United States
Environmental Protection
Agency

Office of Water
(4606)
Washington, DC

EPA 815-R-99-007
March 2000

Technical Background Information for the Unregulated Contaminant Monitoring Regulation

Printed on Recycled Paper

Foreword

Under the Safe Drinking Water Act (SDWA), as amended in 1996, §1445(a)(2)(A), the Environmental Protection Agency (EPA) was to promulgate regulations for a monitoring program for unregulated contaminants by August 1999. In the past, unregulated contaminant monitoring has been performed according to the program described in CFR 141.40. The 1996 SDWA Amendments direct a substantially revised Unregulated Contaminant Monitoring Regulation (UCMR). The revised UCMR (64 FR 50555) has a new list of contaminants and makes other changes in the number of public water systems (PWSs) that must conduct monitoring and in the frequency and schedule for monitoring. Additional regulatory actions also include cancellation of unregulated contaminant monitoring for small systems serving 10,000 or fewer persons under the existing unregulated contaminant monitoring program begun in 1989. The data collected under the UCMR will be used to support the development of the Contaminant Candidate List (CCL), to support the Administrator's determination of whether to regulate a contaminant, and to develop regulations. The revised monitoring program is one of the cornerstones of the sound science approach to future drinking water regulation that is an aim of the 1996 SDWA Amendments. This document provides technical background information on the process used to select contaminants for the revised UCMR, the analytical methods that have been evaluated for use in the revised monitoring program, the spatial distribution of use, environmental release, and production of the UCMR contaminants, and the rationale for the timing and location of monitoring for these contaminants.

Disclaimer

This document is designed to provide technical background information for the Unregulated Contaminant Monitoring Regulation, as published in the *Federal Register* on September 17, 1999. (64 FR 50555). The document does not, however, substitute for the SDWA or EPA's regulations nor is this document a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Acknowledgments

This document was prepared in support of the Unregulated Contaminant Monitoring Regulation (UCMR) for EPA's Office of Ground Water and Drinking Water. Charles Job served as EPA's team leader for development of the UCMR and James Taft as Targeting and Analysis Branch Chief. Rachel Sakata and Yvette Selby served as Work Assignment Managers. The UCMR Work Group provided technical guidance throughout. Evelyn Washington, James Sinclair, and David Munch provided technical and editorial guidance. The Cadmus Group, Inc., served as the prime contractor providing support for this work. The major contributions of Chris Higgins, Aaron Stern, Jonathan Koplos, and Maureen Devitt are gratefully acknowledged. George Hallberg served as Cadmus' Project Manager.

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Section 1. Introduction

The Unregulated Contaminant Monitoring Regulation (UCMR) is required under §1445(a)(2) of the Safe Drinking Water Act (SDWA), as amended in 1996. Under the 1996 Amendments, the Environmental Protection Agency (EPA) is required to publish a list of contaminants to be monitored and to establish a monitoring program for these contaminants.[1] Contaminants on the UCMR List are known or anticipated to occur in public water systems (PWSs) and may require regulation under SDWA, but additional data on their occurrence are needed before regulatory decisions can be made. As EPA will use data collected under the revised UCMR Program in making future regulatory decisions, the monitoring for the contaminants on the UCMR List is one of the cornerstones of the sound science approach to regulatory decision making that is an aim of the 1996 Amendments.

There are 36 contaminants listed on the UCMR (1999) List, as published in the September 17, 1999 *Federal Register* (64 FR 50555). Thirty-four of these contaminants were also included on the 1998 Contaminant Candidate List (CCL) as published in the March 2, 1998 *Federal Register* (63 FR 10273). The CCL, as required by §1412(b)(1) of SDWA, lists contaminants that, at the time of publication, were not subject to any proposed or promulgated national primary drinking water regulations (NPDWRs), were known or anticipated to occur in PWSs, and which may require regulations. The 1998 CCL is comprised of 50 chemical and 10 microbiological contaminants and contaminant groups, and is divided into lists of occurrence, research, and regulation determination priorities (Table 2.1). All 34 of the contaminants included on both the UCMR (1999) List and the 1998 CCL were listed as occurrence priorities on the CCL, although other data (i.e., health effects data) may also be needed. The two contaminants included on the UCMR (1999) List but not included on the 1998 CCL are lead-210 (^{210}Pb) and polonium-210 (^{210}Po).

This document is intended to provide technical background information for the UCMR. Section 2 of this document summarizes the process used to select contaminants for the UCMR (1999) List to be monitored under the UCMR Program. This process was intimately tied to the process used to select contaminants for the 1998 CCL: a brief summary of the CCL selection process is also included. Section 3 of this document provides an overview of the methods approved for monitoring contaminants on List 1 of the UCMR (1999) List, as well as methods that EPA is developing or will shortly begin developing for List 2 and List 3 contaminants. Section 4 provides a brief summary of use, environmental release, and production of all contaminants on the UCMR (1999) List. Finally, Section 5 of this document describes the rationale used to determine the timing and location (at the water system level) of monitoring for UCMR contaminants.

Notes

[1] Although SDWA stipulates that EPA publish a list of not more than 30 contaminants to be monitored, EPA is interpreting this to mean that while no more than 30 contaminants can be monitored in any 5-year UCMR listing cycle, EPA can maintain a list of more than 30 contaminants needing additional occurrence data.

Section 2. The UCMR List Contaminant Selection Process

The UCMR (1999) List, as published in the UCMR (64 FR 50555), is based on the Contaminant Candidate List (CCL), as published in the March 2, 1998 *Federal Register* (63 FR 10273). The CCL is required under SDWA §1412(b)(1) and lists contaminants that, at the time of publication, were not subject to any proposed or promulgated national primary drinking water regulations (NPDWRs), were known or anticipated to occur in PWSs, and which may require regulation. The 1998 CCL is composed of 50 chemical and 10 microbiological contaminants/contaminant groups (Table 2.1).

Of the 60 contaminants on the 1998 CCL, 20 are currently listed as regulation determination priorities (to be evaluated by August 2001 as to whether or not regulations should be developed), and 34

Table 2.1 The 1998 Contaminant Candidate List

Regulatory Determination Priorities	Research Priorities			Occurrence Priorities
	Health Research	Treatment Research	Analytical Methods Research	
Acanthamoeba (guidance) 1,1,2,2-tetrachloroethane 1,1-dichloroethane 1,2,4-trimethylbenzene 1,3-dichloropropene 2,2-dichloropropane Aldrin Boron Bromobenzene Dieldrin Hexachlorobutadiene p-Isopropyltoluene Manganese Metolachlor Metribuzin Naphthalene Organotins Triazines & degradation products (incl., but not limited to Cyanazine and atrazine-desethyl) Sulfate Vanadium	*Aeromonas hydrophila* Cyanobacteria (Blue-green algae), other freshwater algae, and their toxins Caliciviruses *Helicobacter pylori* Microsporidia *Mycobacterium avium intracellulare* (MAC) 1,1-dichloropropene 1,3-dichloropropane Aluminum DCPA mono-acid & di-acid degradates Methyl bromide MTBE Perchlorate Sodium (guidance)	Adenoviruses *Aeromonas hydrophila* Cyanobacteria (Blue-green algae), other freshwater algae, and their toxins Caliciviruses Coxsackieviruses (ICR data) Echoviruses (ICR data) *Helicobacter pylori* Microsporidia *Mycobacterium avium intracellulare* (MAC) Aluminum MTBE Perchlorate	Adenoviruses Cyanobacteria (Blue-green algae), other freshwater algae, and their toxins Caliciviruses *Helicobacter pylor*i Microsporidia 1,2-diphenylhydrazine 2,4,6-trichlorophenol 2,4-dichlorophenol 2,4-dinitrophenol 2-methyl-Phenol Acetochlor Alachlor ESA Fonofos Perchlorate RDX	Adenoviruses *Aeromonas hydrophila* Cyanobacteria (Blue-green algae), other freshwater algae, and their toxins Caliciviruses Coxsackieviruses (ICR data) Echoviruses (ICR data) *Helicobacter pylori* Microsporidia 1,2-diphenylhydrazine 2,4,6-trichlorophenol 2,4-dichlorophenol 2,4-dinitrophenol 2,4-dinitrotoluene 2,6-dinitrotoluene 2-methyl-phenol Alachlor ESA Acetochlor DCPA mono-acid & di-acid degradates DDE Diazinon Disulfoton Diuron EPTC Fonofos Linuron Molinate MTBE Nitrobenzene Perchlorate Prometon RDX Terbacil Terbufos

are listed as occurrence priorities (these contaminants have significant gaps in occurrence data that must be filled before any regulatory decisions can be made). The remaining six contaminants have sufficient occurrence data available, but other data are needed before they can be considered for regulation (i.e., health effects data or efficacy of treatment data). All 34 contaminants listed as occurrence priorities on the 1998 CCL have been included on the UCMR (1999) List. In addition, two other contaminants, lead-210 and polonium-210, were not included on the 1998 CCL but are included on the UCMR (1999) List.

Of the 36 contaminants on the UCMR (1999) List, 12 are on List 1 (to be included in Assessment Monitoring), 16 are on List 2 (to be included in the Screening Surveys), and 8 are on List 3 (possibly to be included in Pre-Screen Testing). For more information on the Assessment Monitoring, Screening Survey, and Pre-Screen Testing components of the UCMR Program, the reader may refer to the UCMR Preamble and Rule (64 FR 50555).

To understand the selection process for the UCMR List, it is necessary to understand the process used to select and categorize contaminants for the CCL.[1] This process is fundamental to the UCMR List, as EPA used the list of contaminants categorized as occurrence priorities on the CCL to develop the UCMR List. In addition, this section briefly explains the process used to prioritize contaminants on the UCMR List into Lists 1, 2, and 3.

2.1. The CCL Selection and Prioritization Process

The SDWA, as amended in 1996, required EPA to publish the first CCL within 18 months of enactment (i.e., by February 1998). In addition, the 1996 Amendments stipulated that the selection process must include consultation and input from the scientific community, and that there must be an opportunity for public comment prior to publication of the final CCL. To fulfill these requirements, the National Drinking Water Advisory Council's (NDWAC) Working Group on Occurrence and Contaminant Selection played an integral role in this process by recommending selection criteria as well as the list of contaminants initially considered for the CCL. During the selection process, EPA also sought input from experts on microbiological contaminants to be included on the CCL through a workshop on microbiology and public health. EPA also consulted with the Science Advisory Board and relied on input from the public (including water utilities, trade associations, and environmental groups) through stakeholder meetings and comments solicited through the October 6, 1997 draft CCL (62 FR 52193).

2.1.1. Microbiological Contaminants

To select microbiological contaminants for the CCL, EPA developed an initial list of 21 microorganisms and groups of microorganisms to be evaluated at a workshop on microbiology and public health held on May 20-21, 1997. Table 2.2 lists the microbiological contaminants included on this initial list. The workshop participants developed criteria to evaluate this initial list of contaminants, as well as other contaminants that were added during workshop discussion. These criteria were:

(1) public health significance;

(2) known waterborne transmission;

(3) occurrence in source water;

(4) effectiveness of current water treatment; and

(5) adequacy of analytical methods.

Table 2.2 Microbiological Contaminants Considered for the CCL (1998) and the UCMR (1999) List

Microbiological Contaminant	Initial list submitted to workshop	Considered by Workshop	Included in Draft CCl (1998)	Not on Draft CCL (1998) but suggested for inclusion by Public	Included on Final CCL (1998)	Included on Draft and Final UCMR (1999) List
Adenoviruses	✔	✔	✔		✔	✔
Aeromonas hydrophila	✔	✔	✔		✔	✔
Coxsackieviruses	✔	✔	✔		✔	✔
Echoviruses	✔	✔	✔		✔	✔
Helicobacter pylori	✔	✔	✔		✔	✔
Microsporidia (*Enterocytozoon bieneus*i and *Encephalitozoon [Septata] intestinalis*)	✔	✔	✔		✔	✔
Norwalk and other Caliciviruses	✔	✔	✔		✔	✔
Cyanobacteria and their toxins	✔	✔			✔	✔
Acanthamoeba	✔	✔	✔		✔	
Mycobacterium avium Complex (MAC)	✔	✔	✔		✔	
Cyclospora cayenanensis	✔	✔	✔			
Toxoplasma gondii	✔	✔	✔			
Pseudomonas aeruginosa	✔	✔	[a]	✔		
Arcobacter	✔	✔		✔		
Campylobacter	✔	✔		✔		
E. Coli O157:H7	✔	✔		✔		
Hepatitis E	✔	✔		✔		
Isospora belli	✔	✔		✔		
Rotavirus	✔	✔		✔		
Astroviruses	✔	✔				
Naegleria fowleri	✔	✔				
Hepatitis A		✔	✔			
Legionella		✔	✔			
Entamoeba histolytica		✔		✔		
Salmonella		✔		✔		
Shigella		✔		✔		
Vibrio spp.		✔		✔		
Yersinia enterocolitica		✔		✔		
Blastocystis hominis		✔				
Picobivirna virus		✔				
Picotrivirna virus		✔				
Bacteriophage				✔		
Pfiesteria piscicidia				✔		

[a] While *Pseudomonas aeruginos*a was not included on the draft or final CCL, EPA had intended to conduct a literature review of this contaminant before making decisions for the final CCL. This literature review was not, however, completed before publication of the final CCL. Because of this,*Pseudomonas aeruginos*a was not considered for the final CCL.

Using these criteria, the workshop identified a list of 13 microorganisms and groups of microorganisms to be included on the draft CCL (Table 2.2). This list was presented to the NDWAC Working Group, and after approval, to the full NDWAC. EPA published this list as part of the draft CCL in the October 6, 1997 *Federal Register* (62 FR 52193).

Based on comments received on the draft CCL, EPA eliminated four microorganisms [*Cyclospora cayetanensis*, *Toxoplasma gondii*, Hepatitis A virus, and Legionella (in ground water)] and added one group of microorganisms (Cyanobacteria, other freshwater algae, and their toxins) to the CCL. The rationale for these changes is documented in the March 2, 1998 *Federal Register* notice announcing the final 1998 CCL (63 FR 10273).

Cyanobacteria and their toxins were added to the 1998 CCL because EPA decided that: (1) pathogenic algae and their toxins are not necessarily associated with fecal contamination, and thus may not be effectively controlled by the Surface Water Treatment Rule (SWTR) or the Enhanced SWTR (ESWTR), and (2) some data suggest that current treatment techniques may be particularly inadequate in controlling algal toxins. For more information, the reader may refer to the publication of the final 1998 CCL published in the March 2, 1998 *Federal Register* (63 FR 10273) and the EPA Drinking Water Microbiology and Public Health Workshop Summary and the NDWAC Working Group Meeting Summaries.[2]

In general, the data available on the occurrence of the microbiological contaminants included on the final 1998 CCL are very limited. Thus, EPA listed almost all of the microbiological contaminants on the CCL as occurrence priorities; the only two microbiological contaminants on the final 1998 CCL that the Agency did *not* list as occurrence priorities are *Acanthamoeba* and *Mycobacterium avium* complex. *Acanthamoeba* are a group of free-living amoeba that can cause inflammation of the eye's cornea, especially in individuals that wear soft or disposable contact lenses. Although no cases of waterborne disease have been reported, *Acanthamoeba* are common in soil and water, and their cysts may be resistant to chlorine. EPA intends to issue guidance for *Acanthamoeba* to educate the public about the potential problems of using tap water to cleanse contact lenses, and has therefore included *Acanthamoeba* as a regulation determination priority.

Mycobacterium avium complex (MAC) is a commonly found pathogen capable of causing pulmonary and other diseases in immuno-compromised individuals. Unlike the other microorganisms on the 1998 CCL, considerable occurrence data exists for MAC, as several epidemiological studies have linked nosocomial infections of MAC to water supplies and distribution systems. EPA listed MAC on the CCL as both a health and treatment research priority, particularly because of its resistance to chlorine, its ability to colonize pipes, and its public health significance. Although additional occurrence data may be warranted because of its likely occurrence in biofilms, EPA believes it is inappropriate to include MAC in a general occurrence study such as the UCMR Program. Instead, EPA believes MAC may require special, focused studies, aimed at obtaining data on the efficacy of current water treatment technologies in removing MAC from drinking water.

2.1.2. Chemical Contaminants

At the first NDWAC Working Group meeting held on April 3-4, 1997, a list of 391 contaminants (including 25 microbiological contaminants) was proposed for consideration for the CCL. (The original list contained 25 microbiological contaminants, but because 4 cyanobacterial toxins were placed in a single group and the viruses were regrouped, Table 2.2 presents only 21 microbiological contaminants.) This list was created by combining lists of contaminants from ten separate sources used as logical starting points for the draft CCL contaminant selection process. These lists included the 1991 Drinking Water Priority List (DWPL), the Health Advisories (HAs) List, the Integrated Risk Information System (IRIS) List, a list of Non-Target Analytes in Public Water Supply Samples, the Comprehensive Environmental

Response, Compensation, and Liability Act (CERCLA) Priority List, the Toxic Release Inventory (TRI) List, a list of contaminants identified by stakeholders, a list of contaminants identified by the Office of Pesticide Programs (OPP), a list of contaminants identified by the Safe Drinking Water Hot-line, and a list of contaminants suspected of causing endocrine disruption.

