environmental Protection Agency, 2010c); and USEPA Office of Water's National Recommended Water-Quality Criteria (NRWQC) for the protection of aquatic life (U.S. Environmental Protection Agency, 2002). Benchmark values were selected in the previously listed order of priority among sources. For a given compound, if multiple benchmarks were available for different taxonomic groups or for acute or chronic exposures, then the lowest (most conservative) value was selected.

For compounds that lacked benchmarks, aquatic-life toxicity data were compiled. Data sources for these toxicity data, selected in the following order of priority, included USEPA OPP RED or ecological risk assessment documents (U.S. Environmental Protection Agency, 2010c), USEPA's ECOTOXicology Database System (U.S. Environmental Protection Agency, 2010a), USEPA OPP Pesticide Ecotoxicity Database (U.S. Environmental Protection Agency, 2009e). Toxicity values from standard test species, endpoints, and test durations were used. In the absence of measured toxicity data, predicted toxicity values from USEPA's Ecological Structure Activity Relationships (ECOSAR) estimation program, part of the EPI Suite™ software (U.S. Environmental Protection Agency, 2009a), were used. A level of concern (LOC) factor of 0.5 was applied to acute fish and invertebrate toxicity values to make them comparable to acute aquatic-life benchmarks consistent with USEPA OPP's methodology (U.S. Environmental Protection Agency, 2009d). The minimum, or most conservative, toxicity value (with the LOC applied to acute values) from the chosen source was selected for each compound. Henceforth in this report, the aquatic-life benchmarks or toxicity values selected for each pesticide compound and used in the prioritization for water will be collectively referred to as "aquatic-life benchmarks"; these values are tabulated in *appendix 3*.

## Sediment Benchmarks and Toxicity Information

Several types of sediment benchmarks for benthic organisms were compiled for comparison with measured pesticide concentrations in sediment, including USEPA equilibrium-partitioning sediment guidelines (U.S. Environmental Protection Agency, 2004), Canadian interim sediment-quality guidelines (Canadian Council of Ministers of the Environment, 2002), sediment-quality screening values from Lopes and Furlong (2001), and consensus-based sediment-quality guidelines from MacDonald and others (2000). Some of these benchmarks—especially those from Canada and MacDonald and others (2000)—consist of a pair of screening values for each compound, with the upper screening value designating concentrations above which effects are likely or frequently observed, and the lower screening value indicating concentrations below which effects are rare or not expected.

For pesticides without sediment benchmarks for benthic organisms, aquatic-toxicity information for pesticides in water, compiled as described in the previous section, was used to categorize pesticide compounds by their potential toxicity to sediment-dwelling organisms. Aquatic toxicity from sediment exposures is predicted to occur at the same concentration in the pore water of the sediment as it would in water-only exposures, with the pore-water concentration, at equilibrium, assumed to be a function of the organic carbon content of the sediment (Di Toro and others, 1991). Therefore, in the present report, the relative toxicity of pesticides in water was used as an indicator of their relative toxicity in sediment—the influence of sediment-organic carbon, which is a characteristic of the sediment, not the pesticide, need not be considered because it is a site-specific concern. Briefly, aquatic-life benchmarks were used to derive Aquatic-Life (AL) Toxicity Bins as summarized in *table 1*. Pesticide compounds with benchmarks that met the acute or chronic threshold concentrations for a given AL Toxicity Bin were classified in that bin. With respect to sediment tier assignments, which is described later, pesticide compounds in AL Toxicity Bins 1 and 2 were considered to have "high" aquatic toxicity, and compounds in AL Toxicity Bin 3, or with no information available (NIA), were considered to have "low" aquatic toxicity. A table of (1) the AL Toxicity Bins with the underlying aquatic-life benchmarks and (2) the available sediment benchmarks, used in the evaluation of pesticides for sediment, is provided in *appendix 4*.

## Human-Health Benchmarks

Human-health benchmarks used in the prioritization strategy include USEPA Maximum Contaminant Levels (MCLs) for drinking water (U.S. Environmental Protection Agency, 2009c); Health-Based Screening Levels (HBSLs) from USGS (Toccalino and others, 2008) or provisional HBSLs (pHBSLs), which were calculated for additional compounds that have yet to have an HBSL determined, using the HBSL methodology (Toccalino, 2007); or Maximum Acceptable Concentrations (MACs) from Canada (Health Canada, 2008). Henceforth in this report, the benchmarks described above will be collectively referred to as human-health benchmarks. Concentrations of pesticide compounds that are regulated by USEPA in drinking water under the SDWA were compared to MCLs, and concentrations of unregulated contaminants were compared

**Table 1.** Thresholds for Aquatic-Life Toxicity Bins for pesticides in sediment.

[**Abbreviations:** AL, aquatic-life; NIA, no information available; µg/L, microgram per liter; <, less than; >, greater than; –, none]

| AL Toxicity Bin | Benchmark type | Benchmark threshold concentration (µg/L) [1] |
|---|---|---|
| 1 | Acute | [2] <50 |
| | Chronic | <10 |
| 2 | Acute | [2] 50 to 50,000 |
| | Chronic | 10 to 10,000 |
| 3 | Acute | [2] >50,000 |
| | Chronic | >10,000 |
| NIA | – | – |

[1] The acute and chronic toxicity thresholds are consistent with the ecotoxicity categories from the Pesticide Properties Database (2009). The acute toxicity thresholds also are consistent with USEPA Environmental Fate and Effects Division's ecotoxicity categories *(http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm*) with the highly, moderately, and slightly toxic categories collapsed into a range of concentrations corresponding to AL Toxicity Bin 2.

[2] AL Toxicity Bin thresholds for acute aquatic-life benchmarks account for the level of concern (LOC) of 0.5 that was applied to acute toxicity values for pesticides to determine benchmark values, consistent with U.S. Environmental Protection Agency Office of Pesticide Programs methodology (U.S. Environmental Protection Agency, 2009e). Acute thresholds would be two-times greater (and ten-times greater than chronic thresholds corresponding to the same AL Toxicity Bin) if raw acute toxicity values (LC50 or EC50 values without an LOC applied) were used to determine AL Toxicity Bins. The acute thresholds for other (non-pesticide) contaminant groups evaluated for analytical methods development priorities were <100, 100 to 100,000, and >100,000 µg/L for AL Toxicity Bins 1, 2, and 3, respectively (Lisa D. Olsen, U.S. Geological Survey, written commun., 2010).

to HBSLs (or pHBSLs), when available, or MACs for a few compounds. MCLs are legally enforceable USEPA drinking-water standards (U.S. Environmental Protection Agency, 2009c). HBSLs are non-enforceable benchmark concentrations of contaminants in water that were developed by the USGS in collaboration with the USEPA and others (Toccalino, 2007).

## The Tiering Process

This section describes the separate screening procedures that were developed to prioritize pesticide compounds for analytical methods development for water and sediment. Compounds were prioritized into three tiers for each medium (water and sediment). Tier 1 includes compounds that are high priority for analytical methods development for future water-quality monitoring and studies because they are known or anticipated to widely occur in the environment, or they can occur at concentrations relevant to the health of humans or aquatic organisms; Tier 2 includes compounds that do not meet the criteria for the highest priority group but that are of moderate priority because of their regulatory status, potential for occurrence, toxicity, or importance to other agencies or organizations; and Tier 3 includes compounds that do not meet the criteria for Tiers 1 or 2 and are currently low priority for analytical methods development efforts.

Pesticide compounds can be categorized as Tier 1, the highest priority, on the basis of measured or predicted occurrence, or potential for toxicity to aquatic life or humans. Prioritization criteria that were common to both water and sediment procedures include measured detection frequency of greater than 10 percent in USGS monitoring studies, inclusion of pesticide degradates in the same tier as parent pesticides, and evaluation of importance to other agencies or organizations. In addition, pesticide-use information and physical-chemical properties were used in both prioritization procedures, although in different manners. As an occurrence-based approach to prioritization, USGS, and primarily NAWQA, datasets were selected for this process because these data adhere to a consistent national design. Extending beyond these data sources into studies with designs that are not consistent with them, as well understood, or that use targeted approaches, was beyond the scope of this approach; however, expanding to outside data sources could be helpful for future work. Further, pesticide compounds with recent agricultural-use data that are not included in USGS analytical methods, as well as compounds that are, were evaluated by prediction means, which expanded the occurrence-based evaluation of pesticide compounds beyond those determined by USGS analytical methods. The specific procedures and uses of data are described for each medium in the following "Water" and "Sediment" sections.

### Water

The screening procedure for pesticide compounds in water incorporates measured or predicted pesticide concentrations, or both, in surface water and groundwater, historical detection-frequency data, and potential toxicity to aquatic organisms and humans. Screening procedures for pesticide compounds in water were carried out in parallel for surface water and groundwater.

Measured and predicted pesticide-concentration statistics were compared to applicable aquatic-life, or human-health benchmarks, or both when available. Benchmark quotients (BQs) were calculated by dividing the concentration statistic by the benchmark value and used to indicate the degree of potential concern for aquatic life and human health. A threshold value of BQ greater than 0.01 for either aquatic life or human health, resulting from either measured or predicted concentrations, was selected as a conservative measure to categorize pesticide compounds as high priority—and thus, in Tier 1. A BQ greater than 0.01 indicates that a contaminant concentration is greater than one-hundredth of the benchmark value. This threshold is more conservative than thresholds often used in analyses of water-quality data. For example, for individual contaminants, concentrations greater than one-tenth of a human-health benchmark commonly are used to identify contaminants that could warrant additional monitoring, to

analyze trends in their occurrence, and to provide an early indication of contaminant concentrations that approach their benchmarks (Toccalino and others, 2006; Toccalino, 2007). The 0.01 BQ threshold was chosen to be more inclusive for identifying compounds for methods development priorities.

There are limitations to the approach of using observed or predicted occurrence for pesticide compounds for which one particular form is measured or predicted, but multiple application forms can exist. An example of this is the chlorophenoxy acid herbicides, which also can be applied as salts or esters and, therefore, have different forms of the pesticide active ingredient introduced to the environment. In these cases, the specific pesticide compound used in the prioritization was determined according to the compound for which data were available. Analytical methods can underestimate the total pesticide concentration when, for example, a particular ester form of a pesticide is measured (for example, sulfometuron-methyl). Further, use data for current agricultural-use pesticides usually list only one form of these compounds but use estimates can include multiple forms. As such, predicted concentrations can provide better estimates of the total concentrations for pesticide compounds such as these. Because pesticide compounds with USGS occurrence data that are current agricultural-use pesticides also were evaluated by predicted concentrations, this limitation is reduced. Benchmarks, when available, were matched to the specific form of the measured or predicted compound.

Detection frequencies of pesticide compounds in surface water and groundwater from NAWQA water-quality monitoring studies also were evaluated. A detection frequency threshold of 10 percent was used to identify "frequently detected" compounds, which were placed in Tier 1. This detection frequency often is selected as a threshold for frequently-occurring compounds in water-quality studies and was consistent with the threshold used to screen occurrence data for other contaminant groups under evaluation for analytical-methods development priorities (Lisa D. Olsen, U.S. Geological Survey, written commun., 2010).

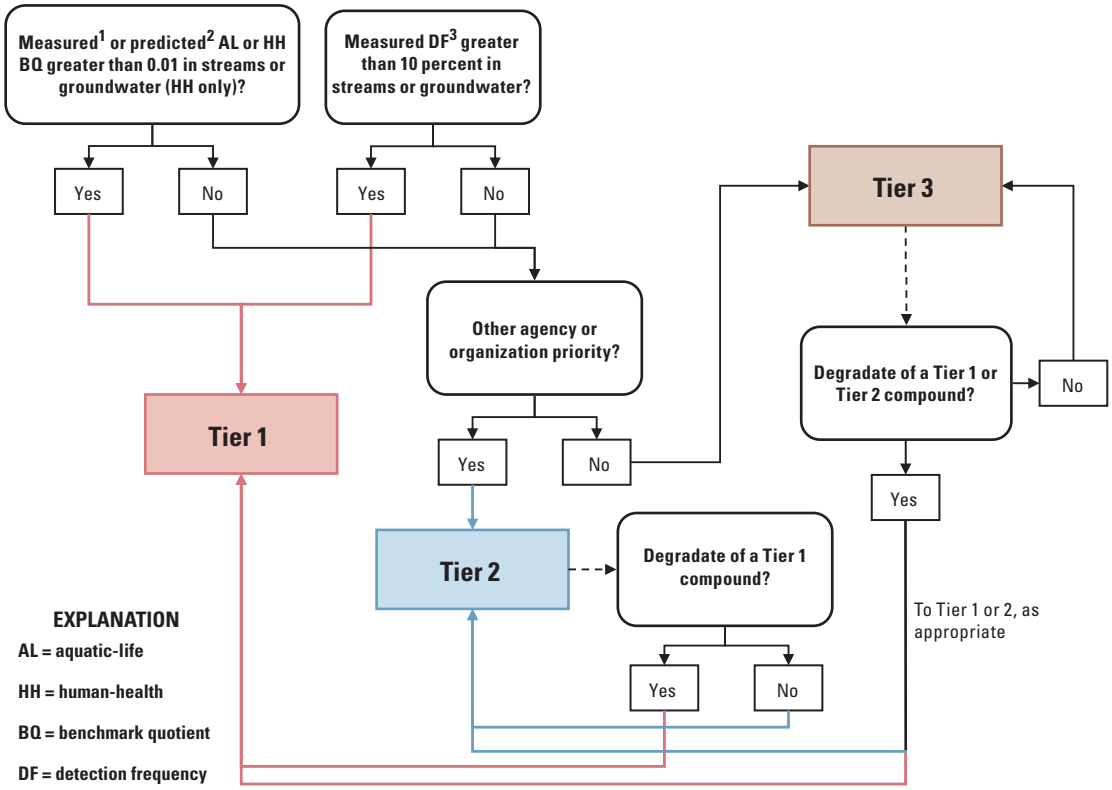
The screening of measured occurrence data, in addition to predicted pesticide concentrations, to determine priority compounds allows inclusion of pesticides no longer registered for use and balances the need to track trends in historically prevalent compounds with the need to include newer current-use pesticide compounds that are potentially important but have yet to be characterized.

## Surface Water

The evaluation of pesticide compounds in surface water was based on measured and predicted concentrations in streams and detection frequency in streams, and is illustrated in *figure 2*. Derivation of measured and predicted pesticide-concentration statistics is described below. These concentration statistics were divided by aquatic-life or human-health benchmarks, when available, to calculate BQs. The 95th-percentile concentration statistic was chosen for comparison to aquatic-life benchmarks because this concentration represents the concentration likely to be exceeded for about 2.5 weeks per year and is appropriate for comparison to chronic benchmarks; the benchmarks selected for comparison were the lowest value for a given compound and are protective of the most sensitive species for short or long-term exposures. The annual mean concentration statistic was chosen for comparison to human-health benchmarks used in this evaluation because benchmarks are based on long-term, lifetime exposure. Measured pesticide detection frequency in streams also was evaluated.

### Measured Concentrations in Streams

Concentration data for 83 pesticide compounds sampled in up to 113 stream sites in previous NAWQA water-quality monitoring studies were evaluated; these data are summarized in *appendix 5*. Pesticide-concentration statistics for agricultural and urban land-use streams that were sampled 8 to 50 times over a 1-year period between 1993 and 2000 were compared to aquatic-life and human-health benchmarks, when available. For a given compound, the maximum of the time-weighted 95th-percentile concentrations among stream sites was compared to the aquatic-life benchmark, and the maximum of the time-weighted annual mean concentrations was compared to the human-health benchmark. The resulting BQ values were used to identify compounds that historically have been detected in streams at concentrations approaching threshold concentrations potentially relevant to aquatic life or human health.




[1]BQs for measured concentrations in streams are the maximum of the 95th percentile concentrations among stream sites divided by the AL benchmark, and the maximum of the annual mean concentrations divided by the HH benchmark. BQ for measured concentrations in groundwater are the 99th percentile concentration of wells divided by the HH benchmark. Measured concentration statistics are for agricultural and urban land-use streams and agricultural, urban, and mixed land-use wells.

[2]BQs for predicted concentrations in streams are the maximum of the 95th percentile concentrations among stream reaches divided by the AL benchmark, and the maximum of the annual mean concentrations divided by the HH benchmark. BQs for predicted concentrations in groundwater are the 99th percentile concentration divided by the HH benchmark.

[3]Measured DFs are for pesticide compounds measured in streams and groundwater in agricultural and urban land-use areas.

**Figure 2.** Flow chart for the evaluation of pesticides and degradates in surface water and groundwater.

### Predicted Concentrations in Streams

The WARP model for atrazine (Stone and Gilliom, 2009) was used to predict pesticide-concentration statistics in streams by using adjustment factors to extrapolate to other pesticides. The WARP models were designed to predict atrazine concentrations in streams on the basis of agricultural-use intensity at the watershed scale; the models have the general form of equation 1:

$$\log_{10}(\text{Concentration}) = f\left[\text{UI}^{1/4} + \log_{10}(\text{R}) + \text{K} + \text{WA}^{1/2} + \text{PERDUN} + \text{PRECIP}\right] \quad (1)$$

where

UI = atrazine-use intensity, or the annual agricultural use in a watershed in kilograms divided by the watershed area in square kilometers;

R = rainfall erosivity factor (R-factor) from Universal Soil Loss Equation (USLE);

K = soil erodibility factor (K-factor) from USLE;

WA = area of the watershed in square kilometers;

PERDUN = percentage of total stream flow derived from Dunne overland flow; and

PRECIP = total precipitation for May and June in millimeters.

Details about the application of the WARP model and coefficients for the model variables are included in *appendix 6*. The model was applied to other pesticides by substituting the use intensity of the pesticide of interest and adjusting the predicted concentrations by using physical-chemical properties of that pesticide, as described in detail in *appendix 6*. Briefly, multi-compound adjustment factors incorporate physical-chemical properties of a pesticide compound—soil degradation half-life, $K_{oc}$, and vapor pressure—that indicate the degree to which the compound is more or less mobile in surface water than atrazine, and adjusts the predicted concentration for that compound accordingly. The physical-chemical property values used in the model are listed in *appendix 1*. Pesticide compounds for which individual physical-chemical properties were unavailable had the properties of atrazine substituted in the adjustment factor; this provides a conservative estimate of concentrations for most other pesticides because atrazine is relatively water soluble, mobile, and persistent in the environment (Gilliom and others, 2006). Recent (2007) agricultural pesticide-use intensity estimates for 331 pesticides (unpublished proprietary data from GfK Kynetec) were used, and, as a worst-case approximation, use estimates for parent compounds were applied to an additional 111 degradation products. These degradates primarily were current analytes in USGS analytical methods and do not represent all possible degradates of the agricultural pesticides evaluated.

Predicted concentration statistics, specifically the 95th percentile and annual mean, in up to more than 62,000 individual stream reaches, depending on the area of pesticide use, were estimated for a total of 442 pesticides and degradates. For each compound, the maximum of the 95th percentile and the maximum of the annual mean concentrations among stream reaches were used to determine aquatic-life and human-health BQs, respectively. The resulting BQ values were used to identify current-use pesticides and degradates that have the potential to occur in streams at concentrations approaching threshold concentrations relevant to aquatic life or human health.

### Detection Frequency in Streams

In addition to screening BQ values, NAWQA detection frequency data for 218 pesticide compounds analyzed in up to 101 agricultural and 51 urban stream sites during 1993–2006 were evaluated (*fig. 2* and *appendix 7*). Detection frequencies of pesticide compounds at individual stream sites were calculated, then pooled by land-use group, to give an overall mean detection frequency for each land-use group, agricultural or urban, that is site-weighted. A minimum of 12 samples per stream site were required to be included in the detection frequency calculations. This screening identified pesticide compounds that were detected frequently—these were placed in Tier 1 even though they have no aquatic-life or human-health benchmarks available or occurred at concentrations below the 0.01 BQ threshold for placement in Tier 1.

## Groundwater

The evaluation of pesticide compounds using measured and predicted pesticide concentrations in groundwater is illustrated in *figure 2*. Determination of measured and predicted pesticide-concentration statistics is described in the following sections. The 99th percentile concentrations were divided by human-health benchmarks, when available, to calculate BQs. The 99th percentile concentration was chosen as a conservative statistic for groundwater concentrations without using the maximum concentration among all wells sampled, which could include high-concentration outliers. Measured pesticide detection frequency in groundwater also was evaluated.

## Measured Concentrations in Groundwater

Concentration data for 83 pesticide compounds sampled in groundwater networks for previous NAWQA water-quality monitoring studies during 1993–2003 were evaluated; these data are summarized in *appendix 8*. Pesticide-concentration statistics were determined for agricultural (920 to 1,406 wells, depending on the pesticide), urban (607 to 856 wells), and mixed (1,446 to 2,732 wells) land-use wells, and the 99th percentile concentration for each pesticide in each land use was compared to human-health benchmarks, when available. The resulting BQs were used to identify compounds that historically have been detected in groundwater at concentrations approaching threshold concentrations that are potentially relevant to human health.

## Predicted Concentrations in Groundwater

A regression model for predicting atrazine occurrence in shallow agricultural groundwater across the United States (Stackelberg and others, 2006) was modified to predict the summed concentration of atrazine and deethylatrazine (Paul Stackelberg, U.S. Geological Survey written commun., 2011). Model variables were selected to represent the environmental setting, agricultural management practices, and atrazine-use intensity. The modified model was used to predict concentrations of other current-use non-atrazine pesticide compounds by substituting recent (2007) agricultural pesticide-use intensity estimates for 331 pesticides in the present study (unpublished proprietary data from GfK Kynetec). The groundwater model has the form of equation 2:

$$\log_{10}(\text{Concentration}) = -3.00 + 0.46(use9200)^{1/3} - 0.1(artdrn)^{1/3} + 0.15(wtdep) + 0.04(artdrn^{1/3} \cdot wtdep) + 0.23(permin)^{1/3} + 0.62(\log_{10}(1 + rech\arg e)) - 0.05(airtemp) \quad (2)$$

where

*use*9200 = the intensity, in kilograms per square kilometer, of atrazine applications for agricultural purposes in 500-meter radial areas around each sampled well. Atrazine-use estimates were based on unpublished proprietary-use data obtained from DMRKYNETEC, Inc. (Thelin and Stone, 2010); *use*9200 represents the average reported use for the years 1992–2000.

*artdrn* = the percentage of 1-square kilometer grid cells with subsurface drains and graded ditches as represented by conservation practices CP606, CP607, and/or CP608 (U.S. Natural Resources Conservation Service, 1995).

*wtdep* = depth the seasonally high water table in meters (Natural Resources Conservation Service, 1994).

*permin* = permeability of the least permeable soils layer in centimeters per hour (U.S. Natural Resources Conservation Service, 1994).

*recharge* = mean annual groundwater recharge in centimeters per year, estimated from a base-flow analysis and mean annual runoff as described in Wolock (2003) and modified to include groundwater withdrawn for irrigation purposes (Karen Burow, U.S. Geological Survey, written commun., May 2009).

*airtemp* = mean annual air temperature during 1980–97 in degrees C (Thornton, 2003).

Details about the development and application of the groundwater model are included in *appendix 9*. A multi-compound model with adjustment factors for non-atrazine pesticides, like that used for streams, has not yet been developed for groundwater, but this method provided a conservative estimate of future pesticide concentrations in groundwater by assuming that all pesticides behave in the environment as atrazine does. The 99th percentile predicted concentration for each compound was divided by the human-health benchmark for the compound, when available, to calculate a BQ. The resulting BQs were used to identify current-use pesticide compounds that have the potential to occur in groundwater at concentrations approaching those relevant to human health.

### Detection Frequency in Groundwater

Pesticide detection frequencies were evaluated for 216 pesticide compounds analyzed in up to 59 agricultural and 34 urban groundwater networks monitored by NAWQA during 1993–2006 (*appendix 7*). Detection frequencies of pesticide compounds in individual wells were pooled by network, and a mean detection frequency was calculated for each network; then networks were pooled by land-use group to give an overall mean detection frequency for the agricultural or urban land-use group that is site- and network-weighted. A minimum of 12 wells per network were required to be included in the detection frequency calculations. As with streams, this screening step identified pesticide compounds that have been detected frequently, that is greater than 10 percent, and places them in Tier 1—regardless of whether they have human-health benchmarks available or are below the 0.01 BQ threshold.

### Other Factors

In a final screening step, pesticide compounds were evaluated on the basis of other priorities relevant to aquatic life or human health (*fig. 2*). Pesticide compounds that did not meet the prioritization criteria for Tier 1, but were determined to be a priority to another agency or organization were assigned to Tier 2; priorities are tabulated in *appendix 3*. Criteria for Tier 2 priorities include pesticide compounds characterized by the following:

- Have USEPA MCL values, but do not meet the criteria for Tier 1 (U.S. Environmental Protection Agency, 2009d).
- Are on USEPA's Contaminant Candidate List 3 (U.S. Environmental Protection Agency, 2009c).
- Have been included in USEPA's Unregulated Contaminant Monitoring (UCM) program on the UCM Regulation (UCMR) 1 or UCMR 2 list (U.S. Environmental Protection Agency, 2006).
- Are on the Association of American Pesticide Control Officials (AAPCO), State FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research and Evaluation Group's (SFIREG) State List of Pesticides of Water Quality Concern (Association of American Pesticide Control Officials, 2005).
- Have USEPA National Recommended Water Quality Criteria for the protection of aquatic life, but do not meet the criteria for Tier 1 (U.S. Environmental Protection Agency, 2002).
- Have specific objectives for aquatic life from the Great Lakes Water Quality Agreement (U.S. Environmental Protection Agency, 1978).
- Have Canadian water-quality guidelines for aquatic-life (Canadian Council of Ministers of the Environment, 2007).
- Have recent (1997–2008) active ingredient registration with the USEPA (U.S. Environmental Protection Agency, 2009b).

### Pesticide Degradates

When possible, pesticide degradates were evaluated in the same manner as parent pesticide compounds, as described in the previous sections, "Surface Water" and "Groundwater." Degradates primarily included those that are current analytes on USGS analytical methods, and they do not represent all possible degradates of the parent pesticides evaluated. Many degradates, however, lack information, such as toxicity or monitoring data, with which to assess their effects or occurrence. Therefore, pesticide degradates that were not prioritized as highly as parent compounds were elevated to the same priority as the parent as a final step to ensure that potentially important degradates were included (*fig. 2*).

## Sediment

A prioritization procedure for pesticide compounds in sediment was developed to incorporate measured occurrence data in stream and lake bed sediments, predicted likelihood of occurrence in sediments, potential toxicity to aquatic organisms, and pesticide use information. Pesticide compounds were further evaluated for their regulatory and non-regulatory importance to other agencies or organizations. The procedure for sediment was less quantitative than that for water because of the limited sediment monitoring data available and the lack of modeling tools. A schematic of the screening procedure for pesticide compounds in sediment is given in *figure 3*, and the pathways in the schematic are listed in *table 2*; details of the screening are described in the subsections that follow.

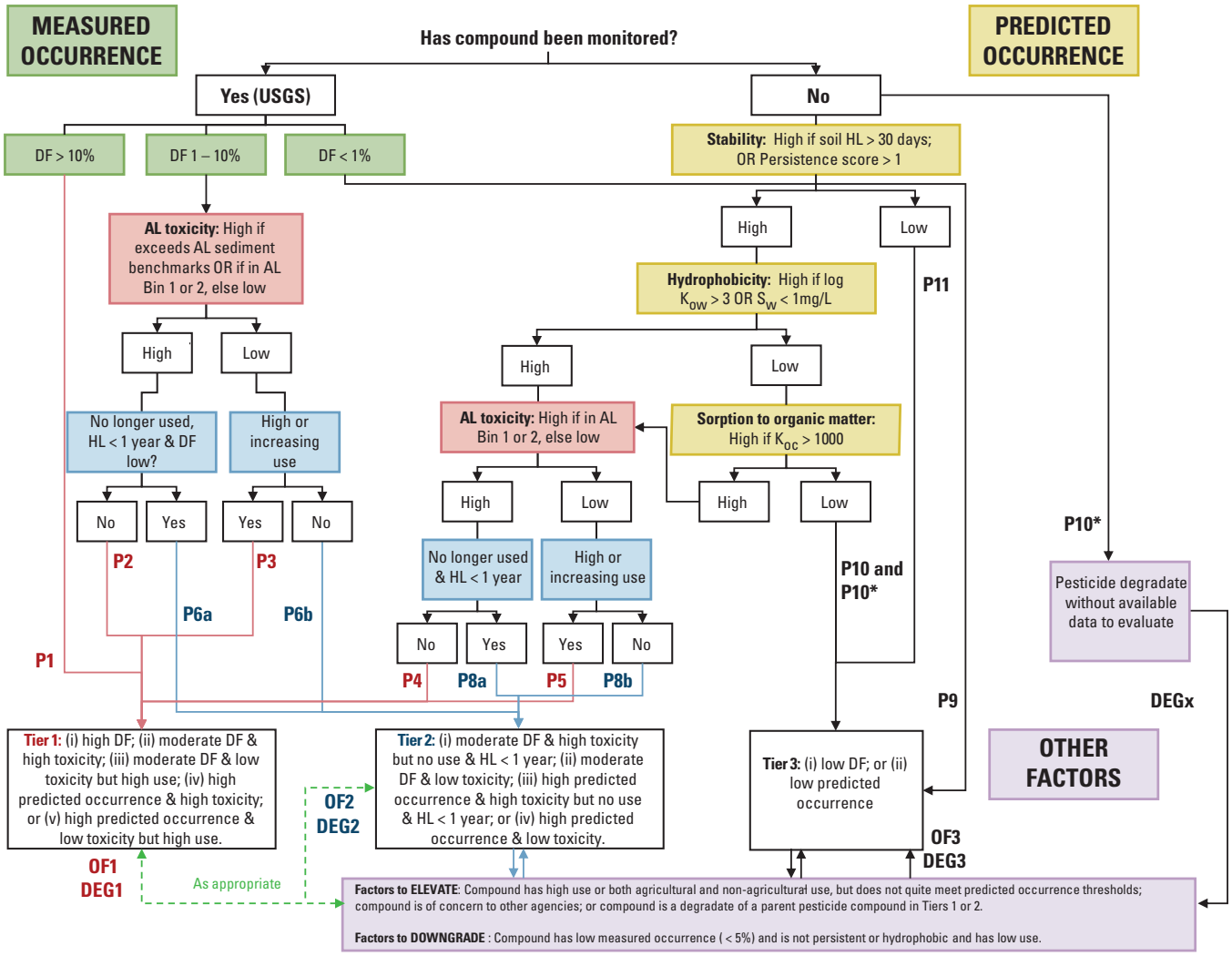



**Figure 3.** Flow chart for the evaluation of pesticides and degradates in sediment.

Explanation: AL, aquatic-life; AL Bin, AL toxicity bin; DEG, degradate; DF, detection frequency; HL, soil degradation half life; $K_{oc}$, soil organic carbon-water partition coefficient; $K_{ow}$, octanol-water partition coefficient; mg/L, milligrams per liter; OF, other factors to elevate or downgrade a pesticide compound to another tier; P, pathway; $S_w$, water solubility; >, greater than; <, less than; %, percent.

Detection frequencies of pesticide compounds in sediments from USGS monitoring studies were evaluated. A detection-frequency threshold of 10 percent was used to identify "frequently detected" compounds, which were included in Tier 1. Measured pesticide-concentration statistics also were compared to aquatic-life benchmarks for sediment, when available. The screening of measured occurrence data, in addition to the predicted likelihood of occurrence in sediments to determine priority compounds, balances the need to track trends with the need to include newer current-use pesticide compounds that could partition to, and accumulate in, sediments and that are potentially important but have not yet been characterized.

## Measured Sediment Occurrence

Measured occurrence data from three USGS sediment datasets, most of which were for organochlorine pesticides, were evaluated as follows:

1. NAWQA stream bed-sediment detection-frequency and concentration data for 34 organochlorine pesticides and degradates during 1992–2001 (*appendix 10*). Pesticides were analyzed in stream sites representing three land uses: agricultural, 176 to 242 samples, depending on the pesticide; urban, 71 to 125 samples; and mixed, 235 to 361 samples.

**Table 2.** Description of screening pathways for sediment.

[**Abbreviations:** AL, aquatic life; >, greater than; <, less than]

| Tier | Pathway number | Pathway description |
|---|---|---|
| 1 | P1 | Measured in >10 percent of samples in sediment datasets. |
| 1 | P2 | Measured in 1 to 10 percent of samples in sediment datasets; high toxicity to AL; and current use, or recent use and soil half-life >1 year. |
| 1 | P3 | Measured in 1 to 10 percent of samples in sediment datasets; low or unknown toxicity to AL; and high or increasing use. |
| 1 | P4 | Predicted occurrence (persistent and hydrophobic or immobile); high toxicity to AL; and current use, or recent use and soil half-life >1 year. |
| 1 | P5 | Predicted occurrence (persistent and hydrophobic or immobile); low or unknown toxicity to AL; and high or increasing use. |
| 1 | OF1 | Compound elevated to Tier 1 from lower Tier because of other factors. |
| 1 | DEG1 | Pesticide degradate placed in Tier 1 with parent because of lack of information to evaluate on its own. |
| 2 | P6a | Measured in 1 to 10 percent of samples in sediment datasets; high toxicity to AL; no longer in use, soil half-life <1 year, and low-detection frequency (<5 percent). |
| 2 | P6b | Measured in 1 to 10 percent of samples in sediment datasets; low or unknown toxicity to AL; use is not high or increasing. |
| 2 | P8a | Predicted occurrence (persistent and hydrophobic or immobile); high toxicity to AL; no longer in use and soil half-life <1 year. |
| 2 | P8b | Predicted occurrence (persistent and hydrophobic or immobile); low or unknown toxicity to AL; use is not high or increasing. |
| 2 | OF2 | Compound elevated to Tier 2 from Tier 3 or downgraded from Tier 1 to Tier 2 because of other factors. |
| 2 | DEG2 | Pesticide degradate placed in Tier 2 with parent because of lack of information to evaluate on its own. |
| 3 | P9 | Measured in <1 percent of samples in sediment datasets. |
| 3 | P10 | Predicted occurrence (persistent, but not hydrophobic); mobile. |
| 3 | P10* | Predicted occurrence (persistence unknown, but not hydrophobic); mobile. |
| 3 | P11 | Predicted occurrence (not persistent). |
| 3 | OF3 | Compound downgraded to Tier 3 because of other factors. |
| 3 | DEG3 | Pesticide degradate placed in Tier 3 with parent because of lack of information to evaluate on its own. |

2. NAWQA lake core detection-frequency data for 14 organochlorine pesticides and degradates sampled during 1994–2001 (*appendix 11*). Pesticides were analyzed in up to 155 core samples collected from 40 urban and reference lakes around the U.S. Core samples represent lake sediments deposited after 1990 (1990 to 2001). Two to seven samples were analyzed from each of 15 dense urban (greater than 50 percent urban land use) lake sites; two to eight samples were analyzed from each of 17 light urban (about 8–50 percent urban land use) sites; and one to five samples were analyzed from each of eight reference (less than 2 percent urban and no agricultural land use) sites (Van Metre and Mahler, 2005).

3. USGS Toxics Program stream bed- and suspended-sediment detection-frequency data for 74 legacy and current-use pesticides and degradates monitored during 2001–08 (*appendix 12*). Pesticide compounds were analyzed in a total of 287 samples, with the number of samples for any individual pesticide compound ranging from 21 to 274. Samples were collected from 67 stream sites in targeted agricultural studies in California, which included 104 bed-sediment samples and 85 suspended-sediment samples. A total of 98 bed-sediment samples were collected from urban streams in seven states across the U.S., with 12 to 21 samples per site.

Pesticides in these datasets were screened by comparison to occurrence thresholds, as illustrated in *figure 3*. Frequently detected compounds, those with a detection frequency of greater than 10 percent, were categorized as high priority, or Tier 1, for sediment by pathway P1 (*fig. 3* and *table 2*). Infrequently detected compounds, those with a detection frequency of less than 1 percent, were categorized in the lowest

priority group, Tier 3, by pathway P9 (*fig. 3* and *table 2*), unless subsequently elevated by other factors. Compounds of moderate occurrence, with a detection frequency of 1 to 10 percent, were further screened for (1) exceedance of sediment benchmarks for aquatic life, when available, or potential toxicity to aquatic life; (2) pesticide use, both agricultural and non-agricultural; and (3) other factors to place them into Tier 1 or 2. These factors used in the screening process are further described in the subsections that follow. Pesticide compounds in the low end of the moderate occurrence range (for example, detection frequency of 1 to 4 percent) were placed in Tier 2 if physical-chemical properties indicated they were unlikely to be present in sediments.

### Predicted Likelihood of Occurrence in Sediment

Pesticide and degradate compounds were evaluated for predicted likelihood of occurrence in sediments on the basis of three parameters: (1) stability, (2) hydrophobicity, and (3) tendency to sorb to sediment organic matter despite a low log $K_{ow}$ (*fig. 3*). The specific physical-chemical properties and thresholds used to evaluate these parameters are summarized in *table 3*. The sources and selection of physical-chemical property data were described earlier in the "Methods" section under the subheading "Physical-Chemical Properties," and the specific values and sources used for the sediment evaluation are tabulated in *appendix 1*.

Pesticide compounds that are both stable and hydrophobic, or stable with a high tendency to sorb to soil organic matter, as defined by the thresholds in *table 3*, were further evaluated for potential toxicity to aquatic life and pesticide use (described in the following sections) in the same manner as the compounds with moderate measured detection frequency (*fig. 3*). Pesticide compounds that did not meet the stability criterion were placed in Tier 3 by pathway P11 (*fig. 3* and *table 2*), and compounds that did not meet at least one of the criteria for hydrophobicity or sorption to organic matter were placed in Tier 3 by pathway P10 (*fig. 3* and *table 2*) on the basis that both persistence and hydrophobicity, or sorption, are needed for a compound to accumulate in sediment.

### Aquatic Toxicity

Pesticide compounds with moderate measured detection frequency, 1 to 10 percent, were evaluated for potential aquatic toxicity by considering (1) whether measured concentrations exceeded sediment benchmarks, if available, and (2) AL Toxicity Bins (*fig. 3*). A pesticide compound was considered to have high aquatic toxicity if it met one or both of the following criteria: (1) more than 5 percent of samples exceeded the upper screening value sediment benchmark, or (2) the pesticide was in AL Toxicity Bins 1 or 2. These thresholds and criteria were consistent with those used for the evaluation of other, non-pesticide, lipophilic organics in sediment (Lisa D. Olsen, U.S. Geological Survey, written commun., 2010).

Pesticide compounds that were predicted to occur in sediment (that is, met thresholds for stability and either hydrophobicity or soil sorption) also were considered to have high aquatic toxicity if they were in AL Toxicity Bins 1 or 2 (*fig. 3*). Compounds with high or low aquatic toxicity were further evaluated for pesticide use and other criteria for placement in Tier 1 or 2, as described in the following section.

### Pesticide Use and Additional Screening Criteria

Compounds with high aquatic toxicity were placed in Tier 1 (pathway P2 or P4, *fig. 3* and *table 2*), unless they are no longer in use, have a soil half-life of less than a year, and, for compounds with measured occurrence data, were detected fairly infrequently, that is, in the 1–4 percent range, in which case they were placed in Tier 2 by pathways P6a or P8a (*fig. 3* and *table 2*).

**Table 3.** Physical-chemical properties and thresholds used to predict likelihood for occurrence in sediments.

[**Abbreviations:** $K_{oc}$, soil organic carbon-water partition coefficient; $K_{ow}$, octanol-water partitioning coefficient; mL/g, milliliters per gram; mg/L, milligrams per liter; <, less than; >, greater than; –, none]

| Parameter | Physical-chemical property (units or value) | Threshold | Notes |
|---|---|---|---|
| Stability | Aerobic soil degradation half-life (days) | >30 | Highest lab or field value. |
| | or | | |
| | Persistence score (1, 2, or 3) | >1 | Limited usage for compounds lacking half-life values. |
| Hydrophobicity | log $K_{ow}$ | >3 | – |
| | or | | |
| | Water solubility (mg/L) | <1 | – |
| Sorption to organic matter | $K_{oc}$ (mL/g) | >1,000 | – |

Compounds with low aquatic toxicity, that is, in AL Toxicity Bin 3 or having no toxicity information available, were placed in Tier 2 by pathways P6b or P8b (*fig. 3* and *table 2*), unless they had high (top 10 percent of compounds in use volume) or increasing pesticide use. These use criteria for compounds with low aquatic toxicity only applied to two pesticide compounds that were classified as Tier 1 by pathway P5 (*fig. 3* and *table 2*). Conceptually, the flow chart allows for compounds with moderate detection frequency that meet these criteria to be placed in Tier 1 by pathway P3 (*fig. 3* and *table 2*); however, in this study, no compounds met all of these criteria.

### Other Factors

Priorities of other agencies or organizations were considered in the screening approach as "other factors" by which a compound could be elevated from a lower Tier (*fig. 3*). These priorities include the following:

- Presence on the AAPCO, SFIREG State List of Pesticides of Water Quality Concern (Association of American Pesticide Control Officials, 2005).
- Presence on the USEPA's Toxics Release Inventory Persistent Bioaccumulative and Toxic list (U.S. Environmental Protection Agency, 2009f).
- Presence on the USEPA Great Lakes Initiative list of bioaccumulative chemicals of concern in the Great Lakes (U.S. Environmental Protection Agency, 2000b).
- Presence on the USEPA list of High Production Volume chemicals (U.S. Environmental Protection Agency, 2005).

Additional factors elevated the priority of some pesticides that were not expected to be very persistent in sediments, especially those that are very toxic. Factors such as high pesticide use, or use in both agricultural and non-agricultural settings, were considered for compounds that are moderately hydrophobic (log $K_{ow}$ >2.8) but not very persistent. Such compounds can exhibit prolonged, semi-continuous, or steady-state, concentrations in sediments due to high or frequent usage, yet according to the predicted occurrence thresholds in the screening (*fig. 3*), they would fall into Tier 3. Further, some compounds that were detected very infrequently (less than 1 percent), but are persistent and hydrophobic according to the predicted occurrence thresholds, were elevated from Tier 3. In contrast, some compounds were downgraded in priority because of other factors, such as those with moderate measured detection frequency of less than 5 percent in sediment that are not persistent or hydrophobic according to the predicted occurrence thresholds, have low use, and are not expected to occur widely. These extenuating factors that elevate or downgrade compounds between Tiers are represented by pathways OF1, OF2, and OF3 in *figure 3* and *table 2*.

### Pesticide Degradates

Pesticide degradates that could not be evaluated by the screening procedure because of lack of data were placed in the same tier as their parent compound by pathways DEG1, DEG2, or DEG3 (*fig. 3* and *table 2*). Degradates that were evaluated on the basis of their own data and that were categorized in a lower tier than their parent compound (for example, were not predicted to be persistent and hydrophobic) also were re-evaluated to determine if other factors indicated that they should be elevated to the same tier as their parent compound.

# Results and Discussion

The evaluation of pesticide compounds for analytical methods development priority resulted in classification of compounds into three priority tiers each for water and sediment. The results for water and sediment are presented separately.

## Water

### Priority Pesticide Compounds for Water

Of the 619 pesticide compounds evaluated, a total of 247 (40 percent) were placed in Tier 1 and are high priority for inclusion in analytical methods available for monitoring and studies. About three-quarters of these, or 184 compounds, are presently included in some USGS analytical method; however, many of these compounds are analyzed by one of several research methods that are expensive and for which there are few data on environmental samples. The large number of analytical methods involved to cover all Tier 1 compounds, the high individual costs of operation, and the various stages of development, make cost-effective application of all the methods impractical. The remaining quarter, or 63 compounds, of which 25 are degradates, are not currently analyzed by USGS laboratories and are high priority as new analytes. The objective for development of analytical methods is to design an integrated analytical strategy that includes as many of the Tier 1 pesticide compounds as possible in a few, relatively cost-effective methods. The Tier 1 compounds are listed in *table 4*, along with their respective reasons for high-priority status. *Table 4* also includes selected Tier 2 compounds that have regulatory relevance for drinking water (that is, they have USEPA MCLs or are on the CCL3). Depending on program objectives, the regulatory status of these Tier 2 compounds potentially elevates their priority, such that they could be included in analytical methods if space and analytical compatibility allow.