Of the lists summarized above, the last two were essentially eliminated from initial consideration because: (1) the Safe Drinking Water Hotline could not ascertain whether calls received were related to general questions and inquiries or to incidents of contamination, and (2) EPA had established a separate committee, the Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), to address concerns regarding the screening and evaluation of contaminants suspected of causing endocrine disruption. However, an interim EPA assessment concluded that for many suspected endocrine disruptors, a causal relationship between exposure to a specific environmental agent and an adverse health effect in humans has not been established (with a few exceptions). Decisions for inclusion of contaminants suspected solely of endocrine disruption on the CCL were deferred pending completion of EDSTAC's recommendations and a National Academy of Sciences (NAS) review, which was completed in 1999.[3] Information contained within this report as well as EDSTAC's recommendations will be used in the development of the next CCL, expected in 2003. Contaminants suspected of endocrine disruption that were also included on any of the other eight lists remained in consideration.

The NDWAC Working Group combined the first 8 lists, and after both eliminating duplicate contaminants and contaminants subject to NPDWRs and relegating the microorganisms to the expert panel, an initial list of 262 chemical contaminants was identified for consideration for the draft CCL. These contaminants were then subjected to criteria developed by the Working Group.[4] The selection criteria are described below. Data used in the screening process were obtained from EPA's Storage and Retrieval System (STORET), the Hazardous Substances Database (HSDB), IRIS, published literature, various EPA reports and documents, EPA's Unregulated Contaminant Information System (URCIS), the U.S. Geological Survey's National Water Quality Assessment (NAWQA), the National Inorganic and Radionuclide Survey (NIRS), EPA's Pesticides in Ground Water Database (PGWD), and the National Pesticides Survey (NPS).

2.1.2.1. Occurrence Criterion

The Working Group evaluated the initial 262 chemical contaminants with regard to their occurrence before considering health effects. An affirmative response to any of the occurrence-related questions resulted in the contaminant being evaluated for health effects. These questions, and the criteria needed for an affirmative response, are listed below.

(1) Was the contaminant looked for and found in drinking water, or in a major drinking water source, or in ambient water at levels that would trigger concern about human health?

To judge if a contaminant was looked for and found in drinking water, it must have been included in a major survey (defined as one including a population of at least 100,000, 2 or more states, or 10 or more small PWSs) or in a data set such as EPA's URCIS.

To judge if a contaminant was looked for and found in a major drinking water source, or in ambient water, any source of occurrence data was used. Major sources were defined as sources supplying a population of at least 100,000, or 2 or more states. Levels that would trigger human health concern were defined as levels within an order of magnitude of concentrations likely to cause health effects, or at least 50 percent of samples with levels at 50 percent (or greater) of concentrations likely to cause health effects. If data indicated occurrence at levels that would trigger human health concern (as defined above) for a population of at least 100,000, in 2 or more states, or in 10 or more small PWSs, this criterion was judged as having been met.

(2) If the contaminant was not looked for, is it likely to be found in water, based on surrogates for occurrence?

To judge if a contaminant was likely to be found, the following surrogates were examined:

TRI releases. If a contaminant was released to surface water in excess of 400,000 pounds per year (400,000 is the cutoff for the top 15 TRI chemicals released in 1995), and the physical-chemical properties indicated persistence and mobility, then this criterion was judged as having been met.

Production Volumes. If a contaminant was produced in excess of 10 billion pounds per year, and the physical-chemical properties indicated persistence and mobility, then this criterion was judged as having been met.

OPP Ground Water (GW) Risk. If a contaminant had an OPP GW Risk value of 2.0 or greater, then this criterion was judged as having been met. However, in the late stages of the screening process, the Working Group decided to defer contaminants *only* having an OPP GW Risk value of 2.0 or greater (i.e., there was no other supporting data), pending further evaluation of the potential occurrence of these contaminants at levels of health concern.

2.1.2.2. Health Effects Criterion

Once a chemical met the occurrence criterion, the Working Group then evaluated it with respect to its potential health effects on humans. If the health effects criterion was also met, then the chemical was included on the draft CCL. This criterion essentially asked if there was evidence, or suspicion, that the contaminant adversely affects human health. To satisfy the health effects criterion, the chemical had to:

(1) be listed by California Proposition 65;

(2) have an EPA Health Advisory;

(3) be a likely (based on animal data) or known (based on human data) carcinogen by EPA or the International Agency for Research on Cancer (IARC);

(4) be included in more than one epidemiological study indicating adverse health effects;

(5) have an oral value (reference dose) in IRIS;

(6) be regulated in drinking water by another industrialized country;

(7) be a member of a chemical family of known toxicity; or

(8) have a structural activity relationship indicating toxicity.

If a chemical satisfied both the occurrence criterion and the health effects criterion, it was included on the draft CCL. There were 55 chemicals that satisfied this criterion, and 3 additional chemicals that EPA included on the draft CCL for other reasons.[5] EPA published the list of 58 chemical contaminants as part of the draft CCL in the October 6, 1997 *Federal Register* (62 FR 52193).

2.1.2.3. Chemical Contaminants on the Final 1998 CCL

Many public comments were received pertaining to the chemical contaminants included on the draft CCL. These comments were reviewed by EPA and the NDWAC Working Group, and a final CCL was first approved by the Working Group, and then the full NDWAC. Of the 58 chemicals listed on the draft CCL, EPA removed 8 chemicals from the list, combined 2 chemicals into a single chemical group, and added 1 chemical to create the final 1998 CCL, as published in the March 2, 1998 *Federal Register* (63 FR 10273). The complete rationale for these revisions is documented in the March 2, 1998 notice.

EPA moved to include triazines and their degradation products (i.e., cyanazine and atrazine-desethyl) as a group on the final 1998 CCL, rather than as individual contaminants. The Agency made this decision in light of comments received regarding other triazine degradation products not included on the draft CCL, as well as a stakeholder request that EPA address these chemicals as a group. In addition, many comments suggested the inclusion of perchlorate on the final CCL. Although it was not included on the draft CCL, the October 6, 1997 *Federal Register* notice specifically solicited comments on perchlorate, as information pertaining to its occurrence had just recently come to light at the time of publication. With strong public support for including it, EPA decided to include perchlorate on the final CCL despite the gaps in supporting data.

Of the 50 chemical contaminants included on the final CCL, the Agency determined that 26 contaminants have significant gaps in occurrence data. These contaminants were therefore listed as occurrence priorities (see Table 2.1). EPA found that 19 chemical contaminants had sufficient occurrence data to be listed as regulatory determination priorities. Data for these contaminants are available from the same data sources used for the occurrence criterion. Additional research is needed for five other chemical contaminants: 1,1-dichloropropene, 1,3-dichloropropane, methyl bromide, aluminum, and sodium. EPA did not list these contaminants as occurrence priorities, since sufficient occurrence data are available from URCIS (for 1,1-dichloropropene, 1,3-dichloropropane, and methyl bromide) and NIRS (for aluminum and sodium). Table 2.3 presents the chemical contaminants that were listed as occurrence priorities, as well as the chemical contaminants on the UCMR (1999) List.

Table 2.3 Chemical Contaminants Considered for the CCL and the UCMR List

Chemical Contaminant	CASRN	Included on Draft CCL	Included on Final CCL	Included on Occurrence Priorities List	Included on proposed UCMR List	Included on final UCMR List
1,2-diphenylhydrazine	122-66-7	✔	✔	✔	✔	✔
2,4-dichlorophenol	120-83-2	✔	✔	✔	✔	✔
2,4-dinitrophenol	51-28-5	✔	✔	✔	✔	✔
2,4-dinitrotoluene	121-14-2	✔	✔	✔	✔	✔
2,4,6-trichlorophenol	88-06-2	✔	✔	✔	✔	✔
2,6-dinitrotoluene	606-20-2	✔	✔	✔	✔	✔
2-methyl-phenol o-cresol)	95-48-7	✔	✔	✔	✔	✔
Acetochlor	34256-82-1	✔	✔	✔	✔	✔
Alachlor ESA		✔	✔	✔	✔	✔
DCPA di-acid degradate	2136-79-0	✔	✔	✔	✔	✔
DCPA mono-acid degradate	887-54-7	✔	✔	✔	✔	✔
DDE	72-55-9	✔	✔	✔	✔	✔
Diazinon	333-41-5	✔	✔	✔	✔	✔
Disulfoton	298-04-4	✔	✔	✔	✔	✔

Table 2.3 Chemical Contaminants Considered for the CCL and the UCMR List (Continued)

Chemical Contaminant	CASRN	Included on Draft CCL	Included on Final CCL	Included on Occurrence Priorities List	Included on proposed UCMR List	Included on final UCMR List
Diuron	330-54-1	✔	✔	✔	✔	✔
EPTC (s-ethyldipropylthiocarba-mate)	759-94-4	✔	✔	✔	✔	✔
Fonofos	944-22-9	✔	✔	✔	✔	✔
Linuron	330-55-2	✔	✔	✔	✔	✔
Methyl tertiary-butyl ether (MTBE)	1634-04-4	✔	✔	✔	✔	✔
Molinate	2212-67-1	✔	✔	✔	✔	✔
Nitrobenzene	98-95-3	✔	✔	✔	✔	✔
Prometon	1610-18-0	✔	✔	✔	✔	✔
Terbacil	5902-51-2	✔	✔	✔	✔	✔
Terbufos	13071-79-9	✔	✔	✔	✔	✔
RDX	121-82-4	✔	✔	✔		✔
Perchlorate	14797-73-0		✔	✔		✔
Lead-210	14255-04-0					✔
Polonium-210	13981-52-7					✔
1,1-dichloroethane	75-34-3	✔	✔			
1,1-dichloropropene	563-58-6	✔	✔			
1,1,2,2-tetrachloroethane	79-34-5	✔	✔			
1,2,4-trimethylbenzene	95-63-6	✔	✔			
1,3-dichloropropane	142-28-9	✔	✔			
1,3-dichloropropene (telone or 1,3-D)	542-75-6	✔	✔			
2,2-dichloropropane	594-20-7	✔	✔			
Aldrin	309-00-2	✔	✔			
Aluminum	7429-90-5	✔	✔			
Boron	7440-42-8	✔	✔			
Bromobenzene	108-86-1	✔	✔			
Dieldrin	60-57-1	✔	✔			
Hexachlorobutadiene	87-68-3	✔	✔			
p-Isopropyltoluene (p-Cymene)	99-87-6	✔	✔			
Manganese	7439-96-5	✔	✔			
Methyl bromide	74-83-9	✔	✔			
Metolachlor	51218-45-2	✔	✔			
Metribuzin	21087-64-9	✔	✔			
Naphthalene	91-20-3	✔	✔			
Organotins		✔	✔			
Sodium	7440-23-5	✔	✔			
Sulfate		✔	✔			

Table 2.3 Chemical Contaminants Considered for the CCL and the UCMR List (Continued)

Chemical Contaminant	CASRN	Included on Draft CCL	Included on Final CCL	Included on Occurrence Priorities List	Included on proposed UCMR List	Included on final UCMR List
Triazines		[a]	✔			
Vanadium	7440-62-2	✔	✔			
Atrazine-desethyl	6190-65-4	✔	[a]			
Cyanazine	21725-46-2	✔	[a]			
2,6-di-tert-butyl-p-benzoquinone (DTBB)	719-22-2	✔				
Acetone	67-64-1	✔				
Aldicarbs		✔				
Dimethoate	60-51-5	✔				
Isopropylbenzene (cumene)	98-82-8	✔				
Nickel		✔				
Rhodamine WT		✔				
Zinc	7440-66-6	✔				

[a] EPA combined atrazine-desethyl and cyanazine, which both appeared on the draft CCL, into a single contaminant group, the triazines, for the final CCL. This group includes all triazines and their degradation products, including, but not limited to, atrazine desethyl and cyanazine.

2.2. The UCMR List Selection Process

EPA used the 1998 CCL as the basis for the proposed UCMR (1999) List of contaminants. All of the contaminants selected for the proposed UCMR (1999) List were listed as occurrence priorities in Table 2 of the final CCL *Federal Register* notice of March 2, 1998 (63 FR 10273). Only two contaminants, RDX and perchlorate, were listed as occurrence priorities but were not included on the proposed UCMR (1999) List. It was initially thought that both RDX and perchlorate would exhibit localized patterns of occurrence, and thus monitoring for these contaminants under a national monitoring program such as the UCMR might not be necessary. However, subsequent data collected by the Interagency Perchlorate Steering Committee (IPSC) indicate perchlorate occurrence is likely to be more widespread. Furthermore, many public comments were received in support of the inclusion of both perchlorate and RDX on the final UCMR (1999) List. For these reasons, EPA moved to include both of these contaminants on the final UCMR (1999) List.

2.2.1. Lead-210 and Polonium-210

In the Preamble to the proposed UCMR (64 FR 23398), EPA requested public comment on the possible inclusion on the final UCMR (1999) List of two contaminants that were not identified through the CCL Process. These contaminants, lead-210 (^{210}Pb) and polonium-210 (^{210}Po), are naturally occurring radionuclides with health concerns at low levels. Both nuclides are in the uranium decay series along with radium-226 and radon-222. Lead-210 with a half life of 22 years, and one of its progeny, polonium-210, with a half life of 138 days, have been found in drinking water. The occurrence of these contaminants in shallow aquifers has been documented in Florida (Harada *et al.*, 1989; Upchurch 1991) and EPA is aware of their occurrence in at least two other States. Because of potential occurrence and consequent health risks, EPA solicited public comments on the inclusion of lead-210 and polonium-210 on the UCMR (1999) List. After receiving public support for their inclusion, EPA moved to include both lead-210 and polonium-210 on the final UCMR (1999) List.

2.2.2. Prioritization of Contaminants on the UCMR List

Once selected for the UCMR (1999) List, EPA then divided the contaminants into three separate monitoring lists, primarily on the basis of the availability of analytical methods. Section 3 of this document provides a more detailed discussion of methods availability. The rationale for these divisions is that while EPA intends to monitor for most of the contaminants on the UCMR (1999) List, suitable methods are not yet available for all of the contaminants. A suitable method is defined as an EPA-evaluated method with a proven track record of providing consistent, quality data on the occurrence of the analyte, and whose cost would not prohibit its use on a national scale. In accordance with §12(d) of the National Technology Transfer and Advancement Act, EPA has approved the use of appropriate voluntary consensus standards for monitoring contaminants on the UCMR List. Methods only published in peer-reviewed literature are not considered suitable because they have often not undergone extensive field-testing, they may not be suitable for routine sampling by PWSs or for routine laboratory implementation, and they may not produce consistent results.

Contaminants for which suitable methods are currently available are included on List 1 of the UCMR (1999) List.[6] There are a total of 12 chemical contaminants on List 1 which will be monitored under the Assessment Monitoring component of the UCMR Program. EPA initially proposed 10 chemical contaminants and 1 microbiological contaminant for List 1 of the UCMR (1999) List. At the time of publication of the final UCMR (September 1999), EPA approved analytical methods for these 10 chemical contaminants, but indicated that suitable analytical methods for two additional chemical contaminants, acetochlor and perchlorate, would be available shortly. On March 2, 2000, EPA published a direct and final Rule (65 FR 11371) approving the use of analytical methods for monitoring acetochlor and perchlorate under the Assessment Monitoring component of the UCMR. Monitoring for all 12 chemical contaminants is to begin in 2001. In the proposed UCMR (64 FR 23398), EPA also included one microbiological contaminant, *Aeromonas hydrophila*, on List 1. However, after additional review of the proposed analytical method for *Aeromonas*, and with extensive public concerns about the use of this method, EPA moved *Aeromonas hydrophila* to List 2 for the final UCMR. For the entire UCMR Program, and particularly for these contaminants, EPA has developed specific quality control procedures that must be followed when conducting analyses for the UCMR (§141.40(a)(5)). These procedures are outlined in the *UCMR Analytical Methods and Quality Control Manual* (EPA 815-R-99-004) and its Supplement (EPA 815-R-00-002).

List 2 contaminants are those for which EPA is currently refining analytical methods. Development of these methods should be completed in time for Screening Surveys to be conducted in 2001 and 2003. EPA initially included 14 chemical contaminants on List 2 of the proposed UCMR (1999) List. With the addition of polonium-210 and RDX to the UCMR (1999) List, as well as the movement of acetochlor from List 2 to List 1 and *Aeromonas hydrophila* from List 1 to List 2, there are currently 15 chemicals and 1 microorganism on List 2 of the UCMR (1999) List.

All remaining contaminants on the UCMR List are included on List 3. List 3 contaminants are those for which EPA has begun or shortly will begin analytical methods development, but completion of those efforts is not expected prior to the Assessment Monitoring or Screening Surveys required under the initial implementation of the UCMR. Instead, EPA may monitor some of these contaminants through the Pre-Screen Testing component of the UCMR Program, to be conducted in 2004. In the proposed UCMR, EPA included seven microbiological contaminants on List 3. After the addition of lead-210 to the UCMR (1999) List, List 3 of the final UCMR (1999) List includes seven microbiological contaminants and 1 chemical contaminant.

2.3. References

Harada, Koh, W.C. Burnett, P.A. LaRock, and J.B. Cowart. 1989. Polonium in Florida groundwater and its possible relationship to the sulfur cycle and bacteria. *Geochemica et Cosmochimica Acta*. **53:**143-150.

Upchurch, S.B. 1991. *Radiochemistry of Uranium-Series Isotopes in Groundwater*. Florida Institute of Phosphate Research (05-022-092)

Notes

[1]The selection process for the CCL is well documented, and for more information, the reader may refer to the *Federal Register* notices announcing the draft CCL (October 6, 1997; 62 FR 52193) and the final CCL (March 2, 1998; 63 FR 10273).

[2]These summaries may be obtained from the EPA Water Docket, (202) 260-3027, Docket Number W-97-11. General information on the UCMR and the CCL can also be obtained from the EPA Safe Drinking Water Hotline, (800) 426-4791, or through the EPA Office of Ground Water and Drinking Water Internet Home page at http://www.epa.gov/safewater.

[3]The NAS report, entitled *Hormonally Active Agents in the Environment*, is available from the National Academy Press, 2101 Constitution Avenue, NW, Lockbox 285, Washington, DC 20055, or http://www.nap.edu.

[4]All contaminants, with the exceptions of nickel, sulfate, and aldicarb and its degradates, were evaluated with respect to these criteria. EPA included these contaminants on the draft CCL because it had previously made commitments to complete regulatory action for them.

[5]As previously noted, EPA included nickel, sulfate, and aldicarb and its degradates, on the draft CCL because of the Agency's prior commitments to complete regulatory action for these contaminants.

[6]For more information, the reader may refer to Section 3 of this document or the *UCMR Analytical Methods and Quality Control Manual* and its supplement (EPA 815-R-99-004).

Section 3. Information on Methods Selected for the UCMR

The UCMR (1999) List, as published in the UCMR (64 FR 50555), includes 36 contaminants, not all of which are to be monitored at any one time. The UCMR List itself is divided into three lists (Lists 1, 2, and 3), primarily on the basis of the availability and demonstrated quality of analytical methods. The 12 contaminants included on List 1 are those that have analytical methods available that are sufficiently developed and suited for monitoring. EPA has reviewed these methods and has established that they will provide consistent, high quality data on the occurrence of the analyte, and that the cost of the method will not prohibit its use on a national scale. All List 1 contaminants will be monitored under the Assessment Monitoring component of the UCMR Program to be conducted from 2001 to 2003. EPA is currently conducting analytical methods development for the 16 contaminants included on List 2, to be included in the Screening Survey component of the UCMR Program. It is anticipated that suitable analytical methods will be available for many of these compounds in time for these contaminants to be included in one of the two Screening Surveys, to be conducted in 2001 and 2003. Although EPA is also conducting analytical methods development for the eight contaminants included on List 3, seven of these contaminants are microbiological in nature, and it is anticipated that methods for these contaminants will be particularly problematic. Some of the List 3 contaminants may be included in the Pre-Screen Testing component of the UCMR Program to be conducted in 2004. For more information on the Screening Survey and Pre-Screen Testing components of the revised UCMR Program, the reader may refer to the UCMR Preamble and Rule (64 FR 50555).

The purpose of the UCMR Program is to obtain occurrence data to support future regulatory decisions. The data required to make these decisions must be of high quality. All analytical methods are subject to some degree of false-negative test results (not detecting an analyte when it is present), false-positive test results (either incorrectly identifying or detecting an analyte, or introducing an analyte into a sample when it is not present), and errors in the accuracy and precision of quantitative results. Methods that yield significant false-negatives, false-positives, or other substantial errors would not provide the quality of data that is needed to support regulatory decisions, and thus are not approved for use.

In addition, the ability to correctly identify a chemical contaminant is directly related to the type of chemical and the analytical method used. For example, compounds such as disinfection byproducts are far less likely to be misidentified than pesticides or herbicides because they are typically present at relatively high concentrations in disinfected waters, while pesticides and herbicides are much less likely to be present, or are present at much lower concentrations. The analytical method used will also determine the accuracy of the qualitative identification. In general, the most reliable qualitative identifications come from methods that use mass spectral data for analyte identification. However, these methods are typically less sensitive than methods that rely on less selective detectors.

To ensure that the data collected under this regulation are of sufficient quality to meet the requirements of these regulatory decisions, EPA has specified that only the analytical methods listed in Table 2 be used in obtaining data for List 1 contaminants (§141.40(a)(5)).[1] In accordance with §12(d) of the National Technology Transfer and Advancement Act, EPA has approved the use of appropriate voluntary consensus standards for monitoring List 1 contaminants. For all contaminants on the UCMR List, methods published only in peer-reviewed literature are not considered suitable because they have often not undergone adequate validation and may not produce consistent results in routine application by numerous laboratories. To ensure adequate quality control, analyses for all approved methods (including EPA methods and voluntary consensus standards) must be conducted using the quality control procedures listed in the

methods as well as those specified in the regulation and described in the *UCMR Analytical Methods and Quality Control Manual* (EPA 815-R-99-004) and its supplement (EPA 815-R-00-002) (§141.40(a)(5)). When procedures listed in the method conflict with those listed in the regulation, the procedures listed in the regulation should be followed.

3.1. List 1 Contaminants

Contaminants for which suitable methods are currently available are included on List 1 of the UCMR (1999) List (Table 3.1). There are a total of 12 chemical contaminants included on List 1 that will be monitored under the Assessment Monitoring component of the UCMR Program. EPA approved specific analytical methods for the detection of these contaminants, and monitoring is to begin in 2001. The methods approved for each contaminant are reviewed below.

3.1.1. Volatile Organic Compounds

Methyl Tertiary-Butyl Ether (MTBE) – EPA Method 524.2 can be used to accurately determine both the qualitative presence and quantitative concentration of MTBE in drinking water. EPA Method 524.2 is a purge and trap, gas chromatography/mass spectrometry (GC/MS) method for the determination of a broad range of organics. Analyte preservation studies conducted using the storage conditions detailed in this method demonstrate that aqueous samples can be held for up to 14 days with minimal analyte degradation. Therefore, EPA has included MTBE on List 1 for Assessment Monitoring. In addition, three voluntary consensus standards, ASTM D5790.95, SM6210D, and SM6200B have been approved for use in measuring MTBE in drinking water (Complete references for these methods are listed in Table 3.1). However, if SM6200B is to be used for monitoring MTBE under the UCMR, sample preservation should be conducted as specified in EPA Method 524.2.

Nitrobenzene – EPA Method 524.2 can be used to accurately determine both the qualitative presence and quantitative concentration of nitrobenzene in drinking water. EPA Method 524.2 is a purge and trap, GC/MS method for the determination of a broad range of organics. Analyte preservation studies conducted using the storage conditions detailed in this method demonstrate that aqueous samples can be held for up to 14 days with minimal analyte degradation. Therefore, EPA has included nitrobenzene on List 1 for Assessment Monitoring. In addition, three voluntary consensus standards, ASTM D5790.95, SM6210D, and SM6200B have been approved for use in measuring nitrobenzene in drinking water. However, if SM6200B is to be used for monitoring nitrobenzene under the UCMR, sample preservation should be conducted as specified in EPA Method 524.2.

3.1.2. Semivolatile Organic Compounds

2,4-dinitrotoluene – EPA Method 525.2 can be used to accurately determine both the qualitative presence and quantitative concentration of 2,4-dinitrotoluene in drinking water. EPA Method 525.2 is a 1 liter solid phase extraction/GC/MS (SPE/GC/MS) method for the determination of a broad range of organics. Analyte preservation studies conducted using the storage conditions detailed in the method demonstrate that aqueous samples can be held for up to 14 days, and extracts for up to 30 days with minimal analyte degradation. Therefore, EPA has included 2,4-dinitrotoluene on List 1 for Assessment Monitoring. No equivalent voluntary consensus standards for measuring 2,4-dinitrotoluene in drinking water have been approved for monitoring under the UCMR.

2,6-dinitrotoluene – EPA Method 525.2 can be used to accurately determine both the qualitative presence and quantitative concentration of 2,6-dinitrotoluene in drinking water. EPA Method 525.2 is a 1 liter SPE/GC/MS method for the determination of a broad range of organics. Analyte preservation studies conducted using the storage conditions detailed in the method demonstrate that aqueous samples can be held for up to

Table 3.1 Approved Analytical Methods for UCMR (1999) List 1 Contaminants

Chemical Contaminant	CASRN	Methodology	
		EPA Method	Equivalent Methods
Volatile Organic Compounds			
MTBE	1634-04-4	EPA 524.2 [a]	D5790-95 [b]; SM6210D [c]; SM6200B [c]
Nitrobenzene	98-95-3	EPA 524.2 [a, e]	D5790-95 [b]; SM6210D [c]; SM6200B [c]
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	121-14-2	EPA 525.2 [a]	none identified
2,6-Dinitrotoluene	606-20-2	EPA 525.2 [a]	none identified
Chlorinated Hydrocarbon Pesticides			
DDE	72-55-9	EPA 525.2 [a]; EPA 508 [a]; EPA 508.1 [a]	D5812-96 [b]; 990.06 [d]
Nitrogen- and Phosphorus-Containing Pesticides			
Acetochlor	34256-82-1	EPA 525.2 [a]	none identified
EPTC	759-94-4	EPA 525.2 [a]; EPA 507 [a]	D5475-93 [b]; 991.07 [d]
Molinate	2212-67-1	EPA 525.2 [a]; EPA 507 a	D5475-93 [b]; 991.07 [d]
Terbacil	5902-51-2	EPA 525.2 a; EPA 507 a	D5475-93 [b]; 991.07 [d]
Acid Herbicides			
DCPA mono-acid degradate	887-54-7	EPA 515.1 a, e ; EPA 515.2 a, e	D5317-93 [b]; 992.32 [d]
DCPA di-acid degradate	2136-79-0	EPA 515.1 a, e ; EPA 515.2 [a, e]	D5317-93 [b]; 992.32 [d]
Inorgnanic Compounds			
Perchlorate	14797-73-0	EPA 314.0 [f]	None identified

[a] The version of the EPA methods approved for the UCMR are listed at 40 CFR 141.24 (e).
[b] Annual Book of ASTM Standards, 1996 and 1998, Vol. 11.02, American Society for Testing and Materials. Method D5812-96 is located in the Annual Book of ASTM Standards, 1998, Vol. 11.02. Methods D5790-95, D5475-93, and D5317-93 are located in the Annual Book of ASTM Standards, 1996 and 1998, Vol 11.02. Copies may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.
[c] SM 6200 B is only found in the 20th edition of Standard Methods for the Examination of Water and Wastewater, 1998. Sample preservation must be conducted as specified in EPA Method 524.2. SM 6210 D is only found in the 18th and 19th editions of Standard Methods for the Examination of Water and Wastewater, 1992 and 1995, American Public Health Association; either edition may be used. Copies may be obtained from the American Public Health Association, 1015 Fifteenth Street NW, Washington, DC 20005.
[d] Official Methods of Analysis of AOAC (Association of Official Analytical Chemist) International, Sixteenth Edition, 4th Revision, 1998, Volume I, AOAC International, First Union National Bank Lockbox, PO Box 75198, Baltimore, MD 21275-5198. (800) 379-2622.
[e] EPA has included specific recommendations regarding the use of EPA Method 524.2 for measuring nitrobenzene and EPA Methods 515.1 and 515.2 for measuring the DCPA degradates in the UCMR Analytical Methods and Quality Control Manual.
[f] Copies of EPA Method 314.0, Determination of Perchlorate in Drinking Water Using Ion Chromatography (EPA 815-B-99-003) may be obtained by contacting the EPA Safe Drinking Water Hotline at (800) 426-4791, or accessing the method directly at http://www.epa.gov/safewater/methods/sourcalt.html.

14 days, and extracts for up to 30 days with minimal analyte degradation. Therefore, EPA has included 2,6-dinitrotoluene on List 1 for Assessment Monitoring. No equivalent voluntary consensus standards for measuring 2,6-dinitrotoluene in drinking water have been approved for monitoring under the UCMR.

3.1.3. Chlorinated Hydrocarbon Pesticides

1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene (DDE) – EPA Method 525.2, EPA Method 508, and EPA Method 508.1 can be used to accurately determine the quantitative concentration of DDE in drinking water. EPA Method 525.2 is a 1 liter SPE/GC/MS method for the determination of a broad range of organics. EPA Method 508 is a 1 liter liquid-liquid extraction/GC/electron capture detector (LLE/GC/ECD) method. EPA Method 508.1 is a 1 liter SPE/GC/ECD method. Analyte preservation studies conducted using the storage conditions detailed in the methods demonstrate that aqueous samples can be held for up to 7-14 days, and extracts for up to 30 days, with minimal analyte degradation, depending on the method used. Therefore, EPA has included 4,4'-DDE on List 1 for Assessment Monitoring. However, the biocide used in EPA Method 508, mercuric chloride, has been withdrawn because of concerns over the disposal of samples. Without the use of a biocide, microbial degradation of the analyte may occur. Two voluntary consensus standards, ASTM D5812.96 and AOAC 990.06, have been approved for use in measuring DDE in drinking water.

3.1.4. Nitrogen- and Phosphorus-Containing Pesticides

Acetochlor – EPA Method 525.2 can be used to accurately determine both the qualitative presence and quantitative concentration of acetochlor in drinking water. EPA Method 525.2 is a 1 liter SPE/GC/MS method for the determination of a broad range of organics. Analyte preservation studies conducted using the storage conditions detailed in the method demonstrate that aqueous samples can be held for up to 14 days, and extracts for up to 30 days with minimal analyte degradation. Therefore, EPA has included acetochlor on List 1 for Assessment Monitoring. No equivalent voluntary consensus standards for measuring acetochlor in drinking water have been approved for monitoring under the UCMR.

S-Ethyl-Dipropylthio-carbamate (EPTC) – EPA Method 525.2 and EPA Method 507 can be used to accurately determine the quantitative concentration of EPTC in drinking water. EPA Method 525.2 is a SPE/GC/MS method for the determination of a broad range of organics. EPA Method 507 is a 1 liter LLE/GC/nitrogen-phosphorus detector (LLE/GC/NPD) method. Analyte preservation studies conducted using the storage conditions detailed in these methods demonstrate that aqueous samples can be held for up to 14 days, and extracts for up to 14-30 days, with minimal analyte degradation, depending upon the method used. Therefore, EPA has included EPTC on List 1 for Assessment Monitoring. However, the biocide used in EPA Method 507, mercuric chloride, has been withdrawn because of concerns over the disposal of samples. Without the use of a biocide, microbiological degradation of the analyte may occur. Two voluntary consensus standards, ASTM D5475-93 and AOAC 991.07, have been approved for use in measuring EPTC in drinking water.

Molinate – EPA Method 525.2 and EPA Method 507 can be used to accurately determine the quantitative concentration of molinate in drinking water. EPA Method 525.2 is a SPE/GC/MS method for the determination of a broad range of organics. EPA Method 507 is a 1 liter LLE/GC/NPD method. Analyte preservation studies conducted using the storage conditions detailed in these methods demonstrate that aqueous samples can be held for up to 14 days, and extracts for up to 14-30 days with minimal analyte degradation, depending upon the method used. Therefore, EPA has included molinate on List 1 for Assessment Monitoring. However, the biocide used in EPA Method 507, mercuric chloride, has been withdrawn because of concerns over the disposal of samples. Without the use of a biocide, microbiological degradation of the analyte may occur. Two voluntary consensus standards, ASTM D5475-93 and AOAC 991.07, have been approved for use in measuring molinate in drinking water.

Terbacil – EPA Method 525.2 and EPA Method 507 can be used to accurately determine the quantitative concentration of terbacil in drinking water. EPA Method 525.2 is a SPE/GC/MS method for the determination of a broad range of organics. EPA Method 507 is a 1 liter LLE/GC/NPD method. Analyte preservation studies conducted using the storage conditions detailed in these methods demonstrate that aqueous

samples can be held for up to 14 days, and extracts for up to 14-30 days with minimal analyte degradation, depending upon the method used. Therefore, EPA has included terbacil on List 1 for Assessment Monitoring. However, the biocide used in EPA Method 507, mercuric chloride, has been withdrawn because of concerns over the disposal of samples. Without the use of a biocide, microbiological degradation of the analyte may occur. Two voluntary consensus standards, ASTM D5475-93 and AOAC 991.07, have been approved for use in measuring terbacil in drinking water.

3.1.5. Acid Herbicides

Dimethyl Tetrachloroterephthalate (DCPA) mono- and di-acid degradates – No analytical methods that were capable of determining these analytes separately and that could be implemented at reasonable costs were identified. Three EPA methods were identified that are capable of determining either the total of the mono- and di-acid forms or the total of the parent DCPA plus both the mono- and di-acid forms. Both EPA Method 515.1 and EPA Method 515.2 contain a methylene chloride wash following hydrolysis. The DCPA parent compound is removed during this sample wash step. EPA Method 515.3 does not contain this solvent wash following hydrolysis, therefore, all three forms of DCPA are measured as a total value with this method. Because of this, EPA Method 515.3 cannot be used for monitoring these contaminants for the UCMR. EPA has included DCPA mono- and di-acid degradates on List 1 for Assessment Monitoring, and is requiring that systems use either EPA Method 515.1 or 515.2, or an approved voluntary consensus standard for these compounds. Documented analyte preservation studies were performed for these methods, although biological stabilization studies were only performed for EPA Method 515.1. However, the biocide used in EPA Method 515.1, mercuric chloride, has been withdrawn because of concerns over the disposal of samples. In addition, two voluntary consensus standards, ASTM D5317.93 and AOAC 992.32, have been approved for use in measuring the DCPA mono- and di-acid degradates in drinking water. Because the approved methods do not allow for the identification and quantification of the individual acids, the single analytical result obtained from these methods should be reported under the UCMR as total DCPA mono- and di-acid degradates.

3.1.6. Inorganic Compounds

Perchlorate – EPA Method 314.0 can be used to accurately determine the quantitative concentration of perchlorate in drinking water. EPA Method 314.0 is an ion chromatography method that utilizes an ion chromatographic pump, sample injection valve, guard column, analytical column, suppressor device, and conductivity detector. Because of interference from common anions such as chloride and sulfate, EPA Method 314.0 recommends the use of Dionex AG16/AS16 columns. Other guard and separator column sets, such as AG5/AS5 and AG11/AS11, can be used, although performance of these columns decreased at higher common anion levels in EPA's validation study of the method. EPA Method 314.0 also requires the determination of the conductivity of the matrix prior to analysis, so that appropriate steps (i.e., pretreatment or dilution) can be taken to minimize the impact of elevated concentrations of common anions. No voluntary consensus standards have been approved for use in measuring perchlorate in drinking water. However, EPA notes that laboratories currently using either of the methods for perchlorate published by the California Department of Health or Dionex Corporation can convert to using EPA Method 314.0 simply by adopting the quality control specified in EPA Method 314.0 without needing to change any other aspects for their analyses.