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tier 1 | | | | | |
| 1,3-Dicarbamoyl-2,4,5,6-tetrachloro-benzene | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | – | Yes | – | – | DEG |
| 1,3-Dichloropropene | 542-75-6 | Fumigant | – | Halogenated organic | 29,194,056 | Yes | AL, Pred SW; HH, Pred SW; HH, Pred GW | – | – |
| 1-Carbamoyl-3-cyano-4-hydroxy-2,5,6-trichlorobenzene | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | – | Yes | – | – | DEG |
| 1-Naphthol | 90-15-3 | Degradate | Carbaryl, napropamide | Phenol | – | Yes | – | SW–UR | – |
| 2-(4-*tert*-butylphenoxy)-Cyclohexanol | 1942-71-8 | Degradate | Propargite | Aliphatic alcohol | – | No | – | SW–AG | – |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 94-75-7 | Herbicide | – | Chlorophenoxy acid | 27,436,879 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG; SW–UR | – |
| 2,4-D methyl ester | 1928-38-7 | Herbicide | – | Chlorophenoxy acid ester | – | Yes | – | SW–AG | – |
| 2,6-Diethylaniline | 579-66-8 | Degradate | Alachlor | Aniline | – | Yes | – | – | DEG |
| 2-[(2-Ethyl-6-methylphenyl)amino]-1-propanol | 61520-53-4 | Degradate | Metolachlor | Aniline | – | No | – | – | DEG |
| 2-Amino-*N*-isopropylbenzamide | 30391-89-0 | Degradate | Bentazon | Amide | – | No | AL, Pred SW | – | – |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | Degradate | Alachlor | Acetanilide degradate | – | Yes | – | – | DEG |
| 2-Chloro-*N*-(2-ethy l-6-methylphenyl)acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | Degradate | Acetochlor, metolachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| 2-Ethyl-6-methylaniline | 24549-06-2 | Degradate | Metolachlor | Aniline | – | Yes | AL, Pred SW | – | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| 2-Hydroxyatrazine | 2163-68-0 | Degradate | Atrazine | Triazine | – | Yes | HH, Pred SW | SW–AG; SW–UR; GW–AG; GW–UR | – |
| 3-(Trifluoromethyl)aniline | 98-16-8 | Degradate | Fluometuron | Aniline | – | Yes | – | – | DEG |
| 3-(Trifluoromethyl)phenylurea | 13114-87-9 | Degradate | Fluometuron | Phenylurea | – | Yes | – | – | DEG |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | Diuron | Aniline | – | Yes | AL, Pred SW | SW–AG; SW–UR | – |
| 3,4-Dichloromethyphenylurea | 3567-62-2 | Degradate | Diuron | Urea | – | Yes | AL, Pred SW | – | – |
| 3,4-Dichlorophenylurea | 2327-02-8 | Degradate | Diuron | Urea | – | Yes | AL, Pred SW | – | – |
| 3,5-Dichloroaniline | 626-43-7 | Degradate | Iprodione | Aniline | – | Yes | AL, Pred SW | – | – |
| 3-Hydroxycarbofuran | 16655-82-6 | Degradate | Carbofuran | Carbamate | – | Yes | – | – | DEG |
| 3-Ketocarbofuran | 16709-30-1 | Degradate | Carbofuran | Carbamate | – | No | – | – | DEG |
| 3-Phenoxybenzoic acid | 3739-38-6 | Degradate | Cypermethrin (and other pyrethroids) | Benzoic acid | – | No | – | – | DEG |
| 4-(Hydroxymethyl)pendimethalin | 56750-76-6 | Degradate | Pendimethalin | Dinitroaniline | – | No | – | – | DEG |
| 4,4′-Dichlorobenzophenone | 90-98-2 | Degradate | DDT, dicofol | Organochlorine | – | No | – | – | DEG |
| 4-Chloro-2-methylphenol | 1570-64-5 | Degradate | MCPA | Chlorinated phenol | – | Yes | – | SW–UR | – |
| 4-Chlorobenzylmethyl sulfone | 98-57-7 | Degradate | Thiobencarb | Thiocarbamate degradate–sulfone | – | No | – | – | DEG |
| 4-Hydroxy-2,5,6-trichloro isophthalonitrile | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | – | Yes | – | – | DEG |
| Acephate | 30560-19-1 | Insecticide | – | Organophosphate | 3,467,587 | No | AL, Pred SW | – | – |
| Acetochlor | 34256-82-1 | Herbicide | – | Chloroacetanilide | 30,471,562 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW; HH, Pred GW | SW–AG | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Acetochlor ethane sulfonic acid (ESA) | 187022-11-3 | Degradate | Acetochlor | Acetanilide degradate–sulfonic acid | – | Yes | – | SW–AG | – |
| Acetochlor oxanilic acid (OA) | 184992-44-4 | Degradate | Acetochlor | Acetanilide degradate–OA | – | Yes | – | SW–AG | – |
| Acetochlor sulfynilacetic acid (SAA) | NAV | Degradate | Acetochlor | Acetanilide degradate–sulfynilacetic acid | – | Yes | – | SW–AG | – |
| Acetochlor/Metolachlor ESA, secondary amide | NAV | Degradate | Acetochlor, metolachlor | Acetanilide degradate–sulfonic acid secondary amide | – | Yes | – | W–AG | – |
| Alachlor | 15972-60-8 | Herbicide | – | Chloroacetanilide | 1,923,064 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG | – |
| Alachlor ESA, secondary amide | NAV | Degradate | Alachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| Alachlor ESA | 142363-53-9 | Degradate | Alachlor | Acetanilide degradate–sulfonic acid | – | Yes | – | SW–AG; GW–AG; GW–UR | – |
| Alachlor OA | 171262-17-2 | Degradate | Alachlor | Acetanilide degradate–OA | – | Yes | – | SW–AG | – |
| Alachlor SAA | 140939-16-8 | Degradate | Alachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| Aldicarb | 116-06-3 | Insecticide | – | Carbamate | 3,926,761 | Yes | AL, Pred SW; HH, Pred SW | – | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Aldicarb sulfone | 1646-88-4 | Degradate | Aldicarb | Carbamate degradate–sulfone | – | Yes | HH, Pred SW | – | – |
| Aldicarb sulfoxide | 1646-87-3 | Degradate | Aldicarb | Carbamate degradate – sulfoxide | – | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | – | – |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | – | Yes | HH, Pred SW | – | – |
| Ametryn | 834-12-8 | Herbicide | – | Triazine | 209,834 | Yes | AL, Pred SW | – | – |
| Aminomethylphosphonic acid | 1066-51-9 | Degradate | Glyphosate | Degradate of amino acid derivative | – | Yes | – | SW–AG; SW–UR | – |
| Asulam | 3337-71-1 | Herbicide | – | Carbamate | 602,898 | No | AL, Pred SW | – | – |
| Atrazine | 1912-24-9 | Herbicide | – | Triazine | 74,779,492 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW; HH, Pred GW; HH, Meas GW | SW–AG; SW–UR; GW–AG | – |
| Azinphos-methyl | 86-50-0 | Insecticide | – | Organophosphate | 680,052 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| Azinphos-methyl-oxon | 961-22-8 | Degradate | Azinphos methyl | Organothio-phosphate | – | Yes | – | – | DEG |
| Azoxystrobin | 131860-33-8 | Fungicide | – | Strobin | 751,757 | Yes | AL, Pred SW | – | – |
| Benfluralin | 1861-40-1 | Herbicide | – | Dinitroaniline | 64,560 | Yes | HH, Pred GW | – | – |
| Benomyl | 17804-35-2 | Fungicide | – | Benzimidazole | 2,894 | Yes | AL, Pred SW | SW–AG; SW–UR | – |
| Bentazon | 25057-89-0 | Herbicide | – | *N*–heterocycle, thiadiazine | 974,909 | Yes | – | SW–AG | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | – | No | HH, Pred SW | – | – |
| Bifenazate | 149877-41-8 | Insecticide | – | NAV | 133,908 | No | AL, Pred SW | – | – |
| Bifenthrin | 82657-04-3 | Insecticide | – | Pyrethroid | 201,291 | Yes | AL, Pred SW | – | – |
| Bromacil | 314-40-9 | Herbicide | – | Uracil | 312,782 | Yes | AL, Pred SW; AL, Meas SW; HH, Meas GW | – | – |
| Bromomethane | 74-83-9 | Fumigant/ adjuvant | – | Halogenated organic | 12,881,246 | Yes | AL, Pred SW | – | – |
| Bromoxynil | 1689-84-5 | Herbicide | – | Nitrile | 1,939,558 | Yes | AL, Meas SW | – | – |
| Butralin | 33629-47-9 | Herbicide | – | Dinitroaniline | 27,490 | No | AL, Pred SW | – | – |
| Carbaryl | 63-25-2 | Insecticide | – | Carbamate | 1,055,991 | Yes | AL, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG; SW–UR | – |
| Carbofuran | 1563-66-2 | Insecticide | – | Carbamate | 460,844 | Yes | AL, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG | – |
| Chlorimuron-ethyl | 90982-32-4 | Herbicide | – | Sulfonylurea | 60,666 | Yes | – | SW–AG | – |
| Chloropicrin | 76-06-2 | Fumigant/ nematocide | – | NAV | 9,912,427 | No | AL, Pred SW | – | – |
| Chlorothalonil | 1897-45-6 | Fungicide | – | Polychlorinated aromatic | 8,024,737 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | – | – |
| Chlorpyrifos | 2921-88-2 | Insecticide | – | Organothio-phosphate | 7,521,292 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG; SW–UR | – |
| Chlorpyrifos oxygen analog | 5598-15-2 | Degradate | Chlorpyrifos | Organophosphate | – | Yes | AL, Pred SW | – | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tier 1–Continued | | | | | |
| Chlorsulfuron | 64902-72-3 | Herbicide | – | Sulfonylurea | 79,869 | No | AL, Pred SW | – | – |
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | c61898-95-1 | Degradate | Cyfluthrin | Aliphatic acid ester | – | No | – | – | DEG |
| *cis*-Permethrin | 61949-76-6 | Insecticide | – | Pyrethroid | – | Yes | AL, Meas SW | – | – |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | – | Conazole | – | Yes | – | SW–AG; SW–UR | – |
| Copper | 7440-50-8 | Fungicide | – | Inorganic | 1,092,516 | Yes | AL, Pred SW | – | – |
| Cyanazine | 21725-46-2 | Herbicide | – | Triazine | 195 | Yes | AL, Meas SW; HH, Meas SW | SW–AG | – |
| Cyanazine acid | NAV | Degradate | Cyanazine | Triazine | – | Yes | – | – | DEG |
| Cyanazine amide | NAV | Degradate | Cyanazine | Triazine | – | Yes | – | SW–AG | – |
| Cyfluthrin | 68359-37-5 | Insecticide | – | Pyrethroid | 119,554 | Yes | AL, Pred SW | – | – |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | – | Pyrethroid | 251,159 | Yes | AL, Pred SW | – | – |
| *gamma*-Cyhalothrin [2] | 76703-62-3 | Insecticide | – | Pyrethroid | 5,115 | No | same as Cyhalothrin | – | – |
| Cypermethrin | 52315-07-8 | Insecticide | – | Pyrethroid | 76,479 | Yes | AL, Pred SW | – | – |
| *zeta*-Cypermethrin [2] | 69865-47-0 | Insecticide | – | Pyrethroid | 101,250 | No | same as Cyper-methrin | – | – |
| Dacthal | 1861-32-1 | Herbicide | – | Chlorobenzoic acid ester | 494,247 | Yes | HH, Meas SW | SW–AG; SW–UR | – |
| Dacthal monoacid | 887-54-7 | Degradate | Dacthal | Chlorobenzoic acid ester | – | Yes | – | – | DEG |
| Dechloroacetochlor | NAV | Degradate | Acetochlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| Dechloroalachlor | NAV | Degradate | Alachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| Dechlorodimethenamid | NAV | Degradate | Dimethenamid | Amide degradate | – | Yes | – | – | DEG |
| Dechlorometolachlor | NAV | Degradate | Metolachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Deethylatrazine | 6190-65-4 | Degradate | Atrazine | Triazine | – | Yes | AL, Pred SW; HH, Pred SW; HH, Meas SW; HH, Meas GW | SW–AG; SW–UR; GW–AG; GW–UR | – |
| Deethylcyanazine | NAV | Degradate | Cyanazine | Triazine | – | Yes | – | – | DEG |
| Deethylcyanazine acid | NAV | Degradate | Cyanazine | Triazine | – | Yes | – | – | DEG |
| Deethylcyanazine amide | NAV | Degradate | Cyanazine | Triazine | – | Yes | – | – | DEG |
| Deethylhydroxyatrazine | NAV | Degradate | Atrazine | Triazine | – | Yes | HH, Pred SW | – | – |
| Deisopropyl prometryn | NAV | Degradate | Prometryn | Triazine | – | Yes | – | – | DEG |
| Deisopropylatrazine | 1007-28-9 | Degradate | Atrazine | Triazine | – | Yes | HH, Pred SW | SW–AG; SW–UR; GW–AG; GW–UR | – |
| Deisopropylhydroxyatrazine | 7313-54-4 | Degradate | Atrazine | Triazine | – | Yes | AL, Pred SW; AL, Meas SW | – | – |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | – | No | – | – | DEG |
| Deltamethrin | 52918-63-5 | Insecticide | – | Pyrethroid | 2,835 | Yes | AL, Pred SW | – | – |
| Demethyl fluometuron | NAV | Degradate | Fluometuron | Urea | – | Yes | – | SW–AG; GW–AG | – |
| Demethyl norflurazon | NAV | Degradate | Norflurazon | Pyridazinone | – | Yes | – | SW–AG; GW–AG | – |
| Desulfinylfipronil (MB46513) | NAV | Degradate | Fipronil | Phenylpyrazole degradate | – | Yes | – | SW–AG; SW–UR | – |
| Desulfinylfipronil amide (RPA 105048) | NAV | Degradate | Fipronil | Phenylpyrazole degradate | – | Yes | – | SW–UR | – |
| Diazinon | 333-41-5 | Insecticide | – | Organothio-phosphate | 639,789 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG; SW–UR | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Diazinon oxygen analog | 962-58-3 | Degradate | Diazinon | Organophosphate | – | Yes | – | – | DEG |
| Dicamba | 1918-00-9 | Herbicide | – | Chlorobenzoic acid | 2,658,259 | Yes | AL, Pred SW | – | – |
| Dichlobenil | 1194-65-6 | Herbicide | – | Nitrile | 1,293 | No | HH, Pred GW | – | – |
| Dichlorvos | 62-73-7 | Insecticide/ fumigant/ degradate | Naled | Organophosphate | – | Yes | – | – | DEG |
| Dicofol[3] | 115-32-2 | Insecticide | – | Organochlorine | 59,461 | No | AL, Pred SW | – | – |
| Dicrotophos | 141-66-2 | Insecticide | – | Organophosphate | 1,233,976 | Yes | AL, Pred SW; HH, Pred SW; HH, Pred GW | – | – |
| Didealkylatrazine | 3397-62-4 | Degradate | Atrazine | Triazine | – | Yes | – | SW–AG; SW–UR; GW–AG; GW–UR; | – |
| Dieldrin | 60-57-1 | Insecticide | – | Organochlorine | – | Yes | AL, Meas SW; HH, Meas SW; HH, Meas GW | – | – |
| Diflubenzuron | 35367-38-5 | Insecticide | – | Benzoylurea | 54,483 | No | AL, Pred SW | – | – |
| Diflufenzopyr | 109293-97-2 | Herbicide | – | Urea | 98,362 | No | AL, Pred SW | – | – |
| Dimethenamid | 87674-68-8 | Herbicide | – | Amide | 2,807,048 | Yes | – | SW–AG | – |
| Dimethenamid ESA | NAV | Degradate | Dimethenamid | Amide degradate–sulfonic acid | – | Yes | – | SW–AG | – |
| Dimethenamid OA | NAV | Degradate | Dimethenamid | Amide degradate–OA | – | Yes | – | – | DEG |
| Dimethenamid-P | 163515-14-8 | Herbicide | – | Amide | 1,826,288 | No | AL, Pred SW | – | – |
| Dimethoate | 60-51-5 | Insecticide | – | Organothio-phosphate | 721,316 | Yes | AL, Pred SW; HH, Pred SW | – | – |
| Diquat | 85-00-7 | Herbicide | – | Bipyridylium | 149,786 | No | AL, Pred SW | – | – |
| Disulfoton | 298-04-4 | Insecticide | – | Organothio-phosphate | 46,151 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | – | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Disulfoton sulfone | 2497-06-5 | Degradate | Disulfoton | Organothio-phosphate | – | Yes | AL, Pred SW | – | – |
| Disulfoton sulfoxide | 2497-07-6 | Degradate | Disulfoton | Organothio-phosphate | – | No | AL, Pred SW | – | – |
| Diuron | 330-54-1 | Herbicide | – | Urea | 2,996,333 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW; HH, Meas GW | SW–AG; SW–UR; GW–UR | – |
| Endosulfan | 115-29-7 | Insecticide | – | Organochlorine | 369,905 | Yes | AL, Pred SW | – | – |
| *alpha*-Endosulfan [2] | 959-98-8 | Insecticide | – | Organochlorine | – | Yes | same as Endosulfan | – | – |
| *beta*-Endosulfan [2] | 33213-65-9 | Insecticide | – | Organochlorine | – | Yes | same as Endosulfan | – | – |
| Endosulfan ether | 3369-52-6 | Degradate | Endosulfan | Organochlorine | – | No | – | – | DEG |
| Endosulfan sulfate | 1031-07-8 | Degradate | Endosulfan | Organochlorine | – | Yes | AL, Pred SW | – | – |
| Endothall [4] | 145-73-3 | Herbicide | – | Dicarboxylic acid | 3,514 | No | AL, Pred SW | – | – |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | – | Thiocarbamate | 1,936,651 | Yes | – | SW–AG | – |
| Esfenvalerate | 66230-04-4 | Insecticide | – | Pyrethroid | 157,969 | Yes | AL, Pred SW | – | – |
| Ethalfluralin | 55283-68-6 | Herbicide | – | Dinitroaniline | 1,251,215 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| Ethoprop | 13194-48-4 | Insecticide | – | Organothio-phosphate | 419,088 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | – | – |
| Etoxazole | 153233-91-1 | Insecticide | – | Diphenyl oxazoline | 19,131 | No | AL, Pred SW | – | – |
| Famoxadone | 131807-57-3 | Fungicide | – | Oxazolidinedione | 31,006 | Yes | AL, Pred SW | – | – |
| Fenamiphos | 22224-92-6 | Insecticide | – | Organophosphate | 72,035 | Yes | AL, Pred SW | – | – |
| Fenamiphos sulfone | 31972-44-8 | Degradate | Fenamiphos | Organophosphate | – | Yes | – | – | DEG |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Fenamiphos sulfoxide | 31972-43-7 | Degradate | Fenamiphos | Organophosphate | – | Yes | AL, Pred SW | – | – |
| Fenbutatin oxide | 13356-08-6 | Insecticide | – | Organotin | 167,625 | No | AL, Pred SW | – | – |
| Fenpropathrin | 39515-41-8 | Insecticide | – | Pyrethroid | 119,467 | Yes | AL, Pred SW | – | – |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/ herbicide | – | Organotin | 270,550 | No | AL, Pred SW | – | – |
| Fipronil | 120068-37-3 | Insecticide | – | Phenylpyrazole | 56,634 | Yes | AL, Pred SW | SW–AG; SW–UR | – |
| Fipronil sulfide | 120067-83-6 | Degradate | Fipronil | Phenylpyrazole degradate | – | Yes | – | SW–AG; SW–UR | – |
| Fipronil sulfone | 120068-36-2 | Degradate | Fipronil | Phenylpyrazole degradate | – | Yes | – | SW–AG; SW–UR | – |
| Flumetsulam | 98967-40-9 | Herbicide | – | Sulfonylurea | 127,340 | Yes | – | SW–AG | – |
| Flumiclorac[5] | 87546-18-7 | Herbicide | – | Phthalimide | 17,649 | No | AL, Pred SW | – | – |
| Fluometuron | 2164-17-2 | Herbicide | – | Urea | 504,361 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG | – |
| Fonofos | 944-22-9 | Insecticide | – | Organothio-phosphate | 0 | Yes | AL, Meas SW | – | – |
| Fonofos oxygen analog | 944-21-8 | Degradate | Fonofos | Organothio-phosphate | – | No | – | – | DEG |
| Formetanate hydrochloride | 23422-53-9 | Insecticide | – | Carbamate | 87,580 | No | AL, Pred SW | – | – |
| *gamma*-HCH | 58-89-9 | Insecticide | – | Organochlorine | 4,593 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Pred GW | – | – |
| Glyphosate | 1071-83-6 | Herbicide | – | Amino acid derivative | 180,075,000 | Yes | – | SW–AG; SW–UR | – |
| Halosulfuron-methyl | 100784-20-1 | Herbicide | – | Sulfonylurea | 28,675 | No | AL, Pred SW | – | – |
| Hexazinone | 51235-04-2 | Herbicide | – | Triazinedione | 287,895 | Yes | AL, Pred SW | SW–AG | – |
| Hydroxyacetochlor | 60090-47-3 | Degradate | Acetochlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Hydroxyalachlor | NAV | Degradate | Alachlor | Chloroacetanilide degradate | – | Yes | – | – | DEG |
| Hydroxydimethanamid | NAV | Degradate | Dimethenamid | Amide degradate | – | Yes | – | – | DEG |
| Hydroxymetolachlor | 131068-72-9 | Degradate | Metolachlor | Chloroacetanilide degradate | – | Yes | – | SW–AG | – |
| Hydroxysimazine | 2599-11-3 | Degradate | Simazine | Triazine | – | Yes | – | – | DEG |
| Imazamox | 114311-32-9 | Herbicide | – | Imidazolinone | 58,014 | No | AL, Pred SW | – | – |
| Imazaquin | 81335-37-7 | Herbicide | – | Imidazolinone | 41,370 | Yes | – | SW–AG; SW–UR | – |
| Imazethapyr | 81335-77-5 | Herbicide | – | Imidazolinone | 206,700 | Yes | – | SW–AG | – |
| Imidacloprid | 138261-41-3 | Insecticide | – | Neonicotinoid | 450,449 | Yes | AL, Pred SW | – | – |
| Indoxacarb | 173584-44-6 | Insecticide | – | Oxadiazine | 46,967 | No | AL, Pred SW | – | – |
| Iprodione | 36734-19-7 | Fungicide | – | Dicarboximide | 500,834 | Yes | HH, Pred SW | – | – |
| Isoxaflutole | 141112-29-0 | Herbicide | – | Isoxazole | 225,071 | Yes | AL, Pred SW | – | – |
| Kresoxim-methyl | 143390-89-0 | Fungicide | – | Strobin | 27,690 | Yes | AL, Pred SW | – | – |
| Linuron | 330-55-2 | Herbicide | – | Urea | 318,944 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| Malaoxon | 1634-78-2 | Degradate | Malathion | Organothio-phosphate | – | Yes | AL, Pred SW | – | – |
| Malathion | 121-75-5 | Insecticide | – | Organothio-phosphate | 949,590 | Yes | AL, Meas SW | SW–UR | – |
| Maneb | 12427-38-2 | Fungicide | – | Dithiocarbamate | 2,326,675 | No | AL, Pred SW | – | – |
| MBC (Carbendazim) | 10605-21-7 | Degradate | Thiophanate methyl | Benzimidazole | – | No | AL, Pred SW | – | – |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 94-74-6 | Herbicide | – | Chlorophenoxy acid | 2,967,715 | Yes | AL, Pred SW; HH, Pred SW | SW–UR | – |
| Metalaxyl | 57837-19-1 | Fungicide | – | Substituted dimethyl aniline | 4,834 | Yes | – | SW–AG | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tier 1–Continued | | | | | |
| Metam sodium | 137-42-8 | Fumigant/ herbicide/ fungicide/ microbiocide/ algaecide | – | Dithiocarbamate | 53,197,744 | No | AL, Pred SW | – | – |
| Metconazole | 125116-23-6 | Fungicide | – | Conazole | 1,189 | Yes | AL, Pred SW | – | – |
| Methamidophos | 10265-92-6 | Insecticide | – | Organothio-phosphate | 157,672 | No | AL, Pred SW | – | – |
| Methidathion | 950-37-8 | Insecticide | – | Organothio-phosphate | 29,175 | Yes | AL, Pred SW; HH, Pred SW | – | – |
| Methomyl | 16752-77-5 | Insecticide | – | Carbamate | 827,449 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| Methomyl-oxime | 13749-94-5 | Degradate | Methomyl | Carbamate degradate–oxime | – | No | – | – | DEG |
| Methoxychlor | 72-43-5 | Insecticide | – | Organochlorine | 4,210 | No | AL, Pred SW | – | – |
| Methoxyfenozide | 161050-58-4 | Insecticide | – | Diacylhydrazine | 215,540 | No | AL, Pred SW | – | – |
| Metolachlor | 51218-45-2 | Herbicide | – | Chloroacetanilide | 1,511,992 | Yes | AL, Pred SW; AL, Meas SW | SW–AG; SW–UR; GW–AG | – |
| Metolachlor ESA | 171118-09-5 | Degradate | Metolachlor | Acetanilide degradate–sulfonic acid | – | Yes | – | SW–AG; GW–AG; GW–UR | – |
| Metolachlor OA | 152019-73-3 | Degradate | Metolachlor | Acetanilide degradate–oxanilic acid | – | Yes | – | SW–AG; GW–AG; GW–UR | – |
| Metribuzin | 21087-64-9 | Herbicide | – | Triazinone | 1,373,567 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | SW–AG | – |
| Molinate | 2212-67-1 | Herbicide | – | Thiocarbamate | 424,051 | Yes | HH, Pred SW; AL, Meas SW; HH, Meas SW | SW–AG | – |
| Myclobutanil | 88671-89-0 | Fungicide | – | Conazole | 111,653 | Yes | – | SW–UR | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| Naled | 300-76-5 | Insecticide | – | Organophosphate | 88,574 | No | AL, Pred SW | – | – |
| Nicosulfuron | 111991-09-4 | Herbicide | – | Sulfonylurea | 103,804 | Yes | – | SW–AG | – |
| Norflurazon | 27314-13-2 | Herbicide | – | Pyridazinone | 487,515 | Yes | AL, Pred SW; AL, Meas SW; HH, Meas SW; HH, Meas GW | – | – |
| Novaluron | 116714-46-6 | Herbicide | – | Benzoylurea | 34,523 | No | AL, Pred SW | – | – |
| *O*-Ethyl-*O*-methyl-*S*-propylphosphorothioate | 76960-87-7 | Degradate | Ethoprop | Organothio-phosphate | – | No | – | – | DEG |
| Oryzalin | 19044-88-3 | Herbicide | – | Dinitroaniline | 1,929,462 | Yes | HH, Pred SW; AL, Meas SW | – | – |
| Oxamyl | 23135-22-0 | Insecticide | – | Carbamate | 815,705 | Yes | AL, Pred SW | – | – |
| Oxamyl oxime | 30558-43-1 | Degradate | Oxamyl | Carbamate degradate–oxime | – | No | AL, Pred SW | – | – |
| Oxyfluorfen | 42874-03-3 | Herbicide | – | Diphenyl ether | 1,154,914 | Yes | AL, Pred SW | – | – |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | Degradate | *p,p′*-DDT | Organochlorine | – | Yes | AL, Meas SW; HH, Meas SW; HH, Meas GW | – | – |
| Paraoxon-methyl | 950-35-6 | Degradate | Parathion-methyl | Organothio-phosphate | – | Yes | AL, Pred SW | – | – |
| Paraquat | 4685-14-7 | Herbicide | – | Bipyridylium | 2,949,751 | No | AL, Pred SW | – | – |
| Parathion-methyl | 298-00-0 | Insecticide | – | Organothio-phosphate | 576,944 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | – | – |
| Pendimethalin | 40487-42-1 | Herbicide | – | Dinitroaniline | 8,193,329 | Yes | AL, Pred SW; AL, Meas SW | SW–UR | – |
| Permethrin | 52645-53-1 | Insecticide | – | Pyrethroid | 287,998 | Yes | AL, Pred SW | – | – |
| Phorate | 298-02-2 | Insecticide | – | Organothio-phosphate | 1,023,804 | Yes | AL, Pred SW; HH, Pred SW | – | – |
| Phorate oxon | 2600-69-3 | Degradate | Phorate | Organothio-phosphate | – | Yes | – | – | DEG |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tier 1–Continued | | | | | |
| Phosmet | 732-11-6 | Insecticide | – | Organothio-phosphate | 1,230,014 | Yes | AL, Pred SW | – | – |
| Phosmet oxon | 3735-33-9 | Degradate | Phosmet | Organothio-phosphate | – | Yes | – | – | DEG |
| Piperonyl butoxide | 51-03-6 | Synergist | – | NAV | 38,808 | Yes | AL, Pred SW | – | – |
| Profenofos | 41198-08-7 | Insecticide | – | Organothio-phosphate | 21,737 | No | AL, Pred SW; HH, Pred SW; HH, Pred GW | – | – |
| Prometon | 1610-18-0 | Herbicide | – | Triazine | 0 | Yes | AL, Meas SW | SW–AG; SW–UR; GW–AG; GW–UR | – |
| Prometryn | 7287-19-6 | Herbicide | – | Triazine | 629,255 | Yes | AL, Pred SW | SW–AG | – |
| Pronamide | 23950-58-5 | Herbicide | – | Amide | 230,075 | Yes | HH, Pred SW; HH, Meas SW | – | – |
| Propanil | 709-98-8 | Herbicide | – | Acetanilide | 5,468,302 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW | – | – |
| Propargite | 2312-35-8 | Insecticide | – | Sulfite ester | 1,129,078 | Yes | HH, Pred SW; AL, Meas SW; HH, Meas SW | – | – |
| Propazine | 139-40-2 | Herbicide | – | Triazine | 70,014 | Yes | – | SW–AG | – |
| Propiconazole | 60207-90-1 | Fungicide | – | Conazole | 751,207 | Yes | AL, Pred SW | – | – |
| Propoxur | 114-26-1 | Insecticide | – | Carbamate | 0 | Yes | AL, Meas SW | – | – |
| Prosulfuron | 94125-34-5 | Herbicide | – | Sulfonylurea | 16,968 | No | AL, Pred SW | – | – |
| Pymetrozine | 123312-89-0 | Insecticide | – | Pyridine azomethines | 8,152 | No | AL, Pred SW | – | – |
| Pyraclostrobin | 175013-18-0 | Fungicide | – | Strobin | 1,430,693 | Yes | AL, Pred SW | – | – |
| Pyrethrins | 8003-34-7 | Insecticide | – | Botanical | 6,378 | No | AL, Pred SW | – | – |
| Pyridaben | 96489-71-3 | Insecticide | – | Pyridazinone | 17,377 | No | AL, Pred SW | – | – |
| RPA 202248 | 143701-75-1 | Degradate | Isoxaflutole | Isoxazole degradate | – | No | – | – | DEG |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1–Continued | | | | | | | | | |
| RPA 203328 | 142994-06-7 | Degradate | Isoxaflutole | Isoxazole degradate | – | No | – | – | DEG |
| Siduron | 1982-49-6 | Herbicide | – | Urea | – | Yes | – | SW–UR | – |
| Simazine | 122-34-9 | Herbicide | – | Triazine | 6,307,887 | Yes | AL, Pred SW; HH, Pred SW; AL, Meas SW; HH, Meas SW; HH, Meas GW | SW–AG; SW–UR; GW–AG GW–UR | – |
| *S*-Metolachlor | 87392-12-9 | Herbicide | – | Chloroacetanilide | 32,089,113 | Yes | AL, Pred SW | – | – |
| Sulfometuron-methyl | 74222-97-2 | Herbicide | – | Sulfonylurea | 0 | Yes | – | SW–UR | – |
| Sulfosulfuron | 141776-32-1 | Herbicide | – | Sulfonylurea | 18,398 | No | AL, Pred SW | – | – |
| TCPSA (Trichloropropene sulfonic acid) | 65600-62-6 | Degradate | Triallate | Sulfonic acid ester | – | No | – | – | DEG |
| Tebuconazole | 107534-96-3 | Fungicide | – | Conazole | 473,347 | Yes | – | SW–UR | – |
| Tebupirimfos | 96182-53-5 | Insecticide | – | Organothio-phosphate | 455,316 | No | AL, Pred SW | – | – |
| Tebupirimfos oxygen analogue | NAV | Degradate | Tebupirimphos | Organophosphate | – | No | – | – | DEG |
| Tebuthiuron | 34014-18-1 | Herbicide | – | Urea | 2,324 | Yes | AL, Meas SW | SW–AG; SW–UR | – |
| Tefluthrin | 79538-32-2 | Insecticide | – | Pyrethroid | 469,696 | Yes | AL, Pred SW | – | – |
| Tefluthrin metabolite [R 119364] | NAV | Degradate | Tefluthrin | Pyrethroid | – | No | – | – | DEG |
| Tefluthrin metabolite [R 152912] | NAV | Degradate | Tefluthrin | Pyrethroid | – | No | – | – | DEG |
| Terbacil | 5902-51-2 | Herbicide | – | Uracil | 44,983 | Yes | AL, Pred SW | – | – |
| Terbufos | 13071-79-9 | Insecticide | – | Organothio-phosphate | 811,755 | Yes | AL, Pred SW; HH, Pred SW; HH, Pred GW | – | – |
| Terbufos sulfone | 56070-16-7 | Degradate | Terbufos | Organothio-phosphate | – | Yes | AL, Pred SW | – | – |
| Terbufos-*O*-analogue sulfone | 56070-15-6 | Degradate | Terbufos | Organothio-phosphate | – | Yes | – | – | DEG |
| Terbuthylazine | 5915-41-3 | Herbicide | – | Triazine | – | Yes | – | SW–UR | – |
| Tetraconazole | 112281-77-3 | Fungicide | – | Conazole | 80,011 | Yes | AL, Pred SW | – | – |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tier 1–Continued | | | | | |
| Thiobencarb | 28249-77-6 | Herbicide | – | Thiocarbamate | 449,712 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | Degradate | Cyfluthrin | Aliphatic acid ester | – | No | – | – | DEG |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | – | Conazole | – | Yes | – | SW–AG; SW–UR | – |
| Triallate | 2303-17-5 | Herbicide | – | Thiocarbamate | 282,642 | Yes | AL, Meas SW | – | – |
| Tribenuron-methyl | 101200-48-0 | Herbicide | – | Sulfonylurea | 50,079 | No | HH, Pred GW | – | – |
| Tribuphos | 78-48-8 | Defoliant | – | Organothio-phosphate | 2,543,020 | Yes | AL, Pred SW | – | – |
| Triclopyr | 55335-06-3 | Herbicide | – | Chloropyridinyl | 919,495 | Yes | AL, Pred SW; AL, Meas SW | – | – |
| Trifloxystrobin | 141517-21-7 | Fungicide | – | Strobin | 208,446 | Yes | AL, Pred SW | – | – |
| Trifluralin | 1582-09-8 | Herbicide | – | Dinitroaniline | 5,638,380 | Yes | AL, Pred SW; AL, Meas SW | SW–AG; SW–UR | – |
| Ziram | 137-30-4 | Fungicide | – | Dithiocarbamate, inorganic | 1,835,781 | No | AL, Pred SW | – | – |
| | | | | Tier 2 | | | | | |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy] propionic acid) | 93-72-1 | Herbicide | – | Chlorophenoxy acid | – | No | – | – | MCL |
| Bensulide | 741-58-2 | Herbicide | – | Organophos-phorous | 695,908 | No | – | – | CCL3 |
| Captan | 133-06-2 | Fungicide | – | Phthalimide | 2,478,917 | No | – | – | CCL3 |
| Chlordane | 57-74-9 | Insecticide | – | Organochlorine | – | No | – | – | MCL |
| Clethodim | 99129-21-2 | Herbicide | – | Cyclohexanone derivative | 279,055 | No | – | – | CCL3 |
| Dimethipin | 55290-64-7 | Plant growth regulator/ defoliant | – | Unclassified | 6,876 | No | – | – | CCL3 |
| Dinoseb | 88-85-7 | Herbicide | – | Nitrophenol | 0 | Yes | – | – | MCL |

**Table 4.** Tier 1 and selected Tier 2 pesticides and degradates in water, and reasons for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** AG, agricultural; AL, aquatic-life; BQ, benchmark quotient; CAS, Chemical Abstracts Service; CCL3, Third Contaminant Candidate List (USEPA); DEG, degradate of Tier 1 parent pesticide; DF, detection frequency; GW, groundwater; HH, human-health; MCL, Maximum Contaminant Level (USEPA); Meas, measured concentration; NAV, not available; OPP, Office of Pesticide Programs (USEPA); Pred, predicted concentration; SW, surface water; UR, urban; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | National agricultural pesticide use (2007) (in pounds) | On a USGS analytical method for water? | [1]BQ reason for Tier 1 | DF reason for Tier 1 | Other or regulatory reason for Tier |
|---|---|---|---|---|---|---|---|---|---|
| Tier 2–Continued | | | | | | | | | |
| Endrin | 72-20-8 | Insecticide/ avicide | – | Organochlorine | – | No | – | – | MCL |
| Ethylenethiourea (ETU) | 96-45-7 | Degradate | Metiram | Dithiocarbamate | – | No | – | – | CCL3 |
| Heptachlor | 76-44-8 | Insecticide | – | Organochlorine | – | No | – | – | MCL |
| Heptachlor epoxide | 1024-57-3 | Degradate | Heptachlor | Organochlorine | – | No | – | – | MCL |
| Oxydemeton-methyl | 301-12-2 | Insecticide | – | Organophosphate | 153,677 | No | – | – | CCL3 |
| Picloram | 1918-02-1 | Herbicide | – | Picolinic acid | 1,018,721 | Yes | – | – | MCL |
| Tebufenozide [1] | 112410-23-8 | Insecticide | – | Diacylhydrazine | 37,665 | No | – | – | CCL3 |
| Thiodicarb | 59669-26-0 | Insecticide | – | Carbamate | 151,498 | No | – | – | CCL3 |
| Thiophanate methyl | 23564-05-8 | Fungicide | – | Benzimidazole precursor | 465,451 | No | – | – | CCL3 |
| Toxaphene | 8001-35-2 | Insecticide/ acaricide | – | Organochlorine | – | No | – | – | MCL |
| Vinclozolin | 50471-44-8 | Fungicide | – | Dicarboximide | 4,587 | Yes | – | – | CCL3 |

[1] Newly released OPP AL benchmarks (September 2010) include new or revised benchmarks for 6 compounds in Tier 2 (orthosulfamuron, sulfentrazone and tebufenozide) or Tier 3 (butylate, lactofen and pyriproxifen). If the updated benchmarks had been available when the prioritization was performed, these compounds would have been placed in Tier 1 on the basis of predicted concentrations in streams. Because of this, these compounds were added to the list of pesticide compounds USGS is evaluating for inclusion in analytical methods.

[2] Included in Tier 1 because compound is related to Tier 1 compound.

[3] Dicofol was evaluated using an AL benchmark based on a USEPA OPP chronic fish toxicity value of 1 µg/L, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 4.4 µg/L. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason dicofol was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

[4] Endothall was evaluated using an AL benchmark based on a USEPA OPP acute non-vascular plant toxicity value of 1.9 µg/L, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 1,300 µg/L for endothall acid (however there are lower benchmark values for other formulations of endothall, including a chronic invertebrate benchmark of 2.3 µg/L for the N,N-dimethylalkylamine salt). The resulting BQ using the new benchmark for endothall is less than 0.01. Because this is the only reason endothall was placed in Tier 1, its priority would have been lower (Tier 2 because it has an MCL for drinking water) if the updated benchmarks had been available when the prioritization was performed.

[5] Flumiclorac was evaluated using an AL benchmark based on a chronic fish toxicity value of 1.49 µg/L, estimated from ECOSAR, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include an acute fish benchmark of 550 µg/L for flumiclorac-pentyl. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason flumiclorac was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

A total of 97 pesticide compounds did not meet the criteria for Tier 1, but were placed in Tier 2 because of importance to other agencies or organizations. These compounds could be worth consideration as future target analytes, depending on the objectives and design of monitoring programs. The remaining 275 pesticide compounds were not identified as analytical priorities at this time and were assigned to Tier 3. A complete list of pesticide compounds for water, arranged by tier, is included in *appendix 3*.

## Basis for High Priority for Pesticide Compounds in Water

According to the flow chart summarizing the prioritization procedure for water in *figure 2*, Tier 1 analytes include pesticide compounds with BQs for aquatic life greater than 0.01 in surface water, BQs for human health greater than 0.01 in surface water or groundwater, or measured detection frequencies greater than 10 percent in surface water or groundwater. BQs from both measured and predicted occurrence and detection frequencies for Tier 1 pesticide compounds are listed in *table 5*.

*Figure 4* illustrates the criteria used to select high-priority pesticide compounds for water (also see *table 4*). About half of the compounds are in Tier 1 solely on the basis of a BQ, either aquatic life or human health, or both, and 17 percent of Tier 1 compounds are high priority because of frequent occurrence in past monitoring alone. Degradates that were included in Tier 1 because their parent pesticide was high priority compose 21 percent of the total.

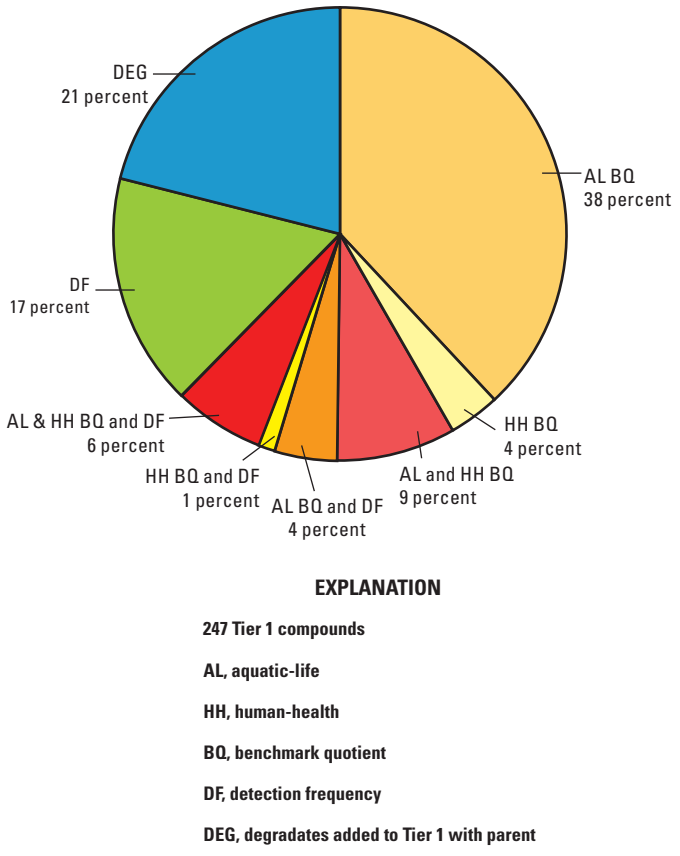


**Figure 4.** Breakdown of Tier 1 pesticide compounds for water by reason for high priority.

Counts summarizing the number and percentage of compounds that met each of the criteria for Tier 1 are tallied in *table 6*. More compounds exceeded the detection-frequency and BQ criteria for surface water than groundwater. The largest share of Tier 1 compounds consists of those whose predicted occurrence in surface water exceeded the 0.01 BQ threshold for aquatic life. Substantial numbers of compounds also exceeded the detection-frequency criterion for surface water or were degradates of Tier 1 parent compounds (*table 6* and *fig. 4*). Several pesticide compounds met the BQ criteria for both aquatic life and human health and for both surface water and groundwater (*table 4*).

Detection-frequency distributions for each of the four datasets evaluated—surface water and groundwater in agricultural and urban land use—are shown in *figure 5*. The 10-percent detection-frequency threshold captures approximately the top 25 percent of pesticide compounds from the occurrence frequency distributions for agricultural and urban streams, and 6 percent of compounds for agricultural and urban groundwater (*fig. 5*). A total of 71 pesticide compounds had a detection frequency greater than 10 percent in agricultural or urban streams, and 13 of these compounds also were frequently detected in groundwater. Of these 71 compounds, 41 were included in Tier 1 on the basis of detection frequency alone, and not on the basis of potential toxicity considerations (*tables 4* and *6* and *fig. 4*).

Degradation products of parent pesticides that did not meet the BQ or detection-frequency criteria for inclusion in Tier 1, often because of inadequate data, were included in the group along with their parent compound (*table 4*). A total of 52 compounds that are degradates of Tier 1 pesticides were assigned to Tier 1 as a conservative measure (*table 4* and *fig. 4*). Several of these compounds are included in existing USGS analytical methods, but most do not have adequate monitoring data to evaluate their occurrence in streams or groundwater. Also, many degradates lack benchmarks or toxicity information with which to compare measured or predicted concentrations. Measuring degradates along with parent compounds in water samples helps improve understanding of the fate and transport of pesticides in the environment.

In terms of distribution of across pesticide-use groups, Tier 1 includes compounds from the major use groups (*fig. 6*). Herbicides and their degradates make up half of all Tier 1 compounds, and another 38 percent are represented by insecticides and degradates. Overall, at 40 percent, degradates make up a large portion of Tier 1 compounds, and about half of them are classified this way because their parent compound was Tier 1.

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates benchmark quotient (BQ) greater than 0.01. ***Bold italic*** indicates detection frequency greater than 10 percent. **Abbreviations**: AG, agricultural land use; AL, aquatic-life; CAS, Chemical Abstracts Service; GW, groundwater; HH, human-health; Meas, measured concentration; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (U.S. Geological Survey); OPP, Office of Pesticide Programs; Pred, predicted concentration; SW, surface water; UR, urban land use; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| 1,3-Dicarbamoyl-2,4,5,6-tetrachlorobenzene | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| 1,3-Dichloropropene | 542-75-6 | Fumigant | **0.036** | **2.0** | – | – | – | – | **2.3** | – | – | – | **2.3** | HH,Pred GW |
| 1-Carbamoyl-3-cyano-4-hydroxy-2,5,6-trichloro-benzene | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| 1-Naphthol | 90-15-3 | Degradate | 0.000042 | – | – | – | 4 | ***14.6*** | – | – | 0 | 0 | 0.000042 | AL,Pred SW |
| 2-(4-*tert*-butylphenoxy)-Cyclohexanol | 1942-71-8 | Degradate | 0.0016 | – | – | – | ***12.7*** | 0.5 | – | – | 0 | – | 0.0016 | AL,Pred SW |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 94-75-7 | Herbicide | **0.12** | **0.10** | **0.015** | **0.011** | ***26.8*** | ***33.9*** | 0.0048 | – | 0.6 | 1.3 | **0.12** | AL,Pred SW |
| 2,4-D methyl ester | 1928-38-7 | Herbicide | – | – | – | – | ***11.8*** | 9 | – | – | 0.4 | 1.4 | – | – |
| 2,6-Diethylaniline | 579-66-8 | Degradate | 0.000014 | – | 6.4E-07 | – | 1.9 | 0.09 | – | – | 1.3 | 0.2 | 0.000014 | AL,Pred SW |
| 2-[(2-Ethyl-6-methylphenyl) amino]-*1*-propanol | 61520-53-4 | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| 2-Amino-*N*-isopropylbenzamide | 30391-89-0 | Degradate | **0.017** | – | – | – | 0.5 | 0 | – | – | 0 | – | **0.017** | AL,Pred SW |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | Degradate | – | – | – | – | 0.4 | 0.5 | – | – | 0 | 0 | – | – |
| 2-Chloro-*N*-(2-ethyl-6-methylphenyl)acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| 2-Ethyl-6-methylaniline | 24549-06-2 | Degradate | **0.16** | – | – | – | 3.1 | 0 | – | – | 2.4 | 0.8 | **0.16** | AL,Pred SW |
| 2-Hydroxyatrazine | 2163-68-0 | Degradate | 0.0066 | **0.033** | – | – | ***67.7*** | **20.8** | – | – | ***15.5*** | ***11*** | **0.033** | HH,Pred SW |
| 3-(Trifluoromethyl)aniline | 98-16-8 | Degradate | 0.0011 | – | – | – | 3.8 | 0.3 | – | – | 3.9 | – | 0.0011 | AL,Pred SW |
| 3-(Trifluoromethyl)phenylurea | 13114-87-9 | Degradate | 0.0053 | – | – | – | 0.8 | 0 | – | – | 1.6 | – | 0.0053 | AL,Pred SW |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | **0.49** | – | – | – | ***35.2*** | ***32.1*** | – | – | 4.6 | 1.4 | **0.49** | AL,Pred SW |
| 3,4-Dichloromethy-phenylurea | 3567-62-2 | Degradate | **0.048** | – | – | – | – | – | – | – | – | – | **0.048** | AL,Pred SW |
| 3,4-Dichlorophenylurea | 2327-02-8 | Degradate | **0.027** | – | – | – | – | – | – | – | – | – | **0.027** | AL,Pred SW |
| 3,5-Dichloroaniline | 626-43-7 | Degradate | **0.015** | – | – | – | 1.4 | 1.8 | – | – | 2 | 1.8 | **0.015** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| 3-Hydroxycarbofuran | 16655-82-6 | Degradate | 0.00000015 | – | – | – | 0.2 | 0.06 | – | – | 0 | 0 | 1.5E-07 | AL,Pred SW |
| 3-Ketocarbofuran | 16709-30-1 | Degradate | 0.00026 | – | – | – | 1.5 | 0 | – | – | 0 | 0 | 0.00026 | AL,Pred SW |
| 3-Phenoxybenzoic acid | 3739-38-6 | Degradate | 0.000021 | – | – | – | – | – | – | – | – | – | 0.000021 | AL,Pred SW |
| 4-(Hydroxymethyl) pendimethalin | 56750-76-6 | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| 4,4'-Dichlorobenzophenone | 90-98-2 | Degradate | 0.00084 | – | – | – | – | – | – | – | – | – | 0.00084 | AL,Pred SW |
| 4-Chloro-2-methylphenol | 1570-64-5 | Degradate | 0.0027 | – | – | – | 1.0 | ***15.6*** | – | – | 0 | 3.4 | 0.0027 | AL,Pred SW |
| 4-Chlorobenzylmethyl sulfone | 98-57-7 | Degradate | 0.000022 | – | – | – | 0 | 0.5 | – | – | 0 | – | 0.000022 | AL,Pred SW |
| 4-Hydroxy-2,5,6-trichloroisophthalonitrile | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Acephate | 30560-19-1 | Insecticide | **0.012** | – | – | – | – | – | – | – | – | – | **0.012** | AL,Pred SW |
| Acetochlor | 34256-82-1 | Herbicide | **3.1** | **1.1** | **4.7** | **0.72** | ***28.8*** | 3.9 | **0.38** | – | 0.3 | 0.5 | **4.7** | AL,Meas SW |
| Acetochlor ethane sulfonic acid (ESA) | 187022-11-3 | Degradate | 0.00075 | – | – | – | ***50.1*** | – | – | – | 6.3 | 1 | 0.00075 | AL,Pred SW |
| Acetochlor oxanilic acid (OA) | 184992-44-4 | Degradate | – | – | – | – | ***33.8*** | – | – | – | 3.2 | 2.1 | – | – |
| Acetochlor sulfynilacetic acid (SAA) | NAV | Degradate | – | – | – | – | ***15.9*** | – | – | – | 0 | – | – | – |
| Acetochlor/Metolachlor ESA, secondary amide | NAV | Degradate | – | – | – | – | ***40.8*** | – | – | – | 0 | – | – | – |
| Alachlor | 15972-60-8 | Herbicide | **1.5** | **0.26** | **2.0** | **0.23** | ***34.4*** | 5.8 | **0.095** | 0.007 | 2.6 | 0.4 | **2.0** | AL,Meas SW |
| Alachlor ESA, secondary amide | NAV | Degradate | – | – | – | – | 6.6 | – | – | – | 0 | – | – | – |
| Alachlor ESA | 142363-53-9 | Degradate | 0.000096 | – | – | – | ***79.4*** | – | – | – | ***32.2*** | ***30.8*** | 0.00010 | AL,Pred SW |
| Alachlor OA | 171262-17-2 | Degradate | 0.00010 | – | – | – | ***23.2*** | – | – | – | 8 | 9.8 | 0.00010 | AL,Pred SW |
| Alachlor SAA | 140939-16-8 | Degradate | – | – | – | – | 2.2 | – | – | – | 0 | – | – | – |
| Aldicarb | 116-06-3 | Insecticide | **2.5** | **0.025** | – | – | 0.1 | 0.06 | **0.025** | – | 0.07 | 0 | **2.5** | AL,Pred SW |
| Aldicarb sulfone | 1646-88-4 | Degradate | 0.0091 | **0.037** | – | – | 0.7 | 0.2 | – | – | 1.1 | 0 | **0.037** | HH,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates benchmark quotient (BQ) greater than 0.01. ***Bold italic*** indicates detection frequency greater than 10 percent. **Abbreviations**: AG, agricultural land use; AL, aquatic-life; CAS, Chemical Abstracts Service; GW, groundwater; HH, human-health; Meas, measured concentration; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (U.S. Geological Survey); OPP, Office of Pesticide Programs; Pred, predicted concentration; SW, surface water; UR, urban land use; µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Aldicarb sulfoxide | 1646-87-3 | Degradate | **0.060** | **0.037** | **0.023** | – | 1.5 | 0 | – | – | 1.4 | 0 | **0.060** | AL,Pred SW |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | 0.00029 | **4.2** | 0.00017 | – | 0.2 | 0.05 | – | – | 0.01 | 0 | **4.2** | HH,Pred SW |
| Ametryn | 834-12-8 | Herbicide | **0.028** | 0.000055 | – | – | 3.7 | – | 0.00030 | – | 0 | 0 | **0.028** | AL,Pred SW |
| Aminomethylphosphonic acid | 1066-51-9 | Degradate | 0.000038 | – | – | – | ***50.2*** | ***44.8*** | – | – | 1.1 | 8.3 | 0.000038 | AL,Pred SW |
| Asulam | 3337-71-1 | Herbicide | **0.051** | – | – | – | – | – | – | – | – | – | **0.051** | AL,Pred SW |
| Atrazine | 1912-24-9 | Herbicide | **21.8** | **1.6** | **58.7** | **3.2** | ***89.6*** | ***71.5*** | **0.18** | **0.4** | ***43.3*** | ***29.2*** | **58.7** | AL,Meas SW |
| Azinphos-methyl | 86-50-0 | Insecticide | **3.4** | 0.0043 | **7.8** | 0.0021 | 3.1 | 0.8 | **0.019** | – | 0.2 | 0 | **7.8** | AL,Meas SW |
| Azinphos-methyl-oxon | 961-22-8 | Degradate | 0.00017 | – | – | – | 0.5 | 0 | – | – | 0 | 0 | 0.00017 | AL,Pred SW |
| Azoxystrobin | 131860-33-8 | Fungicide | **0.025** | – | – | – | – | – | – | – | – | – | **0.025** | AL,Pred SW |
| Benfluralin | 1861-40-1 | Herbicide | 0.0039 | 0.00046 | 0.0053 | – | 0.6 | 3.7 | **0.038** | 0.0015 | 0.1 | 0.17 | **0.038** | HH,Pred GW |
| Benomyl | 17804-35-2 | Fungicide | **0.050** | 0.00069 | – | – | ***10.2*** | ***11.6*** | 0.0037 | – | 2 | 0.6 | **0.050** | AL,Pred SW |
| Bentazon | 25057-89-0 | Herbicide | 0.000094 | 0.00063 | 0.00034 | 0.0015 | ***25.5*** | 5.3 | 0.00088 | 0.0046 | 4 | 2.4 | 0.0046 | HH,Meas GW |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | 0.00021 | **0.63** | – | – | – | – | – | – | – | – | **0.63** | HH,Pred SW |
| Bifenazate | 149877-41-8 | Insecticide | **0.018** | – | – | – | – | – | – | – | – | – | **0.018** | AL,Pred SW |
| Bifenthrin | 82657-04-3 | Insecticide | **0.77** | 0.0011 | – | – | 0 | 0 | **0.017** | – | 0 | – | **0.77** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Bromacil | 314-40-9 | Herbicide | **0.086** | 0.0021 | **0.23** | – | 3.5 | 8.2 | 0.0022 | **0.026** | 2.7 | 3.5 | **0.23** | AL,Meas SW |
| Bromomethane | 74-83-9 | Fumigant/ adjuvant | **0.013** | 0.0037 | – | – | – | – | 0.0021 | – | – | – | **0.013** | AL,Pred SW |
| Bromoxynil | 1689-84-5 | Herbicide | 0.00996 | 0.00043 | **0.024** | – | 1.9 | 0.3 | **0.021** | – | 0.06 | 0 | **0.024** | AL,Meas SW |
| Butralin | 33629-47-9 | Herbicide | **0.014** | – | – | – | – | – | – | – | – | – | **0.014** | AL,Pred SW |
| Carbaryl | 63-25-2 | Insecticide | **3.7** | 0.0083 | **9.6** | **0.016** | ***12*** | ***55.7*** | 0.0047 | 0.00018 | 0.6 | 1.4 | **9.6** | AL,Meas SW |
| Carbofuran | 1563-66-2 | Insecticide | **2.0** | 0.0071 | **4.8** | **0.012** | ***12.9*** | 1.7 | 0.0042 | 0.00043 | 2.1 | 0.7 | **4.8** | AL,Meas SW |
| Chlorimuron-ethyl | 90982-32-4 | Herbicide | 0.00031 | 0.00038 | – | – | [1] ***31*** (5.0) | 0.3 | 0.00025 | – | 0.6 | 0 | 0.00038 | HH,Pred SW |
| Chloropicrin | 76-06-2 | Fumigant/ nematocide | **0.077** | – | – | – | – | – | – | – | – | – | **0.077** | AL,Pred SW |
| Chlorothalonil | 1897-45-6 | Fungicide | **0.72** | **0.018** | **0.050** | – | 0.2 | 1.3 | **0.058** | – | 0 | 0.2 | **0.72** | AL,Pred SW |
| Chlorpyrifos | 2921-88-2 | Insecticide | **14.3** | **0.060** | **3.7** | **0.027** | ***13.3*** | ***22.6*** | **0.14** | – | 0.8 | 0.4 | **14.3** | AL,Pred SW |
| Chlorpyrifos oxygen analog | 5598-15-2 | Degradate | **0.015** | – | – | – | 0.3 | 0 | – | – | 0 | 0 | **0.015** | AL,Pred SW |
| Chlorsulfuron | 64902-72-3 | Herbicide | **7.9** | 0.0051 | – | – | – | – | 0.0015 | – | – | – | **7.9** | AL,Pred SW |
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclo-propane)-carboxylate | c61898-95-1 | Degradate | – | – | – | – | 0 | 0 | – | – | 0 | – | – | – |
| *cis*-Permethrin | 61949-76-6 | Insecticide | See perme-thrin | See perme-thrin | **13.6** | – | 0.2 | 0.1 | See perme-thrin | – | 0.1 | 0 | **13.6** | AL,Meas SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | See propi-conazole | See propi-conazole | – | – | ***12.8*** | ***15.8*** | See propi-conazole | – | 0.4 | 0.7 | – | – |
| Copper | 7440-50-8 | Fungicide | **0.018** | 0.000035 | – | – | – | – | 0.00015 | – | – | – | **0.018** | AL,Pred SW |
| Cyanazine | 21725-46-2 | Herbicide | 0.000024 | 0.0059 | **0.014** | **4.0** | **39.9** | 3.1 | **0.15** | 0.007 | 1.2 | 0.9 | **4.0** | HH,Meas SW |
| Cyanazine acid | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Cyanazine amide | NAV | Degradate | – | – | – | – | ***27.8*** | 2.6 | – | – | 0 | – | – | – |
| Cyfluthrin | 68359-37-5 | Insecticide | **13.6** | 0.00016 | – | – | 0 | 0 | 0.00082 | – | 0 | 0 | **13.6** | AL,Pred SW |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | **8.0** | 0.00070 | – | – | 0 | 0 | 0.0041 | – | 0 | 0 | **8.0** | AL,Pred SW |
| *gamma*-Cyhalothrin | 76703-62-3 | Insecticide | – | – | – | – | – | – | – | – | – | – | – | – |
| Cypermethrin | 52315-07-8 | Insecticide | **3.6** | 0.0011 | – | – | 0 | 0.4 | 0.0037 | – | 0 | 0 | **3.6** | AL,Pred SW |
| *zeta*-Cypermethrin | 69865-47-0 | Insecticide | – | – | – | – | – | – | – | – | – | – | – | – |
| Dacthal | 1861-32-1 | Herbicide | 0.0000093 | 0.00037 | 0.0027 | **0.030** | ***11.5*** | ***20.8*** | 0.0023 | 0.000014 | 0.7 | 0.5 | **0.030** | HH,Meas SW |
| Dacthal monoacid | 887-54-7 | Degradate | 0.00011 | – | 0.000034 | – | 0.3 | 0.2 | – | – | 0.06 | 0 | 0.00011 | AL,Pred SW |
| Dechloroacetochlor | NAV | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| Dechloroalachlor | NAV | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| Dechlorodimethenamid | NAV | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| Dechlorometolachlor | NAV | Degradate | – | – | – | – | 8.3 | – | – | – | 0 | – | – | – |
| Deethylatrazine | 6190-65-4 | Degradate | **0.013** | **0.62** | 0.0017 | **0.066** | ***80.4*** | ***48.7*** | – | **0.14** | ***45.5*** | ***30.6*** | **0.62** | HH,Pred SW |
| Deethylcyanazine | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Deethylcyanazine acid | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Deethylcyanazine amide | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Deethylhydroxyatrazine | NAV | Degradate | – | **0.96** | – | – | – | – | – | – | – | – | **0.96** | HH,Pred SW |
| Deisopropyl prometryn | NAV | Degradate | – | – | – | – | 0.3 | 2.6 | – | – | 0 | – | – | – |
| Deisopropylatrazine | 1007-28-9 | Degradate | 0.0048 | **0.56** | – | – | ***39.5*** | ***13.9*** | – | – | ***28*** | ***15.4*** | **0.56** | HH,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Deisopropylhydroxy atrazine | 7313-54-4 | Degradate | **0.36** | **0.96** | – | – | – | – | – | – | – | – | **0.96** | HH,Pred SW |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | 0.00028 | – | – | – | – | – | – | – | – | – | 0.00028 | AL,Pred SW |
| Deltamethrin | 52918-63-5 | Insecticide | **1.5** | – | – | – | – | – | – | – | – | – | **1.5** | AL,Pred SW |
| Demethyl fluometuron | NAV | Degradate | – | – | – | – | ***37.9*** | 2.7 | – | – | ***16.4*** | – | – | – |
| Demethyl norflurazon | NAV | Degradate | – | – | – | – | ***50.7*** | 0 | – | – | ***24.2*** | – | – | – |
| Desulfinylfipronil (MB46513) | NAV | Degradate | – | – | – | – | ***14.8*** | ***29.9*** | – | – | 0 | 0.5 | – | – |
| Desulfinylfipronil amide (RPA 105048) | NAV | Degradate | – | – | – | – | 8.8 | ***11.4*** | – | – | 0.1 | 0 | – | – |
| Diazinon | 333-41-5 | Insecticide | **1.8** | **0.047** | **18.1** | **0.71** | ***15.1*** | ***67.4*** | **0.17** | 0.004 | 0.4 | 1.3 | **18.1** | AL,Meas SW |
| Diazinon oxygen analog | 962-58-3 | Degradate | 0.00024 | – | – | – | 0 | 0.5 | – | – | 0 | 0 | 0.00024 | AL,Pred SW |
| Dicamba | 1918-00-9 | Herbicide | **0.058** | 0.00023 | 0.0067 | – | 3.9 | 3.4 | 0.000068 | – | 0.3 | 0.6 | **0.058** | AL,Pred SW |
| Dichlobenil | 1194-65-6 | Herbicide | 0.00035 | 0.00033 | 0.010 | – | 0.3 | 4.3 | **0.017** | – | 0.09 | 0.38 | **0.017** | HH,Pred GW |
| Dichlorvos | 62-73-7 | Insecticide/ fumigant/ degradate | – | – | – | – | 0.2 | 9.1 | – | – | 0 | 0 | – | – |
| Dicofol [2] | 115-32-2 | Insecticide | **0.024** | – | – | – | – | – | – | – | – | – | **0.024** | AL,Pred SW |
| Dicrotophos | 141-66-2 | Insecticide | **2.1** | **10.5** | – | – | 2.2 | 0.3 | **3.0** | – | 0 | 0 | **10.5** | HH,Pred SW |
| Didealkylatrazine | 3397-62-4 | Degradate | 0.00041 | – | – | – | ***31*** | ***16.6*** | – | – | ***24.8*** | ***16.8*** | 0.00041 | AL,Pred SW |
| Dieldrin | 60-57-1 | Insecticide | – | – | **1.4** | **22.5** | 3.6 | 3.5 | – | **27.5** | 1.2 | 5.3 | **27.5** | HH,Meas GW |
| Diflubenzuron | 35367-38-5 | Insecticide | **0.16** | – | – | – | – | – | – | – | – | – | **0.16** | AL,Pred SW |
| Diflufenzopyr | 109293-97-2 | Herbicide | **0.48** | – | – | – | – | – | – | – | – | – | **0.48** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Dimethenamid | 87674-68-8 | Herbicide | 0.0020 | – | – | – | ***20*** | – | – | – | 0 | – | 0.0020 | AL,Pred SW |
| Dimethenamid ESA | NAV | Degradate | – | – | – | – | ***13.7*** | – | – | – | 0.9 | – | – | – |
| Dimethenamid OA | NAV | Degradate | – | – | – | – | 4.8 | – | – | – | 0 | – | – | – |
| Dimethenamid-*P* | 163515-14-8 | Herbicide | **0.097** | – | – | – | – | – | – | – | – | – | **0.097** | AL,Pred SW |
| Dimethoate | 60-51-5 | Insecticide | **1.2** | **0.054** | – | – | 2.6 | 0.9 | **0.089** | – | 0 | 0 | **1.2** | AL,Pred SW |
| Diquat | 85-00-7 | Herbicide | **37.5** | 0.0012 | – | – | – | – | 0.00029 | – | – | – | **37.5** | AL,Pred SW |
| Disulfoton | 298-04-4 | Insecticide | **14.8** | **0.029** | **3.2** | – | 0.3 | 0.2 | **0.17** | – | 0 | 0 | **14.8** | AL,Pred SW |
| Disulfoton sulfone | 2497-06-5 | Degradate | **5.6** | – | – | – | 6.2 | 8.1 | – | – | 0 | 0 | **5.6** | AL,Pred SW |
| Disulfoton sulfoxide | 2497-07-6 | Degradate | **0.51** | – | – | – | 1 | 0.8 | – | – | 0 | – | **0.51** | AL,Pred SW |
| Diuron | 330-54-1 | Herbicide | **0.93** | **0.20** | **5.4** | **0.76** | ***24.6*** | ***45.2*** | **0.10** | **0.13** | 5.9 | 3.8 | **5.4** | AL,Meas SW |
| Endosulfan | 115-29-7 | Insecticide | **0.42** | 0.00017 | – | – | See *alpha-* & *beta-* endo-sulfan | See *alpha-* & *beta-* endo-sulfan | 0.0041 | – | See *alpha-* & *beta-* endo-sulfan | See *alpha-* & *beta-* endo-sulfan | **0.42** | AL,Pred SW |
| *alpha*-Endosulfan | 959-98-8 | Insecticide | – | – | – | – | 0.4 | 0 | – | – | 0 | 0 | – | – |
| *beta*-Endosulfan | 33213-65-9 | Insecticide | – | – | – | – | 4.2 | 0 | – | – | 0 | – | – | – |
| Endosulfan ether | 3369-52-6 | Degradate | – | – | – | – | 0 | 0 | – | – | 0 | – | – | – |
| Endosulfan sulfate | 1031-07-8 | Degradate | **0.13** | – | – | – | 8.2 | 0 | – | – | 0 | 0 | **0.13** | AL,Pred SW |
| Endothall [3] | 145-73-3 | Herbicide | **0.14** | 0.00050 | – | – | – | – | 0.0015 | – | – | – | **0.14** | AL,Pred SW |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | 0.00018 | 0.00014 | 0.0057 | 0.0028 | ***17.9*** | 5.6 | 0.0014 | 0.000015 | 0.9 | 0.5 | 0.0057 | AL,Meas SW |
| Esfenvalerate | 66230-04-4 | Insecticide | **9.5** | – | – | – | – | – | – | – | – | – | **9.5** | AL,Pred SW |
| Ethalfluralin | 55283-68-6 | Herbicide | **0.17** | 0.00057 | **0.33** | – | 1.5 | 0 | 0.0061 | – | 0.1 | 0 | **0.33** | AL,Meas SW |
| Ethoprop | 13194-48-4 | Insecticide | **0.019** | **0.094** | **0.015** | **0.013** | 2.9 | 1.1 | **0.18** | – | 0.04 | 0 | **0.18** | HH,Pred GW |
| Etoxazole | 153233-91-1 | Insecticide | **0.010** | – | – | – | – | – | – | – | – | – | **0.010** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Famoxadone | 131807-57-3 | Fungicide | **0.025** | – | – | – | – | – | – | – | – | – | **0.025** | AL,Pred SW |
| Fenamiphos | 22224-92-6 | Insecticide | **0.019** | 0.00081 | – | – | 0 | 1.3 | **0.22** | – | 0 | 0 | **0.22** | HH,Pred GW |
| Fenamiphos sulfone | 31972-44-8 | Degradate | 0.00017 | – | – | – | 0 | 0.5 | – | – | 0 | 0 | 0.00017 | AL,Pred SW |
| Fenamiphos sulfoxide | 31972-43-7 | Degradate | **0.027** | – | – | – | 0 | 0.3 | – | – | 0 | 0 | **0.027** | AL,Pred SW |
| Fenbutatin oxide | 13356-08-6 | Insecticide | **0.033** | – | – | – | – | – | – | – | – | – | **0.033** | AL,Pred SW |
| Fenpropathrin | 39515-41-8 | Insecticide | **0.076** | – | – | – | – | – | – | – | – | – | **0.076** | AL,Pred SW |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/ herbicide | **0.14** | – | – | – | – | – | – | – | – | – | **0.14** | AL,Pred SW |
| Fipronil | 120068-37-3 | Insecticide | **0.011** | – | – | – | ***14.3*** | ***34.1*** | – | – | 0 | 0.2 | **0.011** | AL,Pred SW |
| Fipronil sulfide | 120067-83-6 | Degradate | – | – | – | – | ***13*** | ***21.4*** | – | – | 0 | 0.5 | – | – |
| Fipronil sulfone | 120068-36-2 | Degradate | 0.000043 | – | – | – | ***11.4*** | ***17.1*** | – | – | 0.1 | 0.9 | 0.000043 | AL,Pred SW |
| Flumetsulam | 98967-40-9 | Herbicide | 0.0000049 | 0.000016 | – | – | [1] ***65*** (4.1) | 1.3 | 0.000023 | – | 1.6 | 1.7 | 0.000023 | HH,Pred GW |
| Flumiclorac [4] | 87546-18-7 | Herbicide | **0.067** | – | – | – | – | – | – | – | – | – | **0.067** | AL,Pred SW |
| Fluometuron | 2164-17-2 | Herbicide | **0.045** | **0.085** | **0.25** | **0.23** | ***11.3*** | 0.7 | **0.039** | – | 3.3 | 0.5 | **0.25** | AL,Meas SW |
| Fonofos | 944-22-9 | Insecticide | – | – | **0.17** | 0.0031 | 4.2 | 0.6 | – | – | 0 | 0 | **0.17** | AL,Meas SW |
| Fonofos oxygen analog | 944-21-8 | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Formetanate hydrochloride | 23422-53-9 | Insecticide | **0.20** | – | – | – | – | – | – | – | – | – | **0.20** | AL,Pred SW |
| *gamma*-HCH | 58-89-9 | Insecticide | **0.066** | **0.036** | **0.072** | – | 1 | 2.4 | **0.76** | – | – | – | **0.76** | HH,Pred GW |
| Glyphosate | 1071-83-6 | Herbicide | 0.0086 | 0.0062 | – | – | ***38.1*** | ***21.9*** | 0.0010 | – | 1.6 | 0 | 0.0086 | AL,Pred SW |
| Halosulfuron-methyl | 100784-20-1 | Herbicide | **0.011** | – | – | – | – | – | – | – | – | – | **0.011** | AL,Pred SW |
| Hexazinone | 51235-04-2 | Herbicide | **0.26** | 0.00090 | – | – | ***20.2*** | 8.9 | 0.00042 | – | 5 | 3.5 | **0.26** | AL,Pred SW |
| Hydroxyacetochlor | 60090-47-3 | Degradate | – | – | – | – | 2.3 | – | – | – | 0 | – | – | – |
| Hydroxyalachlor | NAV | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| Hydroxydimethanamid | NAV | Degradate | – | – | – | – | 0 | – | – | – | 0 | – | – | – |
| Hydroxymetolachlor | 131068-72-9 | Degradate | – | – | – | – | ***22.5*** | – | – | – | 0 | – | – | – |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Hydroxysimazine | 2599-11-3 | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Imazamox | 114311-32-9 | Herbicide | **0.049** | – | – | – | – | – | – | – | – | – | **0.049** | AL,Pred SW |
| Imazaquin | 81335-37-7 | Herbicide | 0.0000018 | 0.000028 | – | – | ***13.1*** | ***13.4*** | 0.000076 | – | 3.2 | 4.4 | 0.000076 | HH,Pred GW |
| Imazethapyr | 81335-77-5 | Herbicide | 0.000012 | 0.00013 | – | – | ***15.2*** | 2.2 | 0.000084 | – | 3.8 | 1 | 0.00013 | HH,Pred SW |
| Imidacloprid | 138261-41-3 | Insecticide | **0.67** | 0.00030 | – | – | 3.1 | 7 | 0.00045 | – | 0.9 | 2.4 | **0.67** | AL,Pred SW |
| Indoxacarb | 173584-44-6 | Insecticide | **0.28** | – | – | – | – | – | – | – | – | – | **0.28** | AL,Pred SW |
| Iprodione | 36734-19-7 | Fungicide | 0.0011 | **0.042** | – | – | 3.7 | 2 | **0.22** | – | 0 | 0 | **0.22** | HH,Pred GW |
| Isoxaflutole | 141112-29-0 | Herbicide | **0.025** | – | – | – | – | – | – | – | – | – | **0.025** | AL,Pred SW |
| Kresoxim-methyl | 143390-89-0 | Fungicide | **0.047** | – | – | – | – | – | – | – | – | – | **0.047** | AL,Pred SW |
| Linuron | 330-55-2 | Herbicide | **1.0** | 0.0040 | **3.6** | – | 3.4 | 0.08 | **0.034** | – | 0.3 | 0 | **3.6** | AL,Meas SW |
| Malaoxon | 1634-78-2 | Degradate | **1.2** | – | – | – | 0 | 0.2 | – | – | 0 | 0.3 | **1.2** | AL,Pred SW |
| Malathion | 121-75-5 | Insecticide | 0.0018 | 1.7E-10 | **14,615** | 0.0012 | 5.4 | ***16.5*** | 0.0037 | – | 0.5 | 0.2 | **14,615** | AL,Meas SW |
| Maneb | 12427-38-2 | Fungicide | **0.010** | – | – | – | – | – | – | – | – | – | **0.010** | AL,Pred SW |
| MBC (Carbendazim) | 10605-21-7 | Degradate | **0.33** | – | – | – | – | – | – | – | – | – | **0.33** | AL,Pred SW |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 94-74-6 | Herbicide | **0.012** | **0.013** | 0.0055 | – | 3.7 | ***10.8*** | 0.0077 | – | 0 | 0.4 | **0.013** | HH,Pred SW |
| Metalaxyl | 57837-19-1 | Fungicide | 0.000060 | 0.000028 | – | – | ***33.4*** | 6.9 | 0.00025 | – | 2.5 | 1.4 | 0.00025 | HH,Pred GW |
| Metam sodium | 137-42-8 | Fumigant/herbicide/fungicide/micro-biocide/algaecide | **0.32** | – | – | – | – | – | – | – | – | – | **0.32** | AL,Pred SW |
| Metconazole | 125116-23-6 | Fungicide | **0.011** | – | – | – | – | – | – | – | – | – | **0.011** | AL,Pred SW |
| Methamidophos | 10265-92-6 | Insecticide | **0.011** | – | – | – | – | – | – | – | – | – | **0.011** | AL,Pred SW |
| Methidathion | 950-37-8 | Insecticide | **0.087** | **0.014** | – | – | 0.7 | 0 | **0.15** | – | 0 | 0 | **0.15** | HH,Pred GW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Methomyl | 16752-77-5 | Insecticide | **0.37** | 0.00033 | **0.47** | – | 1.4 | 0.4 | 0.00088 | – | 0.2 | 0.1 | **0.47** | AL,Meas SW |
| Methomyl-oxime | 13749-94-5 | Degradate | 0.00074 | – | – | – | – | – | – | – | – | – | 0.00074 | AL,Pred SW |
| Methoxychlor | 72-43-5 | Insecticide | **0.27** | 0.000049 | – | – | – | – | 0.0037 | – | – | – | **0.27** | AL,Pred SW |
| Methoxyfenozide | 161050-58-4 | Insecticide | **5.6** | – | – | – | – | – | – | – | – | – | **5.6** | AL,Pred SW |
| Metolachlor | 51218-45-2 | Herbicide | **2.6** | 0.00068 | **11.6** | 0.0034 | ***80.6*** | ***46.7*** | 0.00026 | 0.00067 | ***18.1*** | 8.8 | **11.6** | AL,Meas SW |
| Metolachlor ESA | 171118-09-5 | Degradate | 0.0019 | – | – | – | ***89.5*** | – | – | – | ***42.3*** | ***41.7*** | 0.0019 | AL,Pred SW |
| Metolachlor OA | 152019-73-3 | Degradate | 0.0061 | – | – | – | ***83.9*** | – | – | – | ***18.2*** | ***19.6*** | 0.0061 | AL,Pred SW |
| Metribuzin | 21087-64-9 | Herbicide | **2.7** | **0.050** | **0.42** | 0.0050 | ***18.2*** | 4.3 | 0.0025 | 0.00031 | 3 | 0.8 | **2.7** | AL,Pred SW |
| Molinate | 2212-67-1 | Herbicide | 0.0096 | **0.26** | **0.38** | **11.3** | ***11.6*** | 0.9 | **0.22** | – | 0.5 | 0.2 | **11.3** | HH,Meas SW |
| Myclobutanil | 88671-89-0 | Fungicide | 0.000048 | 0.000070 | – | – | 6 | ***11.1*** | 0.00079 | – | 0.3 | 0 | 0.00079 | HH,Pred GW |
| Naled | 300-76-5 | Insecticide | **0.028** | 0.000040 | – | – | – | – | **0.015** | – | – | – | **0.028** | AL,Pred SW |
| Nicosulfuron | 111991-09-4 | Herbicide | 0.0058 | 0.0000063 | – | – | [1] ***53*** (4.5) | 0.3 | 0.000018 | – | 0.4 | 0 | 0.0058 | AL,Pred SW |
| Norflurazon | 27314-13-2 | Herbicide | **0.024** | 0.0043 | **0.060** | **0.043** | 8.7 | 1.4 | **0.017** | **0.13** | 3.7 | 0.3 | **0.13** | HH,Meas GW |
| Novaluron | 116714-46-6 | Herbicide | **0.029** | – | – | – | – | – | – | – | – | – | **0.029** | AL,Pred SW |
| *O*-Ethyl-*O*-methyl-*S*-propylphosphorothioate | 76960-87-7 | Degradate | – | – | – | – | 0 | 0 | – | – | 0 | – | – | – |
| Oryzalin | 19044-88-3 | Herbicide | 0.0079 | **0.011** | **0.12** | – | 0.8 | 2.5 | **0.060** | – | 0.06 | 0.5 | **0.12** | AL,Meas SW |
| Oxamyl | 23135-22-0 | Insecticide | **0.012** | 0.0011 | 0.0017 | 0.00026 | 0.5 | 0 | 0.0010 | – | 0.7 | 0.1 | **0.012** | AL,Pred SW |
| Oxamyl oxime | 30558-43-1 | Degradate | **0.016** | – | – | – | – | – | – | – | – | – | **0.016** | AL,Pred SW |
| Oxyfluorfen | 42874-03-3 | Herbicide | **0.079** | 0.00034 | – | – | 8.3 | 0 | 0.010 | – | 0 | 0 | **0.079** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | Degradate | – | – | **30** | **0.080** | 4.4 | 1.8 | – | **0.02** | – | – | **30.0** | AL,Meas SW |
| Paraoxon-methyl | 950-35-6 | Degradate | **1.2** | – | – | – | 0 | 0 | – | – | 0 | 0 | **1.2** | AL,Pred SW |
| Paraquat | 4685-14-7 | Herbicide | **0.58** | 0.0060 | – | – | – | – | **0.023** | – | – | – | **0.58** | AL,Pred SW |
| Parathion-methyl | 298-00-0 | Insecticide | **0.71** | **0.035** | **0.88** | – | 1.1 | 0.1 | **0.17** | – | 0.05 | 0 | **0.88** | AL,Meas SW |
| Pendimethalin | 40487-42-1 | Herbicide | **0.59** | 0.0089 | **0.14** | 0.0017 | 10.0 | ***12.6*** | 0.0041 | – | 0.4 | 0.4 | **0.59** | AL,Pred SW |
| Permethrin | 52645-53-1 | Insecticide | **73.3** | 0.0051 | See *cis*-permethrin | See *cis*-permethrin | See *cis*-permethrin | See *cis*-permethrin | **0.043** | See *cis*-permethrin | See *cis*-permethrin | See *cis*-permethrin | **73.3** | AL,Pred SW |
| Phorate | 298-02-2 | Insecticide | **2.5** | **0.023** | – | – | 0.1 | 0 | **0.048** | – | 0 | 0 | **2.5** | AL,Pred SW |
| Phorate oxon | 2600-69-3 | Degradate | 0.00036 | – | – | – | 0 | 0 | – | – | 0 | 0 | 0.00036 | AL,Pred SW |
| Phosmet | 732-11-6 | Insecticide | **0.23** | 0.0045 | – | – | 0 | 0 | **0.026** | – | 0 | 0 | **0.23** | AL,Pred SW |
| Phosmet oxon | 3735-33-9 | Degradate | 0.00062 | – | – | – | 0 | 0 | – | – | 0 | 0 | 0.00062 | AL,Pred SW |
| Piperonyl butoxide | 51-03-6 | Synergist | **0.013** | – | – | – | – | – | – | – | – | – | **0.013** | AL,Pred SW |
| Profenofos | 41198-08-7 | Insecticide | **0.19** | **0.020** | – | – | 0 | 0 | **0.37** | – | 0 | – | **0.37** | HH,Pred GW |
| Prometon | 1610-18-0 | Herbicide | – | – | **0.018** | 0.0025 | ***41*** | ***81*** | – | 0.0012 | ***10.9*** | ***20.1*** | **0.018** | AL,Meas SW |
| Prometryn | 7287-19-6 | Herbicide | **0.64** | 0.00055 | – | – | ***12.8*** | 1.3 | 0.00057 | – | 2.5 | 0.4 | **0.64** | AL,Pred SW |
| Pronamide | 23950-58-5 | Herbicide | 0.000092 | **0.018** | 0.00033 | **0.035** | 2.8 | 2.5 | **0.16** | – | 0.2 | 0.02 | **0.16** | HH,Pred GW |
| Propanil | 709-98-8 | Herbicide | **0.17** | **0.058** | **0.026** | – | 1.8 | 0.8 | **0.037** | – | 0.3 | 0.1 | **0.17** | AL,Pred SW |
| Propargite | 2312-35-8 | Insecticide | 0.0048 | **0.013** | **2.2** | **1.2** | 2.6 | 0.2 | **0.21** | – | 0.05 | 0 | **2.2** | AL,Meas SW |
| Propazine | 139-40-2 | Herbicide | 0.00013 | 0.0014 | – | – | ***12.3*** | 0 | 0.0015 | – | 1.2 | 0 | 0.0015 | HH,Pred GW |
| Propiconazole | 60207-90-1 | Fungicide | **0.011** | 0.0029 | – | – | 9.8 | 2.2 | 0.0025 | – | 0.4 | 0.3 | **0.011** | AL,Pred SW |
| Propoxur | 114-26-1 | Insecticide | – | – | **0.020** | – | 1.3 | 5.8 | – | – | 0.2 | 0.6 | **0.020** | AL,Meas SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Prosulfuron | 94125-34-5 | Herbicide | **0.036** | 0.0012 | – | – | – | – | 0.0015 | – | – | – | **0.036** | AL,Pred SW |
| Pymetrozine | 123312-89-0 | Insecticide | **0.28** | – | – | – | – | – | – | – | – | – | **0.28** | AL,Pred SW |
| Pyraclostrobin | 175013-18-0 | Fungicide | **0.055** | 0.00016 | – | – | – | – | 0.00096 | – | – | – | **0.055** | AL,Pred SW |
| Pyrethrins | 8003-34-7 | Insecticide | **0.25** | – | – | – | – | – | – | – | – | – | **0.25** | AL,Pred SW |
| Pyridaben | 96489-71-3 | Insecticide | **0.028** | – | – | – | – | – | – | – | – | – | **0.028** | AL,Pred SW |
| RPA 202248 | 143701-75-1 | Degradate | 0.0072 | – | – | – | – | – | – | – | – | – | 0.0072 | AL,Pred SW |
| RPA 203328 | 142994-06-7 | Degradate | 0.000091 | – | – | – | – | – | – | – | – | – | 0.000091 | AL,Pred SW |
| Siduron | 1982-49-6 | Herbicide | – | – | – | – | 1 | ***11*** | – | – | 0.09 | 0.2 | – | – |
| Simazine | 122-34-9 | Herbicide | **0.035** | **0.079** | **0.25** | **0.89** | ***53.6*** | ***61.8*** | **0.059** | **0.071** | ***19.2*** | ***17.1*** | **0.89** | HH,Meas SW |
| *S*-Metolachlor | 87392-12-9 | Herbicide | **2.7** | – | – | – | – | – | – | – | – | – | **2.7** | AL,Pred SW |
| Sulfometuron-methyl | 74222-97-2 | Herbicide | – | – | – | – | 5.2 | ***16.2*** | – | – | 0.6 | 0.6 | – | – |
| Sulfosulfuron | 141776-32-1 | Herbicide | **0.96** | – | – | – | – | – | – | – | – | – | **0.96** | AL,Pred SW |
| TCPSA (Trichloropropene sulfonic acid) | 65600-62-6 | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Tebuconazole | 107534-96-3 | Fungicide | 0.00014 | – | – | – | 6.4 | ***15*** | – | – | 0 | 0 | 0.00014 | AL,Pred SW |
| Tebupirimfos | 96182-53-5 | Insecticide | **12.9** | – | – | – | 4.5 | 0 | – | – | 0 | – | **12.9** | AL,Pred SW |
| Tebupirimfos oxygen analogue | NAV | Degradate | – | – | – | – | 1.1 | 0 | – | – | 0 | – | – | – |
| Tebuthiuron | 34014-18-1 | Herbicide | 0.0098 | 0.000095 | **0.032** | 0.00068 | ***22.1*** | ***28.6*** | 0.00015 | 0.00011 | 2.2 | 5.4 | **0.032** | AL,Meas SW |
| Tefluthrin | 79538-32-2 | Insecticide | **1.8** | 0.00025 | – | – | 0 | 0 | 0.0043 | – | 0 | 0 | **1.8** | AL,Pred SW |
| Tefluthrin metabolite [R 119364] | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Tefluthrin metabolite [R 152912] | NAV | Degradate | – | – | – | – | – | – | – | – | – | – | – | – |
| Terbacil | 5902-51-2 | Herbicide | **0.19** | 0.0044 | 0.0085 | 0.00048 | 4.2 | 0.9 | 0.0017 | 0.000078 | 0.8 | 1.4 | **0.19** | AL,Pred SW |
| Terbufos | 13071-79-9 | Insecticide | **11.0** | **0.16** | – | – | 0.2 | 0.1 | **0.44** | – | 0 | 0.2 | **11.0** | AL,Pred SW |
| Terbufos sulfone | 56070-16-7 | Degradate | **2.2** | – | – | – | – | – | – | – | – | – | **2.2** | AL,Pred SW |