3.2. List 2 Contaminants

List 2 contaminants are those for which EPA is currently refining analytical methods. These contaminants, as well as the anticipated analytical methods, are listed in Table 3.2. It is expected that analytical methods development for many of these contaminants will be completed in time for their inclusion in the Screening Surveys most likely to be conducted between 2001 and 2003. At this time, there are

15 chemical contaminants and 1 microbiological contaminant on List 2. All of the methods being refined and/or developed for each contaminant are reviewed below.

Table 3.2 Anticipated Analytical Methods for UCMR (1999) List 2 Contaminants

Contaminant	CASRN	Anticipated Analytical Methods
Chemical Contaminants		
1,2-diphenylhydrazine	122-66-7	EPA 525.2 [a]
2-methyl-phenol	95-48-7	SPE/GC/MS [b]
2,4-dichlorophenol	120-83-2	SPE/GC/MS [b]
2,4-dinitrophenol	51-28-5	SPE/GC/MS [b]
2,4,6-trichlorophenol	88-06-2	SPE/GC/MS [b]
Alachlor ESA	NA[c]	Reserved (To be determined)
Diazinon	333-41-5	EPA 525.2 [d]
Disulfoton	298-04-4	EPA 525.2 [d]
Diuron	330-54-1	SPE/HPLC/UV [e]
Fonofos	944-22-9	EPA 525.2 [a]
Linuron	330-55-2	SPE/HPLC/UV [e]
Polonium-210	13981-52-7	Reserved (To be determined)
Prometon	1610-18-0	EPA 525.2 [d]
RDX	121-82-4	Reserved (To be determined)
Terbufos	13071-79-9	EPA 525.2 [d]
Microbiological Contaminants		
Aeromonas hydrophila	NA[c]	Reserved (To be determined)

[a] Contaminant currently not listed as analyte in this method. Methods under current development in an attempt to add this contaminant to the scope of this method. See Table 3.1 for full method reference.
[b] Methods development currently in progress to develop a solid phase extraction/gas chromatography/mass spectrometry (SPE/GC/MS) method for the determination of this compound.
[c] CASRN is Not Applicable.
[d] Contaminant listed to be analyzed with this method; however, adequate sample preservation for this contaminant is not provided by the procedures for this method. Preservation studies are currently being developed for suitable sample preservation for this contaminant.
[e] Methods development currently in progress to develop a solid phase extraction/high performance liquid chromatography/ultraviolet (SPE/HPLC/UV) method for the determination of this compound.

3.2.1. List 2 Chemical Contaminants

1,2-diphenylhydrazine – No well-developed methods that could be implemented at reasonable costs were identified for 1,2-diphenylhydrazine. The methods evaluated required large volume solvent extraction, acid, base/neutral fractionation, and were developed for packed column chromatography. In addition, no documentation of either aqueous or extract analyte stability was available. EPA has identified 1,2-diphenylhydrazine as a priority for methods development. It is anticipated that 1,2-diphenylhydrazine will be monitored with EPA Method 525.2 following the development of a modified analyte preservation technique.

2-methyl-phenol – No well-developed methods that could be implemented at reasonable costs were identified for 2-methyl-phenol. The methods evaluated required the use of large volume solvent extraction, acid, base/neutral fractionation, and were developed for packed column chromatography. In addition, no

documentation of either aqueous or extract analyte stability was available. EPA has identified 2-methyl-phenol as a priority for analytical methods development. It is anticipated that 2-methyl-phenol will be included in a new SPE/GC/MS method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

2,4-dichlorophenol – The only analytical method identified for 2,4-dichlorophenol that was well-developed and of reasonable cost was EPA Method 552. However, under the derivatization conditions specified in this method, only 10 percent to 20 percent of the analyte is derivatized. Identification and quantification is then made on the remaining underivatized analyte. EPA has determined that due to the quantitative uncertainty that would result, this method would not produce data of sufficient quality to meet the objectives of the UCMR. EPA has identified 2,4-dichlorophenol as a priority for analytical methods development. It is anticipated that 2,4-dichlorophenol will be included in a new SPE/GC/MS method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

2,4-dinitrophenol – No well-developed methods that could be implemented at reasonable costs were identified for 2,4-dinitrophenol. The methods evaluated required the use of large volume solvent extraction, acid, base/neutral fractionation, and were developed for packed column chromatography. In addition, no documentation of either aqueous or extract analyte stability was available. EPA has identified 2,4-dinitrophenol as a priority for analytical methods development. It is anticipated that 2,4-dinitrophenol will be included in a new SPE/GC/MS method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

2,4,6-trichlorophenol – EPA Method 552 is the only analytical method identified for 2,4,6-trichlorophenol which is well-developed and of reasonable cost. However, 2,4,6-trichlorophenol is subject to interferences caused by the derivatization product of 2,4-dichlorophenol produced by this method. Due to the need to minimize false positives, EPA determined that this method would not produce data of sufficient quality to meet the objectives of the UCMR. EPA has identified 2,4,6-trichlorophenol as a priority for analytical methods development. It is anticipated that 2,4,6-trichlorophenol will be included in a new SPE/GC/MS method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

Alachlor Ethane Sulfonic Acid (Alachlor ESA) and other degradation products of acetanilide pesticides – EPA is actively evaluating what specific analytes are to be included with this group of compounds. Following the completion of this evaluation, EPA will determine whether analytical methods for the determination of specific compounds are available, if methods development is necessary, or if determination by chemical class would provide the best data.

Diazinon – While diazinon is listed as an analyte in EPA Methods 507, EPA Method 525.2, and several voluntary consensus standards, because of its extremely rapid aqueous degradation, accurate and precise measurement of stored samples is not achieved. Preservation studies conducted during the development of EPA Method 525.2 determined that no diazinon could be detected after 7 days of refrigerated storage of samples spiked with 5.0 µg/L diazinon. EPA has identified diazinon as a priority for analytical methods development. Specifically, EPA is currently conducting research to develop preservation techniques that would permit the use of EPA Method 525.2 for monitoring diazinon. Once these techniques are fully developed, it is anticipated that diazinon will be monitored with EPA Method 525.2.

Disulfoton – While disulfoton is listed as an analyte in EPA Methods 507, EPA Method 525.2, and several voluntary consensus standards, because of its extremely rapid aqueous degradation, accurate and precise measurement of stored samples is not achieved. Preservation studies conducted during the development of EPA Method 525.2 determined that only 1.2 µg/L of disulfoton could be detected after 7 days of

refrigerated storage of samples spiked with 5.0 µg/L, and only 0.7 µg/L after 10 days of refrigerated storage. Preservation studies conducted during the National Pesticide Survey (NPS) determined that less than one percent of the disulfoton spiked into field samples remained after 14 days of refrigerated storage. EPA has identified disulfoton as a priority for analytical methods development. Specifically, EPA is currently conducting research to develop preservation techniques that would permit the use of EPA Method 525.2 for monitoring disulfoton. Once these techniques are fully developed, it is anticipated that disulfoton will be monitored with EPA Method 525.2.

Diuron – Both EPA Method 553 and NPS Method 4 can be used to accurately determine the quantitative concentration of Diuron in drinking water, however, neither method is suitable for the routine analyses required under this regulation. EPA Method 553 is a 1 liter LLE or SPE/high performance liquid chromatography/particle beam/mass spectrometry method (LLE or SPE/HPLC/PB/MS). As particle beam devices are no longer produced, the excessive costs associated with PB/MS methods prohibit their use on a national scale. NPS Method 4 is a 1 liter LLE/HPLC/UV method. However, NPS Method 4 is somewhat cumbersome, and the sensitivity achieved with the method would not be optimal for its use under this regulation. EPA has identified Diuron as a priority for analytical methods development. Determination by HPLC/UV of extracts generated using SPE techniques should be feasible, and it is anticipated that Diuron will be included in a new SPE/HPLC/UV method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

Fonofos – No well-developed methods that could be implemented at reasonable costs were identified for fonofos. Fonofos was evaluated for possible inclusion in EPA Method 507, however, because of its severe aqueous instability, it was not included in the final method. Other EPA and voluntary consensus organization methods list fonofos as an analyte, but experience the same problems with aqueous instability. Preservation studies conducted during the development of EPA Method 507 determined that no fonofos could be detected after 7 days of refrigerated storage of samples spiked with 6.5 µg/L. EPA has identified fonofos as a priority for analytical methods development. Specifically, EPA is currently conducting research to develop preservation techniques that would permit the use of EPA Method 525.2 for monitoring fonofos. Once these techniques are fully developed, it is anticipated that fonofos will be monitored with EPA Method 525.2.

Linuron – Both EPA Method 553 and NPS Method 4 can be used to accurately determine the quantitative concentration of linuron in drinking water, however, neither method is suitable for the routine analyses required under this regulation. EPA Method 553 is a 1 liter LLE or SPE HPLC/PB/MS method. As particle beam devices are no longer produced, the excessive costs associated with PB/MS methods prohibit their use on a national scale. NPS Method 4 is a 1 liter LLE/HPLC/UV method. However, NPS Method 4 is somewhat cumbersome, and the sensitivity achieved with the method would not be optimal for its use under this regulation. EPA has identified Linuron as a priority for analytical methods development. Determination by HPLC/UV of extracts generated using SPE techniques should be feasible, and it is anticipated that Linuron will be included in a new SPE/HPLC/UV method currently under development. Once this method is fully developed, EPA will determine if the quality of data generated by this new method meets the needs of the regulation.

Polonium-210 – Information on the availability of analytical methods for monitoring polonium-210 under the UCMR is limited at the present time. As noted in previous sections of this document, EPA did not initially propose to include polonium-210 on the UCMR (1999) List. EPA is currently evaluating methods for detecting polonium-210 in water samples, but an appropriate method may be very time consuming and will likely require an experienced analyst. There are also significant laboratory capacity and capability concerns. Few, if any, laboratories currently performing compliance drinking water radiochemistry have any experience with polonium-210. EPA will provide additional information on appropriate analytical methods when this information becomes available.

Prometon – EPA Method 507, EPA Method 525.2, and several voluntary consensus standards could be used to accurately determine the quantitative concentration of prometon in drinking water. EPA Method 507 is a 1 liter LLE/GC/NPD method. However, analyte preservation studies conducted during the development of EPA Method 507 demonstrate aqueous instability of spiked reagent water samples. Only 60 percent recovery of prometon was observed in stored spiked reagent water samples on the day they were spiked, 21 percent after 14 days of refrigerated storage, and 11 percent after 28 days of refrigerated storage. In contrast, preservation studies conducted on spiked field samples during the NPS demonstrated excellent stability, with 95 percent recovery after 14 days of refrigerated storage. These data seem to indicate that prometon undergoes significant base-catalyzed hydrolysis, as the spiked field samples collected during the NPS were naturally buffered, whereas the spiked reagent water samples analyzed during the development of EPA Method 507 were not buffered. In addition, acidified stored samples analyzed during preservation studies conducted during the development of EPA Method 525.2 demonstrated analyte stability within the precision of the determination. Unfortunately, analyte recovery was less than 50 percent. EPA Method 525.2 is a SPE/GC/MS method for the determination of a broad range of organics which requires that samples be acidified upon collection. This required acidification resulted in the protonation of prometon's nitrogen atoms, which in turn resulted in poor recovery. Because prometon is unstable in neutral to basic samples, but is not well extracted from acidified samples, a separate, acidified sample, which will be neutralized in the laboratory immediately prior to extraction, should be collected for the analysis of prometon. Neither method has been verified for the determination of prometon using sample neutralization in the laboratory. EPA has identified prometon as a priority for analytical methods development. Specifically, EPA is currently conducting research into neutralizing the pH just prior to extraction, which would permit the use of EPA Method 525.2 for monitoring prometon. Once these techniques are fully developed, it is anticipated that prometon will be monitored with EPA Method 525.2.

RDX – Information on the availability of analytical methods for monitoring RDX under the UCMR is limited at the present time. As noted in previous sections of this document, EPA did not initially propose to include RDX on the UCMR (1999) List. During the peer review conducted for the UCMR, a reviewer identified EPA Method 8330 contained in SW-846 as a method that has been used to measure RDX. However, the reviewer also noted that this method can be difficult, and EPA feels it may be inappropriate for drinking water analyses under the UCMR. EPA will provide additional information on appropriate analytical methods when this information becomes available.

Terbufos – While terbufos is listed as an analyte in EPA Methods 507, EPA Method 525.2, and several voluntary consensus standards, because of its extremely rapid aqueous degradation, accurate and precise measurement of stored samples is not achieved. Preservation studies conducted during the development of EPA Method 525.2 determined that only 2.3 µg/L of terbufos could be detected after 10 days of refrigerated storage of samples spiked with 5.0 µg/L. Preservation studies conducted during the NPS determined that less than one percent of the terbufos spiked into field samples remained after 14 days of refrigerated storage. EPA has identified terbufos as a priority for analytical methods development. Specifically, EPA is currently conducting research to develop preservation techniques that would permit the use of EPA Method 525.2 for monitoring terbufos. Once these techniques are fully developed, it is anticipated that fonofos will be monitored with EPA Method 525.2.

3.2.2. List 2 Microbiological Contaminants

***Aeromonas hydrophila* (sensu lata)** – This group or complex of aeromonads are distinguishable genotypically by DNA-DNA hybridization, but difficult or impossible to distinguish phenotypically by using physiological reactions commonly applied for the identification of bacteria. However, a published membrane filtration method (Havelaar *et al.*, 1987) has been evaluated for use, and with minor modifications, should be suitable for use in the Screening Surveys. Few published studies have compared isolation and enumeration methods, and the sensitivity and detection limits of this method have not been fully deter-

mined. The reliability of the method is dependent upon the experience of the investigator, sample turbidity, and the number and kind of competing bacteria present in the sample, as no proficiency testing program is available at this time.

3.3. List 3 Contaminants

All contaminants not included on Lists 1 or 2 of the UCMR List are included on List 3. List 3 contaminants are those for which EPA has begun or shortly will begin analytical methods development, but completion of those efforts is not expected prior to the Assessment Monitoring or Screening Surveys required under the initial implementation of the UCMR. Instead, these contaminants may be monitored during the Pre-Screen Testing component of the UCMR Program, most likely to be conducted in 2004. At this time, there are seven microbiological contaminants and one chemical contaminant on List 3 of the UCMR (1999) List.

3.3.1. List 3 Chemical Contaminants

Table 3.3 Possible Analytical Methods for UCMR (1999) List 3 Contaminants

Contaminant	CASRN	Possible Analytical Methods
Chemical Contaminants		
Lead-210	14255-04-0	Reserved (To be determined)
Microbiological Contaminants		
Adenoviruses	Not applicable	Reserved (To be determined)
Cyanobacteria (Blue-Green Algae), other Freshwater Algae, and their Toxins	Not applicable	Reserved (To be determined)
Caliciviruses	Not applicable	Reserved (To be determined)
Coxsackieviruses	Not applicable	Reserved (To be determined)
Echoviruses	Not applicable	Reserved (To be determined)
Helicobacter pylori	Not applicable	Reserved (To be determined)
Microsporidia	Not applicable	Reserved (To be determined)

Lead-210 – Information on the availability of analytical methods for monitoring lead-210 under the UCMR is limited at the present time. As noted in previous sections of this document, EPA did not initially propose to include lead-210 on the UCMR (1999) List. EPA is currently evaluating methods for detecting lead-210 in water samples, but an appropriate method may be very time consuming and will likely require an experienced analyst. There are also significant laboratory capacity and capability concerns. Few, if any, laboratories currently performing compliance drinking water radiochemistry have any experience with lead-210. EPA will provide additional information on appropriate analytical methods when this information becomes available.

3.3.2. List 3 Microbiological Contaminants

The status of analytical methods availability for the seven microbiological contaminants included on List 3 is highly dependent on the specific organisms that are to be targeted for monitoring. For example, some of the coxsackieviruses and echoviruses grow in tissue culture assays and are detected with the ICR method (USEPA 1996), although other members of these groups may not be detected. Before

monitoring can begin, the specific organisms must be identified, as partial assays of these organisms might not be useful and might overlook important pathogenic serotypes.

A fundamental issue with method development for all microorganisms is viability. Viable organisms, and particularly those that are infective, are usually the only organisms of concern. While culture methods only count viable organisms, not all of the List 3 microorganisms can presently be cultured, and in the case of the viruses, available culture methods can be very expensive. In addition, different cell culture lines would be required to assay for different viruses, which would multiply costs. In some cases, such as some of the group A coxsackieviruses or the caliciviruses, it may not be possible to develop a culture method. Although potentially less expensive and faster, polymerase chain reaction (PCR) techniques may assay nonviable or even lysed organisms, and are subject to interferences from foreign DNA or inhibiting substances.

All List 3 microbiological contaminants have been identified as needing analytical methods development before occurrence data can be collected. Although clinical detection methods might exist for these organisms, these methods often are incapable of detecting organisms in environmental water samples. Thus, standard EPA methods do not currently exist for these contaminants, and in many cases the development of an assay method will be difficult. Although EPA anticipates having sufficient analytical methods available for these organisms in time for the Pre-Screen Testing component of the UCMR Program in 2003, it should be realized that even after three years of research, method development for some of these microorganisms may not have proceeded to a point where work can begin on determining contaminant occurrence as a prelude to making a regulatory decision. A partial review of potential analytical methods for each contaminant is included below. For a more detailed review of potential analytical methods for the UCMR (1999) List 3 microbiological contaminants, please refer to the draft report entitled *Methods and Occurrence Information for the UCMR List 3 Microbiological Contaminants*, available from Rachel Sakata of US EPA's Office of Ground Water and Drinking Water.

Adenoviruses – Serotypes 1-39 can be grown in tissue cultures, but the enteric adenoviruses, serotypes 40 and 41, have been difficult to grow. Information on and analytical methods for serotypes 42-49 is very limited due the fact that they have only recently been isolated. While several selective tissue culture methods and detection methods have been reported, a selective, standardized method is needed for monitoring. Several cell lines will support the growth of the enteric adenoviruses, although these cell lines have not been evaluated to determine how well they work in assays of water samples. Tissue culture assays would be very expensive and would limit the size of any monitoring that was done for these viruses. Cell lines used for the adenoviruses could be different from those used for other viruses. As discussed above, PCR-based methods are not preferred because of interferences and their inability to demonstrate infectivity.

Cyanobacteria (Blue-Green Algae), other Freshwater Algae, and their Toxins – While EPA methods are available for counting cyanobacteria, new, standardized methods are needed for direct counts of targeted species with filtration methods or a counting chamber. Targeting individual species is essential, as microscopic examination may not be able to distinguish algae that do and do not produce toxins. Although methods have been described for both the alkaloid neurotoxins and the cyclic polypeptide hepatotoxins, no standard methods exist for detecting algal toxins. Once developed, these methods may require costly equipment. A layered approach might be considered for the analyses of algal toxins. This approach could start with screening methods and progress to instrumental analyses and toxicity assays.

Caliciviruses – Two genogroups of human caliciviruses, genogroup I (Norwalk and Norwalk-like viruses) and genogroup II (Snow Mountain and Snow Mountain-like viruses), are of concern because of waterborne outbreaks of gastrointestinal illness. Tissue culture assays have not been developed for these viruses, although some work is in progress. If a tissue culture assay is developed for these viruses, it would have a high cost and would thus limit the size of the sample for the Pre-Screen Testing monitoring compo-

nent. Such a method would most likely involve the use of a separate cell line not used for the other List 3 viruses. Because it would count only viable organisms, a tissue culture assay would be preferred. If it is not possible to develop a tissue culture assay for these viruses, an alternative analytical method will have to be used. However, no sensitive or fully developed detection methods currently exist. As discussed above, PCR-based methods are not preferred because of interferences and their inability to demonstrate infectivity.

Coxsackieviruses – Group B coxsackieviruses are easy to grow in tissue culture, but Group A coxsackieviruses are variable. Culturable coxsackieviruses can be detected with the ICR method, but serotyping is needed to distinguish coxsackie from other viruses. Individual serotypes can be identified by typing with appropriate sera. Decisions will need to be made on exactly which individual or combinations of serotypes will be monitored. As with many of the potential methods for List 3 contaminants, culture and typing methods for detecting coxsackieviruses could be very expensive, and would thus limit the size of the sample for the Pre-Screen Testing monitoring component. Other detection methods using techniques such as immunoassays or PCR do not exist, and as discussed above, PCR-based methods are not preferred because of interferences and their inability to demonstrate infectivity.

Echoviruses – With care to control overgrowths, echoviruses can be cultured on buffalo green monkey (BGM) cells and detected by the ICR method, but methods are needed which include serological typing. As with many of the potential methods for List 3 contaminants, culture and typing methods for detecting echoviruses could be very expensive, and would thus limit the size of the sample for the Pre-Screen Testing monitoring component. As discussed above, PCR-based methods, which are not currently available for echoviruses, are not preferred because of interferences and their inability to demonstrate infectivity.

Helicobacter pylori – A selective growth medium which suppresses background bacteria but allows *H. pylori* to grow does not currently exist. Furthermore, this bacterium is difficult to grow because of slow growth and the need for a low oxygen environment. A PCR-based method is available, but as discussed above, PCR-based methods are not preferred because of interferences and their inability to demonstrate infectivity. A culture method that demonstrates viability is preferred. Immunomagnetic separation (IMS) has been used to concentrate *Helicobacter pylori*.

Microsporidia – The two groups of human microsporidia of interest for the UCMR, *Enterocytozoon bienuesi* and *Encephalitozoon (*formerly *Septata) intestinalis*, do not have suitable analytical methods available. A method capable of detecting oocysts, similar to EPA Method 1622 used for *Giardia* and *Cryptosporidium*, could be developed for these protozoa. A filtration method will have to be developed for the human microsporidia, since they are smaller than *Giardia* or *Cryptosporidium* and would not be amenable to filtration with the filters used for EPA Method 1622 or the ICR method (USEPA 1996). Other potential methods may utilize water filtration, clean-up with IMS, and detection using either microscopy, fluorescent antibody, or gene probe techniques. Work is in progress on developing these techniques for clinical applications and for the water industry.

3.4. References

Havelaar, A. H., M. During and J. F. Versteegh. 1987. Ampicillin-dextrin agar medium for the enumeration of Aeromonas species in water by membrane filtration. *Journal of Applied Bacteriology.* **62**(3):279-287.

USEPA. 1996. ICR Microbial Laboratory Manual. EPA Publication No. EPA/600/R-95/178, Cincinnati, OH.

Notes

[1]Upon completion of methods development for List 2 and/or List 3 contaminants, EPA will specify which methods are approved for monitoring these contaminants. However, it is anticipated that only EPA-designated laboratories will be allowed to perform these analyses.

Section 4. Spatial Distribution

This section is intended to provide additional occurrence information on the 36 contaminants on the UCMR (1999) List. In particular, this section provides a brief summary of the spatial patterns of use, environmental release, and production of the 36 contaminants. This review is not exhaustive; it is designed to provide an overview for consideration of possible monitoring scenarios.

4.1. Sources of Information

Various sources of information on the release, use, and potential use of contaminants were reviewed. This information, in its aggregate form, has been evaluated to estimate the occurrence or potential for occurrence for the UCMR (1999) Lists 1, 2, and 3 contaminants. The primary sources of information reviewed were: the Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI) Database; the United States Geological Survey (USGS) National Water Quality Assessment Pesticide program's National Pesticide Synthesis Project; Larson, Capel, and Majewski, *Pesticides in Surface Water*, 1997; and the 1992 US Census of Manufactures. Other background sources include Agency for Toxic Substances and Disease Registry (ATSDR) fact sheets and other studies. Most of the data are reported release or application estimates. The Census data, however, only provide an idea as to where a compound might be used, whether or not there is an actual release of the compound to the environment. Tables 4.1, 4.2, and 4.3 summarize the data sources and coverage for each compound, according to UCMR (1999) List designation as well as the potential environmental sources for each contaminant. The tables summarize occurrence patterns by EPA Region. Figures 4.1-4.14 show greater detail for select contaminants.

4.1.1. Toxic Release Inventory Database

EPA's TRI Database contains chemical release information from regulated facilities for more than 500 contaminants. Companies are required to report releases to the TRI if they meet three conditions: (1) the company must have the equivalent of ten or more full-time employees; (2) the company must be a manufacturing facility listed under the Standard Industrial Classification (SIC) codes 20 through 39 or else be a metal or coal mining, electric generating, chemical wholesaler, petroleum bulk plant or terminal, commercial hazardous waste treatment, or solvent recycling facility, and; (3) the company must manufacture, import, or process more than 25,000 pounds per year of one or more listed chemicals or use more than 10,000 pounds of listed chemicals. Since the release of contaminants by small businesses or non-manufacturing industries that do not meet all three criteria goes unreported by TRI, occurrence of some contaminants is likely more widespread than TRI data would indicate.

TRI contains data for 15 of the UCMR (1999) List 1 and 2 compounds. These compounds are 2,4-dinitrotoluene, 2,6-dinitrotoluene, methyl tertiary-butyl ether (MBTE), nitrobenzene, s-ethyl-dipropylthio-carbamate (EPTC), molinate, terbacil, 1,2-diphenylhydrazine, 2-methyl-phenol (o-cresol), 2,4-dinitrophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, diazinon, diuron, and linuron.

4.1.2. USGS National Pesticide Synthesis Project

Information on most of the pesticide compounds on the UCMR (1999) Lists 1 and 2 was available in the USGS National Water Quality Assessment program's Pesticide National Synthesis Project. The Pesticide National Synthesis Project produced maps of estimated annual pesticide use by county for the

conterminous United States. The maps are based on the National Center for Food and Agricultural Policy (NCFAP) estimates of pesticide use rates derived from State and federal pesticide application surveys and crop acreage data from the 1992 Census of Agriculture. The NCFAP estimated the average annual application per treated acre of a crop for each compound and the percentage of cropland treated per State. These coefficients were applied to county crop acreage from the 1992 Census of Agriculture to estimate the amount of pesticide used per square mile by county. The NCFAP estimates do not include pesticide applications to non-cropland (such as private residential use or golf-course use) or pesticides applied to pasture land not reported in the Census of Agriculture (such as federally owned pasture and grazing land). In addition, because of Census non-disclosure rules, the 1992 Census of Agriculture might not report all crop acreage in a county when the acreage is small or restricted to very few owners.

USGS map data are available for acetochlor, diazinon, disulfoton, diuron, EPTC, fonofos, linuron, molinate, terbacil, and terbufos. For regional data on the distribution of alachlor ESA, DCPA di-acid degradate, and DCPA mono-acid degradate, the parent compounds alachlor and DCPA are used as proxies. The USGS maps used for this study are included as Figures 4.1 – 4.4 and 4.7 – 4.14.

A report generated by the USGS Pesticide National Synthesis Project provides information on general occurrence of pesticides in ground water from the National Water Quality Assessment Program (NAWQA) (Kolpin *et al.*, 1998). This report provides insight on the herbicide prometon, which was not included in the other data.

4.1.3. Census Data

In cases where other data were lacking, the 1992 Census of Manufactures was used to provide potential compound occurrence information based on presumed usage. While a contaminant might be associated with a given SIC industry, it cannot be assumed, and probably is unlikely, that every facility in the SIC category actually uses that compound. In addition, a few facilities across a wide variety of SIC categories might use a given compound, even if 90 percent or more of the compound's use is concentrated within one SIC industry. In any event, for most UCMR compounds it is difficult to pinpoint a single or small group of industries which adequately represent usage of a contaminant. Thus, the Census SIC data may be the least reliable indicator of potential occurrence. Census of Manufacturing data was used for only one contaminant, Royal Demolition eXplosive (RDX or 1,3,5-trinitro-1,3,5-triazine).

4.1.4. Other Sources of Occurrence Information

Larson and colleagues (1997) provided pesticide coverage data for a number of UCMR (1999) List 1 and 2 compounds, most of which overlap with USGS or TRI data. Data for alachlor (substituted for alachlor ESA), diazinon, disulfoton, terbufos, EPTC, molinate, DDE, and prometon were included (maps of distribution were available for all these compounds except DDE and prometon).

The report *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization Based on Emerging Information,* 1998, contains information on perchlorate releases nationwide. This draft EPA report is still under review. Figures 4.5 and 4.6 are two maps related to perchlorate production and occurrence reproduced from this report.

Often, more than one source of information was available for a contaminant. To provide the most complete picture of occurrence, all overlapping sources of data for a compound were aggregated. As noted, this report presents a brief summary of the geographic distribution from select major information sources. In most cases these data are not entirely comprehensive. If all sites of production, release, use, and transportation could be characterized, the geographic range for most contaminants would be increased from that summarized here.

4.2. Findings

Tables 4.1, 4.2, and 4.3 present regional occurrence patterns for UCMR (1999) Lists 1, 2, and 3 contaminants, respectively. Maps which summarize use, application, and distribution of many pesticides and perchlorate are included as Figures 4.1-4.14.

4.2.1. UCMR (1999) List 1 Contaminants

There are 12 chemical contaminants on List 1 of the UCMR (1999) List. List 1 contaminants are found in all ten EPA Regions. Four contaminants, DCPA di-acid degradate, DCPA mono-acid degradate, EPTC, and MTBE are used or found in all EPA Regions. Every List 1 chemical contaminant except acetochlor is used in Regions 4 and 6 and every contaminant except molinate is used in Region 3. The fewest List 1 contaminants are found in Region 1, where only 6 of the 12 compounds appear in the data. For the 12 contaminants, only 3 are not reported as occurring in seven or more EPA Regions. Nine contaminants appear in at least seven EPA Regions. Molinate exhibits the most restricted geographic use area of any UCMR contaminant, restricted to the rice growing areas of the lower Mississippi River Valley, the Gulf Coast, and California.

2,4-dinitrotoluene (2,4-DNT) is used in the production of isocyanate and explosives. 2,4-DNT appears in the TRI database in EPA Regions 2, 3, 4, 5, 6, 7, and 9.

2,6-dinitrotoluene (2,6-DNT) has similar uses to 2,4-DNT and the two are often used as a mixture. Although 2,6-DNT is listed in the TRI database only for Regions 3, 4, 6, and 9, it may actually used be more widely in conjunction with 2,4-DNT. It is probable that its potential occurrence is more widespread than the TRI data would indicate.

Acetochlor is an herbicide used on corn, cabbage, citrus, and coffee crops. Acetochlor appears on National Pesticide Synthesis Project maps in Regions 3, 5, 7, 8, and 10 (these regions may not include all production and transport areas). Its use may be expanding, however, as it only received registration for corn in 1993. (See Figure 4.1)

DCPA di-acid degradate and DCPA mono-acid degradate are degradation products of DCPA (dimethyl tetrachloroterephthalate, chemical name of the herbicide dacthal), an herbicide used on fruit and vegetable crops to control grasses and weeds. These compounds are expected to be associated with the use of DCPA; thus DCPA is taken as a proxy to estimate potential occurrence of the degradates. DCPA appears in the National Pesticide Synthesis Project in all ten EPA Regions. (See Figure 4.2)

DDE (dichloro dichlorophenyl ethylene) is a degradation product of DDT (dichloro diphenyl trichloroethane), a general-use insecticide banned in 1972. Larson and colleagues (1997) discuss detections of DDE in surface waters in EPA Regions 2, 3, 4, 5, 6, 7, 8, 9, and 10.

EPTC (s-ethyl-dipropylthio-carbamate) is an herbicide used on corn and potatoes to control grasses and weeds. EPTC is listed in all ten EPA Regions in the National Pesticide Synthesis Project maps. (See Figure 4.3)

Molinate exhibits the most geographically restricted usage pattern of the UCMR (1999) List 1 contaminants. This is not surprising: it is used as a pesticide on rice crops to control water grass, mostly along the lower Mississippi River Valley and Gulf Coastal Plain and in California. TRI data shows molinate releases in EPA Regions 4, 6, and 9, while National Pesticide Synthesis Project maps place molinate use in Region 7 as well. Molinate has been detected in 27 percent of targeted surface water sites in the Lower Mississippi Valley and California (Larson *et al.*, 1997). Molinate was only found in regions where rice is grown. (See Figure 4.4)

Table 4.1. UCMR (1999) List 1 Contaminant Occurrence or Use by EPA Region											
UCMR (1999) List 1 Contaminants		**EPA Regions**									
Contaminant	**Potential Environmental Source**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2,4-Dinitrotoluene	Used in the production of isocyanate and explosives	-	A	A	A	A	A	A	-	A	-
2,6-Dinitrotoluene	Used as mixture with 2,4-DNT (similar uses)	-	-	A	A	-	A	-	-	A	-
Acetochlor	Herbicide used on corn, cabbage, citrus, and coffee	-	-	B	-	B	-	B	B	-	B
DCPA di-acid degradate (DCPA used as a proxy for this compound)	Degradation product of DCPA, an herbicide used on grasses and weeds with fruit and vegetable crops	B	B	B	B	B	B	B	B	B	B
DCPA mono-acid degradate (DCPA used as a proxy for this compound)	Degradation product of DCPA, an herbicide used on grasses and weeds with fruit and vegetable crops	B	B	B	B	B	B	B	B	B	B
DDE	Degradation product of DDT; a general insecticide	-	C	C	C	C	C	C	C	C	C
EPTC	Herbicide used on grasses and weeds, with potatoes and corn	B,C	B,C	B,C	A,B,C	B,C	A,B,C	A,B,C	B,C	B,C	B,C
Molinate	Selective herbicide used on rice; controls watergrass	-	-	-	A,B,C	-	A,B,C	B,C	-	A,B,C	-
MTBE	Octane enhancer in unleaded gasoline	A	A	A	A	A	A	A	A	A	A
Nitrobenzene	Used in the production of aniline, which is used to make dyes, herbicides, and drugs; also used as a solvent in paint and shoe, floor, and metal polishes.	A	A	A	A	A	A	A	-	-	-
Perchlorate	Oxygen additive in solid fuel propellant for rockets, missiles, and fireworks	-	E	E	E	E	E	E	E	E	E
Terbacil	Herbicide used on sugarcane, alfalfa, fruit, etc.	B	B	B	A,B	B	A,B	-	B	-	B

No letter entry in a table cell signifies that there is no information in the sources reviewed regarding occurrence or use of a contaminant in a region. Sources are listed below.
A: TRI database
B: USGS National Pesticide Synthesis Project (see Figure 4.1-4.14)
C: Larson, Capel, and Majewski, Pesticides in Surface Water, 1997
D: 1992 US Census of Manufactures
E: Perchlorate Environmental Contamination