**Table 5.** Benchmark quotients and detection frequencies for surface water and groundwater for Tier 1 pesticides and degradates in water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Surface water | | | | | | Groundwater | | | | Max BQ value | Max BQ value type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Predicted BQ | | Measured AG or UR BQ (max) | | Measured detection frequency, in percent | | Predicted BQ | Measured AG, UR or MX BQ (max) | Measured detection frequency, in percent | | | |
| | | | AL | HH | AL | HH | AG | UR | HH | HH | AG | UR | | |
| Terbufos-*O*-analogue sulfone | 56070-15-6 | Degradate | 0.0012 | – | – | – | 0 | 0.2 | – | – | 0.5 | 0 | 0.0012 | AL,Pred SW |
| Terbuthylazine | 5915-41-3 | Herbicide | – | – | – | – | 8.8 | ***17.3*** | – | – | 0 | 0 | – | – |
| Tetraconazole | 112281-77-3 | Fungicide | **0.013** | – | – | – | – | – | – | – | – | – | **0.013** | AL,Pred SW |
| Thiobencarb | 28249-77-6 | Herbicide | **0.23** | 0.00076 | **4.4** | 0.0015 | 4.7 | 0.7 | 0.0022 | – | 0.1 | 0.1 | **4.4** | AL,Meas SW |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | Degradate | – | – | – | – | 0 | 0 | – | – | 0 | – | – | – |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | See propiconazole | See propiconazole | – | – | ***16.3*** | ***17.2*** | See propiconazole | – | 0.4 | 0.7 | – | – |
| Triallate | 2303-17-5 | Herbicide | 0.0039 | 0.00041 | **0.032** | 0.0024 | 3.6 | 1.5 | 0.0086 | – | 0.1 | 0.09 | **0.032** | AL,Meas SW |
| Tribenuron-methyl | 101200-48-0 | Herbicide | 0.0025 | 0.0090 | – | – | – | – | **0.026** | – | – | – | **0.026** | HH,Pred GW |
| Tribuphos | 78-48-8 | Defoliant | **0.17** | 0.0076 | – | – | 0.2 | 0 | **0.027** | – | 0 | 0 | **0.17** | AL,Pred SW |
| Triclopyr | 55335-06-3 | Herbicide | **0.056** | 0.0026 | **0.034** | – | 6.3 | 9.9 | 0.00042 | – | 0 | 0.4 | **0.056** | AL,Pred SW |
| Trifloxystrobin | 141517-21-7 | Fungicide | **0.058** | 0.000092 | – | – | – | – | 0.00054 | – | – | – | **0.058** | AL,Pred SW |
| Trifluralin | 1582-09-8 | Herbicide | **0.72** | 0.00754 | **0.071** | 0.0010 | ***15*** | ***11.6*** | **0.013** | – | 0.7 | 0.6 | **0.72** | AL,Pred SW |
| Ziram | 137-30-4 | Fungicide | **0.012** | – | – | – | – | – | – | – | – | – | **0.012** | AL,Pred SW |

[1] Detection-frequency data in agricultural streams for chlorimuron-ethyl, flumetsulam, and nicosulfuron come from Battaglin and others (2000). Detection frequencies in parentheses for these three compounds correspond to detection frequency in the NAWQA agricultural streams dataset.

[2] Dicofol was evaluated using an AL benchmark based on a USEPA OPP chronic fish toxicity value of 1 µg/L, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 4.4 µg/L. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason dicofol was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

[3] Endothall was evaluated using an AL benchmark based on a USEPA OPP acute non-vascular plant toxicity value of 1.9 µg/L, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 1,300 µg/L for endothall acid (however there are lower benchmark values for other formulations of endothall, including a chronic invertebrate benchmark of 2.3 µg/L for the N,N-dimethylalkylamine salt). The resulting BQ using the new benchmark for endothall is less than 0.01. Because this is the only reason endothall was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

[4] Flumiclorac was evaluated using an AL benchmark based on a chronic fish toxicity value of 1.49 µg/L, estimated from ECOSAR, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include an acute fish benchmark of 550 µg/L for flumiclorac-pentyl. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason flumiclorac was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

**Table 6.** Counts summarizing the number of compounds that meet the criteria for Tier 1 for water.

[**Abbreviations:** AL, aquatic-life; BQ, benchmark quotient; DF, detection frequency; GW, groundwater; HH, human-health; SW, surface water; >, greater than; %, percent; –, none]

| Medium: | SW | | | | GW | | SW | GW | All Tier 1 compounds [1] |
|---|---|---|---|---|---|---|---|---|---|
| Criterion | Measured AL BQ | Predicted AL BQ | Measured HH BQ | Predicted HH BQ | Measured HH BQ | Predicted HH BQ | DF >10% | | |
| Number of pesticide compounds | 44 | 128 | 21 | 39 | 8 | 43 | 71 | 13 | 247 |
| Percent of compounds with concentrations and benchmarks available | 66 | 40 | 53 | 33 | 38 | 37 | – | – | 79 |

[1] Some pesticides meet more than one criteria for inclusion in Tier 1.

Tier 1 pesticide compounds include a diverse range of chemical classes—nearly 40 unique classes in all. Five classes account for more than half of the total compounds in Tier 1: organophosphates are 15 percent, and acetanilides, triazines, carbamates, and ureas make up about 9 percent each (*fig. 7*). Four more chemical classes, azoles, anilines, organochlorines, and pyrethroids raise this to almost 75 percent of Tier 1 compounds, with the remainder made up of compounds in various other chemical classes (*fig. 7*).

Overall, of the 247 pesticide compounds in Tier 1, 142, or 57 percent, were identified as high priority because of potential aquatic-life concerns; some of these compounds also could be high priority for human-health reasons (*tables 4* and *5*). Of the 142 compounds, 79 were classified on the basis of USEPA OPP's aquatic-life benchmarks, and two compounds—dieldrin and *p,p'*-DDE—on the basis of USEPA NRWQC for aquatic life.

Potential concern for human health was the basis for Tier 1 classification of 61, or 25 percent, of the pesticide compounds; however, some of these compounds also could be high priority for aquatic-life reasons (*tables 4* and *5*). Of the 61 compounds, 40 are unregulated in drinking water and had BQ values calculated from USGS HBSLs. Many of the Tier 1 pesticide compounds are included in several national regulatory programs related to drinking water. Of the compounds in Tier 1 for water, currently 12 are regulated in drinking water and have USEPA MCLs, and 29 compounds were included on USEPA's most recently (September 2009) finalized CCL3. Further, 23 compounds have been monitored through USEPA's UCM program and are included on the UCMR 1 or UCMR 2 lists (*appendix 3*).

## Other Important Compounds for Water–Tier 2

A total of 97 pesticide compounds that are not in Tier 1 were identified as Tier 2, or moderate priority, because they are priorities of other agencies or organizations (*appendix 3*). Of these, eight have USEPA MCLs, and ten are on USEPA's CCL3. While not meeting the criteria for Tier 1, these 18 compounds are considered higher priority for potential inclusion in analytical methods than other Tier 2 compounds because of their regulatory status or concern as potential drinking water contaminants (*table 4*). Five of the eight compounds that have MCLs (chlordane, endrin, heptachlor, heptachlor epoxide, and toxaphene) are organochlorine pesticides or degradates that also have USEPA NRWQC for aquatic life (*table 4* and *appendix 3*); however, these are hydrophobic compounds that are unlikely to be detected in water. Additional agency or organization priorities contributed to classification of pesticide compounds as Tier 2, as described in the "Methods" section, including 14 compounds on the AAPCO SFIREG state list of pesticides of water quality concern; 16 compounds that have USEPA NRWQC for the protection of aquatic life; 9 compounds that have specific objectives for aquatic life from the Great Lakes Water Quality Agreement; 10 compounds that have Canadian water-quality guidelines for aquatic life; and 45 compounds that have recent (1997–2008) active ingredient registration with USEPA.

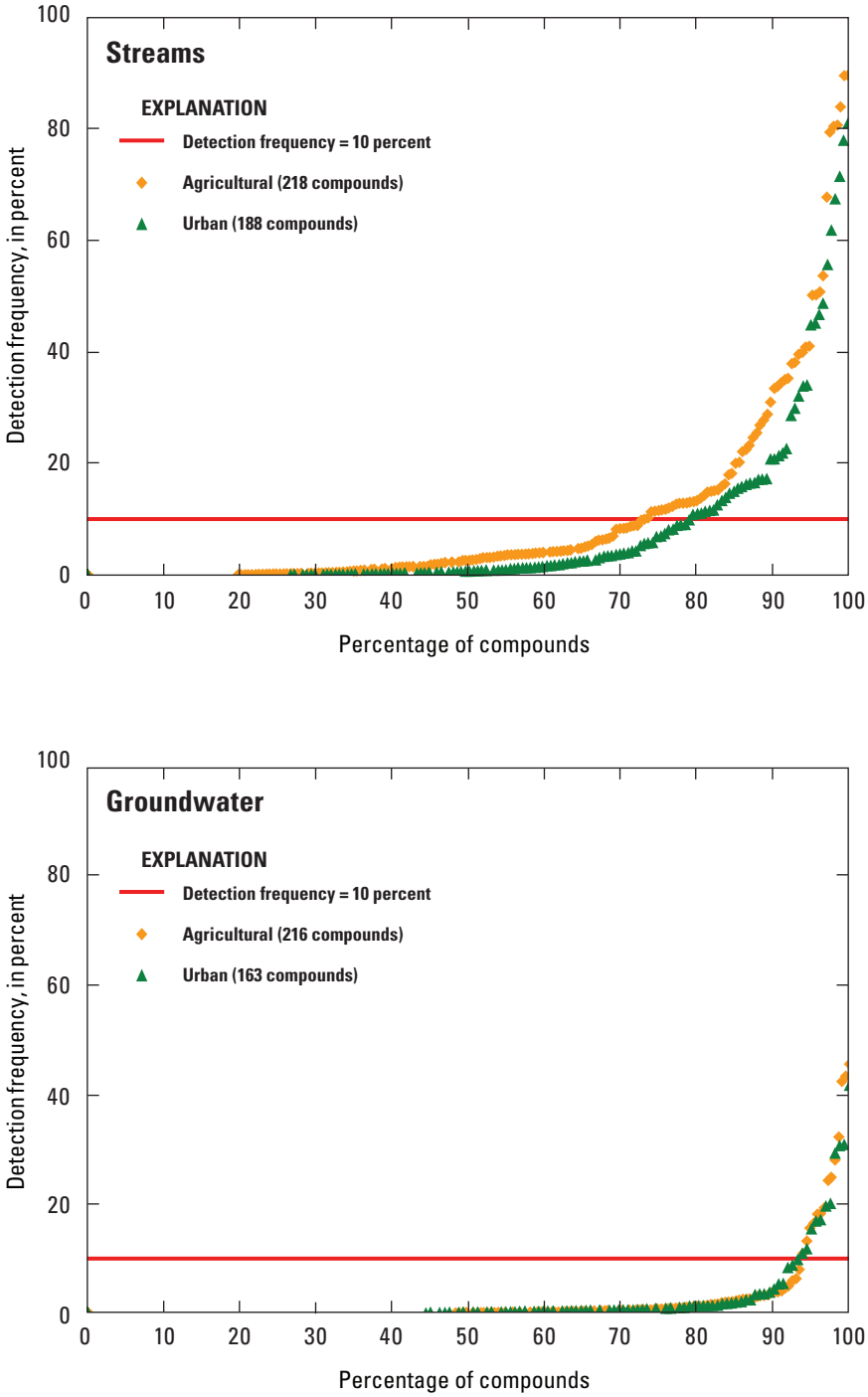


**Figure 5.** Detection-frequency distributions for surface-water and groundwater pesticide datasets.

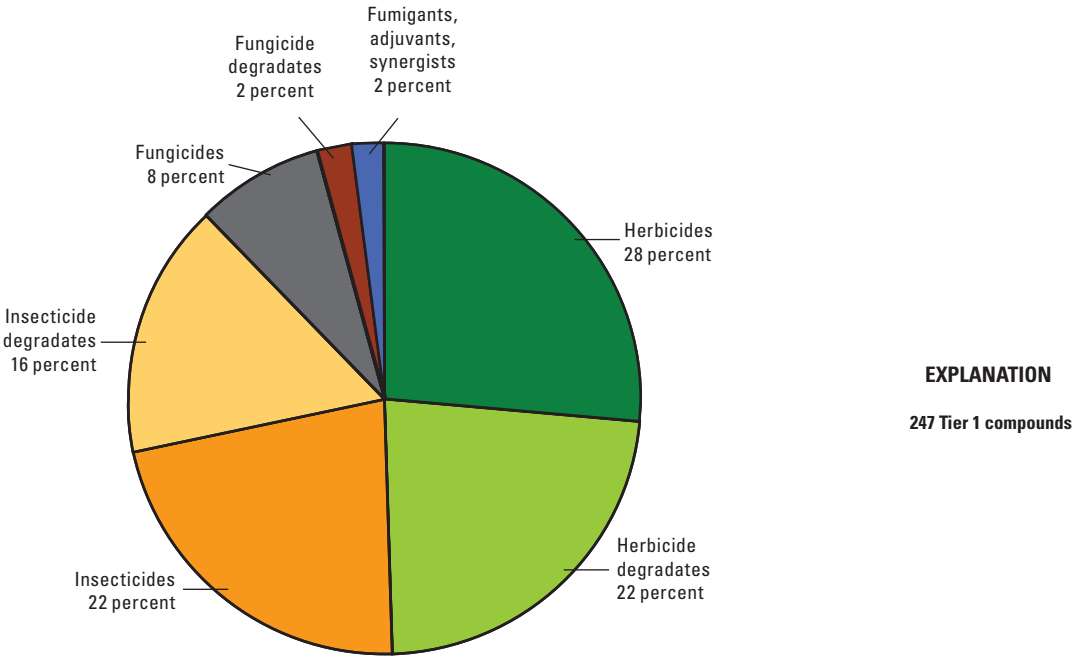


**Figure 6.** Distribution of Tier 1 pesticide compounds for water among pesticide-use groups.

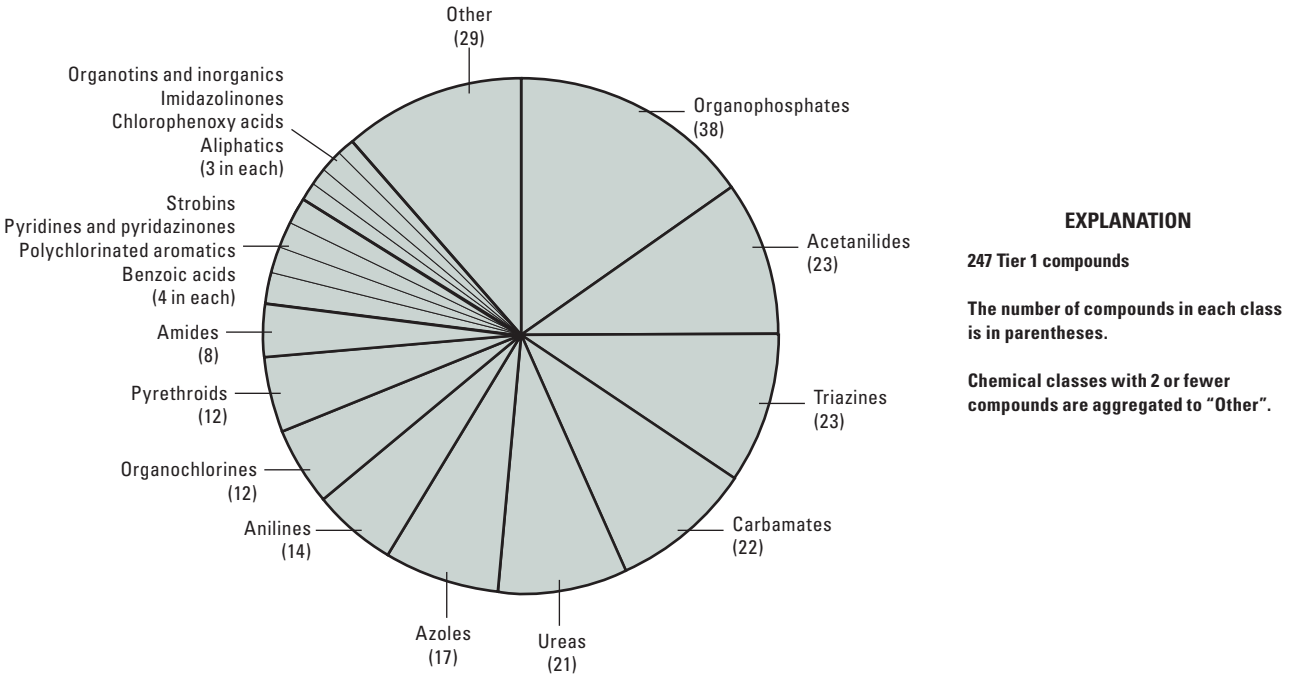


**Figure 7.** Breakdown of Tier 1 pesticide compounds for water by chemical class.

## Sediment

### Priority Pesticide Compounds for Sediment

A total of 175 pesticide and degradate compounds, 29 percent of the 611 compounds evaluated, were classified as Tier 1 for sediment and, thus, are high priority for inclusion in analytical methods available for monitoring and studies. More than 60 percent (106 compounds) of these compounds are included in some USGS analytical method; however, some are spread across several research methods that are expensive to perform, and monitoring data are not extensive for many compounds. The remaining about 40 percent, or 69 compounds, including 27 degradates, of Tier 1 compounds for sediment are high priority as new analytes. The objective for analytical methods development for sediment is to enhance an existing analytical method that currently includes nearly half of the pesticide compounds in Tier 1 by adding as many additional Tier 1 compounds that are analytically compatible. These high priority compounds are listed in *table 7*, along with the respective reasons for their Tier 1 status. The "Pathway to Tier 1" column in *table 7* corresponds to the pathways in the flow chart for sediment prioritization (*fig. 3* and *table 2*).

An additional 68 pesticide compounds did not meet the criteria for Tier 1 and were categorized as Tier 2 (moderate priority) according to the flow chart for the evaluation for sediment (*fig. 3* and *table 2*). The remaining 368 pesticide compounds were not identified as analytical priorities for sediment at this time and were placed in Tier 3.

### Basis for High Priority of Pesticide Compounds in Sediment

The reasons for the high priority status of the 175 Tier 1 pesticide compounds are summarized in *figure 8*. Broken down by the evaluation pathways (*fig. 3* and *table 2*), a total of 62 compounds, or 35 percent, are high priority on the basis of measured occurrence (*fig. 8* and *table 7*). *Table 8* summarizes sediment detection-frequency data for pesticide compounds from the three USGS datasets. Pesticide compounds in Tier 1 include 36 compounds that were frequently detected in USGS monitoring studies (pathway P1) and 26 that have a combination of moderate occurrence, potential toxicity to aquatic life, and pesticide use (pathway P2; *fig. 8* and *table 7*). Of the 36 frequently detected pesticide compounds, 17 are organochlorine pesticides or degradates, most of which are legacy compounds without current use. A total of 74 compounds, or 42 percent, are high priority on the basis of predicted likelihood of occurrence in sediment and either aquatic-life toxicity or pesticide use, or both (pathways P4 and P5; *fig. 8* and *table 7*). The remaining 39 pesticide compounds, or 22 percent, were placed in Tier 1 for sediment because they are degradates of Tier 1 parent compounds (pathway DEG1) or as a result of other factors (pathway OF1; *fig. 8* and *table 7*).

The thresholds and decision criteria used to classify pesticide compounds into tiers for sediment were intentionally conservative, resulting in a relatively large number of Tier 1 compounds, 175 in total. These compounds could be prioritized within the group according to program objectives, such as trends focusing on legacy PBTs, characterization of sediment toxicity, pesticide fate in sediments, or occurrence of current high-use pesticide compounds. The thresholds and decision criteria used in the prioritization procedure can be modified in order to focus on the highest priority compounds for a given objective. For example, a focus on trends of PBTs in sediment could give higher priority to pesticide compounds that are the most stable, hydrophobic, and toxic. Modifying the thresholds for these three parameters, as shown in *table 9* for example, would identify a higher priority group within Tier 1 with respect to this objective. Collectively, if these thresholds were modified as shown in *table 9*, there would be 107 higher priority pesticide compounds within Tier 1 for sediment, and 39 percent of Tier 1 compounds would be lower priority.

The distribution of Tier 1 pesticide compounds for sediment by pesticide-use group is shown in *figure 9*. As with water, Tier 1 for sediment includes compounds from the major pesticide-use groups. The largest single group accounts for 45 percent of the total and is composed of insecticides, including acaricides, and degradates. An additional 36 percent are herbicides, including defoliants and plant-growth regulators, and their degradates, and fungicides and degradates round out the remaining 19 percent of Tier 1 compounds (*fig. 9*). Collectively, pesticide degradates make up almost 30 percent of Tier 1 compounds, and three-quarters of those were included in Tier 1 because of their parent pesticide. The pesticide type, use group, for each Tier 1 compound is shown in *table 7*.

Tier 1 compounds for sediment are represented by a wide range of chemical classes—about 30 unique classes in all. Organochlorines and their degradates compose the largest group of Tier 1 compounds at 17 percent; other groups include azoles at 13 percent, anilines and anilides at 10 percent, and pyrethroids at 9 percent (*fig. 10*).

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2.* **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| 1,3-Dicarbamoyl-2,4,5,6-tetrachlorobenzene | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | DEG1 | Yes | – | AL, HL |
| 1-Carbamoyl-3-cyano-4-hydroxy-2,5,6-trichlorobenzene | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | DEG1 | Yes | – | – |
| 2-(4-*tert*-butylphenoxy)-Cyclohexanol | 1942-71-8 | Degradate | Propargite | Aliphatic alcohol | DEG1 | No | – | – |
| 2,6-Diethylaniline | 579-66-8 | Degradate | Alachlor | Aniline | DEG1 | Yes | USEPA HPV | – |
| 2-[(2-Ethyl-6-methylphenyl)amino]-1-propanol | 61520-53-4 | Degradate | Metolachlor | Aniline | DEG1 | No | – | HL |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | Degradate | Alachlor | Acetanilide degradate | DEG1 | Yes | – | $K_{ow}$, AL |
| 2-Chloro-*N*-(2-ethy l-6-methylphenyl)acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | Degradate | Acetochlor, metolachlor | Chloroacetanilide degradate | DEG1 | No | – | – |
| 2-Hydroxyatrazine | 2163-68-0 | Degradate | Atrazine | Triazine | DEG1 | No | SFIREG | – |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | Diuron | Aniline | P1 | Yes | USEPA HPV | $K_{ow}$, AL |
| 3,5-Dichloroaniline | 626-43-7 | Degradate | Iprodione | Aniline | DEG1 | Yes | – | $K_{ow}$, AL, HL |
| 3-Phenoxybenzoic acid | 3739-38-6 | Degradate | Cypermethrin (and other pyrethroids) | Benzoic acid | DEG1 | No | – | $K_{ow}$, AL |
| 3-Phenoxybenzyl alcohol | 13826-35-2 | Degradate | Permethrin | Diphenyl ether | DEG1 | No | USEPA HPV | – |
| 4-(Hydroxymethyl)pendimethalin | 56750-76-6 | Degradate | Pendimethalin | Dinitroaniline | DEG1 | No | – | AL |
| 4,4'-Dichlorobenzophenone | 90-98-2 | Degradate | *p,p'*-DDT, dicofol | Organochlorine | DEG1 | No | – | – |
| 4-Hydroxy-2,5,6-trichloroisophthalonitrile | NAV | Degradate | Chlorothalonil | Polychlorinated aromatic degradate | DEG1 | Yes | – | $K_{ow}$, AL, HL |
| Alachlor | 15972-60-8 | Herbicide | – | Chloroacetanilide | P2 | Yes | SFIREG | – |
| Alachlor ethane sulfonic acid (ESA), secondary amide | NAV | Degradate | Alachlor | Chloroacetanilide degradate | DEG1 | No | – | – |
| Alachlor sulfynilacetic acid (SAA) | 140939-16-8 | Degradate | Alachlor | Chloroacetanilide degradate | DEG1 | No | – | – |
| Aldrin | 309-00-2 | Insecticide | – | Organochlorine | P2 | Yes | USEPA PBT | – |
| Allethrin | 584-79-2 | Insecticide | – | Pyrethroid | P4 | Yes | – | – |
| *alpha*-Endosulfan | 959-98-8 | Insecticide | – | Organochlorine | P1 | Yes | – | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2.* **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | DEG1 & OF1 | Yes | USEPA GLI | $K_{ow}$, AL |
| Aminomethylphosphonic acid | 1066-51-9 | Degradate | Glyphosate | Degradate of amino acid derivative | P5 | Yes | – | AL |
| Atrazine | 1912-24-9 | Herbicide | – | Triazine | P2 | Yes | USEPA HPV, SFIREG | – |
| Benfluralin | 1861-40-1 | Herbicide | – | Dinitroaniline | P4 | Yes | – | HL |
| Benomyl | 17804-35-2 | Fungicide | – | Benzimidazole | P4 | No | – | – |
| Bensulide | 741-58-2 | Herbicide | – | Organophosphorous | P4 | No | – | AL |
| Benzyladenine | 1214-39-7 | Plant growth regulator | – | Botanical | P4 | No | – | AL, HL |
| *beta*-Endosulfan | 33213-65-9 | Insecticide | – | Organochlorine | P2 | Yes | – | – |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | P1 | Yes | USEPA GLI | – |
| Bifenthrin | 82657-04-3 | Insecticide | – | Pyrethroid | P1 | Yes | – | – |
| Bromuconazole | 116255-48-2 | Fungicide | – | Conazole | P4 | Yes | – | $K_{ow}$ |
| Buprofezin | 69327-76-0 | Insecticide | – | Unclassified | P4 | No | – | – |
| Butralin | 33629-47-9 | Herbicide | – | Dinitroaniline | P4 | No | – | – |
| Chlordane | 57-74-9 | Insecticide | – | Organochlorine | P1 | Yes | USEPA PBT, GLI | – |
| Chlorothalonil | 1897-45-6 | Fungicide | – | Polychlorinated aromatic | P2 | Yes | SFIREG | – |
| Chlorpyrifos | 2921-88-2 | Insecticide | – | Organophosphate | P1 | Yes | SFIREG | – |
| *cis*-Chlordane | 5103-71-9 | Insecticide | – | Organochlorine | P1 | Yes | USEPA GLI | – |
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | c61898-95-1 | Degradate | Cyfluthrin | Aliphatic acid ester | DEG1 | No | – | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2*. **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| *cis*-Nonachlor | 5103-73-1 | Insecticide; component of total chlordane, by-product of technical chlordane | – | Organochlorine | P1 | Yes | – | – |
| *cis*-Permethrin | 61949-76-6 | Insecticide | – | Pyrethroid | P1 | Yes | – | – |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | – | Conazole | P4 | Yes | – | AL |
| Clofentezine | 74115-24-5 | Insecticide | – | Tetrazine | P4 | No | – | AL |
| Copper hydroxide | 20427-59-2 | Fungicide/ microbiocide/ nematicide | – | Inorganic copper | P5 | Yes | – | AL |
| Copper sulfate | 7758-98-7 | Fungicide/ algaecide/ molluscicide | – | Inorganic copper | P4 | Yes | – | – |
| Coumafos | 56-72-4 | Insecticide/ acaricide | – | Organophosphorous | P4 | No | – | – |
| Cyfluthrin | 68359-37-5 | Insecticide | – | Pyrethroid | P2 | Yes | – | – |
| Cyhalothrin-*gamma* | 76703-62-3 | Insecticide | – | Pyrethroid | P1 | Yes | – | – |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | – | Pyrethroid | P1 | Yes | SFIREG | – |
| Cypermethrin | 52315-07-8 | Insecticide | – | Pyrethroid | P2 | Yes | – | – |
| Cyproconazole | 94361-06-5 | Fungicide | – | Conazole | P2 | Yes | – | AL |
| Cyprodinil | 121552-61-2 | Fungicide | – | Pyrimidine | P4 | Yes | – | HL |
| Cytokinins | 525-79-1 | Plant growth regulator | – | Botanical | P4 | No | – | AL |
| Dacthal | 1861-32-1 | Herbicide | – | Chlorobenzoic acid ester | P1 | Yes | SFIREG | – |
| Dacthal monoacid | 887-54-7 | Degradate | Dacthal | Chlorobenzoic acid ester | DEG1 | No | SFIREG | $K_{ow}$, AL |
| Dechloroalachlor | NAV | Degradate | Alachlor | Chloroacetanilide degradate | DEG1 | No | – | – |
| Dechlorometolachlor | NAV | Degradate | Metolachlor | Chloroacetanilide degradate | DEG1 | No | – | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2.* **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| Deethylhydroxyatrazine | NAV | Degradate | Atrazine, cyanazine, simazine | Triazine | DEG1 | No | – | – |
| Deisopropyl prometryn | NAV | Degradate | Prometryn | Triazine | DEG1 | No | – | – |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | Organochlorine | P1 | Yes | USEPA GLI | – |
| Desulfinylfipronil (MB46513) | NAV | Degradate | Fipronil | Phenylpyrazole degradate | DEG1 | Yes | – | – |
| Desulfinylfipronil amide (RPA 105048) | NAV | Degradate | Fipronil | Phenylpyrazole degradate | DEG1 | Yes | – | – |
| Diazinon | 333-41-5 | Insecticide | – | Organothiophosphate | P2 | Yes | SFIREG | – |
| Dicofol | 115-32-2 | Insecticide | – | Organochlorine | P4 | No | – | – |
| Dieldrin | 60-57-1 | Insecticide | – | Organochlorine | P1 | Yes | USEPA GLI | – |
| Difenconazole | 119446-68-3 | Fungicide | – | Conazole | P4 | Yes | – | AL |
| Difenzoquat | 49866-87-7 | Herbicide | – | Pyrazole | P4 | No | – | AL |
| Diquat | 85-00-7 | Herbicide | – | Bipyridylium | P4 | No | – | – |
| Disulfoton | 298-04-4 | Insecticide | – | Organothiophosphate | P4 | Yes | – | HL |
| Dithiopyr | 97886-45-8 | Herbicide | – | Pyridine | P4 | No | – | – |
| Diuron | 330-54-1 | Herbicide | – | Urea | OF1 | No | USEPA HPV, SFIREG | $K_{ow}$ |
| Emamectin | 155569-91-8 | Insecticide | – | Botanical, avermectin | P4 | No | – | – |
| Endosulfan | 115-29-7 | Insecticide | – | Organochlorine | P1 | Yes | SFIREG | – |
| Endosulfan ether | 3369-52-6 | Degradate | *alpha*-Endosulfan | Organochlorine | DEG1 | No | – | – |
| Endosulfan sulfate | 1031-07-8 | Degradate | Endosulfan | Organochlorine | DEG1 | Yes | – | – |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | – | Thiocarbamate | P1 | Yes | – | – |
| Esfenvalerate | 66230-04-4 | Insecticide | – | Pyrethroid | P1 | Yes | SFIREG | – |
| Ethalfluralin | 55283-68-6 | Herbicide | – | Dinitroaniline | P2 | Yes | – | – |
| Fenarimol | 60168-88-9 | Fungicide | – | Pyrimidine | P4 | Yes | – | $K_{ow}$, AL |
| Fenbuconazole | 114369-43-6 | Fungicide | – | Conazole | P4 | Yes | – | AL |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2*. **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| Fenbutatin oxide | 13356-08-6 | Insecticide | – | Organotin | P4 | No | – | – |
| Fenpropathrin | 39515-41-8 | Insecticide | – | Pyrethroid | P2 | Yes | – | – |
| Fenpyroximate | 134098-61-6 | Insecticide | – | Pyrazole | P4 | No | – | AL, HL |
| Fenthion | 55-38-9 | Insecticide | – | Organophosphorous | P4 | Yes | – | HL |
| Fenthion sulfone oxygen analog | NAV | Degradate | Fenthion | Organophosphorous | DEG1 | No | – | – |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/ herbicide | – | Organotin | P4 | No | USEPA HPV | – |
| Fenvalerate | 51630-58-1 | Insecticide | – | Pyrethroid | P4 | No | – | HL |
| Fipronil | 120068-37-3 | Insecticide | – | Phenylpyrazole | P2 | Yes | – | – |
| Fipronil sulfide | 120067-83-6 | Degradate | Fipronil | Phenylpyrazole degradate | DEG1 | Yes | – | – |
| Fipronil sulfone | 120068-36-2 | Degradate | Fipronil | Phenylpyrazole degradate | P2 | Yes | – | AL |
| Fluazinam | 79622-59-6 | Fungicide | – | Pyridine | P4 | Yes | – | – |
| Fludioxonil | 131341-86-1 | Fungicide | – | Pyrrole | P4 | Yes | – | AL |
| Flufenacet | 142459-58-3 | Herbicide | – | Anilide | P4 | No | – | $K_{ow}$, AL, HL |
| Flufenacet ESA | NAV | Degradate | Flufenacet | Anilide degradate -sulfonic acid | DEG1 | No | – | – |
| Flufenacet oxanilic acid (OA) | NAV | Degradate | Flufenacet | Anilide degradate -oxanilic acid | DEG1 | No | – | HL |
| Flumetralin | 62924-70-3 | Plant growth regulator | – | Dinitroaniline | P4 | No | – | – |
| Flutolanil | 66332-96-5 | Fungicide | – | Anilide | P4 | No | – | $K_{ow}$, AL |
| *gamma*-HCH | 58-89-9 | Insecticide | – | Organochlorine | P1 | Yes | USEPA GLI, SFIREG | – |
| Glyphosate | 1071-83-6 | Herbicide | – | Amino acid derivative | P4 | Yes | SFIREG | AL, HL |
| Heptachlor | 76-44-8 | Insecticide | – | Organochlorine | P2 | Yes | USEPA PBT | – |
| Heptachlor epoxide | 1024-57-3 | Degradate | Heptachlor | Organochlorine | P1 | Yes | – | – |
| Hexachlorobenzene | 118-74-1 | Insecticide | – | Organochlorine | P2 | Yes | – | – |
| Hydroxyalachlor | NAV | Degradate | Alachlor | Chloroacetanilide degradate | DEG1 | No | – | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2.* **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| Hydroxymetolachlor | 131068-72-9 | Degradate | Metolachlor | Chloroacetanilide degradate | DEG1 | No | – | – |
| Imazamox | 114311-32-9 | Herbicide | – | Imidazolinone | P4 | No | – | – |
| Iprodione | 36734-19-7 | Fungicide | – | Dicarboximide | P1 | Yes | – | – |
| Isoxaben | 82558-50-7 | Herbicide | – | Amide | P4 | No | – | $K_{ow}$ |
| Kresoxim-methyl | 143390-89-0 | Fungicide | – | Strobin | P4 | Yes | – | $K_{ow}$ |
| Metconazole | 125116-23-6 | Fungicide | – | Conazole | P4 | Yes | – | AL |
| Methoxychlor | 72-43-5 | Insecticide | – | Organochlorine | P2 | Yes | USEPA PBT | – |
| Methoxyfenozide | 161050-58-4 | Insecticide | – | Diacylhydrazine | P4 | No | – | $K_{ow}$ |
| Metolachlor | 51218-45-2 | Herbicide | – | Chloroacetanilide | P1 | Yes | SFIREG | – |
| Mirex | 2385-85-5 | Insecticide | – | Organochlorine | P2 | Yes | USEPA GLI | – |
| Myclobutanil | 88671-89-0 | Fungicide | – | Conazole | P1 | Yes | – | – |
| Naphthylacetamide | 86-86-2 | Plant growth regulator | – | Botanical, naphthalene acetic acid derivative | P4 | Yes | – | AL |
| Napropamide | 15299-99-7 | Herbicide | – | Amide | P2 | Yes | SFIREG | AL |
| Novaluron | 116714-46-6 | Herbicide | – | Benzoylurea | P4 | No | – | – |
| *o,p′*-DDD (*o,p′*-Dichlorodiphenyl-dichloroethane) | 53-19-0 | Degradate | DDT | Organochlorine | P1 | Yes | USEPA GLI | – |
| *o,p′*-DDE (*o,p′*-Dichlorodiphenyl-dichloroethylene) | 3424-82-6 | Degradate | DDT | Organochlorine | P2 | Yes | USEPA GLI | – |
| *o,p′*-DDT (*o,p′*-Dichlorodiphenyl-trichloroethane) | 789-02-6 | Degradate | DDT | Organochlorine | P2 | Yes | USEPA GLI | – |
| Oryzalin | 19044-88-3 | Herbicide | – | Dinitroaniline | P4 | No | – | $K_{ow}$ |
| Oxadiazon | 19666-30-9 | Herbicide | – | Oxadiazolone | P4 | No | – | – |
| Oxychlordane | 27304-13-8 | Degradate; component of total chlordane | Chlordane | Organochlorine | P1 | Yes | – | – |
| Oxyfluorfen | 42874-03-3 | Herbicide | – | Diphenyl ether | P1 | Yes | – | – |
| *p,p′*-DDD | 72-54-8 | Degradate | DDT | Organochlorine | P1 | Yes | USEPA GLI | – |
| *p,p′*-DDE | 72-55-9 | Degradate | DDT | Organochlorine | P1 | Yes | USEPA GLI | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2*. **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| *p,p'*-DDT | 50-29-3 | Insecticide/ acaricide | – | Organochlorine | P1 | Yes | USEPA GLI | – |
| Paclobutrazol | 76738-62-0 | Plant growth regulator | – | Azole | P4 | No | – | $K_{ow}$, AL |
| Paraquat | 4685-14-7 | Herbicide | – | Bipyridylium | P4 | Yes | – | – |
| Parathion-methyl | 298-00-0 | Insecticide | – | Organothiophosphate | P2 | Yes | – | – |
| PCNB (Pentachloronitrobenzene) | 82-68-8 | Fungicide | – | Substituted benzene | P4 | Yes | – | AL |
| Pebulate | 1114-71-2 | Herbicide | – | Thiocarbamate | P2 | Yes | – | AL |
| Pendimethalin | 40487-42-1 | Herbicide | – | Dinitroaniline | P1 | Yes | USEPA PBT, SFIREG | – |
| Pentachloroanisole | 1825-21-4 | Degradate | Pentachlorophenol | Substituted benzene | P2 | Yes | – | – |
| Permethrin | 52645-53-1 | Insecticide | – | Pyrethroid | P1 | Yes | – | – |
| Phenmedipham | 13684-63-4 | Herbicide | – | Carbamate | P4 | No | – | $K_{ow}$, AL, HL |
| Phorate | 298-02-2 | Insecticide | – | Organothiophosphate | P4 | Yes | – | $K_{ow}$ |
| Prodiamine | 29091-21-2 | Herbicide | – | Dinitroaniline | P4 | No | – | AL |
| Prometryn | 7287-19-6 | Herbicide | – | Triazine | P1 | Yes | SFIREG | $K_{ow}$ |
| Pronamide | 23950-58-5 | Herbicide | – | Amide | P4 | Yes | – | $K_{ow}$, AL |
| Propargite | 2312-35-8 | Insecticide | – | Sulfite ester | P4 | Yes | – | – |
| Propiconazole | 60207-90-1 | Fungicide | – | Conazole | P4 | Yes | SFIREG | $K_{ow}$, AL |
| Pymetrozine | 123312-89-0 | Insecticide | – | Pyridine azomethines | P4 | No | – | HL |
| Pyraclostrobin | 175013-18-0 | Fungicide | – | Strobin | P4 | Yes | – | – |
| Pyridaben | 96489-71-3 | Insecticide | – | Pyridazinone | P4 | No | – | – |
| Quinclorac | 84087-01-4 | Herbicide | – | Quinolinecarboxylic acid | P4 | No | – | AL |
| Quinoxyfen | 124495-18-7 | Fungicide | – | Quinoline | P4 | No | – | AL |
| Sabadilla | 8051-02-3 | Insecticide | – | Botanical | P4 | No | – | AL |
| *S*-Metolachlor | 87392-12-9 | Herbicide | – | Chloroacetanilide | P1 | No | – | – |
| TCPSA (Trichloropropene sulfonic acid) | 65600-62-6 | Degradate | Triallate | Sulfonic acid ester | DEG1 | No | – | – |
| Tebuconazole | 107534-96-3 | Fungicide | – | Conazole | P4 | Yes | – | $K_{ow}$, AL |
| Tebufenozide | 112410-23-8 | Insecticide | – | Diacylhydrazine | P4 | No | – | AL |
| Tebupirimfos | 96182-53-5 | Insecticide | – | Organothiophosphate | P4 | No | – | – |
| Tebupirimfos oxygen analogue | NAV | Degradate | Tebupirimfos | Organophosphate | DEG1 | No | – | – |

**Table 7.** Tier 1 pesticides and degradates in sediment with pathways for tier placement.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Pathways to Tier 1 refer to the flow chart in *figure 3* and are described in detail in *table 2.* **Abbreviations:** AL, aquatic-life toxicity; CAS, Chemical Abstracts Service; DEG, degradate; GLI, Great Lakes Initiative; HL, soil half-life; HPV, high production volume chemical; $K_{ow}$, octanol-water partition coefficient; NAV, not available; OF, other factors; PBT, persistent, bioaccumulative and toxic; SFIREG, State-FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Issues Research & Evaluation Group; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Chemical class | Pathway to Tier 1 | On a USGS sediment method? | Other agency priority | Indicator for modifying thresholds shown in *table 9* |
|---|---|---|---|---|---|---|---|---|
| Tefluthrin | 79538-32-2 | Insecticide | – | Pyrethroid | P4 | Yes | – | HL |
| Tefluthrin metabolite [R 119364] | NAV | Degradate | Tefluthrin | Pyrethroid | DEG1 | No | – | – |
| Tefluthrin metabolite [R 152912] | NAV | Degradate | Tefluthrin | Pyrethroid | DEG1 | No | – | – |
| Terbuthylazine | 5915-41-3 | Herbicide | – | Triazine | P2 | Yes | USEPA HPV | AL |
| Tetraconazole | 112281-77-3 | Fungicide | – | Conazole | P1 | Yes | – | – |
| Tetradifon | 116-29-0 | Acaricide | – | Bridged diphenyl | P4 | Yes | – | AL |
| Thiazopyr | 117718-60-2 | Herbicide | – | Pyridine | P4 | No | – | $K_{ow}$, AL |
| Thiobencarb | 28249-77-6 | Herbicide | – | Thiocarbamate | P2 | Yes | – | – |
| *trans*-Chlordane | 5103-74-2 | Insecticide | – | Organochlorine | P1 | Yes | USEPA GLI | – |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | Degradate | Cyfluthrin | Aliphatic acid ester | DEG1 | No | – | – |
| *trans*-Nonachlor | 39765-80-5 | Insecticide; component of total chlordane, by-product of technical chlordane | – | Organochlorine | P1 | Yes | – | – |
| *trans*-Permethrin | 61949-77-7 | Insecticide | – | Pyrethroid | P2 | Yes | – | – |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | – | Conazole | P4 | Yes | – | AL |
| Triadimenol | 55219-65-3 | Fungicide | – | Conazole | P4 | Yes | – | $K_{ow}$, AL |
| Triallate | 2303-17-5 | Herbicide | – | Thiocarbamate | P4 | No | SFIREG | AL |
| Tribuphos | 78-48-8 | Defoliant | – | Organothiophosphate | P4 | Yes | – | – |
| Triclopyr | 55335-06-3 | Herbicide | – | Chloropyridinyl | P4 | No | SFIREG | AL, HL |
| Trifluralin | 1582-09-8 | Herbicide | – | Dinitroaniline | P1 | Yes | USEPA PBT, SFIREG | – |
| Uniconazole | 83657-17-4 | Plant growth regulator | – | Conazole | P4 | No | – | $K_{ow}$, AL |
| Vinclozolin | 50471-44-8 | Fungicide | – | Dicarboximide | P4 | Yes | – | $K_{ow}$, AL, HL |
| *zeta*-Cypermethrin | 69865-47-0 | Insecticide | – | Pyrethroid | P4 | Yes | – | – |

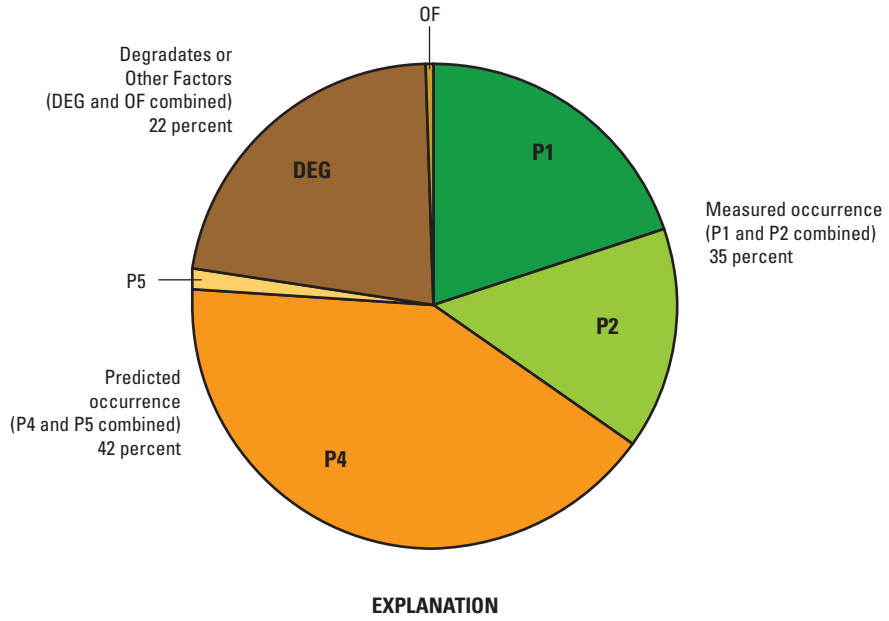


**Figure 8.** Breakdown of Tier 1 pesticide compounds for sediment by reason for high priority.

Some of the Tier 1 pesticide compounds for sediment are included in national regulatory or other programs that are not necessarily sediment-specific. These include six compounds that are listed as USEPA Toxics Release Inventory PBT chemicals, and fifteen that are listed as bioaccumulative chemicals of concern in the Great Lakes (USEPA Great Lakes Initiative; *table 7*). A total of nineteen Tier 1 compounds have at least one sediment benchmark for aquatic organisms. Additionally, 22 compounds are listed on the AAPCO SFIREG state list of pesticides of water-quality concern. And finally, seven compounds are USEPA high production volume (HPV) chemicals (*table 7*).

Of the 175 compounds in Tier 1 for sediment, 45 percent are very highly toxic to aquatic organisms (as defined by USEPA, *http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm*); these correspond to compounds in AL Toxicity Bin 1 (*appendix 4*). An additional 32 percent are in AL Toxicity Bin 2. Together, more than three-quarters of Tier 1 pesticide compounds were classified as "high" toxicity as defined for this evaluation (*fig. 3* and *appendix 4*).

## Other Important Compounds for Sediment–Tier 2

An additional 68 pesticide compounds did not meet the criteria for Tier 1, but were categorized as Tier 2 (moderate priority). Of these 68 pesticide compounds, only 3 were categorized as such on the basis of moderate measured occurrence (pathways P6a and P6b), whereas 46 compounds were included on the basis of predicted likelihood for occurrence in sediment but have low, or unknown, toxicity or no current use (pathways P8a and P8b; *fig. 3* and *table 2*). Another 19 compounds had other factors that elevated them from low priority (Tier 3) or downgraded them from high priority (Tier 1), or were degradates of parent pesticide compounds in the same tier.

**Table 8.** Detection-frequency data for pesticide compounds in sediment from three U.S. Geological Survey (USGS) datasets.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates detection frequency greater than 10 percent. ***Bold italic*** indicates detection frequency of 1 to 10 percent. Sediment occurrence data sets are tabulated in Appendixes 10–12. **Abbreviations**: AG, agricultural land use; CAS, Chemical Abstracts Service; DEG, degradate; DF, detection frequency; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (USGS); OF, other factors; P, pathway; Toxics, Toxic Substances Hydrology Program (USGS); UR, urban land use; USGS, U.S. Geological Survey; >, greater than; –, not applicable; <, less than]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Tier | Sediment detection frequency range (in percent) | Detection frequency, in percent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NAWQA stream-bed sediment | | | NAWQA lake core sediment (144–155 samples) | Toxics stream-bed and suspended sediment (21–274 samples) |
| | | | | | | AG (215–242 samples) | UR (71–125 samples) | MX (235–361 samples) | | |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | Diuron | 1 | >10 | – | – | – | – | **13.6** |
| Alachlor | 15972-60-8 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | 1.3 |
| Aldrin | 309-00-2 | Insecticide | – | 1 | 1 to 10 | 0.84 | ***3.6*** | 0.57 | ***1.9*** | – |
| Allethrin | 584-79-2 | Insecticide | – | 1 | <1 | – | – | – | – | 0 |
| *alpha*-Endosulfan (Endosulfan I) | 959-98-8 | Insecticide | – | 1 | >10 | ***1.29*** | ***2.91*** | ***2.42*** | – | **17.9** |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | 1 | <1 | 0 | 0.92 | 0 | – | – |
| Atrazine | 1912-24-9 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***3.4*** |
| Azinphos-methyl | 86-50-0 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| *beta*-Endosulfan (Endosulfan II) | 33213-65-9 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***8.3*** |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | 1 | >10 | 0 | 0 | 0.60 | – | **29.2** |
| Bifenthrin | 82657-04-3 | Insecticide | – | 1 | >10 | – | – | – | – | **41.9** |
| Butylate | 2008-41-5 | Herbicide | – | 3 | <1 | – | – | – | – | 0 |
| Carbaryl | 63-25-2 | Insecticide | – | 2 | 1 to 10 | – | – | – | – | ***4.0*** |
| Carbofuran | 1563-66-2 | Insecticide | – | 2 | 1 to 10 | – | – | – | – | ***1.3*** |
| Chlordane | 57-74-9 | Insecticide | – | 1 | >10 | ***7.59*** | **68.0** | **26.69** | **67.7** | – |
| Chloroneb | 2675-77-6 | Fungicide | – | 3 | <1 | 0 | 0 | 0 | – | – |
| Chlorothalonil | 1897-45-6 | Fungicide | – | 1 | 1 to 10 | – | – | – | – | ***8.3*** |
| Chlorpyrifos | 2921-88-2 | Insecticide | – | 1 | >10 | – | – | – | – | **32.7** |
| *cis*-Chlordane (*alpha*-Chlordane) | 5103-71-9 | Insecticide | – | 1 | >10 | ***2.56*** | **60.48** | **21.08** | – | **37.5** |
| *cis*-Nonachlor | 5103-73-1 | Insecticide; component of total chlordane, by-product of technical chlordane | – | 1 | >10 | ***2.11*** | **34.48** | **10.76** | – | **12.5** |

**Table 8.** Detection-frequency data for pesticide compounds in sediment from three U.S. Geological Survey (USGS) datasets.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates detection frequency greater than 10 percent. ***Bold italic*** indicates detection frequency of 1 to 10 percent. Sediment occurrence data sets are tabulated in Appendixes 10–12. **Abbreviations**: AG, agricultural land use; CAS, Chemical Abstracts Service; DEG, degradate; DF, detection frequency; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (USGS); OF, other factors; P, pathway; Toxics, Toxic Substances Hydrology Program (USGS); UR, urban land use; USGS, U.S. Geological Survey; >, greater than; –, not applicable; <, less than

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Tier | Sediment detection frequency range (in percent) | Detection frequency, in percent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NAWQA stream-bed sediment | | | NAWQA lake core sediment (144–155 samples) | Toxics stream-bed and suspended sediment (21–274 samples) |
| | | | | | | AG (215–242 samples) | UR (71–125 samples) | MX (235–361 samples) | | |
| *cis*-Permethrin | 61949-76-6 | Insecticide | – | 1 | 1 to 10 (also see permethrin) | ***1.83*** | ***2.82*** | 0 | – | **36.4** |
| Cyanazine | 21725-46-2 | Herbicide | – | 3 | <1 | – | – | – | – | 0 |
| Cycloate | 1134-23-2 | Herbicide | – | 3 | <1 | – | – | – | – | 0 |
| Cyfluthrin | 68359-37-5 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***5.1*** |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | – | 1 | >10 | – | – | – | – | **19.6** |
| Cypermethrin | 52315-07-8 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***3.5*** |
| Cyproconazole | 94361-06-5 | Fungicide | – | 1 | 1 to 10 | – | – | – | – | ***4.2*** |
| Dacthal (DCPA) | 1861-32-1 | Herbicide | – | 1 | >10 | ***2.12*** | 0 | 0.29 | – | **21.6** |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | *gamma*-HCH (and other HCH isomers) | 1 | >10 | – | – | – | – | **12.5** |
| Deltamethrin | 52918-63-5 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| Desulfinylfipronil (MB46513) | NAV | Degradate | Fipronil | 1 | <1 | – | – | – | – | 0 |
| Diazinon | 333-41-5 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***8.3*** |
| Dieldrin | 60-57-1 | Insecticide | – | 1 | >10 | **16.95** | **42.02** | **16.05** | **44.5** | **91.7** |
| Diethatyl | 38727-55-8 | Herbicide | – | 3 | <1 | – | – | – | – | 0 |
| Endosulfan | 115-29-7 | Insecticide | – | 1 | >10 (see *alpha*-endosulfan) | – | – | – | 0 | – |
| Endrin | 72-20-8 | Insecticide/ avicide | – | 2 | 1 to 10 | ***1.28*** | 0.91 | 0 | 0 | – |
| EPTC (S-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | – | 1 | >10 | – | – | – | – | **13.0** |
| Esfenvalerate | 66230-04-4 | Insecticide | – | 1 | >10 | – | – | – | – | **13.6** |
| Ethalfluralin | 55283-68-6 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***7.7*** |
| Fenpropathrin | 39515-41-8 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***5.1*** |
| Fipronil | 120068-37-3 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***1.1*** |
| Fipronil sulfide | 120067-83-6 | Degradate | Fipronil | 1 | 1 to 10 | – | – | – | – | ***4.7*** |
| Fipronil sulfone | 120068-36-2 | Degradate | Fipronil | 1 | 1 to 10 | – | – | – | – | ***3.3*** |
| Fluvalinate-tau | 102851-06-9 | Insecticide | – | 2 | 1 to 10 | – | – | – | – | ***3.4*** |
| Fonofos | 944-22-9 | Insecticide | – | 2 | <1 | – | – | – | – | 0 |

**Table 8.** Detection-frequency data for pesticide compounds in sediment from three U.S. Geological Survey (USGS) datasets.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates detection frequency greater than 10 percent. ***Bold italic*** indicates detection frequency of 1 to 10 percent. Sediment occurrence data sets are tabulated in Appendixes 10–12. **Abbreviations**: AG, agricultural land use; CAS, Chemical Abstracts Service; DEG, degradate; DF, detection frequency; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (USGS); OF, other factors; P, pathway; Toxics, Toxic Substances Hydrology Program (USGS); UR, urban land use; USGS, U.S. Geological Survey; >, greater than; –, not applicable; <, less than

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Tier | Sediment detection frequency range (in percent) | Detection frequency, in percent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NAWQA stream-bed sediment | | | NAWQA lake core sediment (144–155 samples) | Toxics stream-bed and suspended sediment (21–274 samples) |
| | | | | | | AG (215–242 samples) | UR (71–125 samples) | MX (235–361 samples) | | |
| *gamma*-HCH | 58-89-9 | Insecticide | – | 1 | >10 | ***1.29*** | ***1.83*** | 0.30 | 0.6 | **16.7** |
| Heptachlor | 76-44-8 | Insecticide | – | 1 | 1 to 10 | 0 | ***5.36*** | 0 | ***5.2*** | – |
| Heptachlor epoxide | 1024-57-3 | Degradate | Heptachlor | 1 | >10 | 0.85 | **10.91** | 0.89 | ***7.7*** | – |
| Hexachlorobenzene | 118-74-1 | Insecticide | – | 1 | 1 to 10 | ***4.98*** | ***8.42*** | ***3.10*** | – | – |
| Hexazinone | 51235-04-2 | Herbicide | – | 2 | 1 to 10 | – | – | – | – | ***1.3*** |
| Iprodione | 36734-19-7 | Fungicide | – | 1 | >10 | – | – | – | – | **17.7** |
| Isodrin | 465-73-6 | Insecticide | – | 3 | <1 | 0 | 0 | 0 | – | – |
| Malathion | 121-75-5 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| Methidathion | 950-37-8 | Insecticide | – | 3 | <1 | – | – | – | – | 0.6 |
| Methoprene | 40596-69-8 | Insecticide | – | 2 | 1 to 10 | – | – | – | – | ***2.2*** |
| Methoxychlor (*p,p′*-Methoxychlor) | 72-43-5 | Insecticide | – | 1 | 1 to 10 | 0.44 | ***2.13*** | 0 | ***2.8*** | – |
| Metolachlor | 51218-45-2 | Herbicide | – | 1 | >10 | – | – | – | – | **27.8** |
| Mirex | 2385-85-5 | Insecticide | – | 1 | 1 to 10 | ***2.93*** | ***1.82*** | ***2.61*** | ***4.2*** | – |
| Molinate | 2212-67-1 | Herbicide | – | 2 | 1 to 10 | – | – | – | – | ***2.2*** |
| Myclobutanil | 88671-89-0 | Fungicide | – | 1 | >10 | – | – | – | – | **12.5** |
| Napropamide | 15299-99-7 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***5.1*** |
| *o,p′*-DDD (*o,p′*-Dichlorodiphenyl-dichloroethane) | 53-19-0 | Degradate | DDT | 1 | >10 | ***7.31*** | **27.72** | ***8.50*** | – | – |
| *o,p′*-DDE (*o,p′*-Dichlorodiphenyl-dichloroethylene) | 3424-82-6 | Degradate | DDT | 1 | 1 to 10 | ***3.0*** | ***5.83*** | ***1.23*** | – | – |
| *o,p′*-DDT (*o,p′*-Dichlorodiphenyl-trichloroethane) | 789-02-6 | Degradate | DDT | 1 | 1 to 10 | ***5.0*** | ***5.83*** | ***4.08*** | – | – |
| *o,p′*-Methoxychlor | 30667-99-3 | Insecticide | – | 3 | <1 | 0 | 0 | 0 | – | – |
| Oxychlordane | 27304-13-8 | Degradate; component of total chlordane | Chlordane | 1 | >10 | 0.43 | **10.09** | 0.89 | – | – |
| Oxyfluorfen | 42874-03-3 | Herbicide | – | 1 | >10 | – | – | – | – | **30.2** |
| *p,p′*-DDD | 72-54-8 | Degradate | DDT | 1 | >10 | **31.16** | **60.87** | **33.76** | **72.9** | **40.3** |
| *p,p′*-DDE | 72-55-9 | Degradate | DDT | 1 | >10 | **48.75** | **68.0** | **52.37** | **92.3** | **52.6** |
| *p,p′*-DDT | 50-29-3 | Insecticide/ acaricide | – | 1 | >10 | **20.27** | **50.85** | **22.53** | **51.0** | **34.7** |
| Parathion-methyl | 298-00-0 | Insecticide | – | 1 | 1 to 10 | – | – | – | – | ***6.4*** |

**Table 8.** Detection-frequency data for pesticide compounds in sediment from three U.S. Geological Survey (USGS) datasets.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Bold** indicates detection frequency greater than 10 percent. ***Bold italic*** indicates detection frequency of 1 to 10 percent. Sediment occurrence data sets are tabulated in Appendixes 10–12. **Abbreviations**: AG, agricultural land use; CAS, Chemical Abstracts Service; DEG, degradate; DF, detection frequency; MX, mixed land use; NAV, not available; NAWQA, National Water-Quality Assessment Program (USGS); OF, other factors; P, pathway; Toxics, Toxic Substances Hydrology Program (USGS); UR, urban land use; USGS, U.S. Geological Survey; >, greater than; –, not applicable; <, less than

| Chemical name | CAS Registry Number | Primary pesticide type/use | Primary parent pesticide (if degradate) | Tier | Sediment detection frequency range (in percent) | Detection frequency, in percent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NAWQA stream-bed sediment | | | NAWQA lake core sediment (144–155 samples) | Toxics stream-bed and suspended sediment (21–274 samples) |
| | | | | | | AG (215–242 samples) | UR (71–125 samples) | MX (235–361 samples) | | |
| PCNB (Pentachloronitrobenzene) | 82-68-8 | Fungicide | – | 1 | <1 | – | – | – | – | 0 |
| Pebulate | 1114-71-2 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***3.8*** |
| Pendimethalin | 40487-42-1 | Herbicide | – | 1 | >10 | – | – | – | – | **40.5** |
| Pentachloroanisole (PCA) | 1825-21-4 | Degradate | Pentachlorophenol | 1 | 1 to 10 | 0 | 0 | 0.32 | – | ***1.9*** |
| Phosmet | 732-11-6 | Insecticide | – | 2 | <1 | – | – | – | – | 0 |
| Piperonyl butoxide | 51-03-6 | Synergist | – | 3 | >10 | – | – | – | – | **11.3** |
| Prometryn | 7287-19-6 | Herbicide | – | 1 | >10 | – | – | – | – | **22.2** |
| Propiconazole | 60207-90-1 | Fungicide | – | 1 | 1 to 10 | – | – | – | – | ***8.3*** |
| Resmethrin | 10453-86-8 | Insecticide | – | 2 | 1 to 10 | – | – | – | – | ***5.5*** |
| Simazine | 122-34-9 | Herbicide | – | 3 | 1 to 10 | – | – | – | – | ***8.5*** |
| Sulfotepp | 3689-24-5 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| Sumithrin | 26002-80-2 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| Tefluthrin | 79538-32-2 | Insecticide | – | 1 | <1 | – | – | – | – | 0 |
| Terbuthylazine | 5915-41-3 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***4.8*** |
| Tetraconazole | 112281-77-3 | Fungicide | – | 1 | >10 | – | – | – | – | **87.5** |
| Tetramethrin | 7696-12-0 | Insecticide | – | 3 | <1 | – | – | – | – | 0 |
| Thiobencarb | 28249-77-6 | Herbicide | – | 1 | 1 to 10 | – | – | – | – | ***6.9*** |
| Toxaphene | 8001-35-2 | Insecticide/ acaricide | – | 2 | <1 | 0.42 | 0.91 | 0 | 0 | – |
| *trans*-Chlordane (*gamma*-Chlordane) | 5103-74-2 | Insecticide | – | 1 | >10 | ***5.93*** | **62.4** | **22.51** | – | **50.0** |
| *trans*-Nonachlor | 39765-80-5 | Insecticide; component of total chlordane, by-product of technical chlordane | – | 1 | >10 | ***5.08*** | **58.87** | **24.0** | – | **20.8** |
| *trans*-Permethrin | 61949-77-7 | Insecticide | – | 1 | 1 to 10 | ***1.39*** | ***4.23*** | 0 | – | – |
| Trifluralin | 1582-09-8 | Herbicide | – | 1 | >10 | – | – | – | – | **44.9** |
| Total DDT | – | Insecticide | – | [1]1 | >10 | **49.17** | **72.0** | **54.02** | – | – |

[1] See tiers for individual components of DDT (*p,p*- and *o,p*′-DDD, DDE, and DDT).

**Table 9.** Example of modifying thresholds for three prioritization criteria for sediment.

[**Abbreviations:** AL, aquatic-life; $K_{ow}$, octanol-water partition coefficient; >, greater than]

| Parameter | Current threshold | Modified threshold | Number of compounds that do not meet modified threshold |
|---|---|---|---|
| Stability | Aerobic soil half-life >30 days | Aerobic soil half-life >60 days | 19 |
| Hydrophobicity | log $K_{ow}$ >3 | log $K_{ow}$ >4 | 27 |
| Aquatic toxicity | AL Toxicty Bin = 1 or 2 (or exceeds sediment benchmarks) | AL Toxicity Bin = 1 only (or exceeds sediment benchmarks) | 51 |

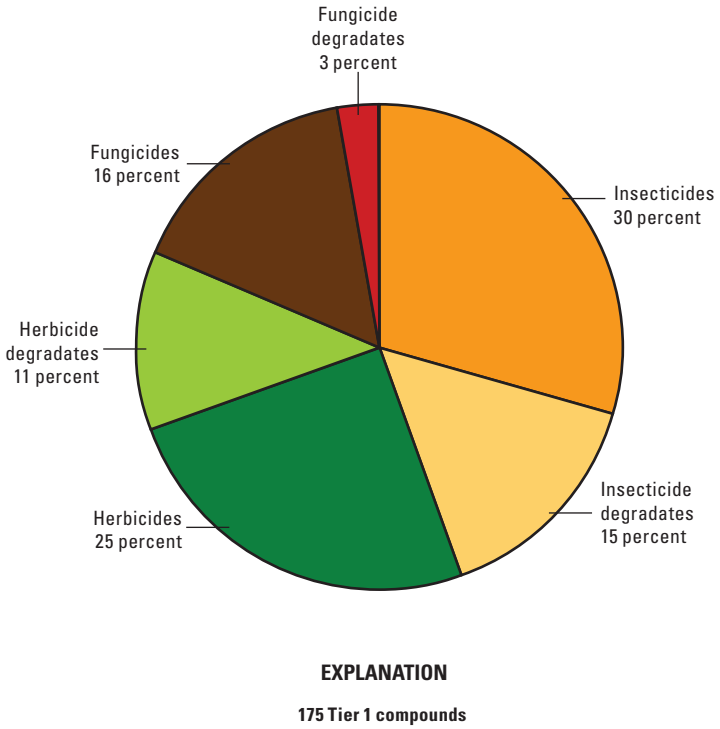


**Figure 9.** Distribution of Tier 1 pesticide compounds for sediment among pesticide-use groups.

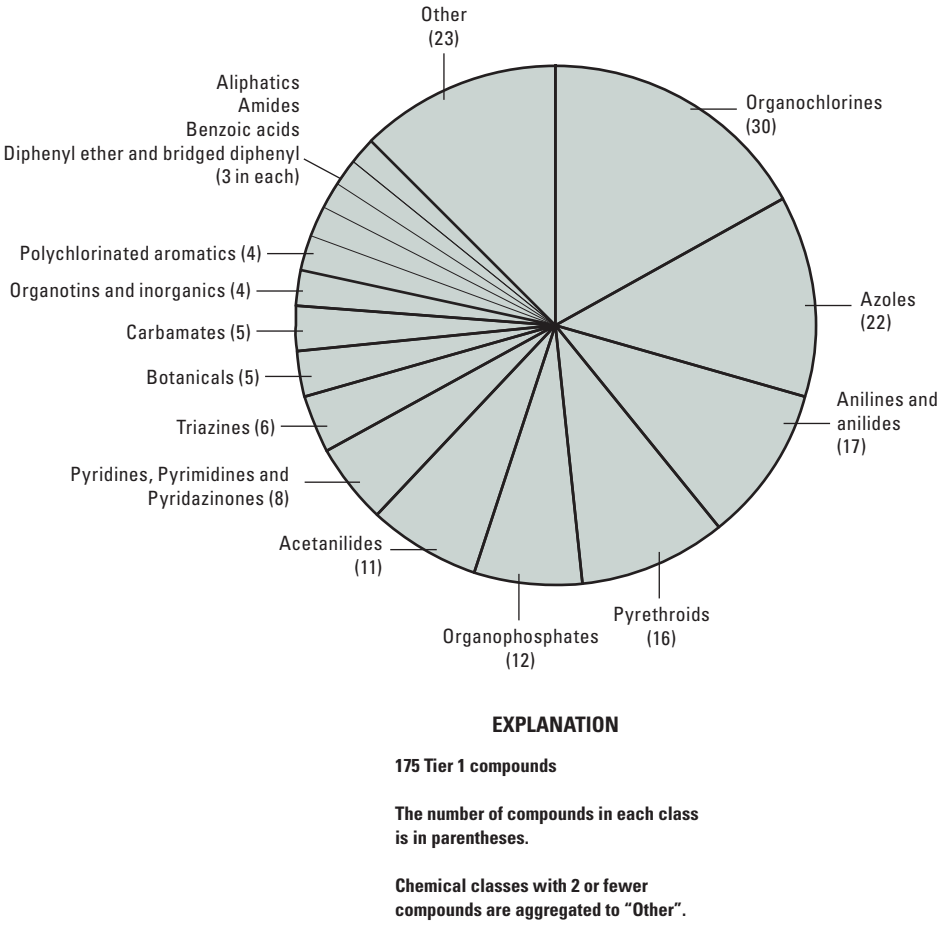


**Figure 10.** Breakdown of Tier 1 pesticide compounds for sediment by chemical class.

## Comparison of Tier 1 Compounds for Both Water and Sediment

A total of 65 parent pesticide compounds, as well as 4 related compounds, overlap Tier 1 for both water and sediment: 26 are herbicides, 13 are fungicides, and 26 are insecticides. These compounds are listed in *table 10* with the reasons for their Tier 1 status; the compounds can be broken down into four groups according to the basis for their Tier 1 status:

1. Twenty compounds are included on the basis of measured BQ or detection frequency in water, and measured detection frequency, as well as, for some compounds, toxicity and use, in sediment. These compounds correspond to sediment pathways P1 and P2 (*fig. 3* and *table 2*). Some of these compounds also qualify for Tier 1 for water because of predicted BQs.
2. Twelve compounds are included on the basis of measured BQ or detection frequency in water, and predicted likelihood of occurrence in sediment, along with toxicity and use (sediment pathways P4 and OF1—one compound). Some of these compounds also qualify for Tier 1 for water because of predicted BQs.
3. Thirteen compounds are included on the basis of predicted BQ in water, and measured detection frequency in sediment, as well as, for some compounds, toxicity and use. These compounds correspond to sediment pathways P1 and P.
4. Twenty compounds are included on the basis of predicted BQ in water, and predicted likelihood of occurrence in sediment, along with toxicity and use (sediment pathway P4).

The two largest groups of compounds are those that were classified as Tier 1 because of measured occurrence in both water and sediment (group 1) and those classified as such because of predicted concentrations (BQs) in water and predicted likelihood of occurrence in sediment (group 4). Pesticide compounds that are moderately hydrophobic can be expected to occur in both water and sediments, to some extent. Conservative thresholds and assumptions were built into the prioritization procedures for both water and sediment, including the use of a BQ threshold of greater than 0.01 for water (*fig. 2*), the thresholds for persistence (soil half-life greater than 30 days) and hydrophobicity (log $K_{ow}$ greater than 3 or water solubility less than 1 mg/L) for sediment, and the designation of AL Toxicity Bin 2 as "high" toxicity in the screening for sediment (*fig. 3*). For example, of the 20 compounds in group 4 with predicted BQs greater than 0.01 in water, 3 are moderately persistent, having a soil half-life greater than 30, but less than 60 days; 4 are moderately hydrophobic, having a log $K_{ow}$ greater than 3, but less than 4; and 2 are in AL Toxicity Bin 2 (*table 10*). These and other factors affect the Tier 1 results and cause pesticide compounds to overlap between the matrices.

**Table 10.** Summary of parent pesticide compounds co-listed in Tier 1 for water and sediment.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** BQ, benchmark quotient; CAS, Chemical Abstracts Service; DF, detection frequency; HL, half-life ; >, greater than; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type | Water-reason for Tier 1 | Sediment-reason for Tier 1 | Combined basis for Tier 1 status group [1] |
|---|---|---|---|---|---|
| Alachlor | 15972-60-8 | Herbicide | Measured & predicted BQ, DF >10% | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Atrazine | 1912-24-9 | Herbicide | Measured & predicted BQ, DF >10% | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Benfluralin [2] | 1861-40-1 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Benomyl | 17804-35-2 | Fungicide | Predicted BQ, DF >10% | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Bifenthrin | 82657-04-3 | Insecticide | Predicted BQ | Measured DF >10% | 3 |
| Butralin | 33629-47-9 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Chlorothalonil | 1897-45-6 | Fungicide | Measured & predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Chlorpyrifos | 2921-88-2 | Insecticide | Measured & predicted BQ, DF >10% | Measured DF >10% | 1 |
| *cis*-Permethrin | 54774-45-7 | Insecticide | Measured BQ | Measured DF >10% | 1 |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | DF >10% | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Cyfluthrin | 68359-37-5 | Insecticide | Predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 3 |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | Predicted BQ | Measured DF >10% | 3 |
| *gamma*-Cyhalothrin | 76703-62-3 | Insecticide | Related compound | Measured DF >10% | Related compound for water |

**Table 10.** Summary of parent pesticide compounds co-listed in Tier 1 for water and sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** BQ, benchmark quotient; CAS, Chemical Abstracts Service; DF, detection frequency; HL, half-life ; >, greater than; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type | Water-reason for Tier 1 | Sediment-reason for Tier 1 | Combined basis for Tier 1 status group [1] |
|---|---|---|---|---|---|
| Cypermethrin | 52315-07-8 | Insecticide | Predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 3 |
| *zeta*-Cypermethrin | 69865-47-0 | Insecticide | Related compound | Predicted to occur; toxicity and current use or recent use and long soil HL | Related compound for water |
| Dacthal | 1861-32-1 | Herbicide | Measured BQ, DF >10% | Measured DF >10% | 1 |
| Diazinon | 333-41-5 | Insecticide | Measured & predicted BQ, DF >10% | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Dicofol | 115-32-2 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Dieldrin | 60-57-1 | Insecticide | Measured BQ | Measured DF >10% | 1 |
| Diquat | 85-00-7 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Disulfoton | 298-04-4 | Insecticide | Measured & predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Diuron | 330-54-1 | Herbicide | Measured & predicted BQ, DF >10% | Persistent & marginally hydrophobic; toxicity; high use, agency priority | 2 |
| Endosulfan | 115-29-7 | Insecticide | Predicted BQ | Measured DF >10% | 3 |
| *alpha*-Endosulfan | 959-98-8 | Insecticide | Related compound | Measured DF >10% | Related compound for water |
| *beta*-Endosulfan | 33213-65-9 | Insecticide | Related compound | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | Related compound for water |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | DF >10% | Measured DF >10% | 1 |
| Esfenvalerate | 66230-04-4 | Insecticide | Predicted BQ | Measured DF >10% | 3 |
| Ethalfluralin | 55283-68-6 | Herbicide | Measured & predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Fenbutatin oxide | 13356-08-6 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Fenpropathrin | 39515-41-8 | Insecticide | Predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 3 |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/ herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Fipronil | 120068-37-3 | Insecticide | Predicted BQ, DF >10% | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| *gamma*-HCH (*gamma*-Hexachlorocyclohexane) | 58-89-9 | Insecticide | Measured & predicted BQ | Measured DF >10% | 1 |
| Glyphosate | 1071-83-6 | Herbicide | DF >10% | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Imazamox | 114311-32-9 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Iprodione | 36734-19-7 | Fungicide | Predicted BQ | Measured DF >10% | 3 |

**Table 10.** Summary of parent pesticide compounds co-listed in Tier 1 for water and sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** BQ, benchmark quotient; CAS, Chemical Abstracts Service; DF, detection frequency; HL, half-life ; >, greater than; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type | Water-reason for Tier 1 | Sediment-reason for Tier 1 | Combined basis for Tier 1 status group [1] |
|---|---|---|---|---|---|
| Kresoxim-methyl [3] | 143390-89-0 | Fungicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Metconazole [4] | 125116-23-6 | Fungicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Methoxychlor | 72-43-5 | Insecticide | Predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 3 |
| Methoxy-fenozide [3] | 161050-58-4 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Metolachlor | 51218-45-2 | Herbicide | Measured & predicted BQ, DF >10% | Measured DF >10% | 1 |
| Myclobutanil | 88671-89-0 | Fungicide | DF >10% | Measured DF >10% | 1 |
| Novaluron | 116714-46-6 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Oryzalin | 19044-88-3 | Herbicide | Measured & predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Oxyfluorfen | 42874-03-3 | Herbicide | Predicted BQ | Measured DF >10% | 3 |
| Paraquat | 4685-14-7 | Herbicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Parathion-methyl | 298-00-0 | Insecticide | Measured & predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| Pendimethalin | 40487-42-1 | Herbicide | Measured & predicted BQ, DF >10% | Measured DF >10% | 1 |
| Permethrin | 52645-53-1 | Insecticide | Predicted BQ | Measured DF >10% | 3 |
| Phorate [3] | 298-02-2 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Prometryn | 7287-19-6 | Herbicide | Predicted BQ, DF >10% | Measured DF >10% | 1 |
| Pronamide | 23950-58-5 | Herbicide | Measured & predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Propargite | 2312-35-8 | Insecticide | Measured & predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Propiconazole [3,4] | 60207-90-1 | Fungicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Pymetrozine [2] | 123312-89-0 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Pyraclostrobin | 175013-18-0 | Fungicide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Pyridaben | 96489-71-3 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| *S*-Metolachlor | 87392-12-9 | Herbicide | Predicted BQ | Measured DF >10% | 3 |
| Tebuconazole | 107534-96-3 | Fungicide | DF >10% | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Tebupirimfos | 96182-53-5 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Tefluthrin [2] | 79538-32-2 | Insecticide | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Terbuthylazine | 5915-41-3 | Herbicide | DF >10% | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |

**Table 10.** Summary of parent pesticide compounds co-listed in Tier 1 for water and sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** BQ, benchmark quotient; CAS, Chemical Abstracts Service; DF, detection frequency; HL, half-life ; >, greater than; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type | Water-reason for Tier 1 | Sediment-reason for Tier 1 | Combined basis for Tier 1 status group [1] |
|---|---|---|---|---|---|
| Tetraconazole | 112281-77-3 | Fungicide | Predicted BQ | Measured DF >10% | 3 |
| Thiobencarb | 28249-77-6 | Herbicide | Measured & predicted BQ | Measured DF 1 to 10%; toxicity and current use, or recent use and long soil HL | 1 |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | DF >10% | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Triallate | 2303-17-5 | Herbicide | Measured BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Tribuphos | 78-48-8 | Defoliant | Predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 4 |
| Triclopyr | 55335-06-3 | Herbicide | Measured & predicted BQ | Predicted to occur; toxicity and current use or recent use and long soil HL | 2 |
| Trifluralin | 1582-09-8 | Herbicide | Measured & predicted BQ, DF >10% | Measured DF >10% | 1 |

[1] The numbers (1–4) correspond to the groups describing the combined basis for water and sediment Tier 1 status, as further explained in the subsection "Comparison of Tier 1 Compounds for Both Water and Sediment" of the "Results and Discussion" section.

[2] Moderately persistent–aerobic soil half-life greater than 30, but less than 60 days.

[3] Moderately hydrophobic–log $K_{ow}$ greater than 3, but less than 4.

[4] Aquatic-Life Toxicity Bin 2.

# Summary and Conclusions

To meet the U.S. Geological Survey's (USGS) periodic need to prioritize contaminants for analytical methods development for future monitoring and studies, a defined universe of pesticides and degradates were screened for their relative importance. The prioritization strategy described in this report identified high priority pesticides and degradates, both legacy compounds and current-use pesticides. Pesticide compounds with current agricultural-use data were evaluated to determine if they are anticipated to occur in the environment at concentrations of potential concern to aquatic organisms or humans, and if they should be considered for inclusion in analytical methods. In addition, pesticide compounds previously monitored in USGS studies, either routinely or infrequently, were evaluated to determine if continued inclusion in analytical methods and monitoring are warranted on the basis of detection frequency or occurrence at concentrations of potential concern for aquatic life or human health.

Depending on their chemical structure and physical-chemical properties, different pesticide compounds behave differently in the environment. To accommodate a broad range of pesticides, from water-soluble to hydrophobic, it was necessary to prioritize pesticide compounds for both water and sediment. Separate screening procedures were used for water and sediment because more data on occurrence and toxicity are available for pesticides in water than sediment; prediction tools were available to predict pesticide concentrations in streams and groundwater; and analytical methods are medium-specific. The approaches considered measured occurrence through detection frequency and concentrations in water and sediment; predicted concentrations in water and predicted likelihood of occurrence in sediment; potential toxicity to aquatic life and humans; and priorities of other agencies or organizations, regulatory or otherwise.

The screening procedures used here are systematic, objective, and semi-quantitative; they rely on concepts common to many previously established approaches for prioritizing chemicals for various purposes, including identifying persistent, bioaccumulative, and toxic (PBT) compounds and determining candidates for future regulation of drinking water contaminants. The evaluation of pesticide compounds for analytical methods development priority resulted in classification of compounds, separately for water and sediment, into three priority tiers: Tier 1 for high priority compounds, Tier 2 for moderate priority compounds, and Tier 3 for low priority compounds.

For water, a total of 247 pesticide compounds were classified as Tier 1 and are high priority for inclusion in analytical methods available for monitoring and studies. About half of the Tier 1 compounds are high priority because they can reach concentrations approaching those that may be of potential concern to human health, aquatic life, or both; 17 percent because they were frequently detected in past water-quality monitoring studies; and 11 percent because they met both criteria. The remaining 21 percent were degradates that were included because their parent pesticides were in Tier 1.

Tier 1 pesticide compounds for water span the major pesticide-use groups, with herbicides and their degradates composing half of all Tier 1 compounds, and insecticides and their degradates making up an additional 38 percent. Overall, degradates from all use groups combined composed 40 percent of Tier 1 compounds. In terms of chemical class, organophosphates are most commonly represented, followed by acetanilides, triazines, and carbamates.

Many of the highest priority pesticide compounds are included in several national regulatory programs for water quality, including those that are regulated in drinking water by the Safe Drinking Water Act, and those that are on the third Contaminant Candidate List. Two compounds, dieldrin and *p,p'*-DDE, that have U.S. Environmental Protection Agency (USEPA) National Recommended Water Quality Criteria for aquatic life, are high priority for both aquatic-life and human-health reasons. Although USEPA Office of Pesticide Programs (OPP) aquatic-life benchmarks are not regulatory standards at the federal level, more than 30 percent of the Tier 1 compounds were classified as such on the basis of aquatic-life benchmark quotients calculated from these OPP benchmarks; some of these compounds also can be high priority for human-health reasons.

For sediment, 175 pesticides and degradates are in Tier 1 and are high priority for inclusion in analytical methods available for monitoring and studies. About 36 percent of the Tier 1 pesticide compounds are high priority on the basis of measured occurrence. This includes 36 compounds that were frequently detected in USGS monitoring studies, having a detection frequency greater than 10 percent, and 26 compounds that had a combination of moderate occurrence, that is a detection frequency from 1 to 10 percent, and either high potential toxicity to aquatic life or high pesticide use, or both. Another 42 percent, or 74 compounds, are high priority on the basis of predicted likelihood of occurrence and either high potential toxicity to aquatic life or high pesticide use, or both. The remaining 22 percent, or 39 compounds, are in Tier 1 because they are degradates of Tier 1 parent compounds or because of other factors.

The Tier 1 pesticide compounds for sediment are distributed among pesticide use-groups, with the largest group composed of insecticides and their degradates at 45 percent. An additional 36 percent of Tier 1 is represented by herbicides and their degradates, with fungicides and their degradates rounding out the remaining 19 percent. Collectively, about 30 percent of Tier 1 compounds for sediment are pesticide degradates. The chemical class composing the largest percentage of Tier 1 compounds in sediment are organochlorines at 17 percent, which is expected because persistent organochlorine pesticides and their degradates continue to be detected widely in sediments, and many are potentially toxic to aquatic life.

Some of the Tier 1 pesticide compounds for sediment are included in national regulatory or other programs, not necessarily sediment-specific, including PBT chemicals that are on USEPA's Toxics Release Inventory or are of concern in the Great Lakes. A total of 19 Tier 1 compounds have at least one sediment benchmark or screening value for aquatic organisms. Of the 175 compounds in Tier 1, 78, or 45 percent, have high aquatic-life toxicity, as defined for this evaluation.

The prioritization of pesticides and degradates resulted in two lists of high-priority compounds for water and sediment. These lists will be used as the basis for redesigning and enhancing USGS analytical capabilities for pesticides in order to capture as many high-priority pesticide compounds as possible using an economically feasible approach. These compounds either have been measured or are predicted to occur in water or sediment at defined thresholds. Detection-frequency thresholds were applied to capture compounds that frequently occur and persist in the environment because tracking trends in contaminant occurrence over time has been an important objective of the National Water-Quality Assessment Program. For both water and sediment, indicators of likely occurrence, toxicity, and high use were combined to capture those compounds most likely to be present at potentially toxic concentrations. For water, where availability of models made it possible to estimate predicted concentrations, concentration thresholds relative to individual benchmark values for aquatic life and human health were used in a conservative manner to give high priority to pesticide compounds that have occurred, or have the potential to occur, in water at concentrations approaching those of concern to aquatic organisms or humans. For sediment, where predicted concentrations were not available, Tier 1 compounds met thresholds for stability, hydrophobicity (or sorption), and either aquatic toxicity or use rates, or both. The Tier 1 pesticide compounds for water and sediment represent pesticides and their degradates that are likely to be high priority for future monitoring programs and studies, and which will need to be supported by the availability of analytical methods capable of detecting these compounds at environmentally-relevant concentrations in matrices of interest.

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# Appendix 1.

## Physical-Chemical Properties Used in the Evaluation of Pesticide Compounds for Analytical Methods Development for Water and Sediment

Table 1–1. Physical-chemical property values and sources used for prioritization of pesticide compounds in water and sediment. (This table is available in a Microsoft Excel workbook, which can be dowloaded from http://pubs.usgs.gov/sir/2012/5045/).

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# Appendix 2.

## Persistence Score Methodology

The Persistence Score is based on the following two data elements: (1) estimated biodegradation time as predicted by the Ultimate Survey Model (USM) of Biodegradation and (2) estimated probability of rapid biodegradation as predicted by the Nonlinear Model of Probability of Rapid Biodegradation. Output for both models is provided simultaneously using the BIOWIN biodegradation probability model, which is an estimation software program created by Syracuse Research Corporation (SRC) that is part of the U.S. Enviromental Protection Agency's (USEPA) EPI Suite™ program, that calculates the probability that an organic chemical will biodegrade rapidly under aerobic conditions (U.S. Environmental Protection Agency, 2009). A free Windows version of EPI Suite is available from USEPA at *http://www.epa.gov/oppt/exposure/pubs/episuite.htm*.

The Persistence Score (1 = low, 2 = medium, 3 = high) was determined using the threshold (binning) approach adapted from USEPA's Waste Minimization Prioritization Tool document (U.S. Environmental Protection Agency, 1997), provided in *table 2–1*.

**Table 2–1.** Thresholds for determining the persistence score (U.S. Environmental Protection Agency, 1997).

| Ultimate survey model of biodegradation | Nonlinear model probability of rapid biodegradation | Persistence Score |
|---|---|---|
| ≤ 2 | – | High (3) |
| > 2 to ≤ 3 | – | Medium (2) |
| > 3 to ≤ 4 | < 0.5 | Medium (2) |
| | ≥ 0.5 | Low (1) |
| > 4 | – | Low (1) |

USM estimates the approximate amount of time needed for complete biodegradation of a chemical in typical water and soil environments. USM was created using the survey results from 17 experts who ranked 200 organic chemicals on their estimated rates of primary degradation (loss of parent chemical identity) and ultimate degradation (conversion to $CO_2$ and $H_2O$). The experts assigned an estimated ultimate biodegradation time (order of magnitude approximation) for each chemical as follows:

- "1" longer than several months
- "2" months
- "3" weeks
- "4" days
- "5" hours

Counts of the frequency of occurrence of 36 structural fragments also were completed as part of the USM. Multiple linear regressions were performed with the mean scores (1 to 5, as designated previously) as dependent variables and the structural fragment counts and molecular weights as independent variables. The USM model calculates the numerical biodegradability "score" for a contaminant, and this number is then related into hours, days, weeks, etc. for interpretation. The persistence score approach designates chemicals with USM scores greater than 2 but less than or equal to 3, corresponding to weeks to months, as medium for persistence, but uses a second model, the Nonlinear Probability Model, to choose between low and medium persistence scores when the USM prediction is in the range greater than 3 but less than or equal to 4, corresponding to days to weeks. If the Nonlinear Probability Model estimates that the probability of rapid biodegradation is low (for example, less than 0.5), then the approach scores persistence as medium rather than low (*table 2–1*). The Nonlinear Probability Model of Biodegradation generates an estimate of the probability of rapid biodegradation using a file of evaluated biodegradation data for more than 800 organic contaminants.

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# Appendix 3.