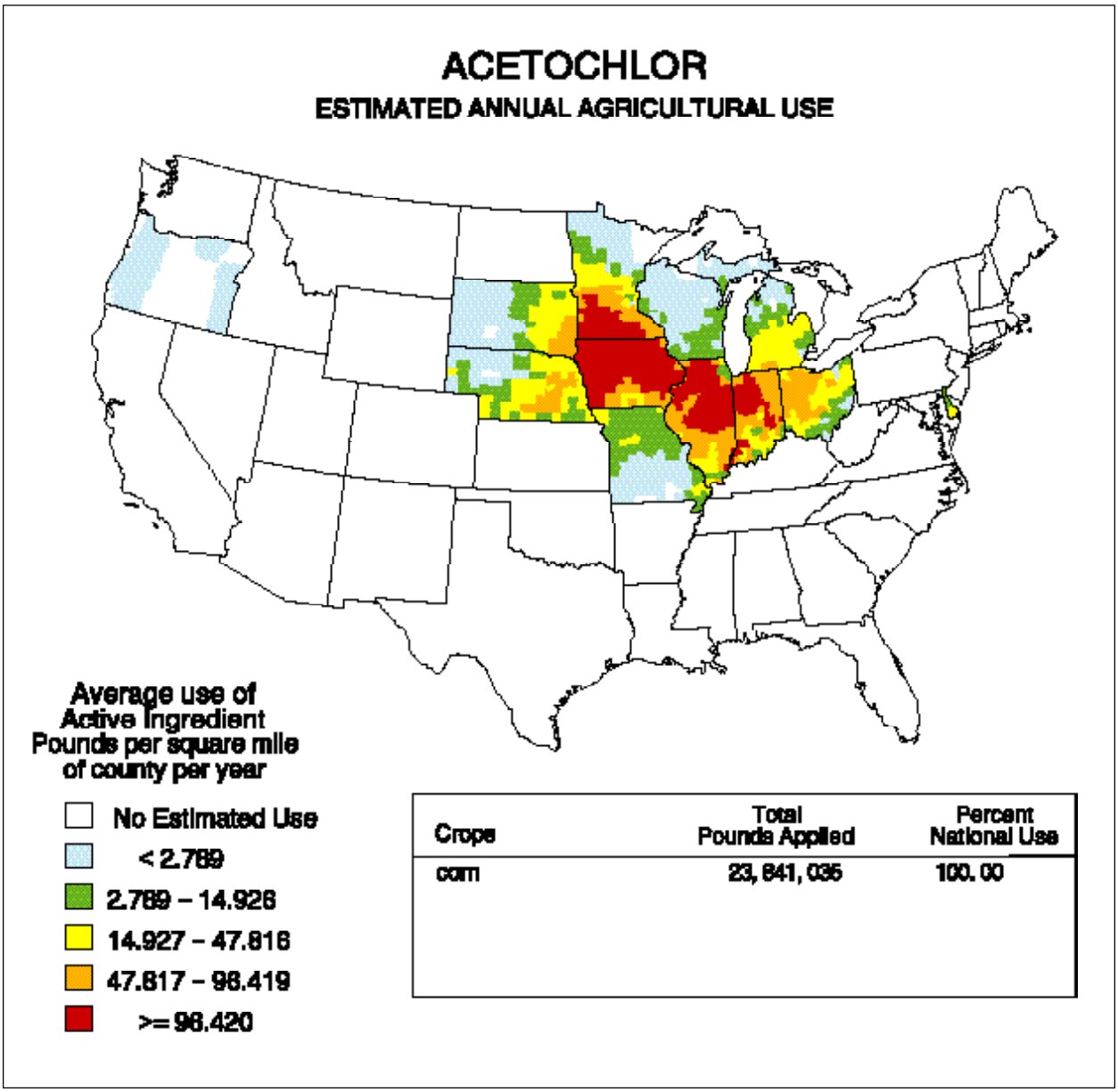
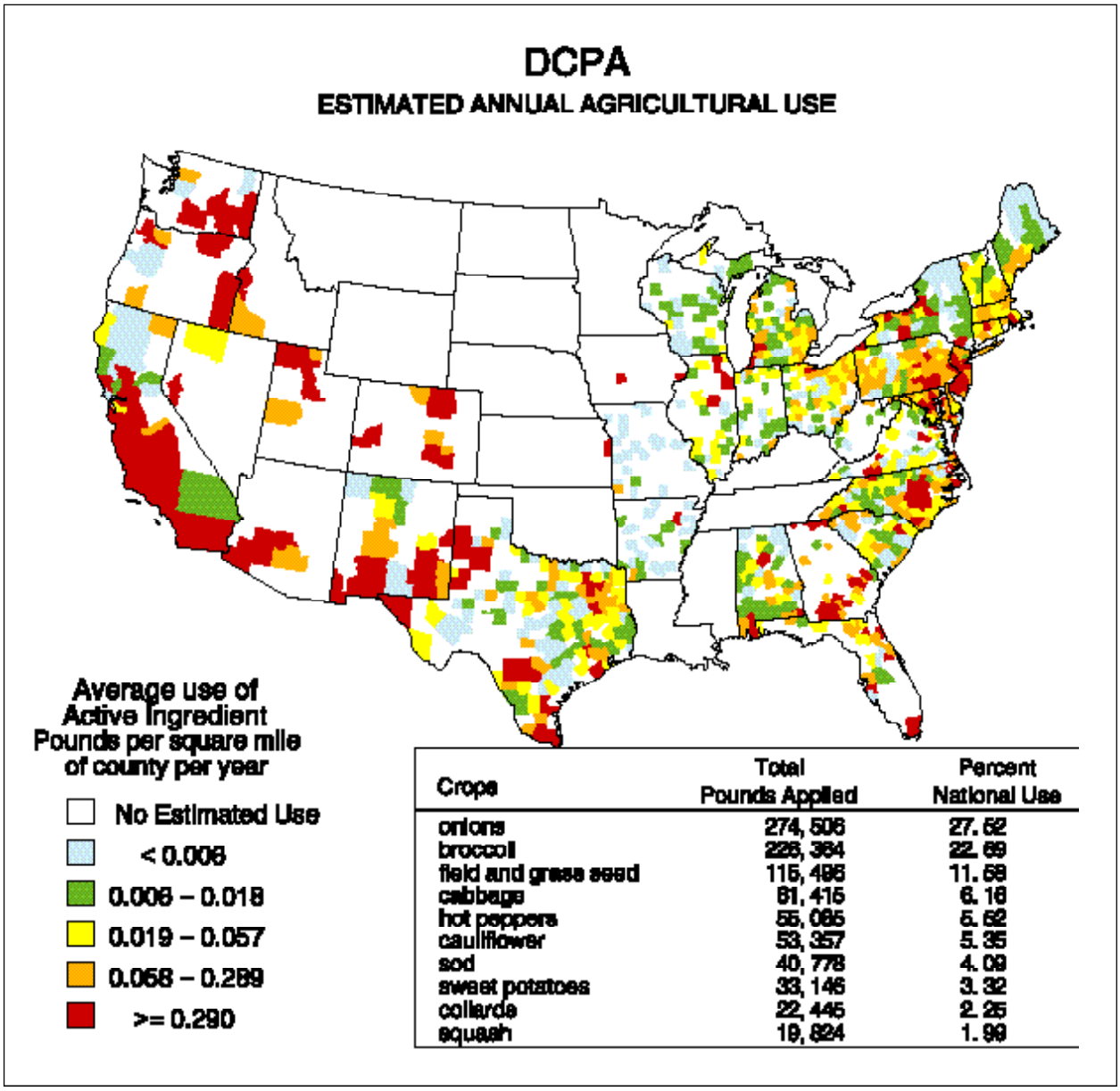


Figure 4.1. Acetochlor—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.



Crops	Total Pounds Applied	Percent National Use
onions	274,506	27.62
broccoli	226,364	22.69
field and grass seed	115,486	11.58
cabbage	61,415	6.18
hot peppers	55,085	5.62
cauliflower	53,357	5.35
sod	40,778	4.09
sweet potatoes	33,146	3.32
collards	22,445	2.25
squash	19,824	1.99

Figure 4.2. DCPA—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

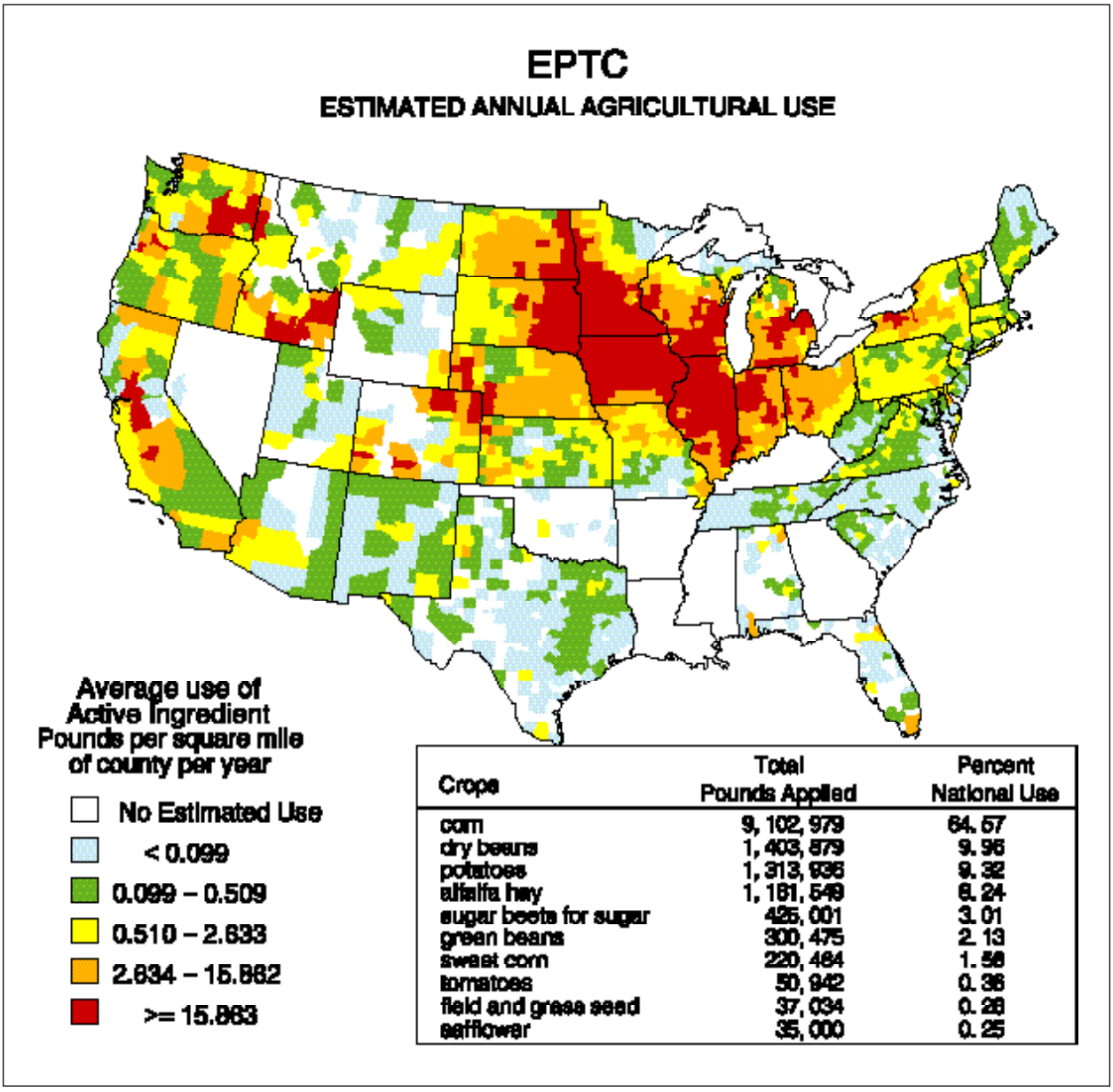


Figure 4.3. EPTC—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

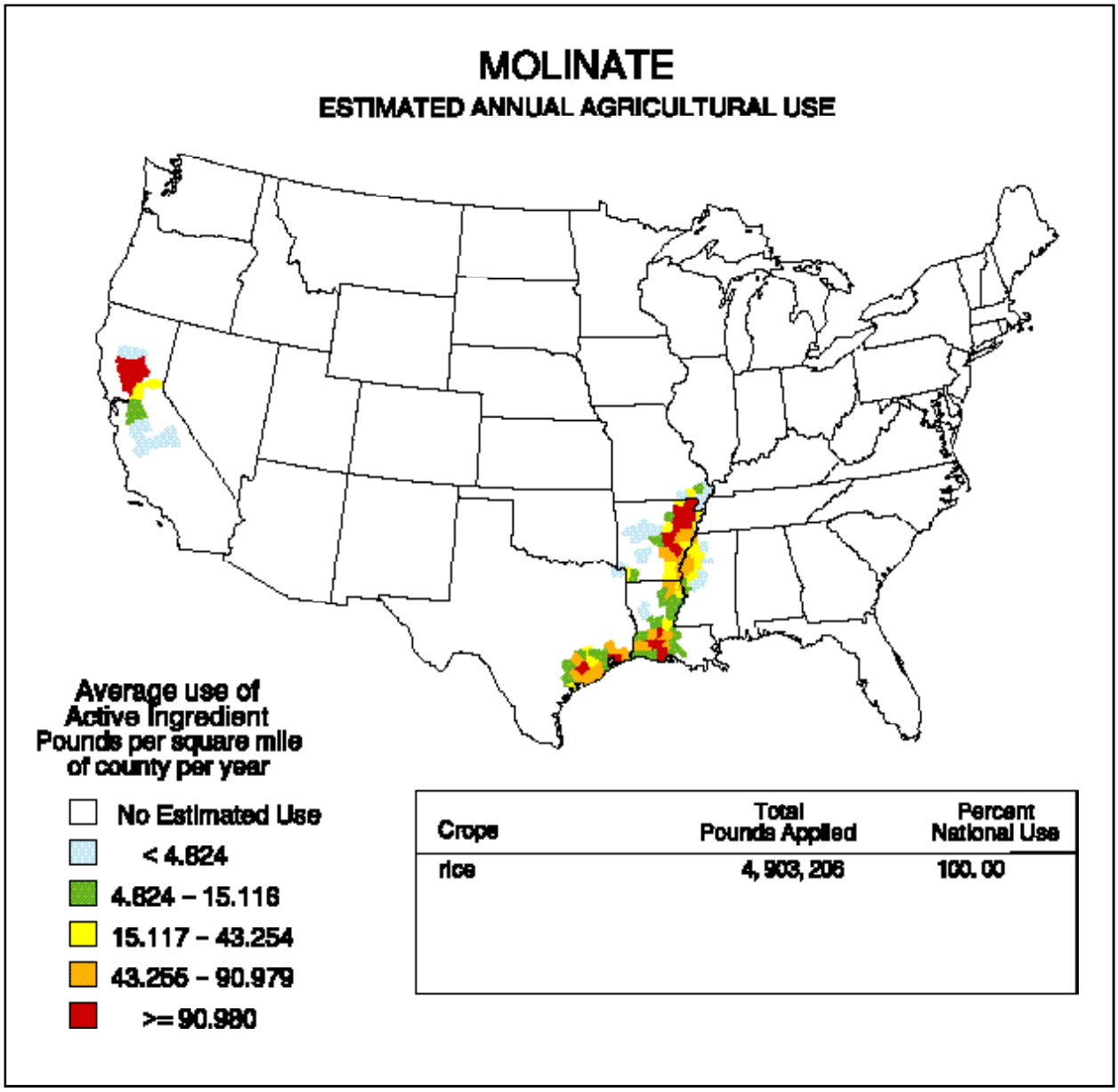


Figure 4.4. Molinate—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

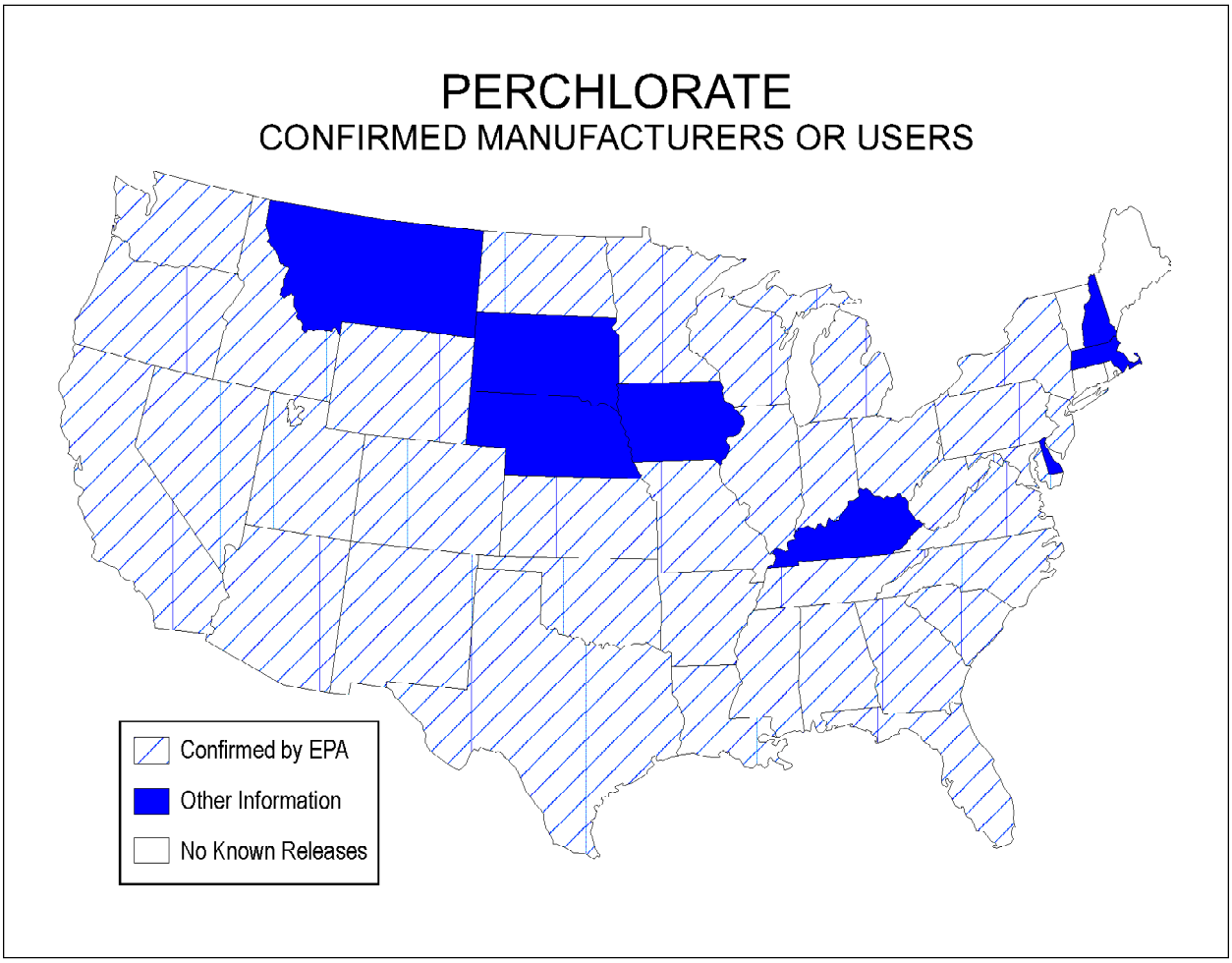


Figure 4.5. Perchlorate—Confirmed Manufacturers or Users. States indicated as having confirmed perchlorate manufacturers or users (hatch marks) are based on EPA Information Request responses from current manufacturers (identifying shipments of at least 500 pounds in any year). States noted by shading resulted from database searches for types of facilities where releases have occurred in California (rocket manufacturing and testing explosives manufacturing). No facilities have been identified in Alaska, Hawaii, Maine, Vermont, Connecticut, or Rhode Island. Adapted from: United States Environmental Agency Office of Research and Development. *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization Based on Emerging Information*. NCEA-1-0503. December 31, 1998. External Review Draft.