## Aquatic-Life and Human-Health Benchmarks Used in the Evaluation of Pesticides for Water

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| 1,3-Dicarbamoyl-2,4,5,6-tetrachlorobenzene | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 1,3-Dichloropropene | 542-75-6 | Fumigant | 1 | 45 | AI OPP | 0.3 | HBSL | HPV |
| 1-Carbamoyl-3-cyano-4-hydroxy-2,5,6-trichlorobenzene | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 1-Naphthol | 90-15-3 | Degradate | 1 | 100 | CF USGS | NAV | NAV | HPV |
| 2-(4-*tert*-butylphenoxy)-Cyclohexanol | 1942-71-8 | Degradate | 1 | 98 | CF ECOSAR | NAV | NAV | – |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 94-75-7 | Herbicide | 1 | 299.2 | AVP USGS | 70 | MCL | MCL, SFIREG, CANALWQG, HPV |
| 2,4-D methyl ester | 1928-38-7 | Herbicide | 1 | NAV | NAV | NAV | NAV | SFIREG, CANALWQG |
| 2,6-Diethylaniline | 579-66-8 | Degradate | 1 | 7,812 | AI ECOTOX | NAV | NAV | HPV |
| 2-([2-Ethyl-6-methylphenyl]amino)-1-propanol | 61520-53-4 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 2-Amino-*N*-isopropylbenzamide | 30391-89-0 | Degradate | 1 | 30 | CI ECOSAR | NAV | NAV | – |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 2-chloro-*N*-(2-ethyl-6-methylphenyl)acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 2-Ethyl-6-methylaniline | 24549-06-2 | Degradate | 1 | 12 | CI ECOSAR | NAV | NAV | HPV |
| 2-Hydroxyatrazine | 2163-68-0 | Degradate | 1 | 1,500 | AF OPP | 70 | HBSL | SFIREG |
| 3-(Trifluoromethyl)aniline | 98-16-8 | Degradate | 1 | 1,350 | AI ECOTOX | NAV | NAV | HPV |
| 3-(Trifluoromethyl)phenylurea | 13114-87-9 | Degradate | 1 | 284 | CF ECOSAR | NAV | NAV | – |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | 1 | 1.7 | AI ECOTOX | NAV | NAV | HPV |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| 3,4-Dichloromethyphenylurea | 3567-62-2 | Degradate | 1 | 72 | CF ECOSAR | NAV | NAV | – |
| 3,4-Dichlorophenylurea | 2327-02-8 | Degradate | 1 | 129 | ANVP ECOSAR | NAV | NAV | – |
| 3,5-Dichloroaniline | 626-43-7 | Degradate | 1 | 18 | CI ECOSAR | NAV | NAV | – |
| 3-Hydroxycarbofuran | 16655-82-6 | Degradate | 1 | 2,254 | CF ECOSAR | NAV | NAV | CCL3 |
| 3-Ketocarbofuran | 16709-30-1 | Degradate | 1 | 1,272 | CF ECOSAR | NAV | NAV | – |
| 3-Phenoxybenzoic acid | 3739-38-6 | Degradate | 1 | 6,650 | AF OPP tox | NAV | NAV | – |
| 4-(Hydroxymethyl)pendimethalin | 56750-76-6 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| 4,4'-Dichlorobenzophenone | 90-98-2 | Degradate | 1 | 171 | CF ECOSAR | NAV | NAV | – |
| 4-Chloro-2-methylphenol | 1570-64-5 | Degradate | 1 | 1,150 | AF ECOTOX | NAV | NAV | – |
| 4-Chlorobenzylmethyl sulfone | 98-57-7 | Degradate | 1 | 37,549 | CI ECOSAR | NAV | NAV | – |
| 4-hydroxy-2,5,6-trichloroisophthalonitrile | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Acephate | 30560-19-1 | Insecticide | 1 | 150 | CI OPP | NAV | NAV | CCL3 |
| Acetochlor | 34256-82-1 | Herbicide | 1 | 1.43 | ANVP OPP | 1 | HBSL | CCL3, UCMR, SFIREG |
| Acetochlor ethane sulfonic acid (ESA) | 187022-11-3 | Degradate | 1 | 9,900 | ANVP OPP | NAV | NAV | CCL3, UCMR, SFIREG |
| Acetochlor oxanilic acid (OA) | 184992-44-4 | Degradate | 1 | NAV | NAV | NAV | NAV | CCL3, UCMR, SFIREG |
| Acetochlor sulfynilacetic acid (SAA) | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Acetochlor/Metolachlor ESA, secondary amide | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Alachlor | 15972-60-8 | Herbicide | 1 | 1.64 | ANVP OPP | 2 | MCL | MCL, UCMR, SFIREG |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Alachlor ESA, secondary amide | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Alachlor ESA | 142363-53-9 | Degradate | 1 | 52,000 | AF OPP | NAV | NAV | CCL3, UCMR, SFIREG |
| Alachlor OA | 171262-17-2 | Degradate | 1 | 47,500 | AF OPP | NAV | NAV | CCL3, UCMR |
| Alachlor SAA | 140939-16-8 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Aldicarb | 116-06-3 | Insecticide | 1 | 0.46 | CF OPP | 9 | HBSL | SFIREG, CANALWQG |
| Aldicarb sulfone | 1646-88-4 | Degradate | 1 | 140 | AI OPP | 7 | HBSL | SFIREG |
| Aldicarb sulfoxide | 1646-87-3 | Degradate | 1 | 21.5 | AI OPP | 7 | HBSL | SFIREG |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | 1 | 400 | AI ECOTOX | 0.006 | HBSL | CCL3 |
| Ametryn | 834-12-8 | Herbicide | 1 | 3.67 | ANVP OPP | 500 | HBSL | – |
| Aminomethylphosphonic acid | 1066-51-9 | Degradate | 1 | 249,500 | AF OPP | NAV | NAV | – |
| Asulam | 3337-71-1 | Herbicide | 1 | 140 | AVP OPP tox | NAV | NAV | – |
| Atrazine | 1912-24-9 | Herbicide | 1 | 1 | ANVP OPP | 3 | MCL | MCL, SFIREG, CANALWQG, HPV |
| Azinphos-methyl | 86-50-0 | Insecticide | 1 | 0.036 | CI OPP | 10 | HBSL | SFIREG, GLWQA, OW NRWQC |
| Azinphos-methyl-oxon | 961-22-8 | Degradate | 1 | 1,461 | ANVP ECOSAR | NAV | NAV | – |
| Azoxystrobin | 131860-33-8 | Fungicide | 1 | 44 | CI OPP | NAV | NAV | OPP Reg |
| Benfluralin | 1861-40-1 | Herbicide | 1 | 1.9 | CF OPP | 4 | HBSL | – |
| Benomyl | 17804-35-2 | Fungicide | 1 | 2.8 | AF ECOTOX | 40 | HBSL | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Bentazon | 25057-89-0 | Herbicide | 1 | 4,500 | ANVP OPP | 200 | HBSL | SFIREG |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | 1 | 550 | AF ECOTOX | 0.04 | HBSL | – |
| Bifenazate | 149877-41-8 | Insecticide | 1 | 0.056 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Bifenthrin | 82657-04-3 | Insecticide | 1 | 0.075 | AF ECOTOX | 10 | HBSL | – |
| Bromacil | 314-40-9 | Herbicide | 1 | 6.8 | ANVP OPP | 70 | HBSL | SFIREG, CANALWQG |
| Bromomethane | 74-83-9 | Fumigant/adjuvant | 1 | 100 | CF OPP | 100 | HBSL | CCL3, HPV |
| Bromoxynil | 1689-84-5 | Herbicide | 1 | 2.5 | CI USGS | 10 | HBSL | CANALWQG |
| Butralin | 33629-47-9 | Herbicide | 1 | 3 | CF ECOSAR | NAV | NAV | – |
| Carbaryl | 63-25-2 | Insecticide | 1 | 0.5 | CI OPP | 40 | HBSL | SFIREG, CANALWQG |
| Carbofuran | 1563-66-2 | Insecticide | 1 | 0.75 | CI OPP | 40 | MCL | MCL, SFIREG, CANALWQG, HPV |
| Chlorimuron-ethyl | 90982-32-4 | Herbicide | 1 | 4,200 | AF ECOTOX | 600 | HBSL | – |
| Chloropicrin | 76-06-2 | Fumigant/nematocide | 1 | 8.49 | AF OPP | NAV | NAV | – |
| Chlorothalonil | 1897-45-6 | Fungicide | 1 | 0.6 | CI OPP | 5 | HBSL | SFIREG, CANALWQG |
| Chlorpyrifos | 2921-88-2 | Insecticide | 1 | 0.04 | CI OPP | 2 | HBSL | SFIREG, CANALWQG, OW NRWQC |
| Chlorpyrifos oxygen analog | 5598-15-2 | Degradate | 1 | 273 | CF ECOSAR | NAV | NAV | – |
| Chlorsulfuron | 64902-72-3 | Herbicide | 1 | 0.35 | AVP OPP tox | 100 | HBSL | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | c61898-95-1 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| *cis*-Permethrin | 61949-76-6 | Insecticide | 1 | 0.0014 | CI OPP | 4 | HBSL | – |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | 1 | 93 | ANVP OPP | 70 | HBSL | – |
| Copper | 7440-50-8 | Fungicide | 1 | 9 | C OW | 1,300 | MCL | MCL, GLWQA, OW NRWQC |
| Cyanazine | 21725-46-2 | Herbicide | 1 | 1,000 | AI ECOTOX | 1 | HBSL | CANALWQG |
| Cyanazine acid | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Cyanazine amide | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Cyfluthrin | 68359-37-5 | Insecticide | 1 | 0.0125 | AI ECOTOX | 200 | HBSL | – |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | Insecticide | 1 | 0.02 | AI ECOTOX | 40 | HBSL | – |
| *gamma*-Cyhalothrin | 76703-62-3 | Insecticide | 1; related compound | – | – | – | – | – |
| Cypermethrin | 52315-07-8 | Insecticide | 1 | 0.069 | CI OPP | 40 | HBSL | – |
| *zeta*-Cypermethrin | 69865-47-0 | Insecticide | 1; related compound | – | – | – | – | – |
| Dacthal | 1861-32-1 | Herbicide | 1 | 11,000 | ANVP OPP | 70 | HBSL | SFIREG |
| Dacthal monoacid | 887-54-7 | Degradate | 1 | 6,111 | CF ECOSAR | NAV | NAV | UCMR, SFIREG |
| Dechloroacetochlor | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dechloroalachlor | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dechlorodimethenamid | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dechlorometolachlor | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Deethylatrazine | 6190-65-4 | Degradate | 1 | 1,000 | ANVP OPP | 5 | CMAC | SFIREG |
| Deethylcyanazine | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Deethylcyanazine acid | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Deethylcyanazine amide | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Deethylhydroxyatrazine | NAV | Degradate | 1 | NAV | NAV | 5 | CMAC | – |
| Deisopropyl prometryn | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Deisopropylatrazine | 1007-28-9 | Degradate | 1 | 2,500 | ANVP OPP | 5 | CMAC | SFIREG |
| Deisopropylhydroxyatrazine | 7313-54-4 | Degradate | 1 | 58 | CI ECOSAR | 5 | CMAC | – |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | 1 | 420 | AF ECOTOX | NAV | NAV | – |
| Deltamethrin | 52918-63-5 | Insecticide | 1 | 0.0145 | AI ECOTOX | NAV | NAV | CANALWQG |
| Demethyl fluometuron | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Demethyl norflurazon | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | SFIREG |
| Desulfinylfipronil (MB46513) | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Desulfinylfipronil amide (RPA 105048) | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Diazinon | 333-41-5 | Insecticide | 1 | 0.105 | AI OPP | 1 | HBSL | UCMR, SFIREG, GLWQA, OW NRWQC |
| Diazinon oxygen analog | 962-58-3 | Degradate | 1 | 3,020 | CF ECOSAR | NAV | NAV | – |
| Dicamba | 1918-00-9 | Herbicide | 1 | 61 | ANVP OPP | 3,000 | HBSL | SFIREG, CANALWQG |
| Dichlobenil | 1194-65-6 | Herbicide | 1 | 30 | AVP OPP | 9 | HBSL | – |
| Dichlorvos | 62-73-7 | Insecticide/fumigant/degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dicofol [1] | 115-32-2 | Insecticide | 1 | 1 | CF OPP tox | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Dicrotophos | 141-66-2 | Insecticide | 1 | 0.99 | CI OPP | 0.05 | HBSL | CCL3 |
| Didealkylatrazine | 3397-62-4 | Degradate | 1 | 50,000 | AF OPP | NAV | NAV | SFIREG |
| Dieldrin | 60-57-1 | Insecticide | 1 | 0.056 | C OW | 0.002 | HBSL | OW NRWQC |
| Diflubenzuron | 35367-38-5 | Insecticide | 1 | 0.06 | CI OPP tox | NAV | NAV | – |
| Diflufenzopyr | 109293-97-2 | Herbicide | 1 | 0.63 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Dimethenamid | 87674-68-8 | Herbicide | 1 | 1,300 | AF ECOTOX | NAV | NAV | SFIREG |
| Dimethenamid ESA | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dimethenamid OA | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Dimethenamid-P | 163515-14-8 | Herbicide | 1 | 8.9 | AVP OPP | NAV | NAV | – |
| Dimethoate | 60-51-5 | Insecticide | 1 | 0.5 | CI OPP | 2 | HBSL | CCL3, UCMR, CANALWQG |
| Diquat | 85-00-7 | Herbicide | 1 | 0.0036 | AVP OPP tox | 20 | MCL | MCL |
| Disulfoton | 298-04-4 | Insecticide | 1 | 0.01 | CI OPP | 0.9 | HBSL | CCL3, UCMR |
| Disulfoton sulfone | 2497-06-5 | Degradate | 1 | 0.14 | CI OPP | NAV | NAV | – |
| Disulfoton sulfoxide | 2497-07-6 | Degradate | 1 | 1.53 | CI OPP | NAV | NAV | – |
| Diuron | 330-54-1 | Herbicide | 1 | 2.4 | ANVP OPP | 2 | HBSL | CCL3, UCMR, SFIREG, HPV |
| Endosulfan | 115-29-7 | Insecticide | 1 | 0.07 | CI OPP | 40 | HBSL | SFIREG, CANALWQG, OW NRWQC |
| *alpha*-Endosulfan | 959-98-8 | Insecticide | 1; related compound | – | – | – | – | CANALWQG, OW NRWQC |
| *beta*-Endosulfan | 33213-65-9 | Insecticide | 1; related compound | – | – | – | – | CANALWQG, OW NRWQC |
| Endosulfan ether | 3369-52-6 | Degradate | 1 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Endosulfan sulfate | 1031-07-8 | Degradate | 1 | 1.9 | AF OPP | NAV | NAV | – |
| Endothall [2] | 145-73-3 | Herbicide | 1 | 1.9 | ANVP OPP tox | 100 | MCL | MCL |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | 1 | 810 | CI OPP | 200 | HBSL | UCMR |
| Esfenvalerate | 66230-04-4 | Insecticide | 1 | 0.017 | CI OPP | NAV | NAV | SFIREG |
| Ethalfluralin | 55283-68-6 | Herbicide | 1 | 0.4 | CF OPP | 30 | HBSL | – |
| Ethoprop | 13194-48-4 | Insecticide | 1 | 22 | AI OPP | 1 | HBSL | CCL3, SFIREG |
| Etoxazole | 153233-91-1 | Insecticide | 1 | 1.07 | CF ECOSAR | NAV | NAV | OPP Reg |
| Famoxadone | 131807-57-3 | Fungicide | 1 | 1.47 | CF ECOSAR | NAV | NAV | OPP Reg |
| Fenamiphos | 22224-92-6 | Insecticide | 1 | 0.12 | CI USGS | 0.7 | HBSL | CCL3 |
| Fenamiphos sulfone | 31972-44-8 | Degradate | 1 | 587 | AF USGS | NAV | NAV | – |
| Fenamiphos sulfoxide | 31972-43-7 | Degradate | 1 | 3.75 | AI USGS | NAV | NAV | – |
| Fenbutatin oxide | 13356-08-6 | Insecticide | 1 | 0.75 | AF OPP tox | NAV | NAV | – |
| Fenpropathrin | 39515-41-8 | Insecticide | 1 | 0.265 | AI ECOTOX | NAV | NAV | – |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/herbicide | 1 | 1.85 | AF ECOTOX | NAV | NAV | CCL3, HPV |
| Fipronil | 120068-37-3 | Insecticide | 1 | 12.5 | AF ECOTOX | NAV | NAV | – |
| Fipronil sulfide | 120067-83-6 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Fipronil sulfone | 120068-36-2 | Degradate | 1 | 5,600 | AI ECOTOX | NAV | NAV | – |
| Flumetsulam | 98967-40-9 | Herbicide | 1 | 127,000 | AI ECOTOX | 7,000 | HBSL | – |
| Flumiclorac [3] | 87546-18-7 | Herbicide | 1 | 1.49 | CF ECOSAR | NAV | NAV | – |
| Fluometuron | 2164-17-2 | Herbicide | 1 | 30 | ANVP OPP | 4 | HBSL | – |
| Fonofos | 944-22-9 | Insecticide | 1 | 1 | AI ECOTOX | 10 | HBSL | UCMR |
| Fonofos oxygen analog | 944-21-8 | Degradate | 1 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Formetanate hydrochloride | 23422-53-9 | Insecticide | 1 | 0.5 | CI OPP tox | NAV | NAV | – |
| *gamma*-HCH | 58-89-9 | Insecticide | 1 | 0.5 | AI OPP | 0.2 | MCL | MCL, SFIREG, CANALWQG, GLWQA, OW NRWQC |
| Glyphosate | 1071-83-6 | Herbicide | 1 | 1,800 | CF OPP | 700 | MCL | MCL, SFIREG, CANALWQG |
| Halosulfuron-methyl | 100784-20-1 | Herbicide | 1 | 49 | ANVP ECOSAR | NAV | NAV | – |
| Hexazinone | 51235-04-2 | Herbicide | 1 | 7 | ANVP OPP | 400 | HBSL | SFIREG |
| Hydroxyacetochlor | 60090-47-3 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Hydroxyalachlor | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Hydroxydimethanamid | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Hydroxymetolachlor | 131068-72-9 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Hydroxysimazine | 2599-11-3 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Imazamox | 114311-32-9 | Herbicide | 1 | 11 | AVP OPP | NAV | NAV | OPP Reg |
| Imazaquin | 81335-37-7 | Herbicide | 1 | 140,000 | AF ECOTOX | 2,000 | HBSL | – |
| Imazethapyr | 81335-77-5 | Herbicide | 1 | 120,000 | AF ECOTOX | 2,000 | HBSL | – |
| Imidacloprid | 138261-41-3 | Insecticide | 1 | 1.05 | CI OPP | 400 | HBSL | SFIREG, CANALWQG |
| Indoxacarb | 173584-44-6 | Insecticide | 1 | 0.099 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Iprodione | 36734-19-7 | Fungicide | 1 | 120 | AI OPP | 0.8 | HBSL | – |
| Isoxaflutole | 141112-29-0 | Herbicide | 1 | 4.9 | AVP OPP | NAV | NAV | SFIREG, OPP Reg |
| Kresoxim-methyl | 143390-89-0 | Fungicide | 1 | 6 | CF ECOSAR | NAV | NAV | OPP Reg |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Linuron | 330-55-2 | Herbicide | 1 | 0.09 | CI OPP | 5 | HBSL | UCMR, CANALWQG |
| Malaoxon | 1634-78-2 | Degradate | 1 | 2.7 | AI ECOTOX | NAV | NAV | – |
| Malathion | 121-75-5 | Insecticide | 1 | 0.000026 | CI OPP | 50 | HBSL | SFIREG, OW NRWQC |
| Maneb | 12427-38-2 | Fungicide | 1 | 13.4 | ANVP OPP | NAV | NAV | – |
| MBC (Carbendazim) | 10605-21-7 | Degradate | 1 | 2 | CF OPP tox | NAV | NAV | – |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 94-74-6 | Herbicide | 1 | 170 | AVP OPP | 30 | HBSL | SFIREG, CANALWQG, HPV |
| Metalaxyl | 57837-19-1 | Fungicide | 1 | 1,200 | CI OPP | 600 | HBSL | SFIREG |
| Metam sodium | 137-42-8 | Fumigant/ herbicide/ fungicide/ microbiocide/ algaecide | 1 | 25.6 | AF OPP | NAV | NAV | – |
| Metconazole | 125116-23-6 | Fungicide | 1 | 20 | CF ECOSAR | NAV | NAV | OPP Reg |
| Methamidophos | 10265-92-6 | Insecticide | 1 | 4.5 | CI OPP | NAV | NAV | CCL3 |
| Methidathion | 950-37-8 | Insecticide | 1 | 0.66 | CI OPP | 1 | HBSL | – |
| Methomyl | 16752-77-5 | Insecticide | 1 | 0.7 | CI OPP | 200 | HBSL | – |
| Methomyl-oxime | 13749-94-5 | Degradate | 1 | 15 | CI ECOSAR | NAV | NAV | HPV |
| Methoxychlor | 72-43-5 | Insecticide | 1 | 0.03 | C OW | 40 | MCL | MCL, GLWQA, OW NRWQC |
| Methoxyfenozide | 161050-58-4 | Insecticide | 1 | 0.069 | ANVP ECOSAR | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Metolachlor | 51218-45-2 | Herbicide | 1 | 1 | CI OPP | 700 | HBSL | CCL3, UCMR, SFIREG, CANALWQG |
| Metolachlor ESA | 171118-09-5 | Degradate | 1 | 24,000 | AF OPP | NAV | NAV | CCL3, UCMR, SFIREG |
| Metolachlor OA | 152019-73-3 | Degradate | 1 | 7,700 | AI OPP | NAV | NAV | CCL3, UCMR, SFIREG |
| Metribuzin | 21087-64-9 | Herbicide | 1 | 8.7 | ANVP OPP | 90 | HBSL | SFIREG, CANALWQG |
| Molinate | 2212-67-1 | Herbicide | 1 | 105 | AF OPP | 0.7 | HBSL | CCL3, UCMR |
| Myclobutanil | 88671-89-0 | Fungicide | 1 | 1,200 | AF ECOTOX | 200 | HBSL | – |
| Naled | 300-76-5 | Insecticide | 1 | 0.045 | CI OPP | 10 | HBSL | – |
| Nicosulfuron | 111991-09-4 | Herbicide | 1 | 46 | ANVP ECOSAR | 9,000 | HBSL | – |
| Norflurazon | 27314-13-2 | Herbicide | 1 | 9.7 | ANVP OPP | 10 | HBSL | SFIREG |
| Novaluron | 116714-46-6 | Herbicide | 1 | 0.99 | CF ECOSAR | NAV | NAV | OPP Reg |
| *O*-Ethyl-*O*-methyl-*S*-propylphosphorothioate | 76960-87-7 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Oryzalin | 19044-88-3 | Herbicide | 1 | 15.4 | AVP OPP | 4 | HBSL | – |
| Oxamyl | 23135-22-0 | Insecticide | 1 | 90 | AI OPP | 200 | MCL | MCL |
| Oxamyl oxime | 30558-43-1 | Degradate | 1 | 35 | CI ECOSAR | NAV | NAV | – |
| Oxyfluorfen | 42874-03-3 | Herbicide | 1 | 0.29 | ANVP OPP | 20 | HBSL | CCL3 |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | Degradate | 1 | 0.001 | C OW | 0.1 | HBSL | UCMR, OW NRWQC |
| Paraoxon-methyl | 950-35-6 | Degradate | 1 | 1 | CI OPP | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Paraquat | 4685-14-7 | Herbicide | 1 | 0.55 | ANVP OPP tox | 10 | CMAC | – |
| Parathion-methyl | 298-00-0 | Insecticide | 1 | 0.25 | CI OPP | 1 | HBSL | – |
| Pendimethalin | 40487-42-1 | Herbicide | 1 | 5.4 | ANVP OPP | 70 | HBSL | SFIREG |
| Permethrin | 52645-53-1 | Insecticide | 1 | 0.0014 | CI OPP | 4 | HBSL | CCL3, CANALWQG |
| Phorate | 298-02-2 | Insecticide | 1 | 0.21 | CI OPP | 4 | HBSL | – |
| Phorate oxon | 2600-69-3 | Degradate | 1 | 5,549 | CF ECOSAR | NAV | NAV | – |
| Phosmet | 732-11-6 | Insecticide | 1 | 0.8 | CI OPP | 8 | HBSL | SFIREG |
| Phosmet oxon | 3735-33-9 | Degradate | 1 | 1,507 | ANVP ECOSAR | NAV | NAV | – |
| Piperonyl butoxide | 51-03-6 | Synergist | 1 | 30 | CI OPP tox | NAV | NAV | – |
| Profenofos | 41198-08-7 | Insecticide | 1 | 0.2 | CI OPP | 0.4 | HBSL | CCL3 |
| Prometon | 1610-18-0 | Herbicide | 1 | 98 | ANVP OPP | 400 | HBSL | UCMR, SFIREG |
| Prometryn | 7287-19-6 | Herbicide | 1 | 1 | ANVP OPP | 300 | HBSL | SFIREG |
| Pronamide | 23950-58-5 | Herbicide | 1 | 600 | CI OPP | 1 | HBSL | – |
| Propanil | 709-98-8 | Herbicide | 1 | 9.1 | CF OPP | 6 | HBSL | – |
| Propargite | 2312-35-8 | Insecticide | 1 | 9 | CI OPP | 1 | HBSL | – |
| Propazine | 139-40-2 | Herbicide | 1 | 5,500 | AI ECOTOX | 100 | HBSL | SFIREG, OPP Reg, HPV |
| Propiconazole | 60207-90-1 | Fungicide | 1 | 93 | ANVP OPP | 70 | HBSL | SFIREG |
| Propoxur | 114-26-1 | Insecticide | 1 | 5.5 | AI OPP | 9 | HBSL | – |
| Prosulfuron | 94125-34-5 | Herbicide | 1 | 19 | CF ECOSAR | 100 | HBSL | – |
| Pymetrozine | 123312-89-0 | Insecticide | 1 | 0.041 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Pyraclostrobin | 175013-18-0 | Fungicide | 1 | 3.1 | AF OPP Ecotox | 200 | PHBSL | – |
| Pyrethrins | 8003-34-7 | Insecticide | 1 | 0.45 | CI ECOSAR | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Pyridaben | 96489-71-3 | Insecticide | 1 | 0.265 | AI ECOTOX | NAV | NAV | – |
| RPA 202248 | 143701-75-1 | Degradate | 1 | 75 | AVP OPP | NAV | NAV | – |
| RPA 203328 | 142994-06-7 | Degradate | 1 | 5,900 | ANVP OPP tox | NAV | NAV | – |
| Siduron | 1982-49-6 | Herbicide | 1 | 6,500 | AF ECOTOX | 1,000 | HBSL | – |
| Simazine | 122-34-9 | Herbicide | 1 | 36 | ANVP OPP | 4 | MCL | MCL, SFIREG, CANALWQG, HPV |
| *S*-Metolachlor | 87392-12-9 | Herbicide | 1 | 8 | ANVP OPP tox | NAV | NAV | – |
| Sulfometuron-methyl | 74222-97-2 | Herbicide | 1 | 6,087,000 | AI ECOTOX | 2,000 | HBSL | – |
| Sulfosulfuron | 141776-32-1 | Herbicide | 1 | 1 | AVP OPP | NAV | NAV | – |
| TCPSA (Trichloropropene sulfonic acid) | 65600-62-6 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Tebuconazole | 107534-96-3 | Fungicide | 1 | 2,000 | AI ECOTOX | NAV | NAV | CCL3 |
| Tebupirimfos | 96182-53-5 | Insecticide | 1 | 0.039 | AI ECOTOX | NAV | NAV | – |
| Tebupirimfos oxygen analogue | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Tebuthiuron | 34014-18-1 | Herbicide | 1 | 50 | ANVP OPP | 1,000 | HBSL | SFIREG, CANALWQG |
| Tefluthrin | 79538-32-2 | Insecticide | 1 | 0.03 | AF ECOTOX | 40 | HBSL | – |
| Tefluthrin metabolite [R 119364] | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Tefluthrin metabolite [R 152912] | NAV | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| Terbacil | 5902-51-2 | Herbicide | 1 | 11 | ANVP OPP | 90 | HBSL | UCMR, SFIREG |
| Terbufos | 13071-79-9 | Insecticide | 1 | 0.03 | CI OPP | 0.4 | HBSL | CCL3, UCMR |
| Terbufos sulfone | 56070-16-7 | Degradate | 1 | 0.66 | AI ECOSAR | NAV | NAV | CCL3, UCMR |
| Terbufos-*O*-analogue sulfone | 56070-15-6 | Degradate | 1 | 1,160 | CF ECOSAR | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Terbuthylazine | 5915-41-3 | Herbicide | 1 | 1,700 | AF USGS | 2 | HBSL | HPV |
| Tetraconazole | 112281-77-3 | Fungicide | 1 | 22 | CF ECOSAR | NAV | NAV | OPP Reg |
| Thiobencarb | 28249-77-6 | Herbicide | 1 | 1 | CI OPP | 70 | HBSL | – |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | Degradate | 1 | NAV | NAV | NAV | NAV | – |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | 1 | 93 | ANVP OPP | 70 | HBSL | – |
| Triallate | 2303-17-5 | Herbicide | 1 | 13 | CI OPP | 20 | HBSL | SFIREG, CANALWQG |
| Tribenuron-methyl | 101200-48-0 | Herbicide | 1 | 111 | CF ECOSAR | 6 | HBSL | – |
| Tribuphos | 78-48-8 | Defoliant | 1 | 1.56 | CI OPP | 7 | HBSL | CCL3 |
| Triclopyr | 55335-06-3 | Herbicide | 1 | 100 | ANVP OPP | 400 | HBSL | SFIREG |
| Trifloxystrobin | 141517-21-7 | Fungicide | 1 | 2.76 | CI OPP Ecotox | 300 | PHBSL | OPP Reg |
| Trifluralin | 1582-09-8 | Herbicide | 1 | 1.14 | CF OPP | 20 | HBSL | SFIREG, CANALWQG |
| Ziram | 137-30-4 | Fungicide | 1 | 9.7 | AF OPP | NAV | NAV | CCL3 |
| 1,4-Napthaquinone | 130-15-4 | Degradate of napropamide | 2 | 83.5 | AF ECOSAR | NAV | NAV | – |
| 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) | 93-76-5 | Herbicide | 2 | 75 | AF ECOTOX | 70 | HBSL | SFIREG, CANALWQG |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy] propionic acid) | 93-72-1 | Herbicide | 2 | 170 | AI ECOTOX | 50 | MCL | MCL, SFIREG, CANALWQG |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| 2,4-DB (4-[2,4-Dichlorophenoxy] butyric acid) | 94-82-6 | Herbicide | 2 | 932 | ANVP OPP | 200 | HBSL | SFIREG, CANALWQG |
| 3-(4-chlorophenyl)-1-methyl urea | 5352-88-5 | Degradate of monuron, monolinuron | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| 3-Phenoxybenzyl alcohol | 13826-35-2 | Degradate of pyrethroids | 2 | 587 | AI ECOSAR | NAV | NAV | HPV |
| Acequinocyl | 57960-19-7 | Insecticide | 2 | 0.71 | CF ECOSAR | NAV | NAV | OPP Reg |
| Acetamiprid | 135410-20-7 | Insecticide | 2 | 104 | AF ECOSAR | NAV | NAV | OPP Reg |
| Acibenzolar | 135158-54-2 | Fungicide | 2 | 5,206 | CF ECOSAR | NAV | NAV | OPP Reg |
| Aldrin | 309-00-2 | Insecticide | 2 | 1.5 | C OW | 0.002 | HBSL | OW NRWQC |
| Aminopyralid | 150114-71-9 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Bensulide | 741-58-2 | Herbicide | 2 | 290 | AI OPP | NAV | NAV | CCL3 |
| Boscalid | 188425-85-6 | Fungicide | 2 | 116 | CF OPP Ecotox | 200 | PHBSL | OPP Reg |
| Captan | 133-06-2 | Fungicide | 2 | 13.1 | AF OPP | 900 | HBSL | CCL3, CANALWQG |
| Carfentrazone | 128639-02-1 | Herbicide | 2 | 0.077 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Chlordane | 57-74-9 | Insecticide | 2 | 0.0043 | C OW | 2 | MCL | MCL, GLWQA, OW NRWQC |
| *cis*-Chlordane | 5103-71-9 | Insecticide | 2; related compound | – | C OW (chlordane) | – | – | GLWQA, OW NRWQC |
| *trans*-Chlordane | 5103-74-2 | Insecticide | 2; related compound | – | C OW (chlordane) | – | – | GLWQA, OW NRWQC |
| Clethodim | 99129-21-2 | Herbicide | 2 | 9,500 | AF ECOTOX | NAV | NAV | CCL3 |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Clodinafop | 114420-56-3 | Herbicide | 2 | 1,455 | AF ECOSAR | NAV | NAV | OPP Reg |
| Clopyralid | 1702-17-6 | Herbicide | 2 | 56,500 | AI OPP | NAV | NAV | SFIREG |
| Cloransulam | 159518-97-5 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Clothianidin | 205510-53-8 | Insecticide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Copper hydroxide | 20427-59-2 | Fungicide/ microbiocide/ nematicide | 2 | 9 (copper) | C OW | NAV | NAV | GLWQA, OW NRWQC |
| Copper octanoate | 20543-04-8 | Fungicide | 2 | 203 | CF ECOSAR | NAV | NAV | OPP Reg |
| Copper oxychloride | 1332-65-6 | Fungicide | 2 | 9 (copper) | C OW | NAV | NAV | GLWQA, OW NRWQC |
| Copper oxychloride sulfate | 8012-69-9 | Fungicide | 2 | 9 (copper) | C OW | NAV | NAV | GLWQA, OW NRWQC |
| Copper sulfate | 7758-98-7 | Fungicide/ algaecide/ molluscicide | 2 | 9 (copper) | C OW | NAV | NAV | GLWQA, OW NRWQC |
| Cuprous oxide | 1317-39-1 | Fungicide/ insecticide | 2 | 9 (copper) | C OW | NAV | NAV | GLWQA, OW NRWQC |
| Cyazofamid | 120116-88-3 | Fungicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Cyclanilide | 113136-77-9 | Plant growth regulator | 2 | 2,500 | AI ECOTOX | NAV | NAV | OPP Reg |
| Cyhalofop | 122008-78-0 | Herbicide | 2 | 93 | CF ECOSAR | NAV | NAV | OPP Reg |
| Cymoxanil | 57966-95-7 | Fungicide | 2 | 14,000 | AI ECOTOX | NAV | NAV | OPP Reg |
| Cyprodinil | 121552-61-2 | Fungicide | 2 | 16 | AI ECOTOX | NAV | NAV | OPP Reg |
| DCNA (Dichloran) | 99-30-9 | Fungicide | 2 | 49 | CF OPP tox | NAV | NAV | HPV |
| Decan-1-ol | 112-30-1 | Plant growth regulator | 2 | 1,200 | AF ECOTOX | NAV | NAV | HPV |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Dichlorprop | 120-36-5 | Herbicide | 2 | 2,680 | AVP OPP tox | 300 | HBSL | CANALWQG |
| Diclofop | 40843-25-2 | Herbicide | 2 | 3,191 | CF ECOSAR | NAV | NAV | – |
| Diclosulam | 145701-21-9 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Dimethipin | 55290-64-7 | Plant growth regulator/ defoliant | 2 | 1,000 | CI OPP tox | NAV | NAV | CCL3 |
| Dimethomorph | 110488-70-5 | Fungicide | 2 | 152 | CF ECOSAR | NAV | NAV | OPP Reg |
| *E*-Dimethomorph | e110488-70-5 | Fungicide | 2; related compound | – | – | – | – | – |
| *Z*-Dimethomorph | z110488-70-5 | Fungicide | 2; related compound | – | – | – | – | – |
| Dinoseb | 88-85-7 | Herbicide | 2 | 14 | AF ECOTOX | 7 | MCL | MCL, CANALWQG, HPV |
| Dinotefuran | 165252-70-0 | Insecticide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Endrin | 72-20-8 | Insecticide/avicide | 2 | 0.086 | C OW | 2 | MCL | MCL, OW NRWQC |
| Endrin aldehyde | 7421-93-4 | Degradate of endrin | 2 | NAV | NAV | NAV | NAV | – |
| Endrin ketone | 53494-70-5 | Degradate of endrin | 2 | NAV | NAV | NAV | NAV | – |
| Ethylenethiourea (ETU) | 96-45-7 | Degradate of metiram | 2 | 2 | CI OPP | NAV | NAV | CCL3 |
| Fenhexamid | 126833-17-8 | Fungicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Fluazinam | 79622-59-6 | Fungicide | 2 | 18 | AF ECOTOX | NAV | NAV | OPP Reg |
| Flucarbazone | 181274-17-9 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Flufenacet | 142459-58-3 | Herbicide | 2 | 2,920 | AF ECOTOX | NAV | NAV | OPP Reg |
| Flufenacet ESA | NAV | Degradate of flufenacet | 2 | NAV | NAV | NAV | NAV | – |
| Flufenacet OA | NAV | Degradate of flufenacet | 2 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Flumioxazin | 103361-09-7 | Herbicide | 2 | 891 | CF ECOSAR | NAV | NAV | OPP Reg |
| Fluroxypyr | 69377-81-7 | Herbicide | 2 | 7,150 | AF ECOTOX | NAV | NAV | OPP Reg |
| Fluthiacet-methyl | 117337-19-6 | Herbicide | 2 | 0.076 | ANVP ECOSAR | NAV | NAV | OPP Reg |
| Foramsulfuron | 173159-57-4 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Heptachlor | 76-44-8 | Insecticide | 2 | 0.0038 | C OW | 0.4 | MCL | MCL, OW NRWQC |
| Heptachlor epoxide | 1024-57-3 | Degradate of heptachlor | 2 | 0.0038 | C OW | 0.2 | MCL | MCL, OW NRWQC |
| Imazamethabenz | 81405-85-8 | Herbicide | 2 | 110,000 | AI ECOTOX | NAV | NAV | SFIREG |
| Imazapyr | 81334-34-1 | Herbicide | 2 | 18 | AVP OPP | 20,000 | HBSL | SFIREG |
| MCPB (4-[4-Chloro-2-methylphenoxy]butanoic acid) | 94-81-5 | Herbicide | 2 | 210 | AVP OPP | 100 | HBSL | SFIREG, CANALWQG |
| Mesosulfuron | 208465-21-8 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Mesotrione | 104206-82-8 | Herbicide | 2 | NAV | NAV | NAV | NAV | SFIREG, OPP Reg |
| Methyl iodide | 74-88-4 | Fumigant/nematocide | 2 | 14,453 | CI ECOSAR | NAV | NAV | OPP Reg |
| Metsulfuron-methyl | 74223-64-6 | Herbicide | 2 | 275,000 | AF ECOTOX | 2,000 | HBSL | SFIREG |
| Mirex | 2385-85-5 | Insecticide | 2 | 0.001 | C OW | 1 | HBSL | OW NRWQC |
| MSMA (Monosodium methylarsenate) | 2163-80-6 | Herbicide | 2 | 2,800 | ANVP OPP tox | NAV | NAV | SFIREG |
| Napropamide | 15299-99-7 | Herbicide | 2 | 1,100 | CF OPP | 800 | HBSL | SFIREG |
| Orthosulfamuron[4] | 213464-77-8 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Oxydemeton-methyl | 301-12-2 | Insecticide | 2 | 5 | CF OPP | NAV | NAV | CCL3 |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| *p,p′*-DDD (*p,p′*-Dichlorodiphenyl-dichloroethane) | 72-54-8 | Degradate of DDT | 2 | 0.001 | C OW | 0.1 | HBSL | OW NRWQC |
| *p,p′*-DDT (*p,p′*-Dichlorodiphenyl-trichloroethane) | 50-29-3 | Insecticide/ acaricide | 2 | 0.001 | C OW | 0.1 | HBSL | OW NRWQC |
| Parathion | 56-38-2 | Insecticide | 2 | 0.002 | CI USGS | 0.02 | HBSL | GLWQA, OW NRWQC |
| Penoxsulam | 219714-96-2 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Picloram | 1918-02-1 | Herbicide | 2 | 550 | CF OPP | 500 | MCL | MCL, SFIREG, CANALWQG, HPV |
| Pinoxaden | 243973-20-8 | Herbicide | 2 | 1,200 | ANVP OPP | NAV | NAV | OPP Reg |
| Pirmicarb | 23103-98-2 | Insecticide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Potassium oleate | 143-18-0 | Adjuvant | 2 | 1.8E+20 | ANVP ECOSAR | NAV | NAV | HPV |
| Prohexadione | 88805-35-0 | Fungicide | 2 | 541,135 | CI ECOSAR | NAV | NAV | OPP Reg |
| Propoxycarbazone | 145026-81-9 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Prothioconazole | 178928-70-6 | Fungicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Spinosad | 131929-60-7 | Insecticide | 2 | 2,970 | AF ECOTOX | NAV | NAV | OPP Reg |
| Spirodiclofen | 148477-71-8 | Insecticide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Sulfcarbamide | 62-56-6 | Rodenticide | 2 | 6,510 | ANVP ECOSAR | NAV | NAV | HPV |
| Sulfentrazone [4] | 122836-35-5 | Herbicide | 2 | 30,200 | AI ECOTOX | NAV | NAV | OPP Reg |
| Tebufenozide [4] | 112410-23-8 | Insecticide | 2 | 1,500 | AF ECOTOX | NAV | NAV | CCL3 |
| Thiacloprid | 111988-49-9 | Insecticide | 2 | NAV | NAV | NAV | NAV | OPP Reg |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Thiamethoxam | 153719-23-4 | Fungicide/insecticide | 2 | NAV | NAV | NAV | NAV | SFIREG |
| Thiazopyr | 117718-60-2 | Herbicide | 2 | 14 | CF ECOSAR | NAV | NAV | OPP Reg |
| Thiodicarb | 59669-26-0 | Insecticide | 2 | 9 | CI OPP tox | NAV | NAV | CCL3 |
| Thiophanate methyl | 23564-05-8 | Fungicide | 2 | 2 | CF OPP tox | NAV | NAV | CCL3 |
| Thiram | 137-26-8 | Fungicide | 2 | 21 | AF OPP | NAV | NAV | HPV |
| Topramezone | 210631-68-8 | Herbicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| Toxaphene | 8001-35-2 | Insecticide/acaricide | 2 | 0.0002 | C OW | 2 | MCL | MCL, GLWQA, OW NRWQC |
| Tralkoxydim | 87820-88-0 | Herbicide | 2 | 2,100 | CI OPP | NAV | NAV | SFIREG, OPP Reg |
| Vinclozolin | 50471-44-8 | Fungicide | 2 | 2,000 | AI OPP tox | 20 | PHBSL | CCL3 |
| Zinc | 7440-66-6 | Herbicide | 2 | 120 | C OW | 2,000 | HBSL | CANALWQG, GLWQA, OW NRWQC |
| Zoxamide | 156052-68-5 | Fungicide | 2 | NAV | NAV | NAV | NAV | OPP Reg |
| 2,5-Dichloroaniline | 95-82-9 | Degradate of chloramben (methyl ester) | 3 | NAV | NAV | NAV | NAV | – |
| 3-DCMT (3-dichloromethyl-5-ethoxy-1,2,4-thiadiazole) | NAV | Degradate of etridiazole | 3 | 385 | AF OPP tox | NAV | NAV | – |
| Abamectin | 71751-41-2 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Acifluorfen | 50594-66-6 | Herbicide | 3 | 265 | AVP OPP | 90 | HBSL | – |
| AE C421200 | NAV | Degradate of thidiazuron | 3 | 70,000 | ANVP OPP tox | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| AE F132345 | NAV | Degradate of thidiazuron | 3 | 980 | ANVP OPP tox | NAV | NAV | – |
| AE F132347 | NAV | Degradate of thidiazuron | 3 | 980 | ANVP OPP tox | NAV | NAV | – |
| Aluminum phosphide | 20859-73-8 | Fumigant/ fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Amitraz | 33089-61-1 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Amitrole | 61-82-5 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Ammonium sulfamate | 7773-06-0 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Amoxicilin | 61336-70-7 | Antibiotic | 3 | NAV | NAV | NAV | NAV | – |
| Ampelomyces quisqualis | NAV | Microbial fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Anilazine | 101-05-3 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Arsenic acid | 7778-39-4 | Herbicide/insecticide/ rodenticide | 3 | NAV | NAV | NAV | NAV | – |
| AVG (Amino ethoxy vinyl glycine hydrochloride) | 49669-74-1 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Aviglycine | 55720-26-8 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Azadirachtin | 11141-17-6 | Insecticide | 3 | 2,000 | AF ECOTOX | NAV | NAV | – |
| Azinphos-ethyl | 2642-71-9 | Insecticide | 3 | 0.55 | AF ECOTOX | NAV | NAV | – |
| Bacillus cereus | NAV | Microbial insecticide/ Plant growth regulator (depends on strain) | 3 | NAV | NAV | NAV | NAV | – |
| Bacillus pumilis | NAV | Microbial other | 3 | NAV | NAV | NAV | NAV | – |
| Bacillus subtilis | NAV | Microbial Fungicide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Bacillus thuringiensis | 68038-71-1 | Microbial insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Barban | 101-27-9 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Barium polysulfide | 50864-67-0 | Insecticide/fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Bendiocarb | 22781-23-3 | Insecticide | 3 | NAV | NAV | 9 | HBSL | – |
| Bensulfuron-methyl | 83055-99-6 | Herbicide | 3 | 46 | ANVP ECOSAR | 1,000 | HBSL | – |
| Benzoic acid | 65-85-0 | Degradate | 3 | 90,000 | AF ECOTOX | NAV | NAV | HPV |
| Benzyladenine | 1214-39-7 | Plant growth regulator | 3 | 10,250 | AI ECOTOX | NAV | NAV | – |
| Bifenox | 42576-02-3 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Bispyribac | 125401-75-4 | Herbicide | 3 | 793,889 | CI ECOSAR | NAV | NAV | – |
| Bordeaux mixture | NAV | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| BTS 27271 | 33089-74-6 | Degradate of amitraz | 3 | NAV | NAV | NAV | NAV | – |
| BTS 27919 | 60397-77-5 | Degradate of amitraz | 3 | NAV | NAV | NAV | NAV | – |
| Buprofezin | 69327-76-0 | Insecticide | 3 | 4 | CF ECOSAR | NAV | NAV | – |
| Burkholderia cepacia | NAV | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Butachlor | 23184-66-9 | Herbicide | 3 | 50 | AF ECOTOX | NAV | NAV | – |
| Butenoic acid | 3724-65-0 | Pheromone | 3 | NAV | NAV | NAV | NAV | HPV |
| Butylate [4] | 2008-41-5 | Herbicide | 3 | 105 | AF OPP | 400 | HBSL | – |
| Cacodylic acid | 75-60-5 | Herbicide/defoliant | 3 | 17,100 | ANVP OPP tox | NAV | NAV | – |
| Caffeine | 58-08-2 | Stimulant | 3; not evaluated as a pesticide | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Calcium chloride | 10043-52-4 | Fungicide/herbicide/ insecticide/microbiocide/ molluscicide | 3 | NAV | NAV | NAV | NAV | – |
| Calcium polysulfide | 1344-81-6 | Insecticide/fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Captafol | 2939-80-2 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Carboxin | 5234-68-4 | Fungicide | 3 | 370 | ANVP OPP | 60 | HBSL | – |
| Chloramben methyl ester | 7286-84-2 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Chlordimeform | 6164-98-3 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Chlorethoxyfos | 54593-83-8 | Insecticide | 3 | 1.15 | AF ECOTOX | NAV | NAV | – |
| Chlorfenapyr | 122453-73-0 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Chlorfevinfos | 470-90-6 | Insecticide/acaricide | 3 | 0.035 | AI ECOTOX | NAV | NAV | – |
| Chlormequat | 7003-89-6 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Chlorobenzilate | 510-15-6 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Chloroneb | 2675-77-6 | Fungicide | 3 | 871 | CI ECOSAR | NAV | NAV | – |
| Chloroxuron | 1982-47-4 | Herbicide | 3 | 135 | AF ECOTOX | NAV | NAV | – |
| Chlorpropham | 101-21-3 | Herbicide/plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Chlorpyriphos-methyl | 5598-13-0 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Cinnamaldehyde | 104-55-2 | Dog and catrepellent/ fungicide/insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Clofentezine | 74115-24-5 | Insecticide | 3 | 4,548 | CI ECOSAR | NAV | NAV | – |
| Clomazone | 81777-89-1 | Herbicide | 3 | 2,600 | AI ECOTOX | NAV | NAV | – |
| Collectotrichum spores | NAV | Mycoherbicide | 3 | NAV | NAV | NAV | NAV | – |
| Coniothyrium minitans | NAV | Microbialfungicide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Copper sulfate tribasic | NAV | Herbicide/algaecide/ fungicide/water treatment | 3 | NAV | NAV | NAV | NAV | – |
| Coumafos | 56-72-4 | Insecticide/acaricide | 3 | 0.0337 | CF OPP tox | NAV | NAV | – |
| CPPU (Forchlorfenuron) | 68157-60-8 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Cryolite | 15096-52-3 | Insecticide | 3 | 5,000 | AI OPP tox | NAV | NAV | – |
| Cyanamide | 420-04-2 | Plant growth regulator/ herbicide | 3 | 267,161 | CI ECOSAR | NAV | NAV | – |
| Cycloate | 1134-23-2 | Herbicide | 3 | 1,300 | AI OPP | 40 | HBSL | – |
| Cydia pomonella | NAV | Insect growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Cyromazine | 66215-27-8 | Insecticide | 3 | 125,000 | AI ECOTOX | NAV | NAV | – |
| Cytokinins | 525-79-1 | Plant growth regulator | 3 | 864.5 | AI ECOSAR | NAV | NAV | – |
| Dalapon | 75-99-0 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Daminozide | 1596-84-5 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Dazomet | 533-74-4 | Fumigant/fungicide/ nematicide | 3 | NAV | NAV | NAV | NAV | – |
| Demeton | 8065-48-3 | Insecticide/nematicide | 3 | NAV | NAV | NAV | NAV | – |
| Desmedipham | 13684-56-5 | Herbicide | 3 | 220 | ANVP OPP tox | NAV | NAV | – |
| Di-allate | 2303-16-4 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Dichlone | 117-80-6 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Dienochlor | 2227-17-0 | Insecticide | 3 | 25 | AF ECOTOX | NAV | NAV | – |
| Diethatyl | 38727-55-8 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Difenzoquat | 49866-87-7 | Herbicide | 3 | 1,315 | AI OPP tox | NAV | NAV | – |
| Dinocap | 39300-45-3 | Fungicide/insecticide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Diphenamid | 957-51-7 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Dithiopyr | 97886-45-8 | Herbicide | 3 | 20 | ANVP ECOTOX | NAV | NAV | – |
| DNOC (4,6-Dinitro-*O*-cresol) | 534-52-1 | Herbicide | 3 | 33 | AF ECOTOX | NAV | NAV | – |
| Dodine | 2439-10-3 | Fungicide | 3 | 0.95 | ANVP OPP tox | NAV | NAV | – |
| DSMA (Disodium methylarsonate) | 144-21-8 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Emamectin | 155569-91-8 | Insecticide | 3 | 0.5 | AI ECOTOX | NAV | NAV | – |
| EPN (*O*-ethyl *O*-(4-nitrophenyl) *P*-phenylphosphonothioate) | 2104-64-5 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Ethametsulfuron | 97780-06-8 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Ethephon | 16672-87-0 | Plant growth regulator | 3 | 2,500 | AVP OPP tox | NAV | NAV | – |
| Ethion | 563-12-2 | Insecticide | 3 | 0.013 | CF USGS | 4 | HBSL | – |
| Ethion monoxon | 17356-42-2 | Degradate of ethion | 3 | NAV | NAV | NAV | NAV | – |
| Ethofumesate | 26225-79-6 | Herbicide | 3 | 250 | CI OPP tox | NAV | NAV | – |
| Etridiazole | 2593-15-9 | Fungicide | 3 | 120 | CF OPP tox | NAV | NAV | – |
| Fatty alcohols | 85566-12-7 | Microbiocide/solvent | 3 | 1,642 | CI ECOSAR | NAV | NAV | – |
| Fenamidone | 161326-34-7 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Fenarimol | 60168-88-9 | Fungicide | 3 | 450 | AF ECOTOX | NAV | NAV | – |
| Fenbuconazole | 114369-43-6 | Fungicide | 3 | 340 | AF ECOTOX | NAV | NAV | – |
| Fenchlorofos | 299-84-3 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Fenitrothion | 122-14-5 | Insecticide | 3 | 0.087 | CI OPP | NAV | NAV | – |
| Fenoxaprop | 66441-23-4 | Herbicide | 3 | 155 | AF ECOTOX | NAV | NAV | – |
| Fenoxycarb | 79127-80-3 | Insecticide/insect growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Fenpyroximate | 134098-61-6 | Insecticide | 3 | 12 | CF ECOSAR | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Fensulfothion | 115-90-2 | Insecticide/nematocide | 3 | NAV | NAV | NAV | NAV | – |
| Fenthion | 55-38-9 | Insecticide | 3 | 0.013 | CI OPP | 0.5 | HBSL | – |
| Fenthion sulfone | 3761-42-0 | Degradate of fenthion | 3 | NAV | NAV | NAV | NAV | – |
| Fenthion sulfone oxygen analog | NAV | Degradate of fenthion | 3 | NAV | NAV | NAV | NAV | – |
| Fenthion sulfoxide | 3761-41-9 | Degradate of fenthion | 3 | NAV | NAV | NAV | NAV | – |
| Fenuron | 101-42-8 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Fenvalerate | 51630-58-1 | Insecticide | 3 | 0.025 | AI ECOTOX | NAV | NAV | – |
| Ferbam | 14484-64-1 | Fungicide | 3 | 500 | AF OPP tox | NAV | NAV | – |
| Flonicamid | 158062-67-0 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Fluazifop | 69335-91-7 | Herbicide | 3 | 10,956 | CI ECOSAR | NAV | NAV | – |
| Fluchloralin | 33245-39-5 | Herbicide | 3 | 4.8 | AF ECOTOX | NAV | NAV | – |
| Flucythrinate | 70124-77-5 | Insecticide | 3 | 0.16 | AF ECOTOX | NAV | NAV | – |
| Fludioxonil | 131341-86-1 | Fungicide | 3 | 82.5 | AF ECOSAR | NAV | NAV | – |
| Flumetralin | 62924-70-3 | Plant growth regulator | 3 | 8.95 | AF ECOTOX | NAV | NAV | – |
| Fluridone | 59756-60-4 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Flutolanil | 66332-96-5 | Fungicide | 3 | 1,250 | AF ECOTOX | NAV | NAV | – |
| Flutriafol | 76674-21-0 | Fungicide | 3 | 157 | CF ECOSAR | NAV | NAV | – |
| Fluvalinate | 69409-94-5 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Fluvalinate-tau | 102851-06-9 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Folpet | 133-07-3 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Fomesafen | 72178-02-0 | Herbicide | 3 | 120 | ANVP OPP tox | NAV | NAV | – |
| Fosamine | 25954-13-6 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Fosetyl aluminum | 39148-24-8 | Fungicide | 3 | 4,990 | ANVP OPP tox | NAV | NAV | – |
| Gallex | NAV | Bactericide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| *gamma*-Aminobutyric acid | 56-12-2 | Plant growth regulator/ Fungicide | 3 | 431 | CI ECOSAR | NAV | NAV | – |
| Garlic juice | 8000-78-0 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Gibberellic acid | 77-06-5 | Plant growth regulator | 3 | 71,500 | AI OPP tox | NAV | NAV | – |
| Glufosinate | 51276-47-2 | Herbicide | 3 | 821 | CI ECOSAR | NAV | NAV | – |
| Harpin protein | NAV | Fungicide/nematicide/ plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Hexythiazox | 78587-05-0 | Insecticide | 3 | 0.6 | CI OPP tox | NAV | NAV | – |
| Hydramethylnon | 67485-29-4 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Hydrated lime | 1305-62-0 | Fungicide/microbiocide/ herbicide | 3 | 520,506 | CI ECOSAR | NAV | NAV | – |
| Hydrogen peroxide | 7722-84-1 | Microbiocide/fungicide/ herbicide/rodenticide | 3 | 31.5 | AF ECOSAR | NAV | NAV | – |
| Hydroxypropanoic acid | 79-33-4 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Imazapic | 104098-48-8 | Herbicide | 3 | 1,706 | CF ECOSAR | NAV | NAV | – |
| Indolyl-butyric acid | 133-32-4 | Plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Iodosulfuron | 144550-36-7 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Isazofos | 42509-80-8 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Isofenphos | 25311-71-1 | Insecticide | 3 | 0.22 | CI USGS | 6 | HBSL | – |
| Isopropalin | 33820-53-0 | Herbicide | 3 | 135 | AI ECOTOX | NAV | NAV | – |
| Isoxaben | 82558-50-7 | Herbicide | 3 | 7 | CF ECOSAR | NAV | NAV | – |
| Kaolin clay | 1332-58-7 | Insecticide/adjuvant/ fungicide/microbiocide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Kinoprene | 42588-37-4 | Insect growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Lactofen [4] | 83513-60-4 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Lead arsenate | 7784-40-9 | Herbicide/insecticide/ rodenticide | 3 | NAV | NAV | NAV | NAV | – |
| Leptofos | 21609-90-5 | Insecticide | 3 | 1.98 | AF ECOTOX | NAV | NAV | – |
| *L*-Glutamic acid | 56-86-0 | Plant growth regulator/ fungicide | 3 | 648 | CI ECOSAR | NAV | NAV | – |
| Maleic hydrazide | 123-33-1 | Plant growth regulator | 3 | 102,000 | ANVP OPP tox | NAV | NAV | – |
| Mancozeb | 8018-01-7 | Fungicide | 3 | 47 | ANVP OPP | NAV | NAV | – |
| MCPP-*p* (Mecoprop-*p*) | 16484-77-8 | Herbicide | 3 | 45,500 | AI OPP | NAV | NAV | – |
| Mefenoxam | 70630-17-0 | Fungicide | 3 | 14,000 | AI OPP | NAV | NAV | – |
| Meflluidide | 53780-34-0 | Herbicide/plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Mepiquat chloride | 24307-26-4 | Plant growth regulator | 3 | 12,500 | CI OPP tox | NAV | NAV | – |
| Merphos | 150-50-5 | Defoliant/plant growth regulator | 3 | NAV | NAV | NAV | NAV | HPV |
| Metaldehyde | 9002-91-9 | Insecticide | 3 | 34,500 | AF OPP tox | NAV | NAV | – |
| Metam potassium | 137-41-7 | Fumigant/fungicide/ microbiocide/algaecide/ nematicide | 3 | 38,338 | ANVP ECOSAR | NAV | NAV | – |
| Methazole | 20354-26-1 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Methiocarb | 2032-65-7 | Insecticide | 3 | 0.1 | CI OPP | 40 | HBSL | – |
| Methoprene | 40596-69-8 | Insecticide | 3 | 48 | CF OPP | NAV | NAV | – |
| Methoprene acid | 302-79-4 | Degradate of methoprene | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Methyl isothiocyanate | 556-61-6 | Fumigant/insecticide/herbicide/nematicide/breakdown product | 3 | NAV | NAV | NAV | NAV | – |
| Metiram | 9006-42-2 | Fungicide | 3 | 77 | ANVP OPP tox | NAV | NAV | – |
| Mevinphos | 7786-34-7 | Insecticide/acaricide | 3 | NAV | NAV | NAV | NAV | – |
| MHPC (Methyl *N*-[3-hydroxyphenol] carbamate) | 13683-89-1 | Degradate of phenmedipham | 3 | 7,000 | AI OPP tox | NAV | NAV | – |
| Minocycline | 10118-90-8 | Antibiotic | 3 | NAV | NAV | NAV | NAV | – |
| Monocrotofos | 6923-22-4 | Insecticide/acaricide | 3 | NAV | NAV | NAV | NAV | – |
| Myrothecium verrucaria | NAV | Insecticide/nematicide | 3 | NAV | NAV | NAV | NAV | – |
| NAD (Nicotinamide adenine dinucleotide) | 53-84-9 | Other | 3 | NAV | NAV | NAV | NAV | – |
| Naphthylacetamide | 86-86-2 | Plant growth regulator | 3 | 234 | CF ECOSAR | NAV | NAV | – |
| Naphthylacetic acid | 86-87-3 | Plant growth regulator | 3 | 14,000 | AF ECOTOX | NAV | NAV | – |
| Naptalam | 132-66-1 | Herbicide | 3 | 59,250 | AI OPP tox | NAV | NAV | – |
| Neburon | 555-37-3 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Neem oil | 8002-65-1 | Insecticide | 3 | 203 | AF ECOSAR | NAV | NAV | – |
| Noruron | 18530-56-8 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Nosema locustae cann | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Oil | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Oxadiazon | 19666-30-9 | Herbicide | 3 | 7.8 | ANVP ECOTOX | NAV | NAV | – |
| Oxytetracycline | 79-57-2 | Fungicide | 3 | 51,000 | AI OPP tox | NAV | NAV | – |
| Oxythioquinox | 2439-01-2 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Paclobutrazol | 76738-62-0 | Plant growth regulator | 3 | 11,800 | AF ECOTOX | NAV | NAV | – |
| Paraoxon-ethyl | 311-45-5 | Degradate of parathion | 3 | NAV | NAV | NAV | NAV | – |
| PCNB (Pentachloronitrobenzene) | 82-68-8 | Fungicide | 3 | 13 | CF OPP tox | NAV | NAV | – |
| Pebulate | 1114-71-2 | Herbicide | 3 | 230 | ANVP OPP | 50 | HBSL | – |
| Pelargonic acid | 112-05-0 | Herbicide/fungicide | 3 | NAV | NAV | NAV | NAV | HPV |
| Penicillin G | 61-33-6 | Antibiotic | 3 | NAV | NAV | NAV | NAV | – |
| Perthane | 72-56-0 | Insecticide | 3 | 2.2 | AF ECOTOX | NAV | NAV | – |
| Petroleum distillate | 8002-05-9 | Insecticide/adjuvant/ solvent | 3 | 625 | AF ECOTOX | NAV | NAV | HPV |
| Petroleum oil | 64741-89-5 | Herbicide/plant growth regulator/insecticide/ adjuvant | 3 | NAV | NAV | NAV | NAV | HPV |
| Phenmedipham | 13684-63-4 | Herbicide | 3 | 320 | AVP OPP tox | NAV | NAV | – |
| Phosalone | 2310-17-0 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Phosphamidon | 13171-21-6 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Phosphoric acid | 7664-38-2 | Fungicide/herbicide/ microbiocide | 3 | 578,554 | CI ECOSAR | NAV | NAV | – |
| Phytophthora spores | NAV | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Pinolene | 68240-09-5 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Polychlorinated naphthalene | NAV | ND | 3 | NAV | NAV | NAV | NAV | – |
| Polyhedrosis virus | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Potassium bicarbonate | 298-14-6 | Fungicide | 3 | 121,000,000 | ANVP ECOSAR | NAV | NAV | – |
| Potassium carbonate | 584-08-7 | Fungicide/microbiocide/ herbicide/pH adjustment | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Primisulfuron | 86209-51-0 | Herbicide | 3 | 105,000 | AF ECOTOX | 2,000 | HBSL | – |
| Prodiamine | 29091-21-2 | Herbicide | 3 | 1,590 | AF ECOTOX | NAV | NAV | – |
| Profluralin | 26399-36-0 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Propachlor | 1918-16-7 | Herbicide | 3 | 13.5 | ANVP OPP | 1 | HBSL | – |
| Propachlor ESA | NAV | Degradate of propachlor | 3 | NAV | NAV | NAV | NAV | – |
| Propachlor OA | NAV | Degradate of propachlor | 3 | NAV | NAV | NAV | NAV | – |
| Propamocarb | 24579-73-5 | Fungicide | 3 | 6,300 | CF OPP tox | NAV | NAV | – |
| Propetamphos | 31218-83-4 | Insecticide | 3 | 1.65 | AI OPP | 4 | HBSL | – |
| Propham | 122-42-9 | Herbicide | 3 | 4,050 | AI ECOTOX | 100 | HBSL | – |
| Pseudomonas fluorescens | NAV | Microbial fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Pyraflufen ethyl | 129630-19-9 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Pyrazon | 1698-60-8 | Herbicide | 3 | 170 | ANVP OPP tox | NAV | NAV | – |
| Pyrazon B-1 metabolite | NAV | Degradate of pyrazon | 3 | 50,000 | AI OPP tox | NAV | NAV | – |
| Pyridate | 55512-33-9 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Pyrimethanil | 53112-28-0 | Fungicide | 3 | 1,298 | CI ECOSAR | NAV | NAV | – |
| Pyriproxyfen [4] | 95737-68-1 | Insecticide | 3 | 200 | AI ECOTOX | NAV | NAV | – |
| Pyrithiobac | 123342-93-8 | Herbicide | 3 | 23,299 | CI-SW ECOSAR | NAV | NAV | – |
| Quinclorac | 84087-01-4 | Herbicide | 3 | 14,900 | AI ECOTOX | NAV | NAV | – |
| Quinoxyfen | 124495-18-7 | Fungicide | 3 | 18 | CF ECOSAR | NAV | NAV | – |
| Quizalofop | 76578-12-6 | Herbicide | 3 | 11,677 | CI ECOSAR | NAV | NAV | – |
| Resmethrin | 10453-86-8 | Insecticide | 3 | 0.14 | AF OPP | NAV | NAV | – |
| Rimsulfuron | 122931-48-0 | Herbicide | 3 | 500,000 | AI ECOTOX | NAV | NAV | – |
| Rotenone | 83-79-4 | Insecticide | 3 | 0.97 | AF OPP | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Ryanodine | 15662-33-6 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Sabadilla | 8051-02-3 | Insecticide | 3 | 39 | CI ECOSAR | NAV | NAV | – |
| Sethoxydim | 74051-80-2 | Herbicide | 3 | 250 | ANVP OPP tox | NAV | NAV | – |
| Silicates | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Simetryn | 1014-70-6 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Sodium arsenite | 7784-46-5 | Herbicide/insecticide/ rodenticide/fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Sodium chlorate | 7775-09-9 | Defoliant/herbicide/ microbiocide | 3 | 43,000 | AVP OPP tox | NAV | NAV | – |
| Sodium metaborate | 7775-19-1 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Spinetoram | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Spiromesifen | 283594-90-1 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Steinernema carpocap | NAV | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Steinernema riobravi | NAV | Biocontrol | 3 | NAV | NAV | NAV | NAV | – |
| Stirofos | 961-11-5 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Streptomycin | 57-92-1 | Fungicide | 3 | 860 | ANVP OPP tox | NAV | NAV | – |
| Sulfallate | 95-06-7 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Sulfosate | 81591-81-3 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Sulfotepp | 3689-24-5 | Insecticide | 3 | NAV | NAV | 4 | HBSL | – |
| Sulfur | 63705-05-5 | Fungicide | 3 | 90,000 | AF OPP tox | NAV | NAV | – |
| Sulfuric acid | 7664-93-9 | Herbicide/dessicant/ fungicide/microbiocide | 3 | 21,000 | AF ECOTOX | NAV | NAV | – |
| Sulprofos | 35400-43-2 | Insecticide | 3 | 0.38 | AI ECOTOX | NAV | NAV | – |
| Sumithrin | 26002-80-2 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| TCA (Trichloroacetic acid) | 76-03-9 | Herbicide/breakdown product | 3 | NAV | NAV | NAV | NAV | – |
| TCMTB (2-[Thiocyanomethylthio] benzothiazole) | 21564-17-0 | Microbiocide/fungicide | 3 | 3.65 | AF ECOTOX | NAV | NAV | – |
| Temephos | 3383-96-8 | Insecticide | 3 | 5 | AI OPP | NAV | NAV | – |
| Terbutryn | 886-50-0 | Herbicide | 3 | 410 | AF ECOTOX | 0.7 | HBSL | – |
| Tetraborohydrate | NAV | Fungicide/insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Tetraoxosulfate | 14808-79-8 | – | 3 | NAV | NAV | NAV | NAV | – |
| Tetrathiocarbonate | 7345-69-9 | Fumigant/fungicide/ nematicide | 3 | 590,000,000 | ANVP ECOSAR | NAV | NAV | – |
| Thiabendazole | 148-79-8 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |
| Thidiazuron | 51707-55-2 | Defoliant/plant growth regulator | 3 | 100 | CI OPP tox | NAV | NAV | – |
| Thifensulfuron | 79277-67-1 | Herbicide | 3 | 418 | ANVP ECOSAR | NAV | NAV | – |
| Thionazin | 297-97-2 | Nematocide | 3 | NAV | NAV | NAV | NAV | – |
| Tokuthion | 34643-46-4 | Insecticide | 3 | 6,500 | AF ECOTOX | NAV | NAV | – |
| Tralomethrin | 66841-25-6 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Triadimefon | 43121-43-3 | Fungicide | 3 | 41 | CF OPP tox | NAV | NAV | – |
| Triadimenol | 55219-65-3 | Fungicide | 3 | 89 | CF ECOSAR | NAV | NAV | – |
| Triasulfuron | 82097-50-5 | Herbicide | 3 | 50,000 | AF OPP | 70 | HBSL | – |
| Triazamate | 112143-82-5 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Trichlorfon | 52-68-6 | Insecticide | 3 | NAV | NAV | NAV | NAV | – |
| Trichloronat | 327-98-0 | Insecticide | 3 | 0.05 | AI ECOTOX | NAV | NAV | – |
| Tridiphane | 58138-08-2 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |

**Table 3–1.** Aquatic-life and human-health benchmarks used in the evaluation of pesticides for water.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Acute fish and invertebrate toxicity values were multiplied by a level of concern (LOC) of 0.5 to be comparable in value to Office of Pesticide Programs aquatic-life benchmarks. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; C OW, chronic OW NRWQC; CAS, Chemical Abstracts Service; CANALWQG, Canadian Water Quality Guidelines for Aquatic Life (Canadian Council of Ministers of the Environment, 2007); CCL3, Third Contaminant Candidate List (USEPA, 2009c); CF, chronic fish; CI, chronic invertebrate; CMAC, Maximum Allowable Concentration (Health Canada, 2008); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (USEPA, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (USEPA, 2010a); GLWQA, Great Lakes Water Quality Agreement aquatic-life water-quality objective (USEPA, 1978); HBSL, Health-Based Screening Level (Toccalino and others, 2008); HPV, high production-volume chemical (USEPA, 2005); MCL, Maximum Contaminant Level (USEPA, 2009d); NAV, not available; OPP, Office of Pesticide Programs aquatic-life benchmark (USEPA, 2009e); OPP Ecotox, OPP Pesticide ecotoxicology database (USEPA, 2009f); OPP Reg, recent (1997–2008) active ingredient registration with USEPA (USEPA, 2009b); OPP tox, toxicity value from OPP reregistration decision documents (USEPA, 2010b); OW NRWQC, Office of Water National Recommended Water Quality Criteria for the protection of aquatic life (USEPA, 2002); PHBSL, Provisional Health-Based Screening Level; SFIREG, State FIFRA Issues Research and Evaluation Group list of pesticides of water-quality concern (Association of American Pesticide Control Officials, 2005); UCMR, Unregulated Contaminant Monitoring Regulation (USEPA, 2006); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (USEPA, 2010b); µg/L, micrograms per liter; –, none]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Selected aquatic-life benchmark (µg/L) | Type/source of aquatic-life benchmark | Human-health benchmark (µg/L) | Type of human-health benchmark | Other agency priorities |
|---|---|---|---|---|---|---|---|---|
| Trifloxysulfuron | 290332-10-4 | Herbicide | 3 | NAV | NAV | NAV | NAV | – |
| Triflumizole | 99387-89-0 | Fungicide | 3 | 1,034 | AI ECOSAR | NAV | NAV | – |
| Triflusulfuron | 126535-15-7 | Herbicide | 3 | 11 | CF ECOSAR | 20 | HBSL | – |
| Triforine | 26644-46-2 | Fungicide | 3 | 10,700 | AF ECOTOX | NAV | NAV | – |
| Trimethacarb | 12407-86-2 | Insecticide/molluscicide/ dog and catrepellent | 3 | NAV | NAV | NAV | NAV | – |
| Trinexapac | 95266-40-3 | Herbicide/plant growth regulator | 3 | NAV | NAV | NAV | NAV | – |
| Trithion | 786-19-6 | Insecticide/acaricide | 3 | 0.60 | AI ECOTOX | NAV | NAV | – |
| Uniconazole | 83657-17-4 | Plant growth regulator | 3 | 3,400 | AF ECOTOX | NAV | NAV | – |
| Vernolate | 1929-77-7 | Herbicide | 3 | NAV | NAV | 7 | HBSL | – |
| Zineb | 12122-67-7 | Fungicide | 3 | NAV | NAV | NAV | NAV | – |

[1] Dicofol was evaluated using an aquatic-life (AL) benchmark based on a USEPA OPP chronic fish toxicity value of 1 µg/L, resulting in an AL benchmark quotient (BQ) for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 4.4 µg/L. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason dicofol was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

[2] Endothall was evaluated using an AL benchmark based on a USEPA OPP acute non-vascular plant toxicity value of 1.9 µg/L, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include a chronic fish benchmark of 1,300 µg/L for endothall acid (however there are lower benchmark values for other formulations of endothall, including a chronic invertebrate benchmark of 2.3 µg/L for the DMA salt). The resulting BQ using the new benchmark for endothall is less than 0.01. Because this is the only reason endothall was placed in Tier 1, its priority would have been lower (Tier 2 because it has an MCL for drinking water) if the updated benchmarks had been available when the prioritization was performed.

[3] Flumiclorac was evaluated using an AL benchmark based on a chronic fish toxicity value of 1.49 µg/L, estimated from ECOSAR, resulting in an AL BQ for predicted concentrations in streams greater than 0.01. Newly released OPP AL benchmarks (September 2010) include an acute fish benchmark of 550 µg/L for flumiclorac-pentyl. The resulting BQ using the new benchmark is less than 0.01. Because this is the only reason flumiclorac was placed in Tier 1, its priority would have been lower (Tier 3) if the updated benchmarks had been available when the prioritization was performed.

[4] Newly released OPP AL benchmarks (September 2010) include new or revised benchmarks for 6 compounds in Tier 2 (orthosulfamuron, sulfentrazone and tebufenozide) or Tier 3 (butylate, lactofen and pyriproxifenan). If the updated benchmarks had been available when the prioritization was performed, these compounds would have been placed in Tier 1 on the basis of predicted concentrations in streams. Because of this, these compounds were added to the list of pesticide compounds USGS is evaluating for inclusion in analytical methods.

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# Appendix 4.

## Aquatic-Life Benchmarks or Toxicity Values With Resulting Aquatic-Life Toxicity Bins and Available Sediment Benchmarks Used in the Evaluation of Pesticides for Sediment

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| 1,3-Dicarbamoyl-2,4,5,6-tetrachlorobenzene | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 1-Carbamoyl-3-cyano-4-hydroxy-2,5,6-trichlorobenzene | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 2-(4-tert-butylphenoxy)-Cyclohexanol | 1942-71-8 | Degradate | 1 | – | – | – | 98 | CF ECOSAR | 2 |
| 2,6-Diethylaniline | 579-66-8 | Degradate | 1 | – | – | – | 7,812 | AI ECOTOX | 2 |
| 2-([2-Ethyl-6-methylphenyl] amino)-1-propanol | 61520-53-4 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 2-chloro-*N*-(2-ethyl-6-methylphenyl) acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 2-Hydroxyatrazine | 2163-68-0 | Degradate | 1 | – | – | – | 1,500 | AF OPP | 2 |
| 3,4-Dichloroaniline | 95-76-1 | Degradate | 1 | – | – | – | 1.7 | AI ECOTOX | 1 |
| 3,5-Dichloroaniline | 626-43-7 | Degradate | 1 | – | – | – | 18 | CI ECOSAR | 2 |
| 3-Phenoxybenzoic acid | 3739-38-6 | Degradate | 1 | – | – | – | 6,650 | AF OPP tox | 2 |
| 3-Phenoxybenzyl alcohol | 13826-35-2 | Degradate | 1 | – | – | – | 587 | AI ECOSAR | 2 |
| 4-(Hydroxymethyl)pendimethalin | 56750-76-6 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| 4,4′-Dichlorobenzophenone | 90-98-2 | Degradate | 1 | – | – | – | 171 | CF ECOSAR | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| 4-Hydroxy-2,5,6-trichloroisophthalonitrile | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Alachlor | 15972-60-8 | Herbicide | 1 | – | – | – | 1.64 | ANVP OPP | 1 |
| Alachlor ethane sulfonic acid (ESA), secondary amide | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Alachlor sulfynilacetic acid (SAA) | 140939-16-8 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Aldrin | 309-00-2 | Insecticide | 1 | – | – | – | 1.5 | C OW | 1 |
| Allethrin | 584-79-2 | Insecticide | 1 | – | – | – | 1.3 | AF ECOTOX | 1 |
| *alpha*-Endosulfan | 959-98-8 | Insecticide | 1 | 0.74; 0.29, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | NAV, DF>10% | – | – | – |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | Insecticide mixture component, by-product, degradate | 1 | – | – | – | 400 | AI ECOTOX | 2 |
| Aminomethylphosphonic acid | 1066-51-9 | Degradate | 1 | – | – | – | 249,500 | AF OPP | 3 |
| Atrazine | 1912-24-9 | Herbicide | 1 | – | – | – | 1 | ANVP OPP | 1 |
| Benfluralin | 1861-40-1 | Herbicide | 1 | – | – | – | 1.9 | CF OPP | 1 |
| Benomyl | 17804-35-2 | Fungicide | 1 | – | – | – | 2.8 | AF ECOTOX | 1 |
| Bensulide | 741-58-2 | Herbicide | 1 | – | – | – | 290 | AI OPP | 2 |
| Benzyladenine | 1214-39-7 | Plant growth regulator | 1 | – | – | – | 10,250 | AI ECOTOX | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| *beta*-Endosulfan | 33213-65-9 | Insecticide | 1 | 3.5; 1.4, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | No | 0.2 | CF OPP tox | 1 |
| *beta*-HCH | 319-85-7 | Insecticide mixture component, by-product, degradate | 1 | – | – | – | 550 | AF ECOTOX | 2 |
| Bifenthrin | 82657-04-3 | Insecticide | 1 | – | – | – | 0.075 | AF ECOTOX | 1 |
| Bromuconazole | 116255-48-2 | Fungicide | 1 | – | – | – | 53 | ANVP ECOTOX | 1 |
| Buprofezin | 69327-76-0 | Insecticide | 1 | – | – | – | 4 | CF ECOSAR | 1 |
| Butralin | 33629-47-9 | Herbicide | 1 | – | – | – | 3 | CF ECOSAR | 1 |
| Chlordane | 57-74-9 | Insecticide | 1 | 8.87; 3.24, µg/kg DW | PEL (Canada-Interim SQG); TEC (consensus-based SQG, MacDonald) | NAV, DF>10% | – | – | – |
| Chlorothalonil | 1897-45-6 | Fungicide | 1 | – | – | – | 0.6 | CI OPP | 1 |
| Chlorpyrifos | 2921-88-2 | Insecticide | 1 | – | – | – | 0.04 | CI OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| *cis*-Chlordane | 5103-71-9 | Insecticide | 1 | 8.87; 3.24, µg/kg DW | PEL - chlordane (Canada-Interim SQG); TEC- chlordane (consensus-based SQG, MacDonald) | NAV, DF>10% | – | – | – |
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | c61898-95-1 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| *cis*-Nonachlor | 5103-73-1 | Insecticide; component of total chlordane, by-product of technical chlordane | 1 | – | – | – | – | – | – |
| *cis*-Permethrin | 61949-76-6 | Insecticide | 1 | – | – | – | 0.0014 | CI OPP | 1 |
| *cis*-Propiconazole | c60207-90-1 | Fungicide | 1 | – | – | – | 93 | ANVP OPP (propiconazole) | 2 |
| Clofentezine | 74115-24-5 | Insecticide | 1 | – | – | – | 4,548 | CI ECOSAR | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Copper hydroxide | 20427-59-2 | Fungicide/ microbiocide/ nematicide | 1 | – | – | – | 9 (copper) | C OW | 3 |
| Copper sulfate | 7758-98-7 | Fungicide/ algaecide/ molluscicide | 1 | – | – | – | 9 (copper) | C OW | 1 |
| Coumafos | 56-72-4 | Insecticide/ acaricide | 1 | – | – | – | 0.0337 | CF OPP tox | 1 |
| Cyfluthrin | 68359-37-5 | Insecticide | 1 | – | – | – | 0.0125 | AI ECOTOX | 1 |
| Cyhalothrin-*gamma* | 76703-62-3 | Insecticide | 1 | – | – | – | 0.02 | AI ECOTOX (*lambda*-cyhalothrin) | 1 |
| Cyhalothrin-*lambda* | 91465-08-6 | Insecticide | 1 | – | – | – | 0.02 | AI ECOTOX | 1 |
| Cypermethrin | 52315-07-8 | Insecticide | 1 | – | – | – | 0.069 | CI OPP | 1 |
| Cyproconazole | 94361-06-5 | Fungicide | 1 | – | – | – | 9,500 | AF ECOTOX | 2 |
| Cyprodinil | 121552-61-2 | Fungicide | 1 | – | – | – | 16 | AI ECOTOX | 1 |
| Cytokinins | 525-79-1 | Plant growth regulator | 1 | – | – | – | 864.5 | AI ECOSAR | 2 |
| Dacthal | 1861-32-1 | Herbicide | 1 | – | – | – | 11,000 | ANVP OPP | 2 |
| Dacthal monoacid | 887-54-7 | Degradate | 1 | – | – | – | 6,111 | CF ECOSAR | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Dechloroalachlor | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Dechlorometolachlor | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Deethylhydroxyatrazine | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Deisopropyl prometryn | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| *delta*-HCH | 319-86-8 | Insecticide mixture component, by-product, degradate | 1 | 230; 13, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | NAV, DF>10% | 420 | AF ECOTOX | 2 |
| Desulfinylfipronil (MB46513) | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Desulfinylfipronil amide (RPA 105048) | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Diazinon | 333-41-5 | Insecticide | 1 | 0.73; 0.19, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | No | 0.105 | AI OPP | 1 |
| Dicofol | 115-32-2 | Insecticide | 1 | – | – | – | 1 | CF OPP tox | 1 |
| Dieldrin | 60-57-1 | Insecticide | 1 | 6.67; 1.90, µg/kg DW | PEL (Canada - Interim SQG); TEC (consensus-based SQG, MacDonald) | NAV, DF>10% | 0.056 | C OW | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Difenconazole | 119446-68-3 | Fungicide | 1 | – | – | – | 385 | AI ECOTOX | 2 |
| Difenzoquat | 49866-87-7 | Herbicide | 1 | – | – | – | 1,315 | AI OPP tox | 2 |
| Diquat | 85-00-7 | Herbicide | 1 | – | – | – | 0.0036 | AVP OPP tox | 1 |
| Disulfoton | 298-04-4 | Insecticide | 1 | – | – | – | 0.01 | CI OPP | 1 |
| Dithiopyr | 97886-45-8 | Herbicide | 1 | – | – | – | 20 | ANVP ECOTOX | 1 |
| Diuron | 330-54-1 | Herbicide | 1 | – | – | – | 2.4 | ANVP OPP | 1 |
| Emamectin | 155569-91-8 | Insecticide | 1 | – | – | – | 0.5 | AI ECOTOX | 1 |
| Endosulfan | 115-29-7 | Insecticide | 1 | 1.4; 0.54, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | See *alpha*-endosulfan (DF>10%) | 0.07 | CI OPP | 1 |
| Endosulfan ether | 3369-52-6 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Endosulfan sulfate | 1031-07-8 | Degradate | 1 | – | – | – | 1.9 | AF OPP | 1 |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | Herbicide | 1 | – | – | – | 810 | CI OPP | 2 |
| Esfenvalerate | 66230-04-4 | Insecticide | 1 | – | – | – | 0.017 | CI OPP | 1 |
| Ethalfluralin | 55283-68-6 | Herbicide | 1 | – | – | – | 0.4 | CF OPP | 1 |
| Fenarimol | 60168-88-9 | Fungicide | 1 | – | – | – | 450 | AF ECOTOX | 2 |
| Fenbuconazole | 114369-43-6 | Fungicide | 1 | – | – | – | 340 | AF ECOTOX | 2 |
| Fenbutatin oxide | 13356-08-6 | Insecticide | 1 | – | – | – | 0.75 | AF OPP tox | 1 |
| Fenpropathrin | 39515-41-8 | Insecticide | 1 | – | – | – | 0.265 | AI ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Fenpyroximate | 134098-61-6 | Insecticide | 1 | – | – | – | 12 | CF ECOSAR | 2 |
| Fenthion | 55-38-9 | Insecticide | 1 | – | – | – | 0.013 | CI OPP | 1 |
| Fenthion sulfone oxygen analog | NAV | Degradate | 1 | – | – | – | – | – | – |
| Fentin hydroxide (TPTH, Triphenyltin hydroxide) | 76-87-9 | Fungicide/ molluscicide/ herbicide | 1 | – | – | – | 1.85 | AF ECOTOX | 1 |
| Fenvalerate | 51630-58-1 | Insecticide | 1 | – | – | – | 0.025 | AI ECOTOX | 1 |
| Fipronil | 120068-37-3 | Insecticide | 1 | – | – | – | 12.5 | AF ECOTOX | 1 |
| Fipronil sulfide | 120067-83-6 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Fipronil sulfone | 120068-36-2 | Degradate | 1 | – | – | – | 5,600 | AI ECOTOX | 2 |
| Fluazinam | 79622-59-6 | Fungicide | 1 | – | – | – | 18 | AF ECOTOX | 1 |
| Fludioxonil | 131341-86-1 | Fungicide | 1 | – | – | – | 82.5 | AF ECOSAR | 2 |
| Flufenacet | 142459-58-3 | Herbicide | 1 | – | – | – | 2,920 | AF ECOTOX | 2 |
| Flufenacet ESA | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Flufenacet (OA) | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Flumetralin | 62924-70-3 | Plant growth regulator | 1 | – | – | – | 8.95 | AF ECOTOX | 1 |
| Flutolanil | 66332-96-5 | Fungicide | 1 | – | – | – | 1,250 | AF ECOTOX | 2 |
| *gamma*-HCH | 58-89-9 | Insecticide | 1 | 1.38; 0.94, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | NAV, DF>10% | 0.5 | AI OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Glyphosate | 1071-83-6 | Herbicide | 1 | – | – | – | 1,800 | CF OPP | 2 |
| Heptachlor | 76-44-8 | Insecticide | 1 | – | – | – | 0.0038 | C OW | 1 |
| Heptachlor epoxide | 1024-57-3 | Degradate | 1 | 2.74; 0.6, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | NAV, DF>10% | – | – | – |
| Hexachlorobenzene | 118-74-1 | Insecticide | 1 | –; 22, µg/kg DW | Low SQSV (Lopes & Furlong); high value NAV | No | 1.8 | CI ECOTOX | 1 |
| Hydroxyalachlor | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Hydroxymetolachlor | 131068-72-9 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Imazamox | 114311-32-9 | Herbicide | 1 | – | – | – | 11 | AVP OPP | 1 |
| Iprodione | 36734-19-7 | Fungicide | 1 | – | – | – | 120 | AI OPP | 2 |
| Isoxaben | 82558-50-7 | Herbicide | 1 | – | – | – | 7 | CF ECOSAR | 1 |
| Kresoxim-methyl | 143390-89-0 | Fungicide | 1 | – | – | – | 6 | CF ECOSAR | 1 |
| Metconazole | 125116-23-6 | Fungicide | 1 | – | – | – | 20 | CF ECOSAR | 2 |
| Methoxychlor | 72-43-5 | Insecticide | 1 | 9.5; 1.9, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | No | 0.03 | C OW | 1 |
| Methoxyfenozide | 161050-58-4 | Insecticide | 1 | – | – | – | 0.069 | ANVP ECOSAR | 1 |
| Metolachlor | 51218-45-2 | Herbicide | 1 | – | – | – | 1 | CI OPP | 1 |
| Mirex | 2385-85-5 | Insecticide | 1 | – | – | – | 0.001 | C OW | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Myclobutanil | 88671-89-0 | Fungicide | 1 | – | – | – | 1,200 | AF ECOTOX | 2 |
| Naphthylacetamide | 86-86-2 | Plant growth regulator | 1 | – | – | – | 234 | CF ECOSAR | 2 |
| Napropamide | 15299-99-7 | Herbicide | 1 | – | – | – | 1,100 | CF OPP | 2 |
| Novaluron | 116714-46-6 | Herbicide | 1 | – | – | – | 0.993 | CF ECOSAR | 1 |
| *o,p′*-DDD (*o,p′*-Dichlorodiphenyl-dichloroethane) | 53-19-0 | Degradate | 1 | 8.51; 3.54, µg/kg DW | PEL; ISQG (*p,p′*-DDD) (Canada - Interim SQG) | NAV, DF>10% | – | – | – |
| *o,p′*-DDE (*o,p′*-Dichlorodiphenyl-dichloroethylene) | 3424-82-6 | Degradate | 1 | 6.75; 1.42, µg/kg DW | PEL; ISQG (*p,p′*-DDE) (Canada - Interim SQG) | Yes (sum of *o,p′* and *p,p′* isomers) | – | – | – |
| *o,p′*-DDT (*o,p′*-Dichlorodiphenyl-trichloroethane) | 789-02-6 | Degradate | 1 | 4.77; 1.19, µg/kg DW | PEL; ISQG (*p,p′*-DDT) (Canada - Interim SQG) | Yes (sum of *o,p′* and p,p′ isomers) | – | – | – |
| Oryzalin | 19044-88-3 | Herbicide | 1 | – | – | – | 15.4 | AVP OPP | 1 |
| Oxadiazon | 19666-30-9 | Herbicide | 1 | – | – | – | 7.8 | ANVP ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Oxychlordane | 27304-13-8 | Degradate; component of total chlordane | 1 | – | – | – | – | – | – |
| Oxyfluorfen | 42874-03-3 | Herbicide | 1 | – | – | – | 0.29 | ANVP OPP | 1 |
| *p,p′*-DDD (*p,p′*-Dichlorodiphenyldichloroethane) | 72-54-8 | Degradate | 1 | 8.51; 3.54, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | NAV, DF>10% | 0.001 | C OW | 1 |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyldichloroethylene) | 72-55-9 | Degradate | 1 | 6.75; 1.42, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | NAV, DF>10% | 0.001 | C OW | 1 |
| *p,p′*-DDT (*p,p′*-Dichlorodiphenyltrichloroethane) | 50-29-3 | Insecticide/ acaricide | 1 | 4.77; 1.19, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | NAV, DF>10% | 0.001 | C OW | 1 |
| Paclobutrazol | 76738-62-0 | Plant growth regulator | 1 | – | – | – | 11,800 | AF ECOTOX | 2 |
| Paraquat | 4685-14-7 | Herbicide | 1 | – | – | – | 0.55 | ANVP OPP tox | 1 |
| Parathion-methyl | 298-00-0 | Insecticide | 1 | – | – | – | 0.25 | CI OPP | 1 |
| PCNB (Pentachloronitrobenzene) | 82-68-8 | Fungicide | 1 | – | – | – | 13 | CF OPP tox | 2 |
| Pebulate | 1114-71-2 | Herbicide | 1 | – | – | – | 230 | ANVP OPP | 2 |
| Pendimethalin | 40487-42-1 | Herbicide | 1 | – | – | – | 5.4 | ANVP OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Pentachloroanisole | 1825-21-4 | Degradate | 1 | – | – | – | 13.6 | AI ECOTOX | 1 |
| Permethrin | 52645-53-1 | Insecticide | 1 | – | – | – | 0.0014 | CI OPP | 1 |
| Phenmedipham | 13684-63-4 | Herbicide | 1 | – | – | – | 320 | AVP OPP tox | 2 |
| Phorate | 298-02-2 | Insecticide | 1 | – | – | – | 0.21 | CI OPP | 1 |
| Prodiamine | 29091-21-2 | Herbicide | 1 | – | – | – | 1,590 | AF ECOTOX | 2 |
| Prometryn | 7287-19-6 | Herbicide | 1 | – | – | – | 1 | ANVP OPP | 1 |
| Pronamide | 23950-58-5 | Herbicide | 1 | – | – | – | 600 | CI OPP | 2 |
| Propargite | 2312-35-8 | Insecticide | 1 | – | – | – | 9 | CI OPP | 1 |
| Propiconazole | 60207-90-1 | Fungicide | 1 | – | – | – | 93 | ANVP OPP | 2 |
| Pymetrozine | 123312-89-0 | Insecticide | 1 | – | – | – | 0.0407 | ANVP ECOSAR | 1 |
| Pyraclostrobin | 175013-18-0 | Fungicide | 1 | – | – | – | 3.1 | AF OPP Ecotox | 1 |
| Pyridaben | 96489-71-3 | Insecticide | 1 | – | – | – | 0.265 | AI ECOTOX | 1 |
| Quinclorac | 84087-01-4 | Herbicide | 1 | – | – | – | 14,900 | AI ECOTOX | 2 |
| Quinoxyfen | 124495-18-7 | Fungicide | 1 | – | – | – | 18 | CF ECOSAR | 2 |
| Sabadilla | 8051-02-3 | Insecticide | 1 | – | – | – | 39 | CI ECOSAR | 2 |
| *S*-Metolachlor | 87392-12-9 | Herbicide | 1 | – | – | – | 8 | ANVP OPP tox | 1 |
| TCPSA (Trichloropropene sulfonic acid) | 65600-62-6 | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Tebuconazole | 107534-96-3 | Fungicide | 1 | – | – | – | 2,000 | AI ECOTOX | 2 |
| Tebufenozide | 112410-23-8 | Insecticide | 1 | – | – | – | 1,500 | AF ECOTOX | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Tebupirimfos | 96182-53-5 | Insecticide | 1 | – | – | – | 0.039 | AI ECOTOX | 1 |
| Tebupirimfos oxygen analogue | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Tefluthrin | 79538-32-2 | Insecticide | 1 | – | – | – | 0.03 | AF ECOTOX | 1 |
| Tefluthrin metabolite [R 119364] | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Tefluthrin metabolite [R 152912] | NAV | Degradate | 1 | – | – | – | NAV | NAV | NIA |
| Terbuthylazine | 5915-41-3 | Herbicide | 1 | – | – | – | 1,700 | AF USGS | 2 |
| Tetraconazole | 112281-77-3 | Fungicide | 1 | – | – | – | 22 | CF ECOSAR | 2 |
| Tetradifon | 116-29-0 | Acaricide | 1 | – | – | – | 100 | CI ECOTOX | 2 |
| Thiazopyr | 117718-60-2 | Herbicide | 1 | – | – | – | 14 | CF ECOSAR | 2 |
| Thiobencarb | 28249-77-6 | Herbicide | 1 | – | – | – | 1 | CI OPP | 1 |
| *trans*-Chlordane | 5103-74-2 | Insecticide | 1 | 17.6; 3.24, µg/kg DW | PEL - chlordane (Canada–Interim SQG); TEC–chlordane (consensus-based SQG, MacDonald) | NAV, DF>10% | – | – | – |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | Degradate | 1 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| *trans*-Nonachlor | 39765-80-5 | Insecticide; component of total chlordane, by-product of technical chlordane | 1 | – | – | – | – | – | – |
| *trans*-Permethrin | 61949-77-7 | Insecticide | 1 | – | – | – | 0.0014 | CI OPP (permethrin) | 1 |
| *trans*-Propiconazole | t60207-90-1 | Fungicide | 1 | – | – | – | 93 | ANVP OPP (propiconazole) | 2 |
| Triadimenol | 55219-65-3 | Fungicide | 1 | – | – | – | 89 | CF ECOSAR | 2 |
| Triallate | 2303-17-5 | Herbicide | 1 | – | – | – | 13 | CI OPP | 2 |
| Tribuphos | 78-48-8 | Defoliant | 1 | – | – | – | 1.56 | CI OPP | 1 |
| Triclopyr | 55335-06-3 | Herbicide | 1 | – | – | – | 100 | ANVP OPP | 2 |
| Trifluralin | 1582-09-8 | Herbicide | 1 | – | – | – | 1.14 | CF OPP | 1 |
| Uniconazole | 83657-17-4 | Plant growth regulator | 1 | – | – | – | 3,400 | AF ECOTOX | 2 |
| Vinclozolin | 50471-44-8 | Fungicide | 1 | – | – | – | 2,000 | AI OPP tox | 2 |
| *zeta*-Cypermethrin | 69865-47-0 | Insecticide | 1 | – | – | – | 0.069 | CI OPP (cypermethrin) | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Total DDT | – | Insecticide | [1]1 | – | – | – | – | – | – |
| 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) | 93-76-5 | Herbicide | 2 | – | – | – | 75 | AF ECOTOX | 2 |
| 2,4,6-Trichlorophenol | 88-06-2 | Microbiocide | 2 | – | – | – | 135 | AI ECOTOX | 2 |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 94-75-7 | Herbicide | 2 | – | – | – | 299.2 | AVP USGS | 2 |
| 2,4-D methyl ester | 1928-38-7 | Herbicide | 2 | – | – | – | 4 | Canada WQG Applies to phenoxy herbicides; based on ester formulations of 2,4-D acid) | 1 |
| 2,4-D plus 2,4-D methyl ester | 94-75-7 & 1928-38-7 | Herbicide | (Sum of 2,4-D & 2,4-D methyl ester) | – | – | – | 4 | Canada WQG Applies to phenoxy herbicides; based on ester formulations of 2,4-D acid) | 1 |
| 2,4-DB (4-[2,4-Dichlorophenoxy] butyric acid) | 94-82-6 | Herbicide | 2 | – | – | – | 932 | ANVP OPP | 2 |
| Acetochlor | 34256-82-1 | Herbicide | 2 | – | – | – | 1.43 | ANVP OPP | 1 |
| Azinphos-ethyl | 2642-71-9 | Insecticide | 2 | – | – | – | 0.55 | AF ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Bacillus subtilis | NAV | Microbial fungicide | 2 | – | – | – | NAV | NAV | NIA |
| BTS 27271 | 33089-74-6 | Degradate | 2 | – | – | – | – | – | – |
| Butachlor | 23184-66-9 | Herbicide | 2 | – | – | – | 50 | AF ECOTOX | 2 |
| Captafol | 2939-80-2 | Fungicide | 2 | – | – | – | – | – | – |
| Carbaryl | 63-25-2 | Insecticide | 2 | – | – | – | 0.5 | CI OPP | 1 |
| Carbofuran | 1563-66-2 | Insecticide | 2 | – | – | – | 0.75 | CI OPP | 1 |
| Chlorfevinfos | 470-90-6 | Insecticide/ acaricide | 2 | – | – | – | 0.035 | AI ECOTOX | 1 |
| Chloroxuron | 1982-47-4 | Herbicide | 2 | – | – | – | 135 | AF ECOTOX | 2 |
| CPPU (Forchlorfenuron) | 68157-60-8 | Plant growth regulator | 2 | – | – | – | NAV | NAV | NIA |
| DCNA (Dichloran) | 99-30-9 | Fungicide | 2 | – | – | – | 49 | CF OPP tox | 2 |
| Decan-1-ol | 112-30-1 | Plant growth regulator | 2 | – | – | – | 1,200 | AF ECOTOX | 2 |
| Dienochlor | 2227-17-0 | Insecticide | 2 | – | – | – | 25 | AF ECOTOX | 1 |
| Dinocap | 39300-45-3 | Fungicide/ insecticide | 2 | – | – | – | – | – | – |
| Dinoseb | 88-85-7 | Herbicide | 2 | – | – | – | 14 | AF ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Endrin | 72-20-8 | Insecticide/ avicide | 2 | 62.4; 2.22, µg/kg DW | PEL (Canada-Interim SQG); TEC (consensus based SQG, MacDonald) | No | 0.086 | C OW | 1 |
| Endrin aldehyde | 7421-93-4 | Degradate | 2 | – | – | – | – | – | – |
| Endrin ketone | 53494-70-5 | Degradate | 2 | – | – | – | – | – | – |
| Ethion | 563-12-2 | Insecticide | 2 | – | – | – | 0.013 | CF USGS | 1 |
| Ethion monoxon | 17356-42-2 | Degradate | 2 | – | – | – | – | – | – |
| Fenchlorofos | 299-84-3 | Insecticide | 2 | – | – | – | – | – | – |
| Fluchloralin | 33245-39-5 | Herbicide | 2 | – | – | – | 4.8 | AF ECOTOX | 1 |
| Flucythrinate | 70124-77-5 | Insecticide | 2 | – | – | – | 0.16 | AF ECOTOX | 1 |
| Fluoxastrobin | 193740-76-0 | Fungicide | 2 | – | – | – | NAV | NAV | NIA |
| Flusilazole | 85509-19-9 | Fungicide | 2 | – | – | – | NAV | NAV | NIA |
| Fluvalinate | 69409-94-5 | Insecticide | 2 | – | – | – | – | – | – |
| Fluvalinate-tau | 102851-06-9 | Insecticide | 2 | – | – | – | NAV | NAV | NIA |
| Fonofos | 944-22-9 | Insecticide | 2 | – | – | – | 1 | AI ECOTOX | 1 |
| Hexazinone | 51235-04-2 | Herbicide | 2 | – | – | – | 7 | ANVP OPP | 1 |
| Imazalil | 35554-44-0 | Fungicide | 2 | – | – | – | 740 | AF ECOTOX | 2 |
| Isazofos | 42509-80-8 | Insecticide | 2 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Isofenphos | 25311-71-1 | Insecticide | 2 | – | – | – | 0.22 | CI USGS | 1 |
| Isopropalin | 33820-53-0 | Herbicide | 2 | – | – | – | 135 | AI ECOTOX | 2 |
| Kinoprene | 42588-37-4 | Plant growth regulator | 2 | – | – | – | – | – | – |
| Leptofos | 21609-90-5 | Insecticide | 2 | – | – | – | 1.98 | AF ECOTOX | 1 |
| Linuron | 330-55-2 | Herbicide | 2 | – | – | – | 0.09 | CI OPP | 1 |
| Methiocarb | 2032-65-7 | Insecticide | 2 | – | – | – | 0.1 | CI OPP | 1 |
| Methoprene | 40596-69-8 | Insecticide | 2 | – | – | – | 48 | CF OPP | 1 |
| Methoprene acid | 302-79-4 | Degradate | 2 | – | – | – | – | – | – |
| Molinate | 2212-67-1 | Herbicide | 2 | – | – | – | 105 | AF OPP | 2 |
| Naphthalene | 91-20-3 | Fumigant | 2 | 391; 34.6, µg/kg DW | PEL; ISQG (Canada - Interim SQG) | No | – | – | – |
| Neburon | 555-37-3 | Herbicide | 2 | – | – | – | NAV | NAV | NIA |
| Oxytetracycline | 79-57-2 | Fungicide | 2 | – | – | – | 51,000 | AI OPP tox | 3 |
| Parathion | 56-38-2 | Insecticide | 2 | – | – | – | 0.002 | CI USGS | 1 |
| Perthane | 72-56-0 | Insecticide | 2 | – | – | – | 2.2 | AF ECOTOX | 1 |
| Phosmet | 732-11-6 | Insecticide | 2 | – | – | – | 0.8 | CI OPP | 1 |
| Profluralin | 26399-36-0 | Herbicide | 2 | – | – | – | – | – | – |
| Quizalofop | 76578-12-6 | Herbicide | 2 | – | – | – | 11,677 | CI ECOSAR | 3 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Resmethrin | 10453-86-8 | Insecticide | 2 | – | – | – | 0.14 | AF OPP | 1 |
| Ryanodine | 15662-33-6 | Insecticide | 2 | – | – | – | – | – | – |
| Sulfallate | 95-06-7 | Herbicide | 2 | – | – | – | – | – | – |
| Sulprofos | 35400-43-2 | Insecticide | 2 | – | – | – | 0.38 | AI ECOTOX | 1 |
| Terbutryn | 886-50-0 | Herbicide | 2 | – | – | – | 410 | AF ECOTOX | 2 |
| Thiabendazole | 148-79-8 | Fungicide | 2 | – | – | – | – | – | – |
| Tokuthion | 34643-46-4 | Insecticide | 2 | – | – | – | 6,500 | AF ECOTOX | 2 |
| Toxaphene | 8001-35-2 | Insecticide/ acaricide | 2 | 490 µg/g OC; 0.1 µg/kg DW | Tier 1 (USEPA ESG); ISQG (Canada - Interim SQG) | No | – | – | – |
| Trichloronat | 327-98-0 | Insecticide | 2 | – | – | – | 0.05 | AI ECOTOX | 1 |
| Trimethacarb | 12407-86-2 | Insecticide/ molluscicide/ dog and cat repellent | 2 | – | – | – | – | – | – |
| Triphenyl phosphate | 115-86-6 | – | 2 | – | – | – | – | – | – |
| Trithion | 786-19-6 | Insecticide/ acaricide | 2 | – | – | – | 0.60 | AI ECOTOX | 1 |
| Triticonazole | 131983-72-7 | Fungicide | 2 | – | – | – | NAV | NAV | NIA |
| Zoxamide | 156052-68-5 | Fungicide | 2 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| 1,2,3-Trichloropropane | 96-18-4 | Fumigant | 3 | – | – | – | – | – | – |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | Fumigant | 3 | – | – | – | – | – | – |
| 1,2-Dibromoethane | 106-93-4 | Fumigant | 3 | – | – | – | – | – | – |
| 1,2-Dichloropropane | 78-87-5 | Fumigant/ adjuvant | 3 | – | – | – | – | – | – |
| 1,3-Dichloropropene | 542-75-6 | Fumigant | 3 | – | – | – | 45 | AI OPP | 1 |
| 1,4-Napthaquinone | 130-15-4 | Degradate | 3 | – | – | – | 83.5 | AF ECOSAR | 2 |
| 1-Naphthol | 90-15-3 | Degradate | 3 | – | – | – | 100 | CF USGS | 2 |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy]propionic acid) | 93-72-1 | Herbicide | 3 | – | – | – | 170 | AI ECOTOX | 2 |
| 2,5-Dichloroaniline | 95-82-9 | Degradate | 3 | – | – | – | – | – | – |
| 2-Amino-*N*-isopropylbenzamide | 30391-89-0 | Degradate | 3 | – | – | – | 30 | CI ECOSAR | 2 |
| 2-Ethyl-6-methylaniline | 24549-06-2 | Degradate | 3 | – | – | – | 12 | CI ECOSAR | 2 |
| 3-(4-chlorophenyl)-1-methyl urea | 5352-88-5 | Degradate | 3 | – | – | – | – | – | – |
| 3-(Trifluoromethyl)aniline | 98-16-8 | Degradate | 3 | – | – | – | 1,350 | AI ECOTOX | 2 |
| 3-(Trifluoromethyl)phenylurea | 13114-87-9 | Degradate | 3 | – | – | – | 284 | CF ECOSAR | 2 |
| 3,4-Dichloromethyphenylurea | 3567-62-2 | Degradate | 3 | – | – | – | 72 | CF ECOSAR | 2 |
| 3,4-Dichlorophenylurea | 2327-02-8 | Degradate | 3 | – | – | – | 129 | ANVP ECOSAR | 2 |
| 3-DCMT (3-dichloromethyl-5-ethoxy-1,2,4-thiadiazole) | NAV | Degradate | 3 | – | – | – | 385 | AF OPP tox | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| 3-Hydroxycarbofuran | 16655-82-6 | Degradate | 3 | – | – | – | 2,254 | CF ECOSAR | 2 |
| 3-Ketocarbofuran | 16709-30-1 | Degradate | 3 | – | – | – | 1,272 | CF ECOSAR | 2 |
| 4-Chloro-2-methylphenol | 1570-64-5 | Degradate | 3 | – | – | – | 1,150 | AF ECOTOX | 2 |
| 4-Chlorobenzylmethyl sulfone | 98-57-7 | Degradate | 3 | – | – | – | 37,549 | CI ECOSAR | 3 |
| Abamectin | 71751-41-2 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Acephate | 30560-19-1 | Insecticide | 3 | – | – | – | 150 | CI OPP | 2 |
| Acequinocyl | 57960-19-7 | Insecticide | 3 | – | – | – | 0.714 | CF ECOSAR | 1 |
| Acetamiprid | 135410-20-7 | Insecticide | 3 | – | – | – | 104 | AF ECOSAR | 2 |
| Acetochlor ESA | 187022-11-3 | Degradate | 3 | – | – | – | 9,900 | ANVP OPP | 2 |
| Acetochlor OA | 184992-44-4 | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Acetochlor SAA | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Acetochlor/Metolachlor ESA, secondary amide | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Acibenzolar | 135158-54-2 | Fungicide | 3 | – | – | – | 5,206 | CF ECOSAR | 2 |
| Acifluorfen | 50594-66-6 | Herbicide | 3 | – | – | – | 265 | AVP OPP | 2 |
| AE C421200 (thidiazuron degradate) | NAV | Degradate | 3 | – | – | – | 70,000 | ANVP OPP tox | 3 |
| AE F132345 (thidiazuron degradate) | NAV | Degradate | 3 | – | – | – | 980 | ANVP OPP tox | 2 |
| AE F132347 (thidiazuron degradate) | NAV | Degradate | 3 | – | – | – | 980 | ANVP OPP tox | 2 |
| Alachlor ESA | 142363-53-9 | Degradate | 3 | – | – | – | 52,000 | AF OPP | 3 |
| Alachlor OA | 171262-17-2 | Degradate | 3 | – | – | – | 47,500 | AF OPP | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Aldicarb | 116-06-3 | Insecticide | 3 | – | – | – | 0.46 | CF OPP | 1 |
| Aldicarb sulfone | 1646-88-4 | Degradate | 3 | – | – | – | 140 | AI OPP | 2 |
| Aldicarb sulfoxide | 1646-87-3 | Degradate | 3 | – | – | – | 21.5 | AI OPP | 1 |
| Aluminum phosphide | 20859-73-8 | Fumigant/ fungicide | 3 | – | – | – | – | – | – |
| Ametryn | 834-12-8 | Herbicide | 3 | – | – | – | 3.67 | ANVP OPP | 1 |
| Aminopyralid | 150114-71-9 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Amitraz | 33089-61-1 | Insecticide | 3 | – | – | – | – | – | – |
| Amitrole | 61-82-5 | Herbicide | 3 | – | – | – | – | – | – |
| Ammonium sulfamate | 7773-06-0 | Herbicide | 3 | – | – | – | – | – | – |
| Amoxicilin | 61336-70-7 | Antibiotic | 3 | – | – | – | – | – | – |
| Anilazine | 101-05-3 | Fungicide | 3 | – | – | – | – | – | – |
| Asulam | 3337-71-1 | Herbicide | 3 | – | – | – | 140 | AVP OPP tox | 2 |
| AVG (Amino ethoxy vinyl glycine hydrochloride) | 49669-74-1 | Plant growth regulator | 3 | – | – | – | – | – | – |
| Aviglycine | 55720-26-8 | Plant growth regulator | 3 | – | – | – | NAV | NAV | NIA |
| Azadirachtin | 11141-17-6 | Insecticide | 3 | – | – | – | 2,000 | AF ECOTOX | 2 |
| Azinphos-methyl | 86-50-0 | Insecticide | 3 | – | – | – | 0.036 | CI OPP | 1 |
| Azinphos-methyl-oxon | 961-22-8 | Degradate | 3 | – | – | – | 1,461 | ANVP ECOSAR | 2 |
| Azoxystrobin | 131860-33-8 | Fungicide | 3 | – | – | – | 44 | CI OPP | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Bacillus thuringiensis | 68038-71-1 | Microbial insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Barban | 101-27-9 | Herbicide | 3 | – | – | – | – | – | – |
| Bendiocarb | 22781-23-3 | Insecticide | 3 | – | – | – | – | – | – |
| Bensulfuron-methyl | 83055-99-6 | Herbicide | 3 | – | – | – | 46 | ANVP ECOSAR | 1 |
| Bentazon | 25057-89-0 | Herbicide | 3 | – | – | – | 4,500 | ANVP OPP | 2 |
| Benzoic acid | 65-85-0 | Degradate | 3 | – | – | – | 90,000 | AF ECOTOX | 3 |
| Bifenazate | 149877-41-8 | Insecticide | 3 | – | – | – | 0.0563 | ANVP ECOSAR | 1 |
| Bifenox | 42576-02-3 | Herbicide | 3 | – | – | – | – | – | – |
| Bispyribac | 125401-75-4 | Herbicide | 3 | – | – | – | 793,889 | CI ECOSAR | 3 |
| Bordeaux mixture | NAV | Fungicide | 3 | – | – | – | NAV | NAV | NIA |
| Boscalid | 188425-85-6 | Fungicide | 3 | – | – | – | 116 | CF OPP Ecotox | 2 |
| Bromacil | 314-40-9 | Herbicide | 3 | – | – | – | 6.8 | ANVP OPP | 1 |
| Bromomethane | 74-83-9 | Fumigant/adjuvant | 3 | – | – | – | 100 | CF OPP | 2 |
| Bromoxynil | 1689-84-5 | Herbicide | 3 | – | – | – | 2.5 | CI USGS | 1 |
| BTS 27919 | 60397-77-5 | Degradate | 3 | – | – | – | – | – | – |
| Butenoic acid | 3724-65-0 | Pheromone | 3 | – | – | – | – | – | – |
| Butylate | 2008-41-5 | Herbicide | 3 | – | – | – | 105 | AF OPP | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Cacodylic acid | 75-60-5 | Herbicide/ defoliant | 3 | – | – | – | 17,100 | ANVP OPP tox | 2 |
| Captan | 133-06-2 | Fungicide | 3 | – | – | – | 13.1 | AF OPP | 1 |
| Carbon disulfide | 75-15-0 | Fumigant/ adjuvant | 3 | – | – | – | – | – | – |
| Carboxin | 5234-68-4 | Fungicide | 3 | – | – | – | 370 | ANVP OPP | 2 |
| Carfentrazone | 128639-02-1 | Herbicide | 3 | – | – | – | 0.0772 | ANVP ECOSAR | 1 |
| Chloramben methyl ester | 7286-84-2 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Chlordimeform | 6164-98-3 | Insecticide | 3 | – | – | – | – | – | – |
| Chlorethoxyfos | 54593-83-8 | Insecticide | 3 | – | – | – | 1.15 | AF ECOTOX | 1 |
| Chlorfenapyr | 122453-73-0 | Insecticide | 3 | – | – | – | – | – | – |
| Chlorimuron-ethyl | 90982-32-4 | Herbicide | 3 | – | – | – | 4,200 | AF ECOTOX | 2 |
| Chlormequat | 7003-89-6 | Plant growth regulator | 3 | – | – | – | – | – | – |
| Chlorobenzilate | 510-15-6 | Insecticide | 3 | – | – | – | – | – | – |
| Chloroneb | 2675-77-6 | Fungicide | 3 | – | – | – | 871 | CI ECOSAR | 2 |
| Chloropicrin | 76-06-2 | Fumigant/ nematocide | 3 | – | – | – | 8.49 | AF OPP | 1 |
| Chlorpropham | 101-21-3 | Herbicide/ plant growth regulator | 3 | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Chlorpyrifos oxygen analog | 5598-15-2 | Degradate | 3 | – | – | – | 273 | CF ECOSAR | 2 |
| Chlorpyriphos-methyl | 5598-13-0 | Insecticide | 3 | – | – | – | – | – | – |
| Chlorsulfuron | 64902-72-3 | Herbicide | 3 | – | – | – | 0.35 | AVP OPP tox | 1 |
| Cinnamaldehyde | 104-55-2 | Dog and cat repellent/ fungicide/ insecticide | 3 | – | – | – | – | – | – |
| *cis*-1,3-Dichloropropene | 10061-01-5 | Fumigant | 3 | – | – | – | 45 | AI OPP (1.3-dichloropropene) | 1 |
| Clethodim | 99129-21-2 | Herbicide | 3 | – | – | – | 9,500 | AF ECOTOX | 2 |
| Clodinafop | 114420-56-3 | Herbicide | 3 | – | – | – | 1,455 | AF ECOSAR | 2 |
| Clomazone | 81777-89-1 | Herbicide | 3 | – | – | – | 2,600 | AI ECOTOX | 2 |
| Clopyralid | 1702-17-6 | Herbicide | 3 | – | – | – | 56,500 | AI OPP | 3 |
| Cloransulam | 159518-97-5 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Clothianidin | 205510-53-8 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Copper oxychloride | 1332-65-6 | Fungicide | 3 | – | – | – | 9 (copper) | C OW | 1 |
| Cuprous oxide | 1317-39-1 | Fungicide/ insecticide | 3 | – | – | – | 9 (copper) | C OW | 1 |
| Cyanamide | 420-04-2 | Plant growth regulator/ herbicide | 3 | – | – | – | 267,161 | CI ECOSAR | 3 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Cyanazine | 21725-46-2 | Herbicide | 3 | – | – | – | 1,000 | AI ECOTOX | 2 |
| Cyanazine acid | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Cyanazine amide | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Cyazofamid | 120116-88-3 | Fungicide | 3 | – | – | – | NAV | NAV | NIA |
| Cyclanilide | 113136-77-9 | Plant growth regulator | 3 | – | – | – | 2,500 | AI ECOTOX | 2 |
| Cycloate | 1134-23-2 | Herbicide | 3 | – | – | – | 1,300 | AI OPP | 2 |
| Cyhalofop | 122008-78-0 | Herbicide | 3 | – | – | – | 93 | CF ECOSAR | 2 |
| Cymoxanil | 57966-95-7 | Fungicide | 3 | – | – | – | 14,000 | AI ECOTOX | 2 |
| Cyromazine | 66215-27-8 | Insecticide | 3 | – | – | – | 125,000 | AI ECOTOX | 3 |
| Dalapon | 75-99-0 | Herbicide | 3 | – | – | – | – | – | – |
| Daminozide | 1596-84-5 | Plant growth regulator | 3 | – | – | – | – | – | – |
| Dazomet | 533-74-4 | Fumigant/ fungicide/ nematicide | 3 | – | – | – | – | – | – |
| Dechloroacetochlor | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Dechlorodimethenamid | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Deethylatrazine | 6190-65-4 | Degradate | 3 | – | – | – | 1,000 | ANVP OPP | 2 |
| Deethylcyanazine | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Deethylcyanazine acid | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Deethylcyanazine amide | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Deisopropylatrazine | 1007-28-9 | Degradate | 3 | – | – | – | 2,500 | ANVP OPP | 2 |
| Deisopropylhydroxyatrazine | 7313-54-4 | Degradate | 3 | – | – | – | 58 | CI ECOSAR | 2 |
| Deltamethrin | 52918-63-5 | Insecticide | 3 | – | – | – | 0.0145 | AI ECOTOX | 1 |
| Demethyl fluometuron | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Demethyl norflurazon | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Demeton | 8065-48-3 | Insecticide/ nematicide | 3 | – | – | – | – | – | – |
| Desmedipham | 13684-56-5 | Herbicide | 3 | – | – | – | 220 | ANVP OPP tox | 2 |
| Di-allate | 2303-16-4 | Herbicide | 3 | – | – | – | – | – | – |
| Diazinon oxygen analog | 962-58-3 | Degradate | 3 | – | – | – | 3,020 | CF ECOSAR | 2 |
| Dicamba | 1918-00-9 | Herbicide | 3 | – | – | – | 61 | ANVP OPP | 2 |
| Dichlobenil | 1194-65-6 | Herbicide | 3 | – | – | – | 30 | AVP OPP | 1 |
| Dichlone | 117-80-6 | Fungicide | 3 | – | – | – | – | – | – |
| Dichlorprop | 120-36-5 | Herbicide | 3 | – | – | – | 2,680 | AVP OPP tox | 2 |
| Dichlorvos | 62-73-7 | Insecticide/ fumigant/ degradate | 3 | – | – | – | – | – | – |
| Diclofop | 40843-25-2 | Herbicide | 3 | – | – | – | 3,191 | CF ECOSAR | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Diclosulam | 145701-21-9 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Dicrotophos | 141-66-2 | Insecticide | 3 | – | – | – | 0.99 | CI OPP | 1 |
| Didealkylatrazine | 3397-62-4 | Degradate | 3 | – | – | – | 50,000 | AF OPP | 2 |
| Diethatyl | 38727-55-8 | Herbicide | 3 | – | – | – | – | – | – |
| Diflubenzuron | 35367-38-5 | Insecticide | 3 | – | – | – | 0.06 | CI OPP tox | 1 |
| Diflufenzopyr | 109293-97-2 | Herbicide | 3 | – | – | – | 0.626 | ANVP ECOSAR | 1 |
| Dimethenamid | 87674-68-8 | Herbicide | 3 | – | – | – | 1,300 | AF ECOTOX | 2 |
| Dimethenamid ESA | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Dimethenamid OA | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Dimethenamid-*P* | 163515-14-8 | Herbicide | 3 | – | – | – | 8.9 | AVP OPP | 1 |
| Dimethipin | 55290-64-7 | Plant growth regulator/ defoliant | 3 | – | – | – | 1,000 | CI OPP tox | 2 |
| Dimethoate | 60-51-5 | Insecticide | 3 | – | – | – | 0.5 | CI OPP | 1 |
| Dimethomorph | 110488-70-5 | Fungicide | 3 | – | – | – | 152 | CF ECOSAR | 2 |
| Dinotefuran | 165252-70-0 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Diphenamid | 957-51-7 | Herbicide | 3 | – | – | – | – | – | – |
| Disulfoton sulfone | 2497-06-5 | Degradate | 3 | – | – | – | 0.14 | CI OPP | 1 |
| Disulfoton sulfoxide | 2497-07-6 | Degradate | 3 | – | – | – | 1.53 | CI OPP | 1 |
| DNOC (4,6-Dinitro-*o*-cresol) | 534-52-1 | Herbicide | 3 | – | – | – | 33 | AF ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Dodine | 2439-10-3 | Fungicide | 3 | – | – | – | 0.95 | ANVP OPP tox | 1 |
| DSMA (Disodium methylarsonate) | 144-21-8 | Herbicide | 3 | – | – | – | – | – | – |
| *E*-Dimethomorph | e110488-70-5 | Fungicide | 3 | – | – | – | – | – | – |
| Endothall | 145-73-3 | Herbicide | 3 | – | – | – | 1.9 | ANVP OPP tox | 1 |
| EPN (*O*-Ethyl *O*-[4-nitrophenyl] *P*-phenylphosphonothioate) | 2104-64-5 | Insecticide | 3 | – | – | – | – | – | – |
| Ethametsulfuron | 97780-06-8 | Herbicide | 3 | – | – | – | – | – | – |
| Ethephon | 16672-87-0 | Plant growth regulator | 3 | – | – | – | 2,500 | AVP OPP tox | 2 |
| Ethofumesate | 26225-79-6 | Herbicide | 3 | – | – | – | 250 | CI OPP tox | 2 |
| Ethoprop | 13194-48-4 | Insecticide | 3 | – | – | – | 22 | AI OPP | 1 |
| Ethylenethiourea (ETU) | 96-45-7 | Degradate | 3 | – | – | – | 2 | CI OPP | 1 |
| Etofenprox | 80844-07-1 | Insecticide | 3 | – | – | – | 5.25 | AI ECOTOX | 1 |
| Etoxazole | 153233-91-1 | Insecticide | 3 | – | – | – | 1.07 | CF ECOSAR | 1 |
| Etridiazole | 2593-15-9 | Fungicide | 3 | – | – | – | 120 | CF OPP tox | 2 |
| Famoxadone | 131807-57-3 | Fungicide | 3 | – | – | – | 1.47 | CF ECOSAR | 1 |
| Fenamidone | 161326-34-7 | Fungicide | 3 | – | – | – | NAV | NAV | NIA |
| Fenamiphos | 22224-92-6 | Insecticide | 3 | – | – | – | 0.12 | CI USGS | 1 |
| Fenamiphos sulfone | 31972-44-8 | Degradate | 3 | – | – | – | 586.5 | AF USGS | 2 |
| Fenamiphos sulfoxide | 31972-43-7 | Degradate | 3 | – | – | – | 3.75 | AI USGS | 1 |
| Fenhexamid | 126833-17-8 | Fungicide | 3 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Fenitrothion | 122-14-5 | Insecticide | 3 | – | – | – | 0.087 | CI OPP | 1 |
| Fenoxaprop | 66441-23-4 | Herbicide | 3 | – | – | – | 155 | AF ECOTOX | 2 |
| Fenoxycarb | 79127-80-3 | Insecticide/ plant growth regulator | 3 | – | – | – | – | – | – |
| Fensulfothion | 115-90-2 | Insecticide/ nematocide | 3 | – | – | – | – | – | – |
| Fenthion sulfone | 3761-42-0 | Degradate | 3 | – | – | – | – | – | – |
| Fenthion sulfoxide | 3761-41-9 | Degradate | 3 | – | – | – | – | – | – |
| Fenuron | 101-42-8 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Ferbam | 14484-64-1 | Fungicide | 3 | – | – | – | 500 | AF OPP tox | 2 |
| Flonicamid | 158062-67-0 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Fluazifop | 69335-91-7 | Herbicide | 3 | – | – | – | 10,956 | CI ECOSAR | 3 |
| Flucarbazone | 181274-17-9 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Flumetsulam | 98967-40-9 | Herbicide | 3 | – | – | – | 127,000 | AI ECOTOX | 3 |
| Flumiclorac | 87546-18-7 | Herbicide | 3 | – | – | – | 1.49 | CF ECOSAR | 1 |
| Flumioxazin | 103361-09-7 | Herbicide | 3 | – | – | – | 891 | CF ECOSAR | 2 |
| Fluometuron | 2164-17-2 | Herbicide | 3 | – | – | – | 30 | ANVP OPP | 1 |
| Fluridone | 59756-60-4 | Herbicide | 3 | – | – | – | – | – | – |
| Fluroxypyr | 69377-81-7 | Herbicide | 3 | – | – | – | 7,150 | AF ECOTOX | 2 |
| Fluthiacet-methyl | 117337-19-6 | Herbicide | 3 | – | – | – | 0.0757 | ANVP ECOSAR | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Flutriafol | 76674-21-0 | Fungicide | 3 | – | – | – | 157 | CF ECOSAR | 2 |
| Folpet | 133-07-3 | Fungicide | 3 | – | – | – | – | – | – |
| Fomesafen | 72178-02-0 | Herbicide | 3 | – | – | – | 120 | ANVP OPP tox | 2 |
| Fonofos oxygen analog | 944-21-8 | Degradate | 3 | – | – | – | – | – | – |
| Foramsulfuron | 173159-57-4 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Formetanate hydrochloride | 23422-53-9 | Insecticide | 3 | – | – | – | 0.5 | CI OPP tox | 1 |
| Fosamine | 25954-13-6 | Herbicide | 3 | – | – | – | – | – | – |
| Fosetyl aluminum | 39148-24-8 | Fungicide | 3 | – | – | – | 4,990 | ANVP OPP tox | 2 |
| Gallex | NAV | Bactericide | 3 | – | – | – | – | – | – |
| *gamma*-Aminobutyric acid | 56-12-2 | Plant growth regulator/ fungicide | 3 | – | – | – | 431 | CI ECOSAR | 2 |
| Gibberellic acid | 77-06-5 | Plant growth regulator | 3 | – | – | – | 71,500 | AI OPP tox | 3 |
| Glufosinate | 51276-47-2 | Herbicide | 3 | – | – | – | 821 | CI ECOSAR | 2 |
| Halosulfuron-methyl | 100784-20-1 | Herbicide | 3 | – | – | – | 49 | ANVP ECOSAR | 1 |
| Hexythiazox | 78587-05-0 | Insecticide | 3 | – | – | – | 0.6 | CI OPP tox | 1 |
| Hydramethylnon | 67485-29-4 | Insecticide | 3 | – | – | – | – | – | – |
| Hydroxyacetochlor | 60090-47-3 | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Hydroxydimethanamid | NAV | Degradate | 3 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Hydroxypropanoic acid | 79-33-4 | Plant growth regulator | 3 | – | – | – | – | – | – |
| Hydroxysimazine | 2599-11-3 | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Imazamethabenz | 81405-85-8 | Herbicide | 3 | – | – | – | 110,000 | AI ECOTOX | 3 |
| Imazapic | 104098-48-8 | Herbicide | 3 | – | – | – | 1,706 | CF ECOSAR | 2 |
| Imazapyr | 81334-34-1 | Herbicide | 3 | – | – | – | 18 | AVP OPP | 1 |
| Imazaquin | 81335-37-7 | Herbicide | 3 | – | – | – | 140,000 | AF ECOTOX | 3 |
| Imazethapyr | 81335-77-5 | Herbicide | 3 | – | – | – | 120,000 | AF ECOTOX | 3 |
| Imidacloprid | 138261-41-3 | Insecticide | 3 | – | – | – | 1.05 | CI OPP | 1 |
| Indolyl-butyric acid | 133-32-4 | Plant growth regulator | 3 | – | – | – | – | – | – |
| Indoxacarb | 173584-44-6 | Insecticide | 3 | – | – | – | 0.0989 | ANVP ECOSAR | 1 |
| Iodosulfuron | 144550-36-7 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Isodrin | 465-73-6 | Insecticide | 3 | – | – | – | – | – | – |
| Isoxaflutole | 141112-29-0 | Herbicide | 3 | – | – | – | 4.9 | AVP OPP | 1 |
| Lactofen | 83513-60-4 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| *L*-Glutamic acid | 56-86-0 | Plant growth regulator/ fungicide | 3 | – | – | – | 648 | CI ECOSAR | 2 |
| Malaoxon | 1634-78-2 | Degradate | 3 | – | – | – | 2.7 | AI ECOTOX | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Malathion | 121-75-5 | Insecticide | 3 | 0.62; 0.067, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | No | 0.000026 | CI OPP | 1 |
| Maleic hydrazide | 123-33-1 | Plant growth regulator | 3 | – | – | – | 102,000 | ANVP OPP tox | 3 |
| Mancozeb | 8018-01-7 | Fungicide | 3 | – | – | – | 47 | ANVP OPP | 1 |
| Maneb | 12427-38-2 | Fungicide | 3 | – | – | – | 13.4 | ANVP OPP | 1 |
| MBC (Carbendazim) | 10605-21-7 | Degradate | 3 | – | – | – | 2 | CF OPP tox | 1 |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 94-74-6 | Herbicide | 3 | – | – | – | 170 | AVP OPP | 2 |
| MCPB (4-[4-Chloro-2-methylphenoxy]butanoic acid) | 94-81-5 | Herbicide | 3 | – | – | – | 210 | AVP OPP | 2 |
| MCPP-*p* (Mecoprop-*p*) | 16484-77-8 | Herbicide | 3 | – | – | – | 45,500 | AI OPP | 2 |
| Mefenoxam | 70630-17-0 | Fungicide | 3 | – | – | – | 14,000 | AI OPP | 2 |
| Mefluidide | 53780-34-0 | Herbicide/ plant growth regulator | 3 | – | – | – | – | – | – |
| Mepiquat chloride | 24307-26-4 | Plant growth regulator | 3 | – | – | – | 12,500 | CI OPP tox | 3 |
| Merphos | 150-50-5 | Defoliant/ plant growth regulator | 3 | – | – | – | – | – | – |
| Mesosulfuron | 208465-21-8 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Mesotrione | 104206-82-8 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Metalaxyl | 57837-19-1 | Fungicide | 3 | – | – | – | 1,200 | CI OPP | 2 |
| Metaldehyde | 9002-91-9 | Insecticide | 3 | – | – | – | 34,500 | AF OPP tox | 2 |
| Metam potassium | 137-41-7 | Fumigant/ fungicide/ microbiocide/ algaecide/ nematicide | 3 | – | – | – | 38,338 | ANVP ECOSAR | 2 |
| Metam sodium | 137-42-8 | Fumigant/ herbicide/ fungicide/ microbiocide/ algaecide | 3 | – | – | – | 25.6 | AF OPP | 1 |
| Methamidophos | 10265-92-6 | Insecticide | 3 | – | – | – | 4.5 | CI OPP | 1 |
| Methazole | 20354-26-1 | Herbicide | 3 | – | – | – | – | – | – |
| Methidathion | 950-37-8 | Insecticide | 3 | – | – | – | 0.66 | CI OPP | 1 |
| Methomyl | 16752-77-5 | Insecticide | 3 | – | – | – | 0.7 | CI OPP | 1 |
| Methomyl-oxime | 13749-94-5 | Degradate | 3 | – | – | – | 15 | CI ECOSAR | 2 |
| Methyl iodide | 74-88-4 | Fumigant/ nematicide | 3 | – | – | – | 14,453 | CI ECOSAR | 3 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Methyl isothiocyanate | 556-61-6 | Fumigant/ insecticide/ herbicide/ nematicide/ breakdown product | 3 | – | – | – | – | – | – |
| Metiram | 9006-42-2 | Fungicide | 3 | – | – | – | 77 | ANVP OPP tox | 2 |
| Metolachlor ESA | 171118-09-5 | Degradate | 3 | – | – | – | 24,000 | AF OPP | 2 |
| Metolachlor OA | 1520197-33- | Degradate | 3 | – | – | – | 7,700 | AI OPP | 2 |
| Metribuzin | 21087-64-9 | Herbicide | 3 | – | – | – | 8.7 | ANVP OPP | 1 |
| Metsulfuron-methyl | 74223-64-6 | Herbicide | 3 | – | – | – | 275,000 | AF ECOTOX | 3 |
| Mevinphos | 7786-34-7 | Insecticide/ acaricide | 3 | – | – | – | – | – | – |
| MHPC (Methyl *N*-[3-hydroxyphenol] carbamate) | 13683-89-1 | Degradate | 3 | – | – | – | 7,000 | AI OPP tox | 2 |
| Monocrotofos | 6923-22-4 | Insecticide/ acaricide | 3 | – | – | – | – | – | – |
| MSMA (Monosodium methylarsenate) | 2163-80-6 | Herbicide | 3 | – | – | – | 2,800 | ANVP OPP tox | 2 |
| NAD (Nicotinamide adenine dinucleotide) | 53-84-9 | Other | 3 | – | – | – | – | – | – |
| Naled | 300-76-5 | Insecticide | 3 | – | – | – | 0.045 | CI OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Naphthylacetic acid (NAA) | 86-87-3 | Plant growth regulator | 3 | – | – | – | 14,000 | AF ECOTOX | 2 |
| Naptalam | 132-66-1 | Herbicide | 3 | – | – | – | 59,250 | AI OPP tox | 3 |
| Nicosulfuron | 111991-09-4 | Herbicide | 3 | – | – | – | 46 | ANVP ECOSAR | 1 |
| Norflurazon | 27314-13-2 | Herbicide | 3 | – | – | – | 9.7 | ANVP OPP | 1 |
| Noruron | 18530-56-8 | Herbicide | 3 | – | – | – | – | – | – |
| *o,p'*-Methoxychlor | 30667-99-3 | Insecticide | 3 | – | – | – | – | – | – |
| *O*-Ethyl-*O*-methyl-*S*-propylphosphorothioate | 76960-87-7 | Degradate | 3 | – | – | – | NAV | NAV | NIA |
| Orthosulfamuron | 213464-77-8 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Oxamyl | 23135-22-0 | Insecticide | 3 | – | – | – | 90 | AI OPP | 2 |
| Oxamyl oxime | 30558-43-1 | Degradate | 3 | – | – | – | 35 | CI ECOSAR | 2 |
| Oxydemeton-methyl | 301-12-2 | Insecticide | 3 | – | – | – | 5 | CF OPP | 1 |
| Oxythioquinox | 2439-01-2 | Insecticide | 3 | – | – | – | – | – | – |
| Paraoxon-ethyl | 311-45-5 | Degradate | 3 | – | – | – | – | – | – |
| Paraoxon-methyl | 950-35-6 | Degradate | 3 | – | – | – | 1 | CI OPP | 1 |
| Pelargonic acid | 112-05-0 | Herbicide/fungicide | 3 | – | – | – | – | – | – |
| Penicillin G | 61-33-6 | Antibiotic | 3 | – | – | – | – | – | – |
| Penoxsulam | 219714-96-2 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Phorate oxon | 2600-69-3 | Degradate | 3 | – | – | – | 5,549 | CF ECOSAR | 2 |
| Phosalone | 2310-17-0 | Insecticide | 3 | – | – | – | – | – | – |
| Phosmet oxon | 3735-33-9 | Degradate | 3 | – | – | – | 1,507 | ANVP ECOSAR | 2 |
| Phosphamidon | 13171-21-6 | Insecticide | 3 | – | – | – | – | – | – |
| Picloram | 1918-02-1 | Herbicide | 3 | – | – | – | 550 | CF OPP | 2 |
| Pinoxaden | 243973-20-8 | Herbicide | 3 | – | – | – | 1,200 | ANVP OPP | 2 |
| Piperonyl butoxide | 51-03-6 | Synergist | 3 | – | – | – | 30 | CI OPP tox | 2 |
| Pirimicarb | 23103-98-2 | Insecticide | 3 | – | – | – | – | – | – |
| Potassium oleate | 143-18-0 | Adjuvant | 3 | – | – | – | 1.84E+20 | ANVP ECOSAR | 3 |
| Primisulfuron | 86209-51-0 | Herbicide | 3 | – | – | – | 105,000 | AF ECOTOX | 3 |
| Profenofos | 41198-08-7 | Insecticide | 3 | – | – | – | 0.2 | CI OPP | 1 |
| Prohexadione | 88805-35-0 | Fungicide | 3 | – | – | – | 541,135 | CI ECOSAR | 3 |
| Prometon | 1610-18-0 | Herbicide | 3 | – | – | – | 98 | ANVP OPP | 2 |
| Propachlor | 1918-16-7 | Herbicide | 3 | – | – | – | 13.5 | ANVP OPP | 1 |
| Propachlor ESA | NAV | Degradate | 3 | – | – | – | – | – | – |
| Propachlor OA | NAV | Degradate | 3 | – | – | – | – | – | – |
| Propamocarb | 24579-73-5 | Fungicide | 3 | – | – | – | 6,300 | CF OPP tox | 2 |
| Propanil | 709-98-8 | Herbicide | 3 | – | – | – | 9.1 | CF OPP | 1 |
| Propazine | 139-40-2 | Herbicide | 3 | – | – | – | 5,500 | AI ECOTOX | 2 |
| Propetamphos | 31218-83-4 | Insecticide | 3 | – | – | – | 1.65 | AI OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