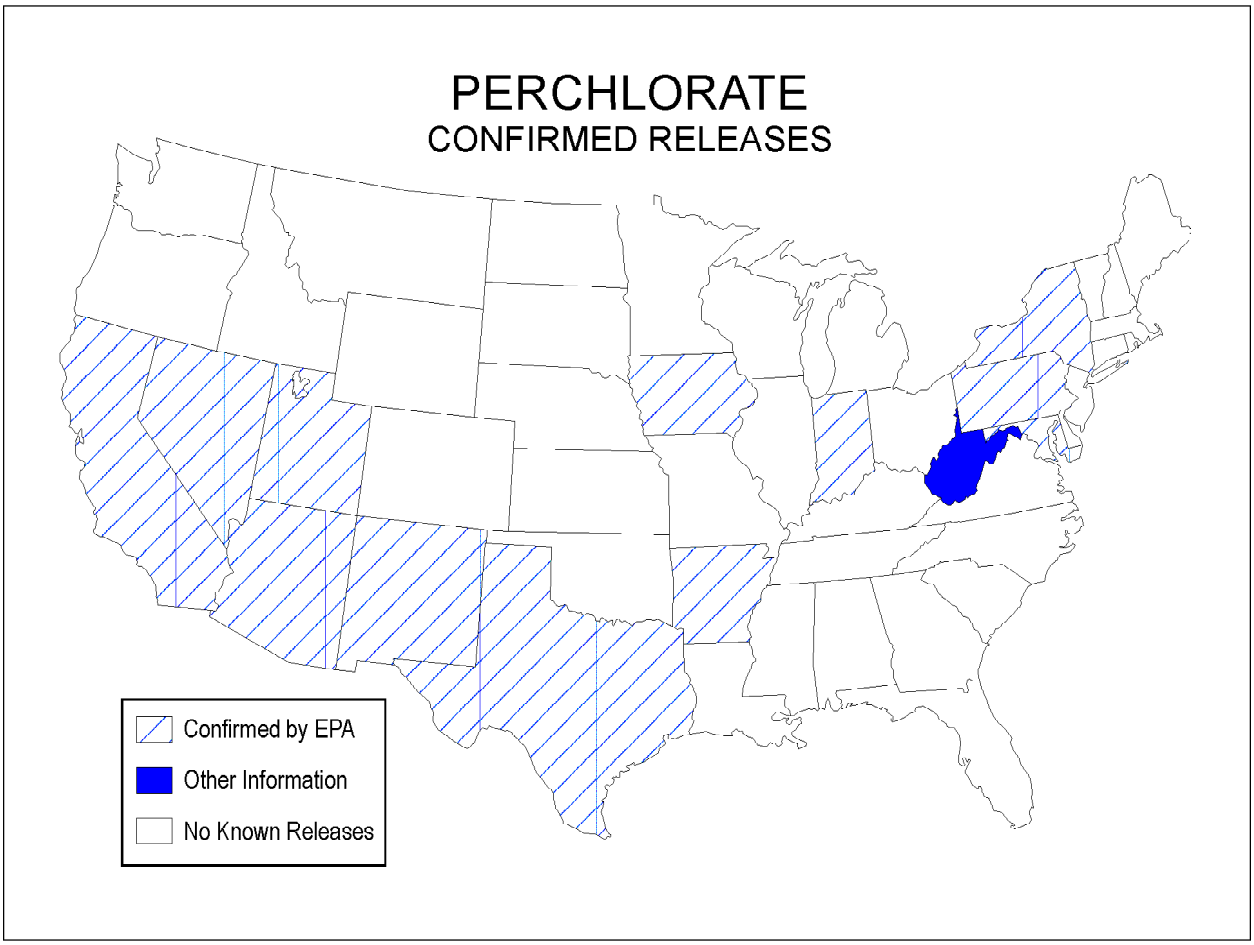


Figure 4.6. Perchlorate—Confirmed Releases. States with confirmed release (hatch marks), in which facilities have directly measured perchlorate in groundwater or surface water. Perchlorate measured in water in West Virginia for a confidential client has been reported at a public conference but has not been confirmed independently by EPA. Monitoring for perchlorate releases in most states is very limited or nonexistent. Adapted from: United States Environmental Agency Office of Research and Development. *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization Based on Emerging Information*. NCEA-1-0503. December 31, 1998. External Review Draft.

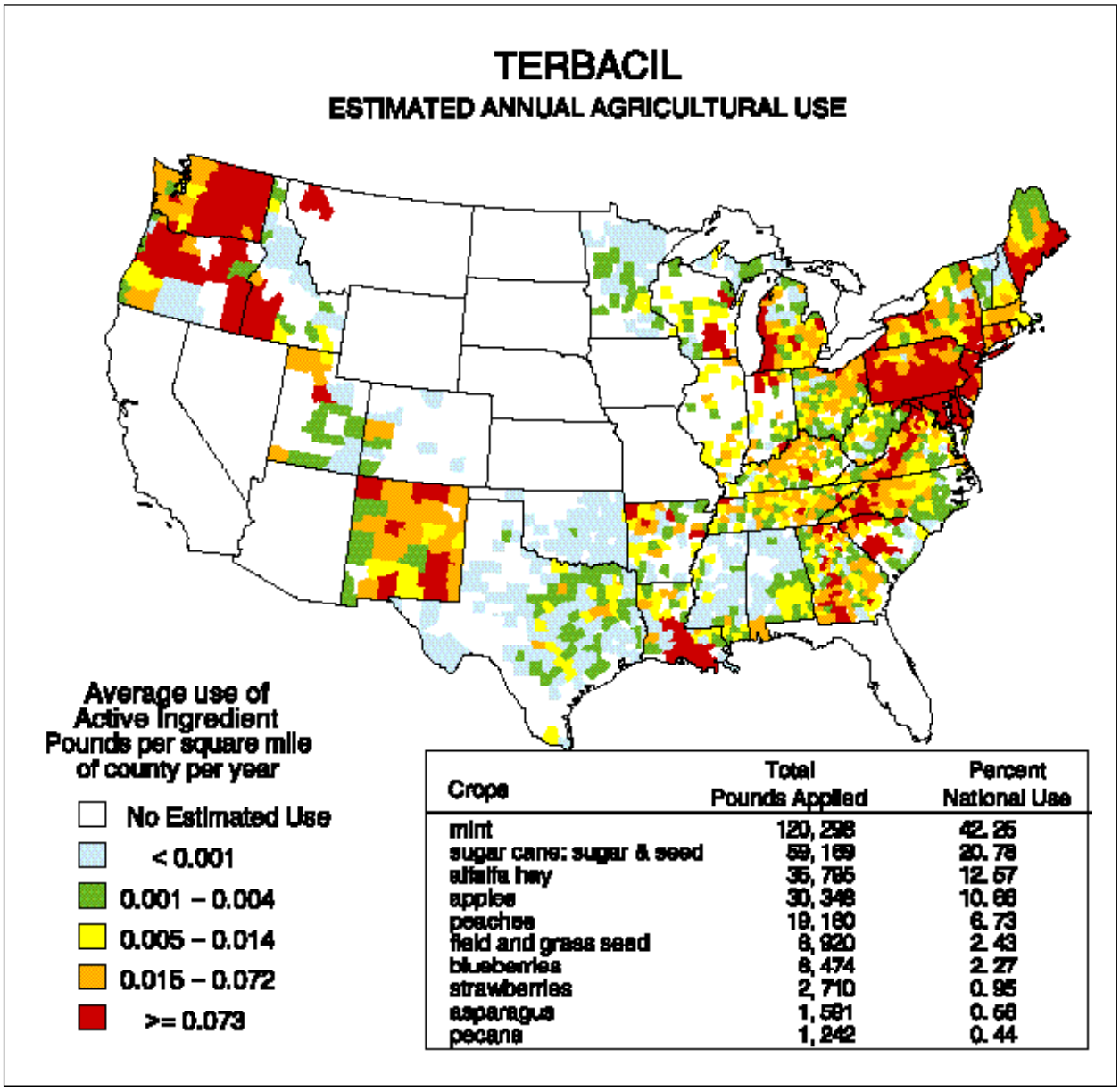


Figure 4.7. Terbacil—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

Methyl tertiary-butyl ether (MTBE), an octane enhancer in unleaded gasoline, appears in the TRI database in all ten EPA Regions. MTBE is also released to the environment through gasoline spills, storage tank leaks, automobile use, and various other non-point sources.

Nitrobenzene is used mostly in the production of aniline, which is used to make dyes, herbicides, and pharmaceuticals. It is also used as a solvent in paint and shoe, metal, and floor polishes. Nitrobenzene appears in the TRI data for Regions 1, 2, 3, 4, 5, 6, and 7.

Perchlorate, an oxygen additive in solid fuel propellant for rockets, missiles, and fireworks, is an emerging contaminant, so monitoring has not been of long duration nor widespread. A recent EPA report (USEPA 1998) identifies facilities where perchlorate releases have occurred in every EPA Region. The report also finds confirmed detections of perchlorate in ground water in EPA Regions 2, 3, 5, 6, 8, and 9. (See Figures 4.5 and 4.6)

Terbacil is an herbicide used on sugarcane, alfalfa, and fruit crops. Terbacil was found in EPA Regions 1, 2, 3, 4, 5, 6, 8, and 10 in the National Pesticide Synthesis Project maps. (See Figure 4.7)

4.2.2. UCMR (1999) List 2 Contaminants

UCMR (1999) List 2 contaminants are found in every EPA Region. The greatest number of contaminants are found to be used in Region 4, where 12 of the 16 List 2 compounds appear in the data. The fewest contaminants appear in Region 10, where only seven List 2 contaminants were found. Only one of the 16 List 2 contaminants (2,4,6-trichlorophenol) appears in fewer than seven EPA Regions. The compound 1,2-diphenylhydrazine is listed in the TRI database but no releases are reported.

Table 4.2. UCMR (1999) List 2 Contaminant Occurrence or Use by EPA Region

UCMR (1999) List 2 Contaminants		EPA Region									
Contaminant	**Potential Environmental Source**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Chemical Contaminants											
1,2-Diphenylhydrazine	Used in the production of benzidine and anti-inflammatory drugs	This contaminant is listed in the TRI database, but there are no records of releases.									
2-Methyl-phenol	Released in automobile and diesel exhaust, coal tar and petroleum refining, and wood pulping	A	A	A	A	A	A	A	-	A	-
2,4-Dinitro-phenol	Released from mines, metal, petroleum, and dye plants	-	A	A	A	-	A	-	-	-	-
2,4,6-Trichloro-phenol	By-product of fossil fuel burning, used as bactericide and wood/glue preservative	-	-	-	A	-	-	-	A	-	-
2,4-Dichloro-phenol	Chemical intermediate in herbicide production	-	A	A	A	A	A	A	-	A	-

Note: No letter entry in a table cell signifies that there is no information in the sources reviewed regarding occurrence or use of a contaminant in a region. Sources are listed below.
A: Data from TRI database
B: Data from USGS National Pesticide Synthesis Project (see Figures 4.1-4.14)
C: Data from Larson et al., 1997.
D: Data from 1992 US Census of Manufactures
E: Data from *Perchlorate Environmental Contamination*

Table 4.2. UCMR (1999) List 2 Contaminant Occurrence or Use by EPA Region (Continued)											
UCMR (1999) List 2 Contaminants		**EPA Region**									
Contaminant	**Potential Environmental Source**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Chemical Contaminants											
Alachlor ESA (alachlor used as a proxy for this compound)	Degradation product of alachlor, an herbicide used on corn, bean, peanut, and soybean crops to control grasses and weeds	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
Diazinon	Insecticide used on corn, rice, fruit, and vineyards	B	A,B,C	B,C	A,B,C	A,B,C	A,B,C	A,B,C	A,B,C	A,B,C	B,C
Disulfoton	Insecticide used on cereal, cotton, tobacco, and potato crops	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
Diuron	Herbicide used on grasses in orchards and wheat crops	B	B	B	A,B	B	A,B	A,B	B	B	B
Fonofos	Soil insecticide used on corn, peanuts, and potatoes to control worms and centipedes	B	B	B	B	B	B	B	B	B	B
Linuron	Herbicide used on corn, soybean, cotton, and wheat crops	B	B	B	A,B	B	B	A,B	B	B	B
Prometon	Non-agricultural herbicide used on weeds and grasses	This contaminant is a widely used (primarily non-cropland) herbicide, which is expected to occur in every EPA Region. There is no discharge data for this contaminant. See text for details.									
Polonium-210	part of the uranium decay series; natural occurrence due to atmospheric fall out	Expected to occur in all Regions.									
RDX	explosives, ammunition plants	D	D	D	D	D	D	D	-	D	-
Terbufos	Insecticide used on corn, sugar beet, and grain sorghum crops	-	B,C	B,C	B,C	B,C	B,C	B,C	B,C	-	B,C
Microbiological Contaminants											
Aeromonas hydrophila	Present in all freshwater and brackish water	Expected to occur in all Regions.									

Note: No letter entry in a table cell signifies that there is no information in the sources reviewed regarding occurrence or use of a contaminant in a region. Sources are listed below.
A: Data from TRI database
B: Data from USGS National Pesticide Synthesis Project (see Figures 4.1-4.14)
C: Data from Larson et al., 1997.
D: Data from 1992 US Census of Manufactures
E: Data from *Perchlorate Environmental Contamination*

1,2-diphenylhydrazine is used in the production of benzidine and anti-inflammatory drugs. This compound is a TRI required contaminant, but there are no recorded releases of 1,2-diphenylhydrazine in the TRI data because it is no longer produced in the United States. 1,2-diphenylhydrazine exists in older products and wastes and it may still be possible for releases of imported quantities to occur based on its use in manufacturing pharmaceuticals. This contaminant has been discovered by the EPA in at least seven sites on the National Priorities List (Toxicological Profile for 1,2-Diphenylhydrazine, 1990).

2-methyl-phenol (o-cresol) is used in wood pulping, coal tar and petroleum refining, and is released in diesel exhaust. The contaminant 2-methyl-phenol appears in EPA Regions 1, 2, 3, 4, 5, 6, 7, and 9 in the TRI database.

2,4-dinitrophenol is used in dye and petroleum and metal refining plants and is released from mines. The contaminant 2,4-dintrophenol appears in the TRI data in EPA Regions 2, 3, 4, and 6.

2,4,6-trichlorophenol is used as a bactericide and a preservative for wood and glue. It is also a by-product of fossil fuel production. This compound is listed in the TRI database for EPA Regions 4 and 8.

2,4-dichlorophenol is a chemical intermediate used in herbicide production. It is listed in the TRI database in EPA Regions 2, 3, 4, 5, 6, 7, and 9.