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| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Propham | 122-42-9 | Herbicide | 3 | – | – | – | 4,050 | AI ECOTOX | 2 |
| Propoxur | 114-26-1 | Insecticide | 3 | – | – | – | 5.5 | AI OPP | 1 |
| Propoxycarbazone | 145026-81-9 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Prosulfuron | 94125-34-5 | Herbicide | 3 | – | – | – | 19 | CF ECOSAR | 2 |
| Prothioconazole | 178928-70-6 | Fungicide | 3 | – | – | – | NAV | NAV | NIA |
| Pyraflufen ethyl | 129630-19-9 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Pyrazon | 1698-60-8 | Herbicide | 3 | – | – | – | 170 | ANVP OPP tox | 2 |
| Pyrazon *B*-1 metabolite | NAV | Degradate | 3 | – | – | – | 50,000 | AI OPP tox | 2 |
| Pyrethrins | 8003-34-7 | Insecticide | 3 | – | – | – | 0.451 | CI ECOSAR | 1 |
| Pyridate | 55512-33-9 | Herbicide | 3 | – | – | – | – | – | – |
| Pyrimethanil | 53112-28-0 | Fungicide | 3 | – | – | – | 1,298 | CI ECOSAR | 2 |
| Pyriproxyfen | 95737-68-1 | Insecticide | 3 | – | – | – | 200 | AI ECOTOX | 2 |
| Pyrithiobac | 123342-93-8 | Herbicide | 3 | – | – | – | 23,299 | CI-SW ECOSAR | 3 |
| Rimsulfuron | 122931-48-0 | Herbicide | 3 | – | – | – | 500,000 | AI ECOTOX | 3 |
| Rotenone | 83-79-4 | Insecticide | 3 | – | – | – | 0.97 | AF OPP | 1 |
| RPA 202248 | 143701-75-1 | Degradate | 3 | – | – | – | 75 | AVP OPP | 2 |
| RPA 203328 | 142994-06-7 | Degradate | 3 | – | – | – | 5,900 | ANVP OPP tox | 2 |
| Sethoxydim | 74051-80-2 | Herbicide | 3 | – | – | – | 250 | ANVP OPP tox | 2 |
| Siduron | 1982-49-6 | Herbicide | 3 | – | – | – | – | – | – |
| Simazine | 122-34-9 | Herbicide | 3 | – | – | – | 36 | ANVP OPP | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Simetryn | 1014-70-6 | Herbicide | 3 | – | – | – | – | – | – |
| Sodium chlorate | 7775-09-9 | Defoliant/ herbicide/ microbiocide | 3 | – | – | – | 43,000 | AVP OPP tox | 2 |
| Spinetoram | NAV | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Spinosad | 131929-60-7 | Insecticide | 3 | – | – | – | 2,970 | AF ECOTOX | 2 |
| Spirodiclofen | 148477-71-8 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Spiromesifen | 283594-90-1 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Stirofos | 961-11-5 | Insecticide | 3 | – | – | – | – | – | – |
| Streptomycin | 57-92-1 | Fungicide | 3 | – | – | – | 860 | ANVP OPP tox | 2 |
| Sulfcarbamide | 62-56-6 | Rodenticide | 3 | – | – | – | 6,510 | ANVP ECOSAR | 2 |
| Sulfentrazone | 122836-35-5 | Herbicide | 3 | – | – | – | 30,200 | AI ECOTOX | 2 |
| Sulfometuron-methyl | 74222-97-2 | Herbicide | 3 | – | – | – | – | – | – |
| Sulfosate | 81591-81-3 | Herbicide | 3 | – | – | – | – | – | – |
| Sulfosulfuron | 141776-32-1 | Herbicide | 3 | – | – | – | 1 | AVP OPP | 1 |
| Sulfotepp | 3689-24-5 | Insecticide | 3 | – | – | – | – | – | – |
| Sulfur | 63705-05-5 | Fungicide | 3 | – | – | – | 90,000 | AF OPP tox | 3 |
| Sumithrin | 26002-80-2 | Insecticide | 3 | – | – | – | – | – | – |
| TCMTB (2-[Thiocyanomethylthio] benzothiazole) | 21564-17-0 | Microbiocide/ fungicide | 3 | – | – | – | 3.65 | AF ECOTOX | 1 |
| Tebuthiuron | 34014-18-1 | Herbicide | 3 | – | – | – | 50 | ANVP OPP | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Temephos | 3383-96-8 | Insecticide | 3 | – | – | – | 5 | AI OPP | 1 |
| Terbacil | 5902-51-2 | Herbicide | 3 | – | – | – | 11 | ANVP OPP | 1 |
| Terbufos | 13071-79-9 | Insecticide | 3 | – | – | – | 0.03 | CI OPP | 1 |
| Terbufos sulfone | 56070-16-7 | Degradate | 3 | – | – | – | 0.655 | AI ECOSAR | 1 |
| Terbufos-*O*-analogue sulfone | 56070-15-6 | Degradate | 3 | – | – | – | 1,160 | CF ECOSAR | 2 |
| Tetrachloromethane | 56-23-5 | Fumigant/ adjuvant | 3 | 2,100; 120, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | No | – | – | – |
| Tetramethrin | 7696-12-0 | Insecticide | 3 | – | – | – | 1.85 | AF ECOTOX | 1 |
| Tetraoxosulfate | 14808-79-8 | – | 3 | – | – | – | – | – | – |
| Tetrathiocarbonate | 7345-69-9 | Fumigant/ fungicide/ nematicide | 3 | – | – | – | 590,000,000 | ANVP ECOSAR | 3 |
| Thiacloprid | 111988-49-9 | Insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Thiamethoxam | 153719-23-4 | Fungicide/ insecticide | 3 | – | – | – | NAV | NAV | NIA |
| Thidiazuron | 51707-55-2 | Defoliant/ plant growth regulator | 3 | – | – | – | 100 | CI OPP tox | 2 |
| Thifensulfuron | 79277-67-1 | Herbicide | 3 | – | – | – | 418 | ANVP ECOSAR | 2 |
| Thiodicarb | 59669-26-0 | Insecticide | 3 | – | – | – | 9 | CI OPP tox | 1 |
| Thionazin | 297-97-2 | Nematocide | 3 | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Thiophanate methyl | 23564-05-8 | Fungicide | 3 | – | – | – | 2 | CF OPP tox | 1 |
| Thiram | 137-26-8 | Fungicide | 3 | – | – | – | 21 | AF OPP | 1 |
| Topramezone | 210631-68-8 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Tralkoxydim | 87820-88-0 | Herbicide | 3 | – | – | – | 2,100 | CI OPP | 2 |
| Tralomethrin | 66841-25-6 | Insecticide | 3 | – | – | – | – | – | – |
| Triadimefon | 43121-43-3 | Fungicide | 3 | – | – | – | 41 | CF OPP tox | 2 |
| Triasulfuron | 82097-50-5 | Herbicide | 3 | – | – | – | 50,000 | AF OPP | 2 |
| Triazamate | 112143-82-5 | Insecticide | 3 | – | – | – | – | – | – |
| Tribenuron-methyl | 101200-48-0 | Herbicide | 3 | – | – | – | 111 | CF ECOSAR | 2 |
| Trichlorfon | 52-68-6 | Insecticide | 3 | – | – | – | – | – | – |
| Tridiphane | 58138-08-2 | Herbicide | 3 | – | – | – | – | – | – |
| Trifloxystrobin | 141517-21-7 | Fungicide | 3 | – | – | – | 2.76 | CI OPP Ecotox | 1 |
| Trifloxysulfuron | 290332-10-4 | Herbicide | 3 | – | – | – | NAV | NAV | NIA |
| Triflumizole | 99387-89-0 | Fungicide | 3 | – | – | – | 1,034 | AI ECOSAR | 2 |
| Triflusulfuron | 126535-15-7 | Herbicide | 3 | – | – | – | 11 | CF ECOSAR | 2 |
| Triforine | 26644-46-2 | Fungicide | 3 | – | – | – | 10,700 | AF ECOTOX | 2 |
| Trinexapac | 95266-40-3 | Herbicide/ plant growth regulator | 3 | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Vernolate | 1929-77-7 | Herbicide | 3 | – | – | – | – | – | – |
| Z-Dimethomorph | z110488-70-5 | Fungicide | 3 | – | – | – | – | – | – |
| Zineb | 12122-67-7 | Fungicide | 3 | – | – | – | – | – | – |
| Ziram | 137-30-4 | Fungicide | 3 | – | – | – | 9.7 | AF OPP | 1 |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment | | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | Adjuvant | – | 170; 17, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| 1,1,2-Trichloroethane | 79-00-5 | Adjuvant | – | – | – | – | – | – | – |
| 1,1,2-Trichlorotrifluoroethane | 76-13-1 | Adjuvant | – | – | – | – | – | – | – |
| 1,2-Dichlorobenzene | 95-50-1 | Adjuvant | – | 340; 50, µg/kg DW | High SQSV; low SQSV (Lopes & Furlong) | Concentration data NAV | – | – | – |
| 1,2-Dichloroethane | 107-06-2 | Fumigant/ adjuvant | – | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| 1,4-Dichlorobenzene | 106-46-7 | Adjuvant | – | 350; 110, µg/kg DW | High SQSV; low SQSV (Lopes & Furlong) | Concentration data NAV | – | – | – |
| 2-Chlorotoluene | 95-49-8 | Adjuvant | – | – | – | – | – | – | – |
| Acetone | 67-64-1 | Adjuvant | – | – | – | – | – | – | – |
| Ampelomyces quisqualis | NAV | Microbial fungicide | – | – | – | – | – | – | – |
| Arsenic acid | 7778-39-4 | Herbicide/ insecticide/ rodenticide | – | – | – | – | – | – | – |
| Bacillus cereus | NAV | Microbial insecticide/ plant growth regulator (depends on strain) | – | – | – | – | NAV | NAV | NIA |
| Bacillus pumilis | NAV | Microbial other | – | – | – | – | NAV | NAV | NIA |
| Barium polysulfide | 50864-67-0 | Insecticide/ fungicide | – | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Benzene | 71-43-2 | Adjuvant | – | 100; 5.7, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Burkholderia cepacia | NAV | Fungicide | – | – | – | – | – | – | – |
| Caffeine | 58-08-2 | Stimulant | – | – | – | – | – | – | – |
| Calcium chloride | 10043-52-4 | Fungicide/ herbicide/ insecticide/ microbiocide/ molluscicide | – | – | – | – | – | – | – |
| Calcium polysulfide | 1344-81-6 | Insecticide/ fungicide | – | – | – | – | NAV | NAV | NIA |
| Chlorobenzene | 108-90-7 | Adjuvant | – | 1,500; 82, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Chloroethane | 75-00-3 | Adjuvant | – | – | – | – | – | – | – |
| Chloroform | 67-66-3 | Fumigant/ adjuvant | – | – | – | – | – | – | – |
| Chloromethane | 74-87-3 | Adjuvant | – | – | – | – | – | – | – |
| Chlorotetracycline | 57-62-5 | Antibiotic | – | – | – | – | – | – | – |
| Collectotrichum spores | NAV | Mycoherbicide | – | – | – | – | – | – | – |
| Coniothyrium minitans | NAV | Microbial fungicide | – | – | – | – | NAV | NAV | NIA |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Copper | 7440-50-8 | Fungicide | – | 149,000; 31,600, µg/kg DW | PEC; TEC (consensus-based SQG, MacDonald) | Concentration data NAV | 9 | C OW | 1 |
| Copper octanoate | 20543-04-8 | Fungicide | – | – | – | – | 203 | CF ECOSAR | 2 |
| Copper oxychloride S | 8012-69-9 | Fungicide | – | – | – | – | 9 (copper) | C OW | 1 |
| Copper sulfate tribasic | 55200-89-0 | Herbicide/ algaecide/ fungicide/ water treatment | – | – | – | – | – | – | – |
| Cryolite | 15096-52-3 | Insecticide | – | – | – | – | 5,000 | AI OPP tox | 2 |
| Cydia pomonella | NAV | Plant growth regulator | – | – | – | – | NAV | NAV | NIA |
| Dichlorodifluoromethane | 75-71-8 | Adjuvant | – | – | – | – | – | – | – |
| Dichloromethane | 75-09-2 | Fumigant/ adjuvant | – | – | – | – | – | – | – |
| Doxycycline | 564-25-0 | Antibiotic | – | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Ethylbenzene | 100-41-4 | Adjuvant | – | 8,500; 480, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Fatty alcohols | 85566-12-7 | Microbiocide/ solvent | – | – | – | – | 1,642 | CI ECOSAR | 2 |
| Garlic juice | 8000-78-0 | Insecticide | – | – | – | – | – | – | – |
| Geosmin | 23333-91-7 | – | – | – | – | – | – | – | – |
| Harpin protein | NAV | Fungicide/ nematicide/ plant growth regulator | – | – | – | – | NAV | NAV | NIA |
| Hydrated lime | 1305-62-0 | Fungicide/ microbiocide/ herbicide | – | – | – | – | 520,506 | CI ECOSAR | 3 |
| Hydrogen peroxide | 7722-84-1 | Microbiocide/ fungicide/ herbicide/ rodenticide | – | – | – | – | 31.5 | AF ECOSAR | 1 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Kaolin clay | 1332-58-7 | Insecticide/ adjuvant/ fungicide/ microbiocide | – | – | – | – | NAV | NAV | NIA |
| Lead arsenate | 7784-40-9 | Herbicide/ insecticide/ rodenticide | – | – | – | – | – | – | – |
| *m*- and *p*-Xylene | 108-38-3 & 106-42-3 | Adjuvant | – | 45; 2.5, µg/g OC | Tier 1; Tier 2 - *m*-xylene (USEPA ESG) | Concentration data NAV | – | – | – |
| Methylisoborneol | 2371-42-8 | – | – | – | – | – | – | – | – |
| Minocycline | 10118-90-8 | Antibiotic | – | – | – | – | – | – | – |
| Myrothecium verrucaria | NAV | Insecticide/ nematicide | – | – | – | – | NAV | NAV | NIA |
| Neem oil | 8002-65-1 | Insecticide | – | – | – | – | 203 | AF ECOSAR | 2 |
| Nosema locustae cann | NAV | Insecticide | – | – | – | – | – | – | – |
| *n*-Propylbenzene | 103-65-1 | Adjuvant | – | – | – | – | – | – | – |
| Oil | NAV | Insecticide | – | – | – | – | – | – | – |
| *o*-Xylene | 95-47-6 | Adjuvant | – | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Petroleum distillate | 8002-05-9 | Insecticide/ adjuvant/ solvent | – | – | – | – | 625 | AF ECOTOX | 2 |
| Petroleum oil | 64741-89-5 | Herbicide/ plant growth regulator/ insecticide/ adjuvant | – | – | – | – | NAV | NAV | NIA |
| Phosphoric acid | 7664-38-2 | Fungicide/ herbicide/ microbiocide | – | – | – | – | 578,554 | CI ECOSAR | 3 |
| Phytophthora spores | NAV | Herbicide | – | – | – | – | – | – | – |
| Pinolene | 68240-09-5 | Insecticide | – | – | – | – | NAV | NAV | NIA |
| Polychlorinated naphthalene | NAV | – | – | – | – | – | – | – | – |
| Polyhedrosis virus | NAV | Insecticide | – | – | – | – | – | – | – |
| Potassium bicarbonate | 298-14-6 | Fungicide | – | – | – | – | 121,000,000 | ANVP ECOSAR | 3 |
| Potassium carbonate | 584-08-7 | Fungicide/ microbiocide/ herbicide/ ph adjustment | – | – | – | – | – | – | – |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| Pseudomonas fluorescens | NAV | Microbial fungicide | – | – | – | – | NAV | NAV | NIA |
| Silicates | NAV | Insecticide | – | – | – | – | – | – | – |
| Sodium arsenite | 7784-46-5 | Herbicide/ insecticide/ rodenticide/ fungicide | – | – | – | – | – | – | – |
| Sodium metaborate | 7775-19-1 | Insecticide | – | – | – | – | – | – | – |
| Steinernema carpocap | NAV | Insecticide | – | – | – | – | – | – | – |
| Steinernema riobravi | NAV | Biocontrol | – | – | – | – | – | – | – |
| Sulfachloropyridazine | 80-32-0 | Antibiotic | – | – | – | – | – | – | – |
| Sulfadimethoxine | 112-11-2 | Antibiotic | – | – | – | – | – | – | – |
| Sulfamerazine | 127-97-7 | Antibiotic | – | – | – | – | – | – | – |
| Sulfamethazine | 57-68-1 | Antibiotic | – | – | – | – | – | – | – |
| Sulfamethoxazole | 723-46-6 | Antibiotic | – | – | – | – | – | – | – |
| Sulfathiazole | 72-14-0 | Antibiotic | – | – | – | – | – | – | – |
| Sulfuric acid | 7664-93-9 | Herbicide/ dessicant/ fungicide/ microbiocide | – | – | – | – | 21,000 | AF ECOTOX | 2 |

**Table 4–1.** Aquatic-life benchmarks or toxicity values with resulting Aquatic-Life Toxicity Bins and available sediment benchmarks used in the evaluation of pesticides for sediment.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Sediment screening values shown are the lowest of the available sources. Pesticide compounds were determined to exceed a benchmark if concentrations at more than 5 percent of sites exceed the upper screening value. **Abbreviations:** AF, acute fish; AI, acute invertebrate; ANVP, acute non-vascular plant; AVP, acute vascular plant; CAS, Chemical Abstracts Service; CF, chronic fish; CI, chronic invertebrate; C OW, chronic Office of Water National Recommended Water Quality Criteria for the Protection of Aquatic Life (U.S Environmental Protection Agency, 2002); DF >10 %, benchmark comparison not applicable because compound has detection frequency >10 percent (Tier 1); ECOSAR, estimated toxicity value from USEPA's EPI Suite ECOSAR estimation program (U.S Environmental Protection Agency, 2009a); ECOTOX, toxicity value from USEPA's ECOTOXicology database (U.S Environmental Protection Agency, 2010a); ESG, equilibrium-partitioning sediment guideline (U.S Environmental Protection Agency, 2004); ISQG, interim sediment-quality guideline (Canadian Council of Ministers of the Environment, 2002); NAV, not available; NIA, no information available; OPP, Office of Pesticide Programs aquatic-life benchmark (U.S Environmental Protection Agency, 2009b); OPP Ecotox, OPP Pesticide ecotoxicology database (U.S Environmental Protection Agency, 2009c); OPP tox, toxicity value from OPP reregistration decision documents (U.S Environmental Protection Agency, 2010b); PEC, probable effect concentration (MacDonald and others, 2000); PEL, probable effect level (Canadian Council of Ministers of the Environment, 2002); SQG, sediment quality guideline; SQSV, sediment-quality screening value (Lopes and Furlong, 2001); SW, salt water; TEC, threshold effect concentration (MacDonald and others, 2000); USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey aquatic-life benchmark determined using OPP methods and toxicity data (U.S Environmental Protection Agency, 2010b); WQG, water-quality guideline (Canadian Council of Ministers of the Environment, 2007); >, greater than; µg/g OC, microgram per gram organic carbon; µg/kg DW, microgram per kilogram dry weight; µg/L, microgram per liter; –, none; %, percent]

| Chemical name | CAS Registry Number | Primary pesticide type/use | Tier | Sediment benchmarks | | | Aquatic-life toxicity | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Upper; lower sediment screening values, units | Type of screening value | Exceeds benchmark? | Aquatic-life benchmark (µg/L) | Type of benchmark | Aquatic-life toxicity bin (1,2,3 or NIA) |
| Not tiered–pesticide-related compounds in other contaminant groups or species that would not be analyzed in sediment–Continued | | | | | | | | | |
| TCA (Trichloroacetic acid) | 76-03-9 | Herbicide/ breakdown product | – | – | – | – | – | – | – |
| Tetraborohydrate | NAV | Fungicide/ insecticide | – | – | – | – | NAV | NAV | NIA |
| Tetrachloroethylene | 127-18-4 | Fumigant/ adjuvant | – | 420; 53, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Toluene | 108-88-3 | Adjuvant | – | 1,600; 89, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Trichloroethylene | 79-01-6 | Fumigant/ adjuvant | – | 2,000; 210, µg/g OC | Tier 1; Tier 2 (USEPA ESG) | Concentration data NAV | – | – | – |
| Trichlorofluoromethane | 75-69-4 | Adjuvant | – | – | – | – | – | – | – |
| Zinc | 7440-66-6 | Herbicide | – | 315,000;, 121,000, µg/kg DW | PEL (Canada - Interim SQG); TEC (consen-sus-based SQG, MacDonald) | Concentration data NAV | 120 | C OW | 2 |

[1] See tiers for individual components of DDT (*p,p*- and *o,p'*-DDD, DDE, and DDT).

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# Appendix 5.

## Concentration Statistics for 83 Pesticide Compounds Sampled in Agricultural and Urban Land-Use Streams Over a 1-Year Period from the National Water-Quality Assessment (NAWQA) Program Monitoring Studies, 1993–2000

**Table 5–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural and urban land-use streams over a 1-year period from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2000.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural and urban land-use stream sites with a minimum of eight samples in a 1-year period using the methods of Martin (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; NAV, not available; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Agricultural Streams | | | | Urban Streams | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] |
| 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) | 39742 | 93-76-5 | 0.04 | 62 | 10 to 44 | <0.04 | <0.04 | 19 | 14 to 45 | <0.04 | <0.04 |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy]propionic acid) | 39762 | 93-72-1 | 0.03 | 62 | 10 to 44 | <0.03 | <0.03 | 19 | 14 to 45 | <0.03 | <0.03 |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 39732 | 94-75-7 | 0.08 | 62 | 10 to 44 | <0.636 | 3.87 (19) | 19 | 14 to 45 | 0.739 (25) | 4.34 (25) |
| 2,4-DB (4-[2,4-Dichlorophenoxy]butyric acid) | 38746 | 94-82-6 | 0.13 | 62 | 10 to 44 | <0.13 | <0.13 | 19 | 14 to 45 | <0.134 | <0.13 |
| 2,6-Diethylaniline | 82660 | 579-66-8 | 0.003 | 83 | 10 to 49 | 0.002 (30) | 0.005 (30) | 30 | 14 to 50 | <0.003 | <0.003 |
| 3-Hydroxycarbofuran | 49308 | 16655-82-6 | 0.05 | 62 | 10 to 46 | <0.05 | <0.05 | 19 | 14 to 46 | <0.05 | <0.05 |
| Acetochlor | 49260 | 34256-82-1 | 0.003 | 49 | 8 to 49 | 0.716 (19) | 6.68 (19) | 21 | 8 to 42 | <0.022 | 0.16 (29) |
| Acifluorfen | 49315 | 50594-66-6 | 0.04 | 62 | 10 to 44 | 0.138 (36) | 0.81 (36) | 19 | 14 to 45 | <0.04 | 0.06 (25) |
| Alachlor | 46342 | 15972-60-8 | 0.002 | 83 | 10 to 49 | 0.457 (19) | 3.33 (19) | 30 | 13 to 49 | 0.004 (26) | 0.019 (25) |
| Aldicarb | 49312 | 116-06-3 | 0.1 | 62 | 10 to 46 | <0.116 | <0.1 | 19 | 14 to 46 | <0.1 | <0.1 |
| Aldicarb sulfone | 49313 | 1646-88-4 | 0.1 | 62 | 10 to 46 | <0.1 | <0.1 | 19 | 14 to 46 | <0.1 | <0.1 |
| Aldicarb sulfoxide | 49314 | 1646-87-3 | 0.14 | 62 | 10 to 46 | <0.205 | 0.5 (28) | 19 | 14 to 46 | <0.14 | <0.14 |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 34253 | 319-84-6 | 0.002 | 83 | 10 to 49 | <0.011 | 0.069 (18) | 30 | 14 to 50 | <0.002 | <0.002 |
| Atrazine | 39632 | 1912-24-9 | 0.004 | 83 | 10 to 49 | 9.622 (30) | 58.7 (27) | 30 | 12 to 50 | 0.585 (30) | 2.68 (30) |
| Azinphos-methyl | 82686 | 86-50-0 | 0.02 | 83 | 10 to 49 | 0.021 (24) | 0.28 (44) | 30 | 14 to 50 | <0.031 | 0.171 (18) |
| Benfluralin | 82673 | 1861-40-1 | 0.005 | 83 | 10 to 49 | <0.005 | 0.006 (49) | 30 | 14 to 50 | <0.005 | 0.01 (34) |
| Bentazon | 38711 | 25057-89-0 | 0.03 | 62 | 10 to 44 | 0.293 (36) | 1.53 (36) | 19 | 14 to 45 | <0.03 | <0.03 |
| Bromacil | 04029 | 314-40-9 | 0.04 | 62 | 10 to 46 | <0.395 | 0.88 (20) | 19 | 14 to 46 | <0.175 | 1.55 (30) |
| Bromoxynil | 49311 | 1689-84-5 | 0.03 | 62 | 10 to 44 | <0.045 | 0.06 (15) | 19 | 14 to 45 | <0.03 | <0.03 |
| Butylate | 04028 | 2008-41-5 | 0.001 | 83 | 10 to 49 | 0.148 (30) | 0.85 (24) | 30 | 14 to 50 | <0.001 | <0.001 |
| Carbaryl | 82680 | 63-25-2 | 0.021 | 83 | 10 to 49 | 0.116 (24) | 0.568 (18) | 30 | 14 to 50 | 0.644 (19) | 4.8 (19) |
| Carbofuran | 82674 | 1563-66-2 | 0.01 | 83 | 10 to 49 | 0.493 (18) | 3.61 (18) | 30 | 14 to 50 | <0.013 | 0.05 (23) |

**Table 5–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural and urban land-use streams over a 1-year period from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2000.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural and urban land-use stream sites with a minimum of eight samples in a 1-year period using the methods of Martin (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; NAV, not available; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Agricultural Streams | | | | Urban Streams | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] |
| Chloramben methyl | 61188 | 7286-84-2 | 0.11 | 62 | 10 to 46 | <0.11 | <0.11 | 19 | 14 to 46 | <0.11 | <0.11 |
| Chlorothalonil | 49306 | 1897-45-6 | 0.07 | 62 | 10 to 46 | <0.07 | <0.07 | 19 | 14 to 45 | <0.07 | 0.03 (26) |
| Chlorpyrifos | 38933 | 2921-88-2 | 0.003 | 83 | 10 to 49 | 0.019 (47) | 0.085 (47) | 30 | 14 to 50 | 0.054 (25) | 0.149 (25) |
| *cis*-Permethrin | 82687 | 54774-45-7 | 0.003 | 83 | 10 to 49 | <0.004 | 0.019 (15) | 30 | 14 to 50 | <0.003 | <0.003 |
| Clopyralid | 49305 | 1702-17-6 | 0.21 | 62 | 10 to 44 | <0.21 | <0.21 | 19 | 14 to 45 | <0.21 | <0.21 |
| Cyanazine | 04041 | 21725-46-2 | 0.009 | 83 | 10 to 48 | 4.04 (30) | 13.9 (14) | 30 | 14 to 50 | <0.013 | 0.043 (34) |
| Dacthal | 82682 | 1861-32-1 | 0.002 | 83 | 10 to 49 | 2.128 (24) | 30 (24) | 30 | 14 to 50 | 0.006 (24) | 0.029 (19) |
| Dacthal monoacid | 49304 | 887-54-7 | 0.04 | 62 | 10 to 44 | <0.06 | 0.21 (24) | 19 | 14 to 45 | <0.04 | <0.04 |
| Deethylatrazine | 04040 | 6190-65-4 | 0.003 | 83 | 10 to 49 | 0.329 (30) | 1.72 (30) | 30 | 12 to 50 | 0.044 (29) | 0.19 (25) |
| Diazinon | 39572 | 333-41-5 | 0.003 | 83 | 10 to 49 | 0.063 (46) | 0.36 (46) | 30 | 12 to 50 | 0.705 (21) | 1.9 (21) |
| Dicamba | 38442 | 1918-00-9 | 0.05 | 62 | 10 to 44 | <0.085 | 0.41 (20) | 19 | 14 to 45 | <0.057 | 0.16 (20) |
| Dichlobenil | 49303 | 1194-65-6 | 0.05 | 62 | 10 to 46 | <0.05 | 0.01 (17) | 19 | 14 to 46 | <0.074 | 0.3 (14) |
| Dichlorprop | 49302 | 120-36-5 | 0.06 | 62 | 10 to 44 | <0.068 | 0.11 (18) | 19 | 14 to 45 | <0.067 | 0.07 (25) |
| Dieldrin | 39381 | 60-57-1 | 0.002 | 83 | 10 to 49 | 0.006 (44) | 0.029 (15) | 30 | 14 to 50 | 0.045 (22) | 0.077 (22) |
| Dinoseb | 49301 | 88-85-7 | 0.04 | 62 | 10 to 44 | <0.083 | 0.02 (22) | 19 | 14 to 45 | <0.04 | <0.04 |
| Disulfoton | 82677 | 298-04-4 | 0.011 | 83 | 10 to 49 | <0.068 | 0.032 (36) | 30 | 14 to 50 | <0.011 | <0.011 |
| Diuron | 49300 | 330-54-1 | 0.06 | 62 | 10 to 46 | 0.227 (36) | 13 (17) | 19 | 14 to 46 | 1.526 (23) | 6.76 (23) |
| DNOC (4,6-Dinitro-*o*-cresol) | 49299 | 534-52-1 | 0.13 | 62 | 10 to 44 | <0.13 | 0.19 (21) | 19 | 14 to 45 | <0.142 | 0.32 (20) |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 82668 | 759-94-4 | 0.001 | 83 | 10 to 49 | 0.564 (24) | 4.6 (24) | 30 | 14 to 50 | 0.005 (27) | 0.037 (18) |
| Ethalfluralin | 82663 | 55283-68-6 | 0.005 | 83 | 10 to 49 | <0.022 | 0.13 (45) | 30 | 14 to 50 | <0.005 | <0.005 |
| Ethoprop | 82672 | 13194-48-4 | 0.002 | 83 | 10 to 49 | 0.013 (31) | 0.329 (18) | 30 | 14 to 49 | <0.006 | 0.029 (29) |
| Fenuron | 49297 | 101-42-8 | 0.03 | 62 | 10 to 46 | <0.03 | <0.03 | 19 | 14 to 46 | <0.03 | <0.03 |
| Fluometuron | 38811 | 2164-17-2 | 0.03 | 62 | 10 to 46 | 0.925 (28) | 7.56 (28) | 19 | 14 to 46 | <0.03 | <0.03 |
| Fonofos | 04095 | 944-22-9 | 0.001 | 83 | 10 to 49 | 0.031 (44) | 0.17 (14) | 30 | 14 to 50 | <0.006 | 0.028 (19) |
| *gamma*-HCH | 39341 | 58-89-9 | 0.002 | 83 | 10 to 49 | <0.01 | 0.036 (18) | 30 | 14 to 50 | <0.005 | 0.015 (14) |
| Linuron | 82666 | 330-55-2 | 0.018 | 83 | 10 to 49 | <0.061 | 0.32 (31) | 30 | 14 to 50 | <0.029 | <0.018 |
| Malathion | 39532 | 121-75-5 | 0.014 | 83 | 10 to 49 | 0.044 (26) | 0.243 (26) | 30 | 14 to 50 | 0.059 (24) | 0.38 (21) |

**Table 5–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural and urban land-use streams over a 1-year period from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2000.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural and urban land-use stream sites with a minimum of eight samples in a 1-year period using the methods of Martin (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; NAV, not available; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Agricultural Streams | | | | Urban Streams | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] |
| MCPA (2-Methyl-4-chloro-phenoxyacetic acid) | 38482 | 94-74-6 | 0.1 | 62 | 10 to 44 | <0.192 | 0.94 (16) | 19 | 14 to 45 | <0.229 | 0.68 (25) |
| MCPB (4-[4-Chloro-2-methylphenoxy]butanoic acid) | 38487 | 94-81-5 | 0.13 | 62 | 10 to 44 | <0.13 | <0.13 | 19 | 14 to 45 | <0.13 | <0.13 |
| Methiocarb | 38501 | 2032-65-7 | 0.03 | 62 | 10 to 46 | <0.03 | <0.03 | 19 | 14 to 46 | <0.03 | <0.03 |
| Methomyl | 49296 | 16752-77-5 | 0.24 | 62 | 10 to 46 | <0.261 | 0.33 (20) | 19 | 14 to 46 | <0.24 | <0.24 |
| Metolachlor | 39415 | 51218-45-2 | 0.006 | 83 | 10 to 49 | 2.395 (23) | 11.6 (30) | 30 | 14 to 50 | 0.465 (25) | 2 (25) |
| Metribuzin | 82630 | 21087-64-9 | 0.003 | 83 | 10 to 49 | 0.446 (19) | 3.66 (23) | 30 | 14 to 50 | <0.02 | 0.188 (22) |
| Molinate | 82671 | 2212-67-1 | 0.001 | 83 | 10 to 49 | 7.896 (21) | 40 (21) | 30 | 14 to 50 | <0.008 | 0.061 (25) |
| Napropamide | 82684 | 15299-99-7 | 0.003 | 83 | 10 to 49 | 0.101 (18) | 0.767 (18) | 30 | 14 to 50 | <0.005 | 0.008 (28) |
| Neburon | 49294 | 555-37-3 | 0.03 | 62 | 10 to 46 | <0.03 | <0.03 | 19 | 14 to 46 | <0.03 | 0.02 (17) |
| Norflurazon | 49293 | 27314-13-2 | 0.021 | 62 | 10 to 46 | 0.426 (20) | 0.58 (20) | 19 | 14 to 46 | <0.021 | <0.021 |
| Oryzalin | 49292 | 19044-88-3 | 0.14 | 62 | 10 to 46 | <0.239 | 1.8 (17) | 19 | 14 to 46 | <0.216 | 1.51 (23) |
| Oxamyl | 38866 | 23135-22-0 | 0.08 | 62 | 10 to 46 | 0.052 (25) | 0.15 (25) | 19 | 14 to 46 | <0.08 | <0.08 |
| *p,p'*-DDE (*p,p'*-Dichlorodiphenyl-dichloroethylene) | 34653 | 72-55-9 | 0.001 | 83 | 10 to 49 | 0.008 (49) | 0.03 (49) | 30 | 14 to 50 | <0.001 | 0.002 (31) |
| Parathion | 39542 | 56-38-2 | 0.005 | 83 | 10 to 49 | <0.005 | <0.005 | 30 | 14 to 50 | <0.006 | <0.005 |
| Parathion-methyl | 82667 | 298-00-0 | 0.003 | 83 | 10 to 49 | <0.029 | 0.219 (35) | 30 | 13 to 50 | <0.005 | <0.003 |
| Pebulate | 82669 | 1114-71-2 | 0.002 | 83 | 10 to 49 | 0.024 (43) | 0.14 (43) | 30 | 14 to 50 | <0.003 | 0.023 (19) |
| Pendimethalin | 82683 | 40487-42-1 | 0.011 | 83 | 10 to 49 | 0.116 (35) | 0.779 (35) | 30 | 14 to 50 | 0.079 (25) | 0.287 (25) |
| Phorate | 82664 | 298-02-2 | 0.006 | 83 | 9 to 49 | <0.013 | <0.006 | 30 | 14 to 50 | <0.006 | <0.006 |
| Picloram | 49291 | 1918-02-1 | 0.04 | 62 | 10 to 44 | <0.04 | <0.04 | 19 | 14 to 45 | <0.04 | <0.04 |
| Prometon | 04037 | 1610-18-0 | 0.007 | 83 | 10 to 48 | 0.075 (24) | 0.118 (22) | 30 | 14 to 50 | 0.998 (30) | 1.8 (32) |
| Pronamide | 82676 | 23950-58-5 | 0.002 | 83 | 10 to 49 | 0.035 (22) | 0.2 (21) | 30 | 14 to 50 | 0.032 (25) | 0.092 (25) |
| Propachlor | 04024 | 1918-16-7 | 0.005 | 83 | 10 to 49 | <0.014 | 0.107 (15) | 30 | 14 to 50 | <0.005 | 0.008 (18) |
| Propanil | 82679 | 709-98-8 | 0.005 | 83 | 10 to 49 | <0.066 | 0.238 (34) | 30 | 14 to 50 | <0.009 | 0.022 (24) |

**Table 5–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural and urban land-use streams over a 1-year period from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2000.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural and urban land-use stream sites with a minimum of eight samples in a 1-year period using the methods of Martin (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; NAV, not available; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Agricultural Streams | | | | Urban Streams | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] | Number of sites | Range of number of samples per site | Maximum of annual means (number of samples), in µg/L [1] | Maximum of 95th percentiles (number of samples), in µg/L [1] |
| Propargite | 82685 | 2312-35-8 | 0.011 | 83 | 10 to 49 | 1.242 (49) | 20 (49) | 30 | 14 to 50 | <0.012 | <0.011 |
| Propham | 49236 | 122-42-9 | 0.11 | 62 | 10 to 46 | <0.11 | <0.11 | 19 | 14 to 46 | <0.11 | 0.07 (23) |
| Propoxur | 38538 | 114-26-1 | 0.06 | 62 | 10 to 46 | <0.06 | 0.11 (24) | 19 | 14 to 46 | <0.068 | <0.06 |
| Simazine | 04035 | 122-34-9 | 0.006 | 83 | 10 to 49 | 0.719 (22) | 3.12 (22) | 30 | 13 to 50 | 3.574 (25) | 9.03 (25) |
| Tebuthiuron | 82670 | 34014-18-1 | 0.008 | 83 | 10 to 49 | 0.683 (15) | 1.58 (15) | 30 | 13 to 50 | 0.228 (31) | 1.07 (31) |
| Terbacil | 82665 | 5902-51-2 | 0.017 | 83 | 10 to 49 | 0.043 (25) | 0.094 (25) | 30 | 14 to 50 | <0.02 | 0.069 (31) |
| Terbufos | 82675 | 13071-79-9 | 0.009 | 83 | 10 to 49 | <0.009 | <0.009 | 30 | 14 to 50 | <0.009 | <0.009 |
| Thiobencarb | 82681 | 28249-77-6 | 0.002 | 83 | 10 to 49 | 0.102 (33) | 4.38 (15) | 30 | 14 to 50 | <0.003 | 0.009 (25) |
| Triallate | 82678 | 2303-17-5 | 0.001 | 83 | 10 to 49 | 0.048 (22) | 0.41 (22) | 30 | 14 to 50 | <0.024 | 0.026 (14) |
| Triclopyr | 49235 | 55335-06-3 | 0.04 | 62 | 10 to 44 | <0.675 | 2.27 (36) | 19 | 14 to 45 | <0.348 | 3.35 (23) |
| Trifluralin | 82661 | 1582-09-8 | 0.005 | 83 | 10 to 49 | 0.02 (44) | 0.081 (35) | 30 | 14 to 50 | 0.004 (25) | 0.02 (24) |

[1] The number of samples for the maximum of the annual means and 95th percentiles is given only when the value is not a less-than value.

## Reference Cited, Appendix 5

Martin, J.D., 2006, The quality of our nation's waters–pesticides in the nation's streams and ground water, 1992–2001, Appendix 8A: Analytical approach and methods for pesticides in stream water: U.S. Geological Survey, Circular 1291, accessed at *http://water.usgs.gov/nawqa/pnsp/pubs/circ1291/appendix8/8a.html* (available online only).

# Appendix 6.

## Summary of the Multi-Compound Watershed Regressions for Pesticides (WARP) Model Methodology

Larson and others (2004) developed and applied regression models for predicting atrazine concentration statistics in streams. These Watershed Regressions for Pesticides (WARP) use nationally and readily available watershed characteristics and atrazine use intensity (kilograms per square kilometer) within the watersheds as explanatory variables to facilitate model extrapolation to unmonitored streams. Stone and Gilliom (2009) updated the WARP models to incorporate updated, annually variable atrazine use and precipitation information. The WARP atrazine models have the form of equation 1 and coefficients for the model variables are listed in *table 6-1*.

$$\log_{10}(\text{Concentration}) = f\left[\text{UI}^{1/4} + \log_{10}(\text{R}) + \text{K} + \text{WA}^{1/2} + \text{PERDUN} + \text{PRECIP}\right] \quad (1)$$

where

UI = atrazine-use intensity, or the annual agricultural use in a watershed in kilograms divided by the watershed area in square kilometers;
R = rainfall erosivity factor (R-factor) from Universal Soil Loss Equation (USLE);
K = soil erodibility factor (K-factor) from USLE;
WA = area of the watershed in square kilometers;
PERDUN = percentage of total stream flow derived from Dunne overland flow; and
PRECIP = total precipitation for May and June in millimeters.

Pesticide properties influence their transport to streams. Direct use of the atrazine WARP models to predict concentrations of other pesticides in streams will be affected by differences between atrazine properties and those of other pesticides. For pesticides that have properties that make them less mobile than atrazine in surface runoff, the direct application of the atrazine WARP models will consistently over-predict concentrations in streams.

To support the pesticide prioritization effort, non-atrazine pesticide concentrations can be predicted using the WARP models by substituting the use intensity of the pesticides of interest and adjusting the predicted concentrations based on the properties of the pesticides (Charles G. Crawford, U.S. Geological Survey, written commun., 2009). The surface water mobility index (SWMI) attempts to quantify pesticide mobility through use of the soil degradation half-life and organic carbon sorption coefficient (Chen and others, 2002). Vapor pressure also influences transport, in that pesticides with high vapor pressures have more potential to volatize, reducing the likelihood of direct transport to streams. In addition, pesticides with high vapor pressures may require application through soil incorporation, which reduces their availability for transport by surface runoff.

The SWMI and vapor pressure values of the non-atrazine pesticides were incorporated in the WARP models as multiplicative factors that adjust the pesticide concentrations predicted by the atrazine WARP models (Charles G. Crawford, U.S. Geological Survey, written commun., 2009). The SWMI adjustment factor ($\text{SWMI}_{AF}$) was calculated as shown in equation 2.

$$\text{SWMI}_{AF} = (\text{SWMI}_{pesticide}/\text{SWMI}_{atrazine})^{0.8692} \quad (2)$$

where

$\text{SWMI}_{pesticide}$ = surface water mobility index for a non-atrazine pesticide, and
$\text{SWMI}_{atrazine}$ = surface water mobility index for atrazine.

The vapor pressure adjustment factor ($\text{VP}_{AF}$) was calculated as shown in equation 3. If $\text{VP}_{pesticide}$ was less than $\text{VP}_{atrazine}$, then $\text{VP}_{AF}$ was considered to be 1.

$$\text{VP}_{AF} = \left(\text{VP}_{atrazine} / \text{VP}_{pesticide}\right)^{0.0871} \quad (3)$$

where

$\text{VP}_{atrazine}$ = vapor pressure of atrazine, and
$\text{VP}_{pesticide}$ = vapor pressure of a non-atrazine pesticide.

**Table 6–1.** Coefficients for variables in the annual mean and 95th percentile Watershed Regressions for Pesticides (WARP) models.

[Model variables are defined in equation 1]

| Concentration statistic | Regression coefficients | | | | | | |
|---|---|---|---|---|---|---|---|
| | Intercept | $UI^{1/4}$ | $\log_{10}R$ | K | $WA^{1/2}$ | PERDUN | PRECIP |
| Annual mean | –4.23 | 0.75 | 0.571 | 2.40 | 0.00046 | –0.096 | 0.0022 |
| 95th percentile | –4.01 | 0.71 | 0.665 | 2.89 | 0.00058 | –0.091 | 0.0024 |

The coefficients for the SWMI ratio (0.8691812) and the vapor pressure ratio (0.08713313) were estimated from the relation shown in equation 4 using uncensored observations for 30 pesticides (excluding atrazine) for which both estimated agricultural pesticide use and concentration data were available (*table 6-2*). Annual concentration statistics for these pesticides were calculated for one year of data from each of the WARP model-development stations to avoid any one station from having undue influence on the relation because of having multiple years of data. The years available for selection ranged from 1992 to 2003, and the year selection was based on the number of samples collected and the timing of sample collection in order to strengthen the calculation of the annual frequency distribution of pesticide concentrations in the streams. To optimize the estimation process, the uncensored observations were pooled across the various concentration statistics because of the limited amount of uncensored observations for the individual concentrations statistics. This pooling resulted in a total of 1,706 uncensored observations for the estimation process. Metolachlor contributed the most data to this pool (41 percent), which was followed by cyanazine (18 percent), acetochlor (13 percent), bentazon (6 percent), EPTC (5 percent), and triallate (3 percent); the remaining pesticides combined contributed 14 percent. Herbicides made up 96 percent of pooled uncensored observations.

$$\log_{10}\left(\text{Concentration}_{observed}\right) = \log_{10}\left(\text{Concentration}_{predicted}\right) + \text{coefficient}_{SWMI} \times \log_{10}\left(\text{SWMI}_{pesticide} / \text{SWMI}_{atrazine}\right) + \text{coefficient}_{VP} \times \log_{10}\left(\text{VP}_{atrazine} / \text{VP}_{pesticide}\right) \quad (4)$$

where

$\text{Concentration}_{observed}$ = observed concentration of pesticide,

$\text{Concentration}_{predicted}$ = predicted concentration of pesticide,

$\text{coefficient}_{SWMI}$ = coefficient for SWMI ratio, and

$\text{coefficient}_{VP}$ = coefficient for vapor pressure ratio.

The WARP regression models will predict non-zero pesticide concentrations for streams with zero pesticide use intensity, which will contribute toward over prediction of stream concentrations for non-atrazine pesticides. The WARP models used in the pesticide prioritization effort were corrected for this by subtracting predicted concentrations for zero use intensity from the predicted concentration according to equation 5.

$$\text{Concentration}_{Corrected} = \left(\text{Concentration}_{Predicted} - \text{Concentration}_{ZeroUse}\right) \times \frac{}{\text{SWMI}_{AF} \times \text{VP}_{AF}} \quad (5)$$

where

$\text{Concentration}_{Corrected}$ = predicted concentration for a pesticide corrected for zero use intensity in the watershed,

$\text{Concentration}_{Predicted}$ = predicted concentration for a pesticide based on 2007 agricultural pesticide use intensity (GfK Kynetec, 2007), and

$\text{Concentration}_{ZeroUse}$ = predicted concentration for a pesticide with use intensity equal to zero.

**Table 6–2.** Pesticides used in estimating the adjustment factor coefficients for the adjusted atrazine Watershed Regressions for Pesticides (WARP) model.

| Compound name | | | | |
|---|---|---|---|---|
| Acetochlor | Chlorimuron ethyl | Fonofos | Pebulate | Propiconazole |
| Acifluorfen | Cyanazine | Linuron | Phorate | Terbacil |
| Bentazon | EPTC (*S*-Ethyl dipropylthiocarbamate) | Methomyl | Pronamide | Terbufos |
| Bromoxynil | Ethalfluralin | Metolachlor | Propachlor | Thiobencarb |
| Butylate | Ethoprop | Nicosulfuron | Propanil | Triallate |
| Carbofuran | Fluometuron | Oxamyl | Propargite | Trifluralin |

## References Cited, Appendix 6

Chen, W., Hertl, P., Chen, S., and Tierney, D., 2002, A pesticide surface water mobility index and its relationship with concentrations in agriculture drainage watersheds: Environmental Toxicology and Chemistry, v. 21, no. 2, p. 298–308.

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Stone, W.W., and Gilliom, R.J., 2009, Update of watershed regressions for pesticides (WARP) for predicting atrazine concentration in streams: U.S. Geological Survey Open-File Report 2009–1122, 22 p. Available at *http://pubs.usgs.gov/of/2009/1122/*

# Appendix 7.

## Detection Frequencies in Agricultural and Urban Streams and Groundwater from the National Water-Quality Assessment (NAWQA) Program Monitoring Studies, 1993–2006

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| 1,4-Napthaquinone | 130-15-4 | 3.19 | 9 | 3.43 | 9 | 0 | 7 | – | – |
| 1-Naphthol | 90-15-3 | 4 | 20 | 14.65 | 16 | 0 | 15 | 0 | 6 |
| 2-(4-*tert*-butylphenoxy)-cyclohexanol | 1942-71-8 | 12.68 | 9 | 0.46 | 9 | 0 | 7 | – | – |
| 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) | 93-76-5 | 0.04 | 62 | 0 | 19 | 0.08 | 42 | 0 | 22 |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy] propionic acid) | 93-72-1 | 0 | 62 | 0 | 19 | 0.08 | 42 | 0 | 22 |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 94-75-7 | 26.83 | 89 | 33.88 | 40 | 0.56 | 59 | 1.29 | 34 |
| 2,4-D methyl ester | 1928-38-7 | 11.76 | 27 | 9.01 | 21 | 0.42 | 17 | 1.44 | 12 |
| 2,4-DB (4-[2,4-Dichlorophenoxy]butyric acid) | 94-82-6 | 0.19 | 89 | 0.13 | 40 | 0.00 | 59 | 0 | 34 |
| 2,5-Dichloroaniline | 95-82-9 | 0 | 9 | 3.77 | 9 | 0 | 7 | – | – |
| 2,6-Diethylaniline | 579-66-8 | 1.92 | 83 | 0.09 | 30 | 1.28 | 51 | 0.18 | 32 |
| 2-Amino-*N*-isopropylbenzamide | 30391-89-0 | 0.46 | 9 | 0 | 9 | 0 | 7 | – | – |
| 2-Chloro-2,6-diethylacetanilide | 6967-29-9 | 0.41 | 20 | 0.5 | 16 | 0 | 15 | 0 | 6 |
| 2-Ethyl-6-methylaniline | 24549-06-2 | 3.08 | 20 | 0 | 16 | 2.35 | 15 | 0.83 | 6 |
| 2-Hydroxyatrazine | 2163-68-0 | 67.7 | 34 | 20.81 | 20 | 15.53 | 21 | 10.95 | 12 |
| 3-(4-chlorophenyl)-1-methyl urea | 5352-88-5 | 3.60 | 27 | 0.18 | 21 | 0.78 | 17 | 0.32 | 12 |
| 3-(Trifluoromethyl)aniline | 98-16-8 | 3.82 | 15 | 0.26 | 10 | 3.87 | 9 | – | – |
| 3-(Trifluoromethyl)phenylurea | 13114-87-9 | 0.83 | 6 | 0 | 1 | 1.56 | 2 | – | – |
| 3,4-Dichloroaniline | 95-76-1 | 35.24 | 20 | 32.08 | 16 | 4.61 | 15 | 1.36 | 6 |
| 3,5-Dichloroaniline | 626-43-7 | 1.44 | 18 | 1.81 | 15 | 2 | 11 | 1.85 | 5 |
| 3-Hydroxycarbofuran | 16655-82-6 | 0.24 | 89 | 0.06 | 40 | 0 | 59 | 0 | 34 |
| 3-Ketocarbofuran | 16709-30-1 | 1.49 | 23 | 0 | 17 | 0 | 17 | 0 | 9 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| 4-Chloro-2-methylphenol | 1570-64-5 | 1.04 | 20 | 15.55 | 16 | 0 | 15 | 3.39 | 6 |
| 4-Chlorobenzylmethyl sulfone | 98-57-7 | 0 | 9 | 0.46 | 9 | 0 | 2 | – | – |
| Acetochlor | 34256-82-1 | 28.79 | 90 | 3.92 | 30 | 0.28 | 45 | 0.49 | 27 |
| Acetochlor ethane sulfonic acid (ESA) | 187022-11-3 | 50.14 | 25 | – | – | 6.27 | 12 | 1.04 | 2 |
| Acetochlor oxanilic acid (OA) | 184992-44-4 | 33.77 | 25 | – | – | 3.15 | 12 | 2.09 | 2 |
| Acetochlor sulfynilacetic acid (SAA) | NAV | 15.91 | 8 | – | – | 0 | 4 | – | – |
| Acetochlor/Metolachlor ESA, secondary amide | NAV | 40.83 | 5 | – | – | 0 | 1 | – | – |
| 2-Chloro-*N*-(2-ethy l-6-methylphenyl) acetamide (Acetochlor/Metolachlor, secondary amide) | 32428-71-0 | 0 | 2 | – | – | 0 | 1 | – | – |
| Acifluorfen | 50594-66-6 | 3.95 | 87 | 0.27 | 39 | 0.26 | 59 | 0.23 | 34 |
| Alachlor | 15972-60-8 | 34.44 | 101 | 5.83 | 31 | 2.57 | 51 | 0.43 | 32 |
| Alachlor ESA, secondary amide | NAV | 6.58 | 5 | – | – | 0 | 1 | – | – |
| Alachlor ESA | 142363-53-9 | 79.38 | 25 | – | – | 32.18 | 12 | 30.84 | 2 |
| Alachlor OA | 171262-17-2 | 23.22 | 25 | – | – | 7.95 | 12 | 9.79 | 2 |
| Alachlor SAA | 140939-16-8 | 2.2 | 8 | – | – | 0 | 4 | – | – |
| Alachlor, secondary amide | NAV | 2.28 | 2 | – | – | 0 | 1 | – | – |
| Aldicarb | 116-06-3 | 0.11 | 89 | 0.06 | 40 | 0.07 | 59 | 0 | 34 |
| Aldicarb sulfone | 1646-88-4 | 0.71 | 89 | 0.20 | 40 | 1.07 | 59 | 0 | 34 |
| Aldicarb sulfoxide | 1646-87-3 | 1.45 | 88 | 0 | 40 | 1.36 | 59 | 0 | 34 |
| *alpha*-Endosulfan | 959-98-8 | 0.35 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | 0.23 | 83 | 0.05 | 30 | 0.01 | 51 | 0 | 32 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Ametryn | 834-12-8 | 3.73 | 11 | – | – | 0 | 4 | 0 | 1 |
| Aminomethylphosphonic acid | 1066-51-9 | 50.20 | 13 | 44.84 | 6 | 1.11 | 6 | 8.34 | 2 |
| Atrazine | 1912-24-9 | 89.57 | 101 | 71.47 | 30 | 43.29 | 51 | 29.25 | 32 |
| Azinphos-methyl | 86-50-0 | 3.11 | 83 | 0.75 | 30 | 0.16 | 51 | 0 | 32 |
| Azinphos-methyl-oxon | 961-22-8 | 0.47 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Bendiocarb | 22781-23-3 | 2.59 | 27 | 0.51 | 21 | 0 | 17 | 0 | 12 |
| Benfluralin | 1861-40-1 | 0.63 | 83 | 3.67 | 30 | 0.1 | 51 | 0.17 | 32 |
| Benomyl | 17804-35-2 | 10.22 | 27 | 11.57 | 21 | 1.96 | 17 | 0.63 | 12 |
| Bensulfuron-methyl | 83055-99-6 | 8.41 | 27 | 0 | 21 | 0 | 17 | 2.01 | 12 |
| Bentazon | 25057-89-0 | 25.46 | 89 | 5.28 | 40 | 4.04 | 59 | 2.43 | 34 |
| *beta*-Endosulfan | 33213-65-9 | 4.17 | 9 | 0 | 9 | 0 | 7 | – | – |
| Bifenthrin | 82657-04-3 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Bromacil | 314-40-9 | 3.46 | 89 | 8.22 | 40 | 2.66 | 59 | 3.53 | 34 |
| Bromoxynil | 1689-84-5 | 1.89 | 89 | 0.32 | 40 | 0.06 | 59 | 0 | 34 |
| Butylate | 2008-41-5 | 4.33 | 83 | 0.19 | 30 | 0.23 | 51 | 0.23 | 32 |
| Caffeine [1] | 58-08-2 | 35.01 | 27 | 77.93 | 21 | 13.16 | 17 | 11.77 | 12 |
| Carbaryl | 63-25-2 | 11.98 | 83 | 55.66 | 30 | 0.57 | 51 | 1.35 | 32 |
| Carbofuran | 1563-66-2 | 12.89 | 83 | 1.68 | 30 | 2.07 | 51 | 0.69 | 32 |
| Chloramben methyl | 7286-84-2 | 0.07 | 89 | 0.11 | 39 | 0 | 59 | 0 | 34 |
| Chlorimuron-ethyl | 90982-32-4 | 5.02 | 27 | 0.31 | 21 | 0.56 | 17 | 0 | 12 |
| Chlorothalonil | 1897-45-6 | 0.18 | 85 | 1.29 | 36 | 0 | 59 | 0.21 | 31 |
| Chlorpyrifos | 2921-88-2 | 13.29 | 83 | 22.65 | 30 | 0.77 | 51 | 0.45 | 32 |
| Chlorpyrifos oxygen analog | 5598-15-2 | 0.26 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| *cis*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | c61898-95-1 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| *cis*-Permethrin | 54774-45-7 | 0.18 | 83 | 0.1 | 30 | 0.1 | 51 | 0 | 32 |
| *cis*-Propiconazole | c60207-90-1 | 12.84 | 18 | 15.85 | 15 | 0.36 | 11 | 0.74 | 5 |
| Clopyralid | 1702-17-6 | 1.43 | 89 | 1.67 | 40 | 0.08 | 59 | 0 | 34 |
| Cyanazine | 21725-46-2 | 39.89 | 101 | 3.10 | 31 | 1.19 | 51 | 0.88 | 32 |
| Cyanazine amide | NAV | 27.75 | 6 | 2.63 | 1 | 0 | 5 | – | – |
| Cycloate | 1134-23-2 | 2.06 | 27 | 0 | 27 | 0 | 11 | 0.93 | 12 |
| Cyfluthrin | 68359-37-5 | 0 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Cyhalothrin-*lambda* | 91465-08-6 | 0 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |
| Cypermethrin | 52315-07-8 | 0 | 20 | 0.37 | 16 | 0 | 15 | 0 | 6 |
| Dacthal | 1861-32-1 | 11.52 | 83 | 20.82 | 30 | 0.71 | 51 | 0.49 | 32 |
| Dacthal monoacid | 887-54-7 | 0.32 | 88 | 0.18 | 40 | 0.06 | 59 | 0 | 34 |
| Dechloroacetochlor | NAV | 0 | 2 | – | – | 0 | 1 | – | – |
| Dechloroalachlor | NAV | 0 | 2 | – | – | 0 | 1 | – | – |
| Dechlorodimethenamid | NAV | 0 | 2 | – | – | 0 | 1 | – | – |
| Dechlorometolachlor | NAV | 8.34 | 2 | – | – | 0 | 1 | – | – |
| Deethylatrazine | 6190-65-4 | 80.42 | 101 | 48.71 | 31 | 45.49 | 51 | 30.63 | 32 |
| Deisopropyl prometryn | NAV | 0.28 | 6 | 2.63 | 1 | 0 | 2 | – | – |
| Deisopropylatrazine | 1007-28-9 | 39.54 | 27 | 13.9 | 21 | 27.96 | 17 | 15.41 | 12 |
| Demethyl fluometuron | NAV | 37.87 | 6 | 2.7 | 1 | 16.41 | 2 | – | – |
| Demethyl norflurazon | NAV | 50.74 | 6 | 0 | 1 | 24.22 | 2 | – | – |
| Desulfinylfipronil (MB46513) | NAV | 14.84 | 38 | 29.89 | 20 | 0 | 16 | 0.52 | 8 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Desulfinylfipronil amide (RPA 105048) | NAV | 8.81 | 38 | 11.42 | 20 | 0.11 | 17 | 0 | 8 |
| Diazinon | 333-41-5 | 15.09 | 83 | 67.44 | 30 | 0.43 | 51 | 1.31 | 32 |
| Diazinon oxygen analog | 962-58-3 | 0 | 15 | 0.49 | 7 | 0 | 11 | 0 | 6 |
| Dicamba | 1918-00-9 | 3.92 | 89 | 3.35 | 40 | 0.28 | 59 | 0.59 | 34 |
| Dichlobenil | 1194-65-6 | 0.26 | 62 | 4.31 | 19 | 0.09 | 42 | 0.38 | 22 |
| Dichlorprop | 120-36-5 | 0.38 | 89 | 1.39 | 40 | 0.16 | 59 | 0.22 | 34 |
| Dichlorvos | 62-73-7 | 0.21 | 20 | 9.06 | 16 | 0 | 14 | 0 | 6 |
| Dicrotophos | 141-66-2 | 2.2 | 20 | 0.28 | 16 | 0 | 15 | 0 | 6 |
| Didealkylatrazine | 3397-62-4 | 30.97 | 25 | 16.56 | 21 | 24.81 | 17 | 16.84 | 11 |
| Dieldrin | 60-57-1 | 3.62 | 83 | 3.49 | 30 | 1.2 | 51 | 5.33 | 32 |
| Dimethenamid | 87674-68-8 | 19.99 | 5 | – | – | 0 | 2 | – | – |
| Dimethenamid ESA | NAV | 13.74 | 15 | – | – | 0.93 | 8 | – | – |
| Dimethenamid OA | NAV | 4.76 | 15 | – | – | 0 | 8 | – | – |
| Dimethoate | 60-51-5 | 2.6 | 20 | 0.86 | 16 | 0 | 15 | 0 | 6 |
| Dinoseb | 88-85-7 | 3.40 | 87 | 0.94 | 40 | 1.85 | 59 | 0 | 34 |
| Diphenamid | 957-51-7 | 6.96 | 27 | 4 | 21 | 0 | 17 | 1.77 | 12 |
| Disulfoton | 298-04-4 | 0.33 | 83 | 0.15 | 30 | 0 | 51 | 0 | 32 |
| Disulfoton sulfone | 2497-06-5 | 6.22 | 18 | 8.1 | 15 | 0 | 11 | 0 | 5 |
| Disulfoton sulfoxide | 2497-07-6 | 0.97 | 9 | 0.82 | 9 | 0 | 7 | – | – |
| Diuron | 330-54-1 | 24.61 | 89 | 45.17 | 40 | 5.90 | 59 | 3.82 | 34 |
| DNOC (4,6-Dinitro-*o*-cresol) | 534-52-1 | 0.06 | 62 | 0.24 | 19 | 0 | 42 | 0.15 | 22 |
| *E*-Dimethomorph | e110488-70-5 | 1.48 | 9 | 0 | 9 | 0 | 7 | – | – |
| Endosulfan ether | 3369-52-6 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Endosulfan sulfate | 1031-07-8 | 8.18 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | 17.94 | 83 | 5.64 | 30 | 0.88 | 51 | 0.46 | 32 |
| Ethalfluralin | 55283-68-6 | 1.52 | 83 | 0 | 30 | 0.12 | 51 | 0 | 32 |
| Ethion | 563-12-2 | 0 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Ethion monoxon | 17356-42-2 | 0 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Ethoprop | 13194-48-4 | 2.91 | 83 | 1.13 | 30 | 0.04 | 51 | 0 | 32 |
| Fenamiphos | 22224-92-6 | 0 | 20 | 1.32 | 16 | 0 | 15 | 0 | 6 |
| Fenamiphos sulfone | 31972-44-8 | 0 | 20 | 0.5 | 16 | 0 | 15 | 0 | 6 |
| Fenamiphos sulfoxide | 31972-43-7 | 0 | 19 | 0.31 | 16 | 0 | 15 | 0 | 6 |
| Fenthion | 55-38-9 | 0 | 9 | 0 | 8 | 0 | 7 | – | – |
| Fenthion sulfoxide | 3761-41-9 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Fenuron | 101-42-8 | 0.53 | 89 | 0.19 | 40 | 0.15 | 59 | 0.60 | 34 |
| Fipronil | 120068-37-3 | 14.27 | 38 | 34.06 | 20 | 0 | 17 | 0.17 | 8 |
| Fipronil sulfide | 120067-83-6 | 13.04 | 38 | 21.39 | 20 | 0 | 16 | 0.52 | 8 |
| Fipronil sulfone | 120068-36-2 | 11.42 | 38 | 17.12 | 20 | 0.11 | 17 | 0.93 | 8 |
| Flufenacet | 142459-58-3 | 4 | 5 | – | – | 0 | 1 | – | – |
| Flufenacet ESA | NAV | 2.33 | 15 | – | – | 0 | 8 | – | – |
| Flufenacet OA | NAV | 1.11 | 15 | – | – | 0.43 | 8 | – | – |
| Flumetralin | 62924-70-3 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Flumetsulam | 98967-40-9 | 4.1 | 27 | 1.31 | 21 | 1.62 | 17 | 1.74 | 12 |
| Fluometuron | 2164-17-2 | 11.31 | 89 | 0.69 | 40 | 3.30 | 59 | 0.53 | 34 |
| Fonofos | 944-22-9 | 4.24 | 83 | 0.55 | 30 | 0 | 51 | 0 | 32 |
| *gamma*-HCH | 58-89-9 | 0.99 | 83 | 2.39 | 30 | – | – | – | – |
| Glufosinate | 51276-47-2 | 0.32 | 13 | 0 | 6 | 0 | 7 | 0 | 2 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Glyphosate | 1071-83-6 | 38.10 | 13 | 21.87 | 6 | 1.55 | 7 | 0 | 2 |
| Hexazinone | 51235-04-2 | 20.19 | 20 | 8.89 | 16 | 4.96 | 15 | 3.5 | 6 |
| Hydroxyacetochlor | 60090-47-3 | 2.28 | 2 | – | – | 0 | 1 | – | – |
| Hydroxyalachlor | NAV | 0 | 2 | – | – | 0 | 1 | – | – |
| Hydroxydimethanamid | NAV | 0 | 2 | – | – | 0 | 1 | – | – |
| Hydroxymetolachlor | 131068-72-9 | 22.48 | 2 | – | – | 0 | 1 | – | – |
| Imazaquin | 81335-37-7 | 13.14 | 27 | 13.35 | 21 | 3.2 | 17 | 4.42 | 12 |
| Imazethapyr | 81335-77-5 | 15.23 | 25 | 2.2 | 21 | 3.85 | 17 | 1.05 | 12 |
| Imidacloprid | 138261-41-3 | 3.1 | 27 | 6.98 | 21 | 0.94 | 17 | 2.42 | 12 |
| Iprodione | 36734-19-7 | 3.69 | 20 | 2.02 | 16 | 0 | 15 | 0 | 6 |
| Isofenphos | 25311-71-1 | 0 | 20 | 0 | 16 | 0 | 15 | 0.31 | 6 |
| Linuron | 330-55-2 | 3.35 | 83 | 0.08 | 30 | 0.26 | 51 | 0 | 32 |
| Malaoxon | 1634-78-2 | 0 | 20 | 0.23 | 16 | 0 | 15 | 0.33 | 6 |
| Malathion | 121-75-5 | 5.43 | 83 | 16.47 | 30 | 0.46 | 51 | 0.21 | 32 |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 94-74-6 | 3.69 | 87 | 10.85 | 40 | 0 | 59 | 0.40 | 34 |
| MCPB (4-[4-Chloro-2-methylphenoxy] butanoic acid) | 94-81-5 | 0.05 | 89 | 0 | 40 | 0 | 59 | 0 | 34 |
| Metalaxyl | 57837-19-1 | 33.43 | 27 | 6.88 | 21 | 2.53 | 17 | 1.39 | 12 |
| Methidathion | 950-37-8 | 0.7 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Methiocarb | 2032-65-7 | 0.12 | 89 | 0.06 | 40 | 0.03 | 59 | 0 | 34 |
| Methomyl | 16752-77-5 | 1.39 | 89 | 0.39 | 40 | 0.18 | 59 | 0.10 | 34 |
| Metolachlor | 51218-45-2 | 80.64 | 101 | 46.71 | 31 | 18.06 | 51 | 8.78 | 32 |
| Metolachlor ESA | 171118-09-5 | 89.51 | 25 | – | – | 42.32 | 12 | 41.67 | 2 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

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| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Metolachlor OA | 1520197-33- | 83.91 | 25 | – | – | 18.17 | 12 | 19.59 | 2 |
| Metribuzin | 21087-64-9 | 18.19 | 101 | 4.32 | 31 | 3.01 | 51 | 0.83 | 32 |
| Metsulfuron-methyl | 74223-64-6 | 1.51 | 26 | 7.43 | 21 | 0.57 | 17 | 0.09 | 12 |
| Molinate | 2212-67-1 | 11.65 | 89 | 0.89 | 31 | 0.51 | 51 | 0.21 | 32 |
| Myclobutanil | 88671-89-0 | 5.99 | 20 | 11.09 | 16 | 0.3 | 15 | 0 | 6 |
| Napropamide | 15299-99-7 | 3.76 | 83 | 1.14 | 30 | 0.46 | 51 | 0 | 32 |
| Neburon | 555-37-3 | 0.03 | 89 | 0.15 | 40 | 0.06 | 59 | 0 | 34 |
| Nicosulfuron | 111991-09-4 | 4.47 | 27 | 0.31 | 21 | 0.43 | 17 | 0 | 12 |
| Norflurazon | 27314-13-2 | 8.70 | 89 | 1.44 | 39 | 3.70 | 59 | 0.31 | 34 |
| *O*-Ethyl-*O*-methyl-*S*-propylphosphorothioate | 76960-87-7 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Oryzalin | 19044-88-3 | 0.80 | 89 | 2.51 | 40 | 0.06 | 59 | 0.49 | 34 |
| Oxamyl | 23135-22-0 | 0.53 | 89 | 0 | 40 | 0.73 | 59 | 0.10 | 34 |
| Oxyfluorfen | 42874-03-3 | 8.29 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |
| *p,p'*-DDE (*p,p'*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | 4.35 | 83 | 1.85 | 30 | – | – | – | – |
| Paraoxon-ethyl | 311-45-5 | 0 | 9 | 0.85 | 9 | 0 | 7 | – | – |
| Paraoxon-methyl | 950-35-6 | 0 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Parathion | 56-38-2 | 0.17 | 83 | 0.18 | 30 | 0 | 51 | 0 | 32 |
| Parathion-methyl | 298-00-0 | 1.11 | 83 | 0.11 | 30 | 0.05 | 51 | 0 | 32 |
| Pebulate | 1114-71-2 | 0.83 | 83 | 0.1 | 30 | 0.19 | 51 | 0 | 32 |
| Pendimethalin | 40487-42-1 | 9.95 | 84 | 12.58 | 30 | 0.38 | 51 | 0.38 | 32 |
| Phorate | 298-02-2 | 0.13 | 83 | 0 | 30 | 0 | 51 | 0 | 32 |
| Phorate oxon | 2600-69-3 | 0 | 20 | 0 | 16 | 0 | 15 | 0 | 6 |
| Phosmet | 732-11-6 | 0 | 16 | 0 | 13 | 0 | 13 | 0 | 6 |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Phosmet oxon | 3735-33-9 | 0 | 15 | 0 | 12 | 0 | 12 | 0 | 6 |
| Picloram | 1918-02-1 | 0.42 | 89 | 0.53 | 40 | 0.15 | 59 | 0.38 | 34 |
| Profenofos | 41198-08-7 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Prometon | 1610-18-0 | 41.00 | 95 | 81.02 | 30 | 10.88 | 51 | 20.06 | 32 |
| Prometryn | 7287-19-6 | 12.83 | 37 | 1.30 | 17 | 2.5 | 15 | 0.35 | 6 |
| Pronamide | 23950-58-5 | 2.75 | 83 | 2.49 | 30 | 0.2 | 51 | 0.02 | 32 |
| Propachlor | 1918-16-7 | 2.68 | 94 | 0.62 | 30 | 0.13 | 51 | 0 | 32 |
| Propachlor ESA | NAV | 0 | 10 | – | – | 0 | 5 | – | – |
| Propachlor OA | NAV | 0 | 10 | – | – | 0 | 5 | – | – |
| Propanil | 709-98-8 | 1.82 | 89 | 0.77 | 31 | 0.27 | 51 | 0.13 | 32 |
| Propargite | 2312-35-8 | 2.57 | 83 | 0.17 | 30 | 0.05 | 51 | 0 | 32 |
| Propazine | 139-40-2 | 12.26 | 17 | 0 | 1 | 1.15 | 6 | 0 | 1 |
| Propetamphos | 31218-83-4 | 0 | 9 | 0.85 | 9 | 0 | 7 | – | – |
| Propham | 122-42-9 | 0.03 | 89 | 0.28 | 40 | 0.06 | 59 | 0.10 | 34 |
| Propiconazole | 60207-90-1 | 9.81 | 27 | 2.18 | 21 | 0.45 | 17 | 0.31 | 12 |
| Propoxur | 114-26-1 | 1.33 | 89 | 5.76 | 39 | 0.16 | 59 | 0.58 | 34 |
| Siduron | 1982-49-6 | 0.99 | 27 | 11.02 | 21 | 0.09 | 17 | 0.15 | 12 |
| Simazine | 122-34-9 | 53.63 | 101 | 61.83 | 31 | 19.23 | 51 | 17.09 | 32 |
| Sulfometuron-methyl | 74222-97-2 | 5.17 | 27 | 16.24 | 21 | 0.58 | 17 | 0.58 | 12 |
| Sulfotepp | 3689-24-5 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Sulprofos | 35400-43-2 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Tebuconazole | 107534-96-3 | 6.43 | 9 | 15 | 5 | 0 | 3 | 0 | 5 |
| Tebupirimfos | 96182-53-5 | 4.47 | 9 | 0 | 9 | 0 | 7 | – | – |
| Tebupirimfos oxygen analogue | NAV | 1.12 | 9 | 0 | 9 | 0 | 7 | – | – |

**Table 7–1.** Detection frequencies in agricultural and urban surface water and groundwater from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2006.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Detection frequencies for streams were calculated by first determining detection frequency by site (minimum of 12 samples per site), then pooling sites by land-use group, and finally calculating a site-weighted detection frequency for the land-use group. Detection frequencies for groundwater were calculated by first determining detection frequency for a well, then pooling wells by network (minimum of 12 wells per network), followed by calculating the site-weighted mean detection frequency for the network, then pooling networks by land-use group, and finally calculating a site and network weighted mean detection frequency for the land-use group. For some compounds, more than one analytical method was used to report detection frequencies; in these cases, the "main" method by which most samples were analyzed was used to report detection frequency. If detection frequencies from a similar number of sites or networks were reported under two different methods, the detection frequencies were averaged. Data from multiple analytical methods using liquid chromatography (LC) were aggregated, as were data from gas chromatography (GC) methods; data from LC and GC methods were not combined together. **Abbreviations:** CAS, Chemical Abstracts Service; NAV, not available; –, none]

| Chemical name | CAS Registry Number | Streams | | | | Groundwater | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | | Urban | | Agricultural | | Urban | |
| | | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of sites | Detection frequency, in percent | Number of well networks | Detection frequency, in percent | Number of well networks |
| Tebuthiuron | 34014-18-1 | 22.1 | 83 | 28.60 | 31 | 2.21 | 51 | 5.42 | 32 |
| Tefluthrin | 79538-32-2 | 0 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |
| Temephos | 3383-96-8 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| Terbacil | 5902-51-2 | 4.19 | 83 | 0.89 | 51 | 0.81 | 51 | 1.37 | 32 |
| Terbufos | 13071-79-9 | 0.16 | 83 | 0.12 | 30 | 0 | 51 | 0.16 | 32 |
| Terbufos-*O*-analogue sulfone | 56070-15-6 | 0 | 20 | 0.25 | 16 | 0.51 | 15 | 0 | 6 |
| Terbuthylazine | 5915-41-3 | 8.84 | 20 | 17.27 | 15 | 0 | 15 | 0 | 6 |
| Terbutryn | 886-50-0 | 0 | 11 | – | – | 0 | 4 | 0 | 1 |
| Thiobencarb | 28249-77-6 | 4.71 | 83 | 0.69 | 30 | 0.12 | 51 | 0.1 | 32 |
| *trans*-Methyl-3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane)-carboxylate | t61898-95-1 | 0 | 9 | 0 | 9 | 0 | 7 | – | – |
| *trans*-Propiconazole | t60207-90-1 | 16.31 | 18 | 17.17 | 15 | 0.36 | 11 | 0.74 | 5 |
| Triallate | 2303-17-5 | 3.61 | 83 | 1.52 | 30 | 0.11 | 51 | 0.09 | 32 |
| Tribuphos | 78-48-8 | 0.24 | 18 | 0 | 15 | 0 | 11 | 0 | 5 |
| Triclopyr | 55335-06-3 | 6.27 | 89 | 9.89 | 40 | 0 | 59 | 0.40 | 34 |
| Trifluralin | 1582-09-8 | 14.98 | 89 | 11.65 | 31 | 0.68 | 51 | 0.59 | 32 |
| *Z*-Dimethomorph | z110488-70-5 | 1.48 | 9 | 0 | 9 | 0 | 7 | – | – |

[1] Compound not evaluated as a pesticide.

# Appendix 8.

## Concentration Statistics for 83 Pesticide Compounds Sampled in Agricultural, Urban, and Mixed Land-Use Groundwater Networks from the National Water-Quality Assessment (NAWQA) Program Monitoring Studies, 1993–2003

**Table 8–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural, urban, and mixed land-use groundwater networks from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2003.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural, urban, and mixed land-use wells using the methods of Stackelberg (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Groundwater | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Agricultural | | Urban | | Mixed | |
| | | | | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) |
| 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) | 39742 | 93-76-5 | 0.04 | 1,158 | <0.04 | 607 | <0.04 | 1,446 | <0.04 |
| 2,4,5-TP (2-[2,4,5-Trichlorophenoxy]propionic acid) | 39762 | 93-72-1 | 0.03 | 1,158 | <0.03 | 607 | <0.03 | 1,446 | <0.03 |
| 2,4-D (2,4-Dichlorophenoxy acetic acid) | 39732 | 94-75-7 | 0.08 | 1,206 | <0.08 | 665 | <0.08 | 1,568 | <0.08 |
| 2,4-DB (4-[2,4-Dichlorophenoxy]butyric acid) | 38746 | 94-82-6 | 0.13 | 1,184 | <0.13 | 665 | <0.13 | 1,536 | <0.13 |
| 2,6-Diethylaniline | 82660 | 579-66-8 | 0.003 | 1,402 | 0.002 | 855 | <0.003 | 2,730 | <0.003 |
| 3-Hydroxycarbofuran | 49308 | 16655-82-6 | 0.05 | 1,186 | <0.05 | 662 | <0.05 | 1,569 | <0.05 |
| Acetochlor | 49260 | 34256-82-1 | 0.003 | 920 | <0.003 | 666 | <0.003 | 2,266 | <0.003 |
| Acifluorfen | 49315 | 50594-66-6 | 0.04 | 1,185 | <0.04 | 665 | <0.04 | 1,571 | <0.04 |
| Alachlor | 46342 | 15972-60-8 | 0.002 | 1,401 | 0.014 | 854 | <0.002 | 2,729 | <0.002 |
| Aldicarb | 49312 | 116-06-3 | 0.1 | 1,187 | <0.1 | 663 | <0.1 | 1,573 | <0.1 |
| Aldicarb sulfone | 49313 | 1646-88-4 | 0.1 | 1,173 | <0.1 | 653 | <0.1 | 1,544 | <0.1 |
| Aldicarb sulfoxide | 49314 | 1646-87-3 | 0.14 | 1,174 | <0.14 | 653 | <0.14 | 1,547 | <0.14 |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 34253 | 319-84-6 | 0.002 | 1,402 | <0.002 | 855 | <0.002 | 2,729 | <0.002 |
| Atrazine | 39632 | 1912-24-9 | 0.004 | 1,406 | 1.2 | 851 | 0.553 | 2,730 | 0.28 |
| Azinphos-methyl | 82686 | 86-50-0 | 0.02 | 1,399 | <0.02 | 852 | <0.02 | 2,728 | <0.02 |
| Benfluralin | 82673 | 1861-40-1 | 0.005 | 1,402 | <0.005 | 854 | <0.005 | 2,729 | <0.005 |
| Bentazon | 38711 | 25057-89-0 | 0.03 | 1,204 | 0.91 | 665 | 0.08 | 1,568 | 0.06 |
| Bromacil | 04029 | 314-40-9 | 0.04 | 1,213 | 1.83 | 663 | 0.194 | 1,575 | <0.04 |
| Bromoxynil | 49311 | 1689-84-5 | 0.03 | 1,181 | <0.03 | 665 | <0.03 | 1,569 | <0.03 |
| Butylate | 04028 | 2008-41-5 | 0.001 | 1,401 | <0.001 | 854 | <0.001 | 2,729 | <0.001 |
| Carbaryl | 82680 | 63-25-2 | 0.021 | 1,401 | <0.021 | 854 | 0.007 | 2,729 | <0.021 |
| Carbofuran | 82674 | 1563-66-2 | 0.01 | 1,404 | 0.017 | 853 | <0.01 | 2,727 | <0.01 |
| Chloramben methyl | 61188 | 7286-84-2 | 0.11 | 1,187 | <0.11 | 665 | <0.11 | 1,580 | <0.11 |
| Chlorothalonil | 49306 | 1897-45-6 | 0.07 | 1,187 | <0.07 | 660 | <0.07 | 1,574 | <0.07 |
| Chlorpyrifos | 38933 | 2921-88-2 | 0.003 | 1,402 | <0.003 | 852 | <0.003 | 2,727 | <0.003 |
| *cis*-Permethrin | 82687 | 54774-45-7 | 0.003 | 1,402 | <0.003 | 854 | <0.003 | 2,728 | <0.003 |
| Clopyralid | 49305 | 1702-17-6 | 0.21 | 1,178 | <0.21 | 662 | <0.21 | 1,569 | <0.21 |
| Cyanazine | 04041 | 21725-46-2 | 0.009 | 1,404 | 0.007 | 853 | <0.009 | 2,729 | <0.009 |
| Dacthal | 82682 | 1861-32-1 | 0.002 | 1,402 | 0.001 | 854 | <0.002 | 2,730 | <0.002 |
| Dacthal monoacid | 49304 | 887-54-7 | 0.04 | 1,179 | <0.04 | 635 | <0.04 | 1,568 | <0.04 |
| Deethylatrazine | 04040 | 6190-65-4 | 0.003 | 1,404 | 0.68 | 851 | 0.229 | 2,726 | 0.222 |
| Diazinon | 39572 | 333-41-5 | 0.003 | 1,400 | <0.003 | 853 | 0.004 | 2,728 | 0.004 |

**Table 8–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural, urban, and mixed land-use groundwater networks from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2003.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural, urban, and mixed land-use wells using the methods of Stackelberg (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Groundwater | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Agricultural | | Urban | | Mixed | |
| | | | | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) |
| Dicamba | 38442 | 1918-00-9 | 0.05 | 1,177 | <0.05 | 665 | <0.05 | 1,575 | <0.05 |
| Dichlobenil | 49303 | 1194-65-6 | 0.05 | 1,160 | <0.05 | 607 | <0.05 | 1,453 | <0.05 |
| Dichlorprop | 49302 | 120-36-5 | 0.06 | 1,184 | <0.06 | 664 | <0.06 | 1,576 | <0.06 |
| Dieldrin | 39381 | 60-57-1 | 0.002 | 1,396 | <0.002 | 843 | 0.055 | 2,728 | <0.002 |
| Dinoseb | 49301 | 88-85-7 | 0.04 | 1,185 | <0.04 | 665 | <0.04 | 1,569 | <0.04 |
| Disulfoton | 82677 | 298-04-4 | 0.011 | 1,405 | <0.011 | 854 | <0.011 | 2,730 | <0.011 |
| Diuron | 49300 | 330-54-1 | 0.06 | 1,212 | 0.14 | 664 | 0.25 | 1,566 | 0.07 |
| DNOC (4,6-Dinitro-*o*-cresol) | 49299 | 534-52-1 | 0.13 | 1,155 | <0.13 | 607 | <0.13 | 1,446 | <0.13 |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 82668 | 759-94-4 | 0.001 | 1,399 | 0.003 | 852 | <0.001 | 2,725 | <0.001 |
| Ethalfluralin | 82663 | 55283-68-6 | 0.005 | 1,401 | <0.005 | 854 | <0.005 | 2,728 | <0.005 |
| Ethoprop | 82672 | 13194-48-4 | 0.002 | 1,401 | <0.002 | 854 | <0.002 | 2,728 | <0.002 |
| Fenuron | 49297 | 101-42-8 | 0.03 | 1,187 | <0.03 | 632 | <0.03 | 1,567 | <0.03 |
| Fluometuron | 38811 | 2164-17-2 | 0.03 | 1,217 | <0.03 | 634 | <0.03 | 1,575 | <0.03 |
| Fonofos | 04095 | 944-22-9 | 0.001 | 1,401 | <0.001 | 854 | <0.001 | 2,729 | <0.001 |
| *gamma*-HCH | 39341 | 58-89-9 | 0.002 | 1,397 | <0.002 | 843 | <0.002 | 2,728 | <0.002 |
| Linuron | 82666 | 330-55-2 | 0.018 | 1,401 | <0.018 | 854 | <0.018 | 2,729 | <0.018 |
| Malathion | 39532 | 121-75-5 | 0.014 | 1,403 | <0.014 | 856 | <0.014 | 2,732 | <0.014 |
| MCPA (2-Methyl-4-chlorophenoxyacetic acid) | 38482 | 94-74-6 | 0.1 | 1,179 | <0.1 | 665 | <0.1 | 1,576 | <0.1 |
| MCPB (4-[4-Chloro-2-methylphenoxy] butanoic acid) | 38487 | 94-81-5 | 0.13 | 1,184 | <0.13 | 665 | <0.13 | 1,575 | <0.13 |
| Methiocarb | 38501 | 2032-65-7 | 0.03 | 1,186 | <0.03 | 634 | <0.03 | 1,573 | <0.03 |
| Methomyl | 49296 | 16752-77-5 | 0.24 | 1,174 | <0.24 | 653 | <0.24 | 1,537 | <0.24 |
| Metolachlor | 39415 | 51218-45-2 | 0.006 | 1,405 | 0.466 | 856 | 0.029 | 2,729 | 0.031 |
| Metribuzin | 82630 | 21087-64-9 | 0.003 | 1,397 | 0.028 | 846 | 0.004 | 2,729 | <0.003 |
| Molinate | 82671 | 2212-67-1 | 0.001 | 1,401 | <0.001 | 854 | <0.001 | 2,726 | <0.001 |
| Napropamide | 82684 | 15299-99-7 | 0.003 | 1,400 | <0.003 | 852 | <0.003 | 2,729 | <0.003 |
| Neburon | 49294 | 555-37-3 | 0.03 | 1,188 | <0.03 | 635 | <0.03 | 1,574 | <0.03 |
| Norflurazon | 49293 | 27314-13-2 | 0.021 | 1,173 | 1.32 | 630 | <0.021 | 1,552 | <0.021 |
| Oryzalin | 49292 | 19044-88-3 | 0.14 | 1,170 | <0.14 | 665 | <0.14 | 1,492 | <0.14 |
| Oxamyl | 38866 | 23135-22-0 | 0.08 | 1,172 | <0.08 | 652 | <0.08 | 1,542 | <0.08 |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 34653 | 72-55-9 | 0.001 | 1,402 | 0.002 | 854 | 0.002 | 2,729 | 0.002 |
| Parathion | 39542 | 56-38-2 | 0.005 | 1,401 | <0.005 | 854 | <0.005 | 2,728 | <0.005 |
| Parathion-methyl | 82667 | 298-00-0 | 0.003 | 1,399 | <0.003 | 853 | <0.003 | 2,718 | <0.003 |

**Table 8–1.** Concentration statistics for 83 pesticide compounds sampled in agricultural, urban, and mixed land-use groundwater networks from the National Water-Quality Assessment (NAWQA) Program monitoring studies, 1993–2003.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. Concentration statistics were determined for agricultural, urban, and mixed land-use wells using the methods of Stackelberg (2006). **Abbreviations:** CAS, Chemical Abstracts Service; LT-MDL, long-term method detection level; µg/L, micrograms per liter; <, less than]

| Chemical name | Parameter code | CAS Registry Number | Maximum LT-MDL (µg/L) | Groundwater | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Agricultural | | Urban | | Mixed | |
| | | | | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) | Number of samples | 99th percentile concentration (µg/L) |
| Pebulate | 82669 | 1114-71-2 | 0.002 | 1,402 | <0.002 | 854 | <0.002 | 2,728 | <0.002 |
| Pendimethalin | 82683 | 40487-42-1 | 0.011 | 1,404 | <0.011 | 854 | <0.011 | 2,729 | <0.011 |
| Phorate | 82664 | 298-02-2 | 0.006 | 1,404 | <0.006 | 855 | <0.006 | 2,730 | <0.006 |
| Picloram | 49291 | 1918-02-1 | 0.04 | 1,166 | <0.04 | 658 | <0.04 | 1,545 | <0.04 |
| Prometon | 04037 | 1610-18-0 | 0.007 | 1,405 | 0.169 | 855 | 0.485 | 2,731 | 0.031 |
| Pronamide | 82676 | 23950-58-5 | 0.002 | 1,401 | <0.002 | 854 | <0.002 | 2,728 | <0.002 |
| Propachlor | 04024 | 1918-16-7 | 0.005 | 1,401 | <0.005 | 854 | <0.005 | 2,729 | <0.005 |
| Propanil | 82679 | 709-98-8 | 0.005 | 1,400 | <0.005 | 854 | <0.005 | 2,728 | <0.005 |
| Propargite | 82685 | 2312-35-8 | 0.011 | 1,403 | <0.011 | 854 | <0.011 | 2,716 | <0.011 |
| Propham | 49236 | 122-42-9 | 0.11 | 1,188 | <0.11 | 664 | <0.11 | 1,577 | <0.11 |
| Propoxur | 38538 | 114-26-1 | 0.06 | 1,177 | <0.06 | 663 | <0.06 | 1,565 | <0.06 |
| Simazine | 04035 | 122-34-9 | 0.006 | 1,404 | 0.131 | 855 | 0.283 | 2,732 | 0.031 |
| Tebuthiuron | 82670 | 34014-18-1 | 0.008 | 1,405 | 0.018 | 854 | 0.113 | 2,720 | 0.032 |
| Terbacil | 82665 | 5902-51-2 | 0.017 | 1,398 | <0.017 | 852 | 0.007 | 2,717 | <0.017 |
| Terbufos | 82675 | 13071-79-9 | 0.009 | 1,405 | <0.009 | 855 | <0.009 | 2,729 | <0.009 |
| Thiobencarb | 82681 | 28249-77-6 | 0.002 | 1,401 | <0.002 | 854 | <0.002 | 2,727 | <0.002 |
| Triallate | 82678 | 2303-17-5 | 0.001 | 1,402 | <0.001 | 854 | <0.001 | 2,730 | <0.001 |
| Triclopyr | 49235 | 55335-06-3 | 0.04 | 1,186 | <0.04 | 664 | <0.04 | 1,570 | <0.04 |
| Trifluralin | 82661 | 1582-09-8 | 0.005 | 1,401 | <0.005 | 854 | <0.005 | 2,727 | <0.005 |

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# Appendix 9.

## Summary of the Groundwater Regression for Pesticides Model Methodology

## Background

National models of atrazine occurrence in shallow groundwater were previously developed by Kolpin and others (2002) and Stackelberg and others (2006) to evaluate atrazine-detection frequencies in well networks (typically 20–30 wells each) associated with NAWQA land-use studies (Gilliom and others, 2006). Explanatory variables whose values were averaged across each study area were used to represent the natural setting, agricultural management practices, and atrazine-use intensity (kilograms per square kilometer). The model of Kolpin and others (2002) was developed from data on the occurrence of atrazine in shallow groundwater underlying agricultural and urban land-use settings, whereas the model of Stackelberg and others (2006) focused solely on atrazine occurrence in agricultural settings. Both models used ordinary least-squares regression methods to identify and quantify the effect of factors that were significantly correlated with atrazine-detection frequencies. Stackelberg and others (2006) then applied their model to predict the frequency with which atrazine would be detected in groundwater beneath unmonitored agricultural settings across the conterminous United States.

More recently, the model of Stackelberg and others (2006) has been modified by using the summed concentration of atrazine and one of its degradates, deethylatrazine (DEA)—rather than atrazine-detection frequencies—as the response variable (Paul E. Stackelberg, U.S. Geological Survey, written commun., 2011). The reason for using the sum of atrazine and DEA concentrations as the response variable, rather than the concentration of atrazine alone, was to capture as much information as possible on factors that control the transport and fate of atrazine-derived compounds in the subsurface. Three other major atrazine degradates—deisopropylatrazine, didealkylatrazine, and hydroxyatrazine—were considered, but not examined because of considerations related to analytical performance (Mark Sandstrom, U.S. Geological Survey, written commun., 2011). A benefit of this newly developed model over previous national regression models is that it predicts concentrations rather than detection frequency, which can be directly compared to water-quality criteria.

## Model Development

Measured atrazine and DEA concentrations in 1,298 samples of shallow groundwater underlying 55 areas of regionally extensive combinations of agricultural land and hydrogeological conditions were used for model development. Because 52 percent of the atrazine and DEA concentrations were censored (deemed to be non-detections), a Tobit model, which provides parameter estimates for a censored linear model (Tobin, 1958; Judge and others, 1985), was used for development of the regression model as described in Larson and others (2004), Stone and others (2008), and Nowell and others (2009). The response variable represents the summed concentration of atrazine and DEA; therefore, the Tobit regression model used interval censoring (Helsel, 2005), whereby two values of the response variable are calculated for each sample—(1) a lower bound representing summed concentrations on the assumption that censored values are equal to zero, and (2) an upper bound representing summed concentrations on the assumption that censored values are equal to their maximum long term-method detection level (LT-MDL). For example, the interval-censoring approach for a sample in which atrazine concentration is reported as 0.009 micrograms per liter (µg/L) and DEA is not detected (and reported as less than the max LT-MDL of 0.007 µg/L) computes total atrazine-residue concentrations to be between 0.009 and 0.016 µg/L. When both atrazine and DEA concentrations were censored, the observation was considered to be left-censored at the sum of the max LT-MDLs (0.011 µg/L).

Potential explanatory variables for the model were screened through a stepwise, interval-censored Tobit regression procedure that used the *Akaike Information Criterion* (AIC) statistic to select variables. The AIC statistic balances the desire to explain as much variability as possible in the response variable (here, atrazine-residue concentration) with the practicality of including as few explanatory variables as possible (Helsel and Hirsch, 1992). Groups of explanatory variables were sequentially added prior to each step of the stepwise procedure, and variables were retained if their probability (p) values remained less than or equal to 0.25. A p-value of 0.25 was used at this stage of model development to ensure that all explanatory variables that might contribute significantly to a final model formulation would be considered. Remaining variables were dropped from further consideration if they were redundant (derived from the same ancillary data set), highly correlated with one another (correlation coefficient greater than 0.75), or dependent as indicated by a condition index near 30 and variance decomposition proportions greater than 0.5 (Belsley and others, 1980). In these cases, the variable with the lowest p-value was retained, and the redundant, correlated, or dependent variable(s) were eliminated from further consideration.

The optimal model formulation was identified by maximizing *pseudo-R*$^2$ ($pR^2$) values (Laitila, 1993) and minimizing the scale parameter. The $pR^2$ and scale parameter are alternatives to the coefficient of determination ($R^2$) and the standard deviation of the residual error, respectively, which are used in conventional least-squares analysis. As with conventional $R^2$, the $pR^2$ ranges from 0 to 1 and is an estimate of the percentage of the variation in the response variable that is explained by the regression model. Thus, a $pR^2$ value of zero indicates that no variation is explained, and a value of unity indicates that 100 percent of the variation is explained. The $pR^2$ was calculated through methods described by Laitila (1993). Estimates of the standard deviation of the residual error from maximum-likelihood methods provide only asymptotically unbiased estimates of the standard deviation of the residual error when estimated from sample data (Aitkin, 1981). These estimates, on average, underestimate the true standard deviation. The bias is a function of the sample size and degree of censoring and is expected to be minimal for models with low percentages of censored observations. In this report, biased estimates of the standard deviation of the residual error are referred to as *scale*.

Before the final model formulation was established, all explanatory variables that had previously been dropped were reevaluated to confirm that they did not contribute significantly (p-value less than 0.05, and model $pR^2$ increased by 1 percent or more) to the final model. Finally, each pairwise combination of explanatory variables in the final model was considered as a cross-product term to assess whether interaction of explanatory variables contributed significantly to the final model.

The optimal model formulation (*table 9–1*) explains 41 percent of the variability in the concentration of atrazine residues measured in shallow groundwater beneath agricultural areas across the conterminous United States. Interaction between the variables *artdrn* (artificial drainage) and *wtdep* (depth to the seasonally high water table) was found to be significant and thus required that both variables remain in the final model formulation (Kleinbaum and Klein, 2002) despite an increase in the p-value for *wtdep* to greater than 0.05 (*table 9–1*). The groundwater model has the form of equation 1.

$$\log_{10}(\text{Concentration}) = -3.00 + 0.46(use9200)^{1/3} - 0.1(artdrn)^{1/3} + 0.15(wtdep) + 0.04\left(artdrn^{1/3} \bullet wtdep\right) + 0.23(permin)^{1/3} + 0.62\left(\log_{10}(1+recharge)\right) - 0.05(airtemp) \quad (1)$$

where

*use*9200 = the intensity, in kilograms per square kilometer, of atrazine applications for agricultural purposes in 500-meter radial areas around each sampled well. Atrazine-use estimates were based on unpublished proprietary-use data obtained from DMRKYNETEC, Inc. (Thelin and Stone, 2010); *use*9200 represents the average reported use for the years 1992–2000.

*artdrn* = the percentage of 1-square kilometer grid cells with subsurface drains and graded ditches as represented by conservation practices CP606, CP607, and/or CP608 (U.S. Natural Resources Conservation Service, 1995).

*wtdep* = depth to the seasonally high water table in meters (Natural Resources Conservation Service, 1994).

*permin* = permeability of the least permeable soils layer in centimeters per hour (U.S. Natural Resources Conservation Service, 1994).

*recharge* = mean annual groundwater recharge in centimeters per year, estimated from a base-flow analysis and mean annual runoff as described in Wolock (2003) and modified to include groundwater withdrawn for irrigation purposes (Karen Burow, U.S. Geological Survey, written commun., May 2009).

*airtemp* = mean annual air temperature during 1980–97 in degrees C (Thornton, 2003).

**Table 9–1.** Statistics for Tobit regression model.

[Model variables are defined in equation 1. **Abbreviations:** N, number of samples; <, less than; –, none]

| Variable | Coefficient | p-value | Contribution to overall $pR^2$ by addition of variable | N | Overall $pR^2$ | Scale | Censored data (percent) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Left censored | Interval censored |
| *wtdep* | 0.15 | 0.11 | 0.13 | 1,298 | 0.41 | 0.82 | 51.6 | 10.2 |
| *use*9200$^{1/3}$ | 0.46 | <0.0001 | 0.09 | – | – | – | – | – |
| *airtemp* | –0.05 | <0.0001 | 0.08 | – | – | – | – | – |
| *artdrn*$^{1/3}$ | –0.1 | <0.0001 | 0.06 | – | – | – | – | – |
| *artdrn*$^{1/3}$**wtdep* | 0.04 | 0.0002 | 0.03 | – | – | – | – | – |
| $\log_{10}$(1+*recharge*) | 0.62 | <0.0001 | 0.01 | – | – | – | – | – |
| *permin*$^{1/3}$ | 0.23 | <0.0001 | 0.01 | – | – | – | – | – |
| *intercept* | –3.00 | – | – | – | – | – | – | – |

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# Appendix 10.

## Summary of Occurrence of Pesticide Compounds in Bed Sediment from Agricultural, Urban, and Mixed Land-Use Streams Sampled by the National Water-Quality Assessment (NAWQA) Program, 1992–2001

**Table 10–1.** Summary of occurrence of pesticide compounds in bed sediment from agricultural, urban, and mixed land-use streams sampled by the National Water-Quality Assessment (NAWQA) Program, 1992–2001.

[**Abbreviations:** The CAS Registry Number® is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠; ND, no data; No., number; µg/kg, micrograms per kilogram (dry weight); –, not detected]

| Chemical name | CAS Registry Number | Reporting level (µg/kg) | Agricultural land use | | | | | Urban land use | | | | | Mixed land use | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | |
| | | | | | 50th | 95th | Max | | | 50th | 95th | Max | | | 50th | 95th | Max |
| Aldrin | 309-00-2 | 1 | 239 | 0.84 | – | – | 3.0 | 111 | 3.60 | – | – | 11.0 | 348 | 0.57 | – | – | 1.9 |
| *cis*-Chlordane | 5103-71-9 | 1 | 234 | 2.56 | – | – | 3.7 | 124 | 60.48 | 1.7 | 23.0 | 118.0 | 351 | 21.08 | – | 3.7 | 14.0 |
| *trans*-Chlordane | 5103-74-2 | 1 | 236 | 5.93 | – | 1.0 | 5.6 | 125 | 62.40 | 1.8 | 23.0 | 121.0 | 351 | 22.51 | – | 4.2 | 16.0 |
| Chloroneb | 2675-77-6 | 5 | 229 | 0.00 | – | – | – | 103 | 0.00 | – | – | – | 335 | 0.00 | – | – | – |
| DCPA (Dacthal) | 1861-32-1 | 5 | 236 | 2.12 | – | – | 25.0 | 110 | 0.00 | – | – | – | 349 | 0.29 | – | – | 33.7 |
| *o,p'*-DDD (*o,p'*-Dichlorodiphenyl-dichloroethane) | 53-19-0 | 1 | 219 | 7.31 | – | 2.2 | 33.0 | 101 | 27.72 | – | 9.6 | 22.0 | 306 | 8.50 | – | 2.7 | 150.0 |
| *p,p'*-DDD (*p,p'*-Dichlorodiphenyl-dichloroethane) | 72-54-8 | 1 | 215 | 31.16 | – | 13.0 | 71.0 | 115 | 60.87 | 1.8 | 48.0 | 120.0 | 314 | 33.76 | – | 11.2 | 130.0 |
| *o,p'*-DDE (*o,p'*-Dichlorodiphenyl-dichloroethylene) | 3424-82-6 | 1 | 233 | 3.00 | – | – | 4.4 | 103 | 5.83 | – | 1.0 | 26.7 | 326 | 1.23 | – | – | 22.0 |
| *p,p'*-DDE (*p,p'*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | 1 | 240 | 48.75 | – | 37.5 | 190.0 | 125 | 68.00 | 2.4 | 27.0 | 160.0 | 359 | 52.37 | – | 14.0 | 440.0 |
| *o,p'*-DDT (*o,p'*-Dichlorodiphenyl-trichloroethane) | 789-02-6 | 2 | 220 | 5.00 | – | – | 30.0 | 103 | 5.83 | – | – | 9.8 | 319 | 4.08 | – | – | 11.0 |
| *p,p'*-DDT (*p,p'*-Dichlorodiphenyl-trichloroethane) | 50-29-3 | 2 | 222 | 20.27 | – | 11.0 | 51.0 | 118 | 50.85 | 2.1 | 25.0 | 57.6 | 324 | 22.53 | – | 13.0 | 180.0 |
| Dieldrin | 60-57-1 | 1 | 236 | 16.95 | – | 2.8 | 9.7 | 119 | 42.02 | – | 27.0 | 295.0 | 349 | 16.05 | – | 3.1 | 9.1 |
| Endosulfan I (*alpha*-Endosulfan) | 959-98-8 | 1 | 233 | 1.29 | – | – | 4.7 | 103 | 2.91 | – | – | 4.9 | 331 | 2.42 | – | – | 8.8 |
| Endrin | 72-20-8 | 2 | 234 | 1.28 | – | – | 3.1 | 110 | 0.91 | – | – | 3.1 | 345 | 0.00 | – | – | – |
| *alpha*-HCH (*alpha*-Hexachlorocyclohexane) | 319-84-6 | 1 | 234 | 0.00 | – | – | – | 109 | 0.92 | – | – | 1.0 | 335 | 0.00 | – | – | – |

**Table 10–1.** Summary of occurrence of pesticide compounds in bed sediment from agricultural, urban, and mixed land-use streams sampled by the National Water-Quality Assessment (NAWQA) Program, 1992–2001.—Continued

[**Abbreviations:** The CAS Registry Number® is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠; ND, no data; No., number; µg/kg, micrograms per kilogram (dry weight) –, not detected]

| Chemical name | CAS Registry Number | Reporting level (µg/kg) | Agricultural land use | | | | | Urban land use | | | | | Mixed land use | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | | No. of sites | Detection frequency, in percent | Percentiles of concentration, in µg/kg (dry weight) | | |
| | | | | | 50th | 95th | Max | | | 50th | 95th | Max | | | 50th | 95th | Max |
| *beta*-HCH | 319-85-7 | 1 | 232 | 0.00 | – | – | – | 108 | 0.00 | – | – | – | 333 | 0.60 | – | – | 1.2 |
| Heptachlor | 76-44-8 | 1 | 239 | 0.00 | – | – | – | 112 | 5.36 | – | – | 8.3 | 348 | 0.00 | – | – | - |
| Heptachlor epoxide | 1024-57-3 | 1 | 234 | 0.85 | – | – | 4.6 | 110 | 10.91 | – | 6.2 | 19.7 | 337 | 0.89 | – | – | 1.8 |
| Hexachlorobenzene | 118-74-1 | 1 | 221 | 4.98 | – | – | 11.0 | 95 | 8.42 | – | 2.4 | 56.0 | 323 | 3.10 | – | – | 190.0 |
| Isodrin | 465-73-6 | 1 | 237 | 0.00 | – | – | – | 106 | 0.00 | – | – | – | 343 | 0.00 | – | – | – |
| Lindane (*gamma*-HCH) | 58-89-9 | 1 | 233 | 1.29 | – | – | 2.0 | 109 | 1.83 | – | – | 1.0 | 333 | 0.30 | – | – | 5.2 |
| *o,p'*-Methoxychlor | 30667-99-3 | 5 | 226 | 0.00 | – | – | – | 98 | 0.00 | – | – | – | 314 | 0.00 | – | – | – |
| *p,p'*-Methoxychlor | 72-43-5 | 5 | 227 | 0.44 | – | – | 213.0 | 94 | 2.13 | – | – | 71.0 | 310 | 0.00 | – | – | – |
| Mirex | 2385-85-5 | 1 | 239 | 2.93 | – | – | 3.0 | 110 | 1.82 | – | – | 1.6 | 345 | 2.61 | – | – | 4.4 |
| *cis*-Nonachlor | 5103-73-1 | 1 | 237 | 2.11 | – | – | 2.5 | 116 | 34.48 | – | 7.5 | 30.1 | 237 | 10.76 | – | 1.8 | 23.0 |
| *trans*-Nonachlor | 39765-80-5 | 1 | 236 | 5.08 | – | 1.0 | 3.4 | 124 | 58.87 | 1.4 | 15.3 | 86.8 | 236 | 24.00 | – | 3.4 | 8.4 |
| Oxychlordane | 27304-13-8 | 1 | 235 | 0.43 | – | – | 1.2 | 109 | 10.09 | – | 4.8 | 13.7 | 235 | 0.89 | – | – | 3.2 |
| Pentachloroanisole (PCA) | 1825-21-4 | 1 | 217 | 0.00 | – | – | – | 97 | 0.00 | – | – | – | 313 | 0.32 | – | – | 3.8 |
| *cis*-Permethrin | 52645-53-1 | 5 | 219 | 1.83 | – | – | 26.0 | 71 | 2.82 | – | – | 10.4 | 294 | 0.00 | – | – | – |
| *trans*-Permethrin | 61949-77-7 | 5 | 216 | 1.39 | – | – | 15.0 | 71 | 4.23 | – | – | 15.1 | 283 | 0.00 | – | – | – |
| Toxaphene | 8001-35-2 | 200 | 240 | 0.42 | – | – | 240.0 | 110 | 0.91 | – | – | 351.0 | 349 | 0.00 | – | – | – |
| Total chlordane [1] | ND | ND | 237 | 7.59 | – | 1.4 | 15.6 | 125 | 68.00 | 4.9 | 66.6 | 348.1 | 356 | 26.69 | – | 12.8 | 43.6 |
| Total DDT [1] | ND | ND | 242 | 49.17 | – | 78.7 | 308.2 | 125 | 72.00 | 6.8 | 133.0 | 262.8 | 361 | 54.02 | 1.2 | 38.4 | 553.0 |

[1] Concentration was determined by summing concentrations of individual components. Non-detections and missing data for components were assumed equal to zero. Therefore, percentiles for summed analytes represent the lower-bound estimates.

# Appendix 11.

## Summary of Occurrence of Pesticide Compounds in Lake Core Sediment from Urban and Reference Lakes Sampled Across the United States by the National Water-Quality Assessment (NAWQA) Program, 1992–2001

**Table 11–1.** Summary of occurrence of pesticide compounds in lake core sediment from urban and reference lakes sampled across the United States by the National Water-Quality Assessment (NAWQA) Program, 1992–2001.

[The CAS Registry Number® is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** CAS, Chemical Abstracts Service]

| Chemical name | CAS Registry Number | Number of samples | Detection frequency (in percent) |
|---|---|---|---|
| Aldrin | 309-00-2 | 155 | 1.94 |
| Chlordane | 57-74-9 | 155 | 67.74 |
| *p,p′*-DDD (*p,p′*-Dichlorodiphenyl-dichloroethane) | 72-54-8 | 155 | 72.90 |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | 155 | 92.26 |
| *p,p′*-DDT (*p,p′*-Dichlorodiphenyl-trichloroethane) | 50-29-3 | 155 | 50.97 |
| Dieldrin | 60-57-1 | 155 | 44.52 |
| Endosulfan I (*alpha*-Endosulfan) | 959-98-8 | 155 | 0.00 |
| Endrin | 72-20-8 | 144 | 0.00 |
| Heptachlor | 76-44-8 | 155 | 5.16 |
| Heptachlor epoxide | 1024-57-3 | 155 | 7.74 |
| Lindane (*gamma*-Hexachlorocyclohexane) | 58-89-9 | 155 | 0.65 |
| *p,p′*-Methoxychlor | 72-43-5 | 144 | 2.78 |
| Mirex | 2385-85-5 | 144 | 4.17 |
| Toxaphene | 8001-35-2 | 144 | 0.00 |

# Appendix 12.

## Summary of Occurrence of Legacy and Current-Use Pesticide Compounds in Stream Bed and Suspended Sediment from Agricultural and Urban Streams Sampled by the Toxics Program, 2001–08

**Table 12–1.** Summary of occurrence of legacy and current-use pesticide compounds in stream bed and suspended sediment from agricultural and urban streams sampled by the U.S. Geological Survey Toxics Program, 2001–08.

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** CAS, Chemical Abstracts Service]

| Chemical name | CAS Registry Number | Number of samples | Detection frequency (in percent) |
|---|---|---|---|
| 3,4-Dichloroaniline | 95-76-1 | 103 | 13.6 |
| Alachlor | 15972-60-8 | 157 | 1.3 |
| Allethrin | 584-79-2 | 79 | 0 |
| *alpha*-Endosulfan (Endosulfan I) | 959-98-8 | 78 | 17.9 |
| Atrazine | 1912-24-9 | 177 | 3.4 |
| Azinphos-methyl | 86-50-0 | 51 | 0 |
| *beta*-Endosulfan (Endosulfan II) | 33213-65-9 | 24 | 8.3 |
| *beta*-HCH (*beta*-Hexachlorocyclohexane) | 319-85-7 | 24 | 29.2 |
| Bifenthrin | 82657-04-3 | 260 | 41.9 |
| Butylate | 2008-41-5 | 130 | 0 |
| Carbaryl | 63-25-2 | 150 | 4.0 |
| Carbofuran | 1563-66-2 | 154 | 1.3 |
| Chlorothalonil | 1897-45-6 | 24 | 8.3 |
| Chlorpyrifos | 2921-88-2 | 214 | 32.7 |
| *cis*-Chlordane (*alpha*-Chlordane) | 5103-71-9 | 24 | 37.5 |
| *cis*-Nonachlor | 5103-73-1 | 24 | 12.5 |
| Cyanazine | 21725-46-2 | 54 | 0 |
| Cycloate | 1134-23-2 | 130 | 0 |
| Cyfluthrin | 68359-37-5 | 79 | 5.1 |
| Cyhalothrin (*lambda*-Cyhalothrin) | 91465-08-6 | 225 | 19.6 |
| Cypermethrin | 52315-07-8 | 143 | 3.5 |
| Cyproconazole | 94361-06-5 | 24 | 4.2 |
| Dacthal (DCPA) | 1861-32-1 | 208 | 21.6 |
| *delta*-HCH | 319-86-8 | 24 | 12.5 |
| Deltamethrin | 52918-63-5 | 79 | 0 |
| Desulfinylfipronil (MB46513) | not available | 79 | 0 |
| Diazinon | 333-41-5 | 181 | 8.3 |
| Dieldrin | 60-57-1 | 24 | 91.7 |
| Diethatyl | 38727-55-8 | 24 | 0 |
| EPTC (*S*-Ethyl dipropylthiocarbamate) | 759-94-4 | 154 | 13.0 |
| Esfenvalerate | 66230-04-4 | 154 | 13.6 |
| Ethalfluralin | 55283-68-6 | 130 | 7.7 |
| Fenpropathrin | 39515-41-8 | 79 | 5.1 |
| Fipronil | 120068-37-3 | 93 | 1.1 |
| Fipronil sulfide | 120067-83-6 | 106 | 4.7 |
| Fipronil sulfone | 120068-36-2 | 91 | 3.3 |
| Fluvalinate-tau | 102851-06-9 | 87 | 3.4 |
| Fonofos | 944-22-9 | 54 | 0 |
| *gamma*-HCH | 58-89-9 | 24 | 16.7 |
| Hexazinone | 51235-04-2 | 159 | 1.3 |
| Iprodione | 36734-19-7 | 79 | 17.7 |
| Malathion | 121-75-5 | 157 | 0 |
| Methidathion | 950-37-8 | 157 | 0.6 |
| Methoprene | 40596-69-8 | 91 | 2.2 |

**Table 12–1.** Summary of occurrence of legacy and current-use pesticide compounds in stream bed and suspended sediment from agricultural and urban streams sampled by the U.S. Geological Survey Toxics Program, 2001–08.—Continued

[The CAS Registry Number® is a registered trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client Services℠. **Abbreviations:** CAS, Chemical Abstracts Service]

| Chemical name | CAS Registry Number | Number of samples | Detection frequency (in percent) |
|---|---|---|---|
| Metolachlor | 51218-45-2 | 198 | 27.8 |
| Molinate | 2212-67-1 | 138 | 2.2 |
| Myclobutanil | 88671-89-0 | 24 | 12.5 |
| Napropamide | 15299-99-7 | 138 | 5.1 |
| Oxyfluorfen | 42874-03-3 | 162 | 30.2 |
| *p,p′*-DDD (*p,p′*-Dichlorodiphenyl-dichloroethane) | 72-54-8 | 248 | 40.3 |
| *p,p′*-DDE (*p,p′*-Dichlorodiphenyl-dichloroethylene) | 72-55-9 | 274 | 52.6 |
| *p,p′*-DDT (*p,p′*-Dichlorodiphenyl-trichloroethane) | 50-29-3 | 248 | 34.7 |
| Parathion-methyl | 298-00-0 | 157 | 6.4 |
| PCNB (Pentachloronitrobenzene) | 82-68-8 | 79 | 0 |
| Pebulate | 1114-71-2 | 130 | 3.8 |
| Pendimethalin | 40487-42-1 | 247 | 40.5 |
| Pentachloroanisole (PCA) | 1825-21-4 | 103 | 1.9 |
| Permethrin (*cis*-Permethrin) | 52645-53-1 | 140 | 36.4 |
| Phosmet | 732-11-6 | 103 | 0 |
| Piperonyl butoxide | 51-03-6 | 160 | 11.3 |
| Prometryn | 7287-19-6 | 194 | 22.2 |
| Propiconazole | 60207-90-1 | 24 | 8.3 |
| Resmethrin | 10453-86-8 | 127 | 5.5 |
| Simazine | 122-34-9 | 130 | 8.5 |
| Sulfotepp | 3689-24-5 | 27 | 0 |
| Sumithrin | 26002-80-2 | 79 | 0 |
| Tefluthrin | 79538-32-2 | 79 | 0 |
| Terbuthylazine | 5915-41-3 | 21 | 4.8 |
| Tetraconazole | 112281-77-3 | 24 | 87.5 |
| Tetramethrin | 7696-12-0 | 79 | 0 |
| Thiobencarb | 28249-77-6 | 144 | 6.9 |
| *trans*-Chlordane (*gamma*-Chlordane) | 5103-74-2 | 24 | 50.0 |
| *trans*-Nonachlor | 39765-80-5 | 24 | 20.8 |
| Trifluralin | 1582-09-8 | 214 | 44.9 |

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