Alachlor ESA (alachlor ethane sulfonic acid) is a degradation product of alachlor, an herbicide used on corn, bean, peanut, and soybean crops to control grasses and weeds. Alachlor ESA is an emerging contaminant, so monitoring has not been widespread or of long duration. Therefore, alachlor is used a proxy to estimate potential occurrence. Alachlor is found in all ten EPA Regions on the National Pesticide Synthesis Project maps. (See Figure 4.8)

Diazinon is an insecticide used on corn, rice, fruit crops, and vineyards. Diazinon appears on the National Pesticide Synthesis Project maps in all ten EPA Regions. (See Figure 4.9)
Disulfoton is an insecticide used on cereal, cotton, tobacco, and potato crops. Disulfoton appears on the National Pesticide Synthesis Project maps in all ten EPA Regions. (See Figure 4.10)

Diuron is an herbicide used on grasses in orchards and with wheat crops. Diuron is found on the National Pesticide Synthesis Project maps in all ten EPA Regions. (See Figure 4.11)

Fonofos is a soil insecticide used on corn, peanuts, potatoes, and other crops to control worms and centipedes. Fonofos appears on the National Pesticide Synthesis Project maps in all ten EPA Regions. (See Figure 4.12)

Linuron is an herbicide used on corn, soybean, cotton, and wheat crops. Linuron is found on the National Pesticide Synthesis Project maps in all ten EPA Regions. (See Figure 4.13)

Polonium-210 (Po-210) is an isotope in the uranium decay series along with lead-210, radium-226, and radon-222. Polonium-210, with a half-life of 138 days, has been found in drinking water. EPA is aware of the occurrence of this contaminant in shallow aquifers in Florida (Harada, *et al.*, 1989; Upchurch, 1991), and in at least two other states. In addition, polonium-210 is expected to occur naturally in essentially every part of the country as atmospheric fallout.

Prometon is a generic non-agricultural herbicide used on weeds and grasses. Prometon is widely used on residential and commercial properties alongside buildings, fences, and other areas. As prometon is primarily a non-agricultural pesticide, there are no maps of usage for this contaminant. However, USGS monitoring provides perspective on occurrence. A USGS National Pesticide Synthesis Project report (Kolpin *et al.*, 1998) cited prometon detections in 14 percent of 1,034 urban and agricultural wells sampled across the United States. Larson, Capel, and Majewski (1997) detected prometon in 27 percent of midwest urban monitoring wells.

RDX (Royal Demolition eXplosive; 1,3,5-trinitro-1,3,5-triazine) is commonly used in military ammunition plants (SIC code 3483). The U.S. Census of Manufacturers identifies these facilities in EPA Regions 1, 2, 3, 4, 5, 6, 7, and 9. RDX might also be released to the environment near arsenals, military bases, or construction sites using explosives.

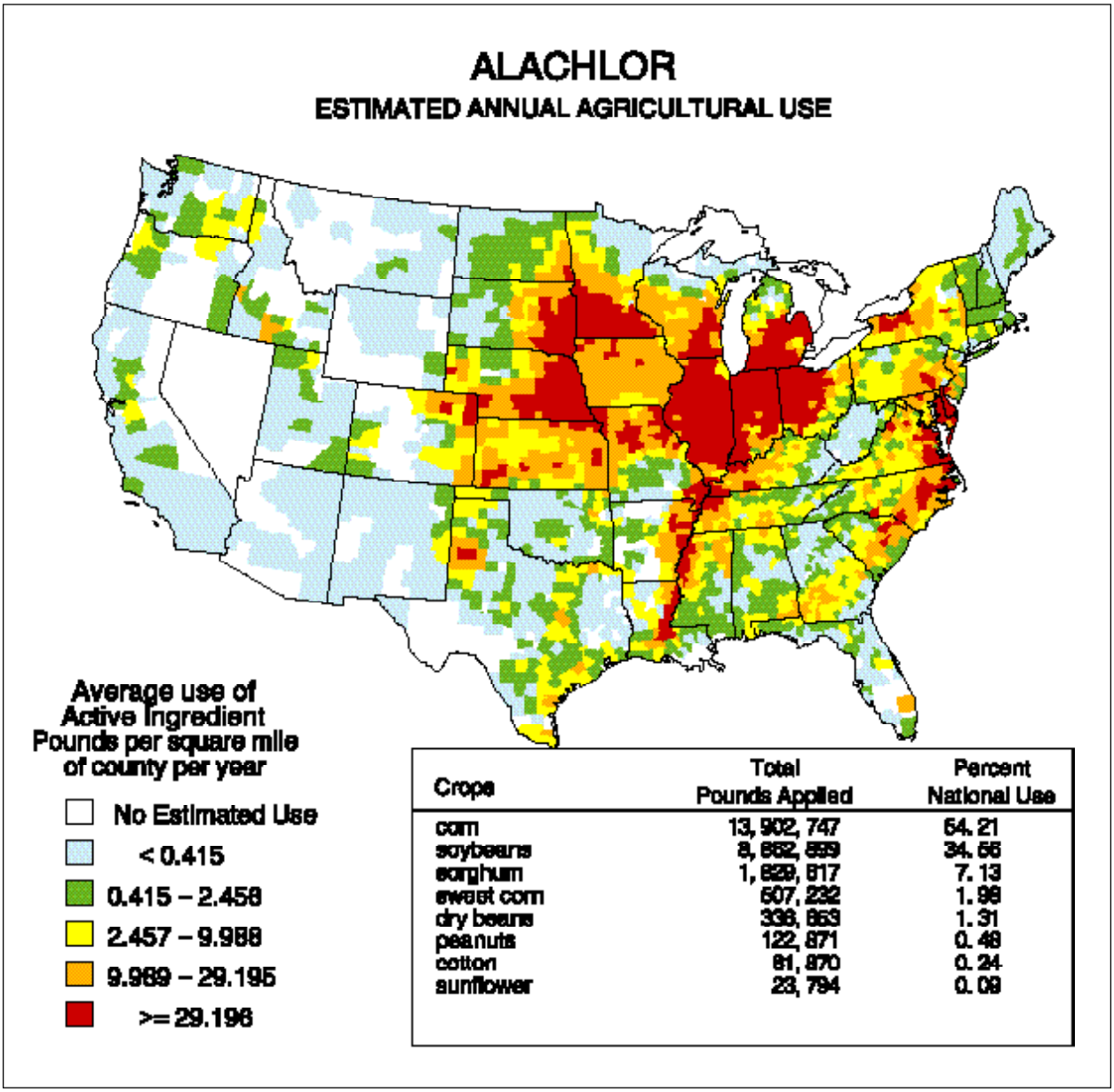


Figure 4.8. Alachlor—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

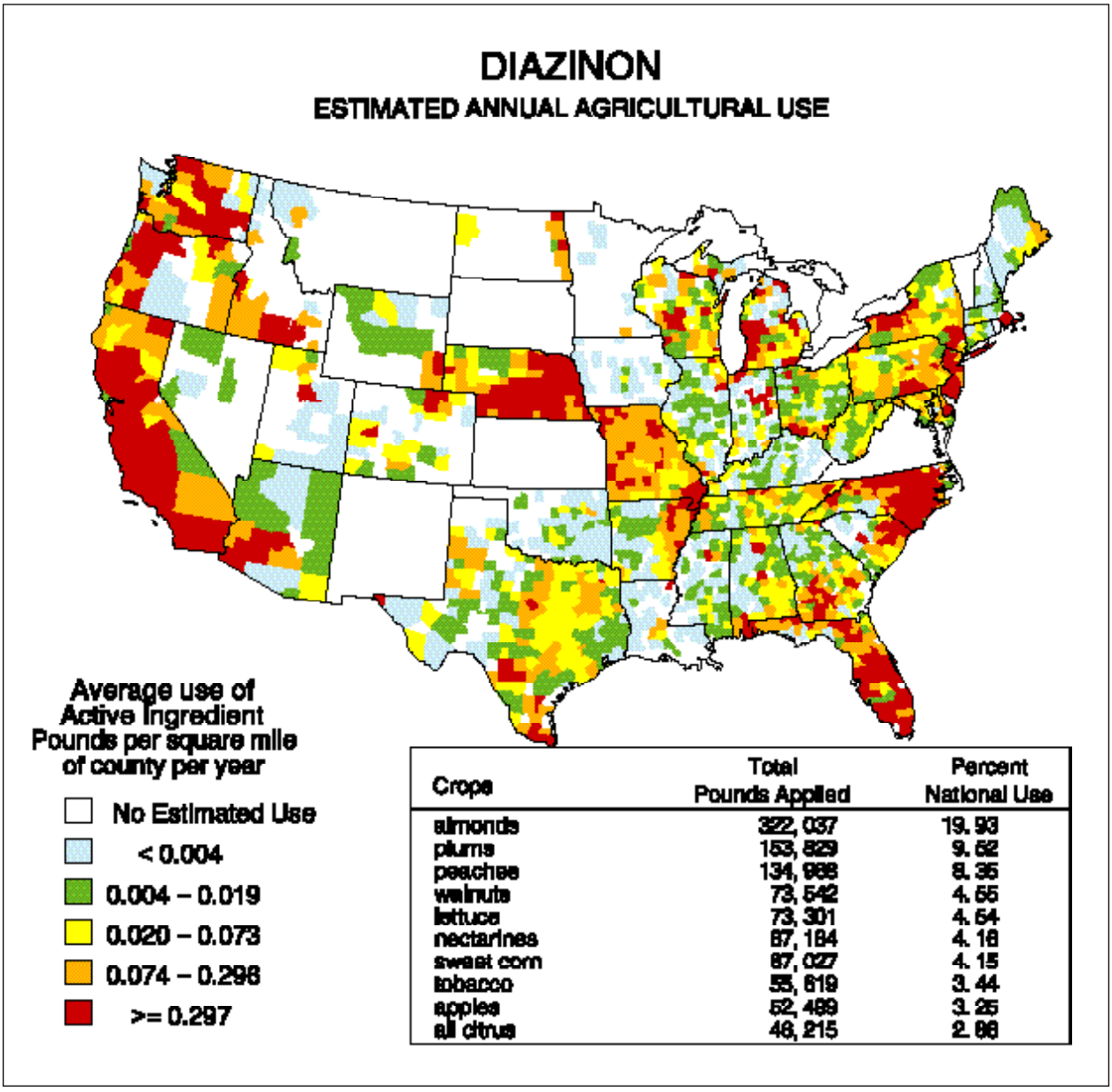


Figure 4.9. Diazinon—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

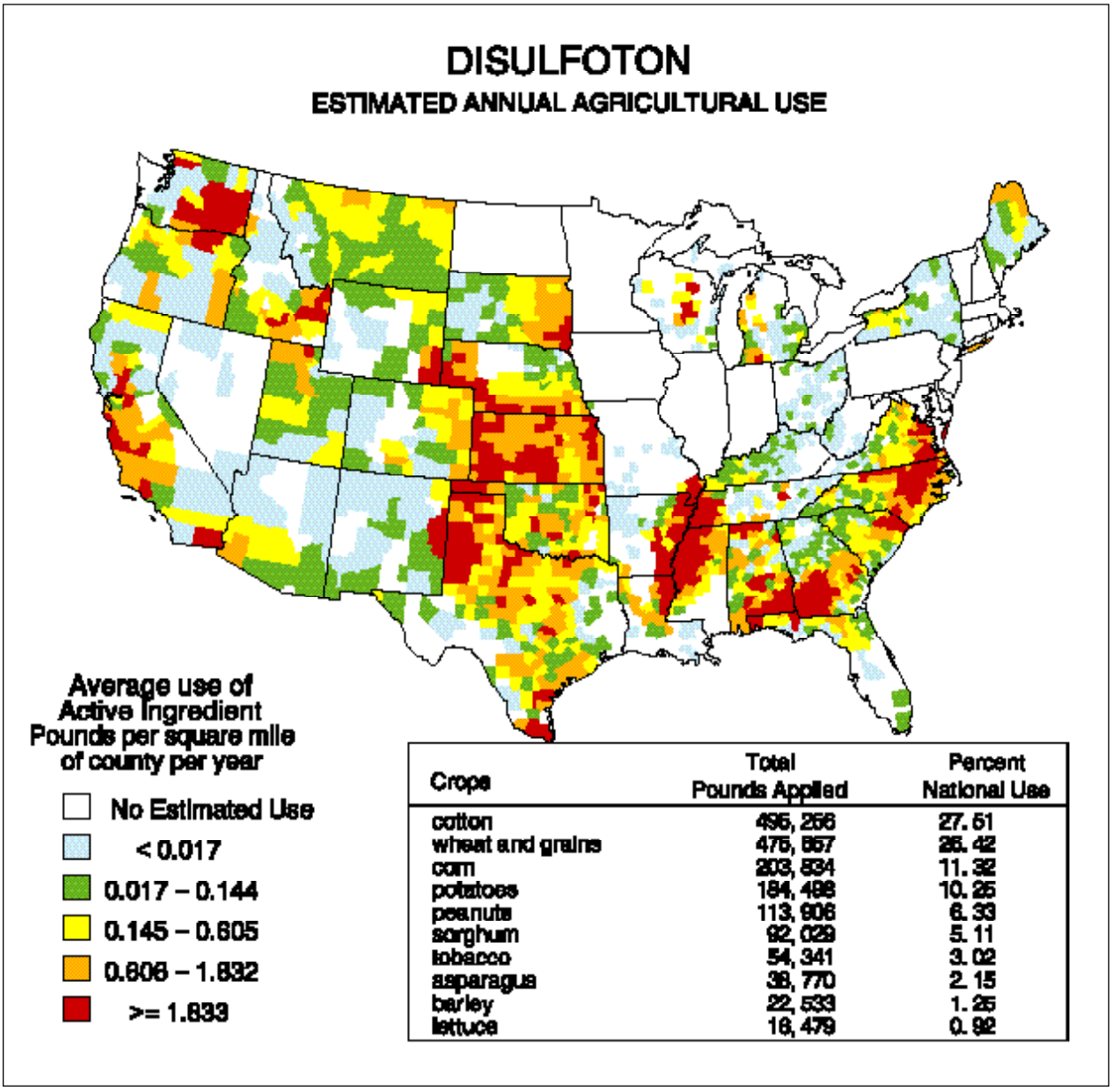


Figure 4.10. Disulfoton—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

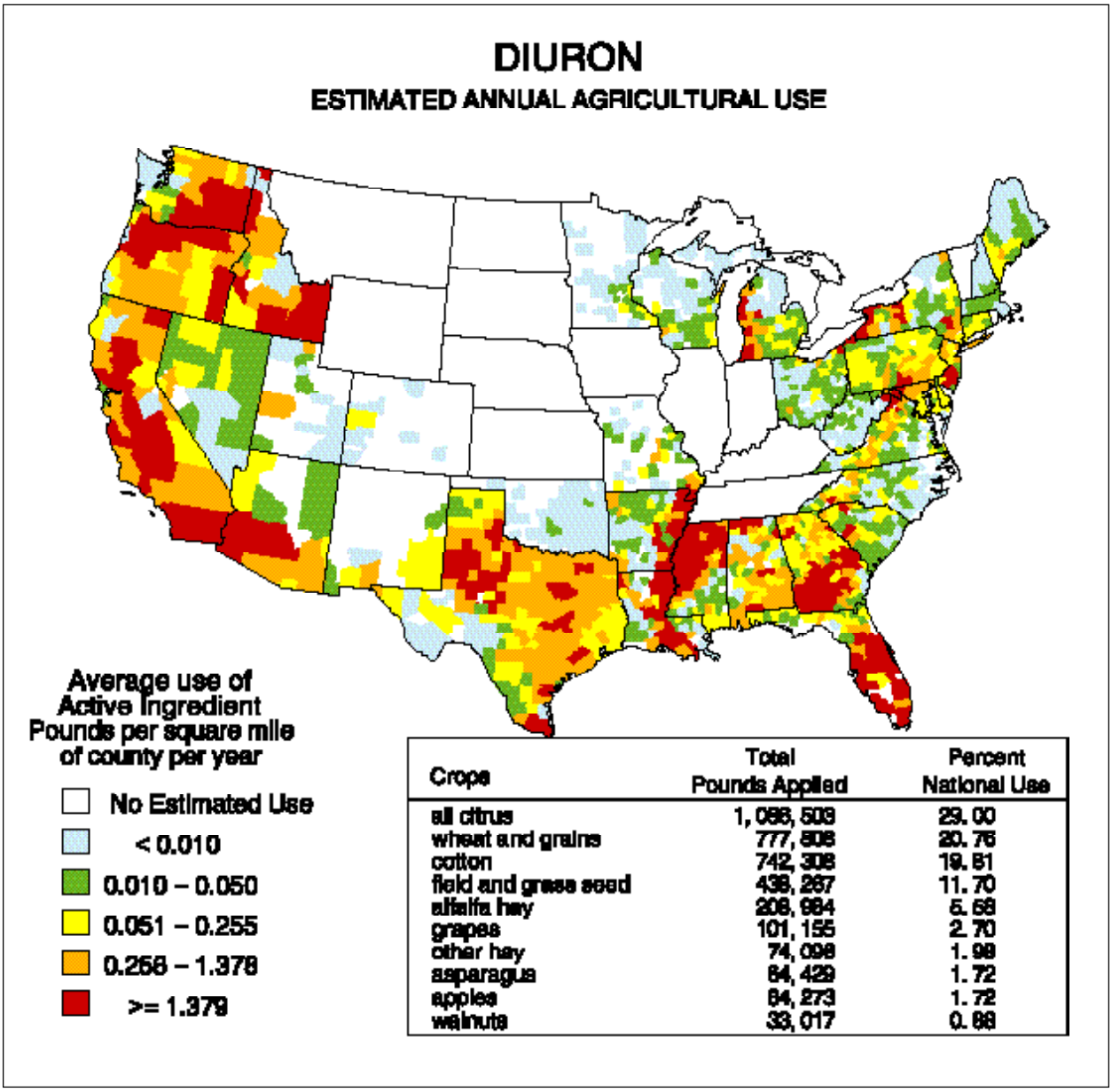
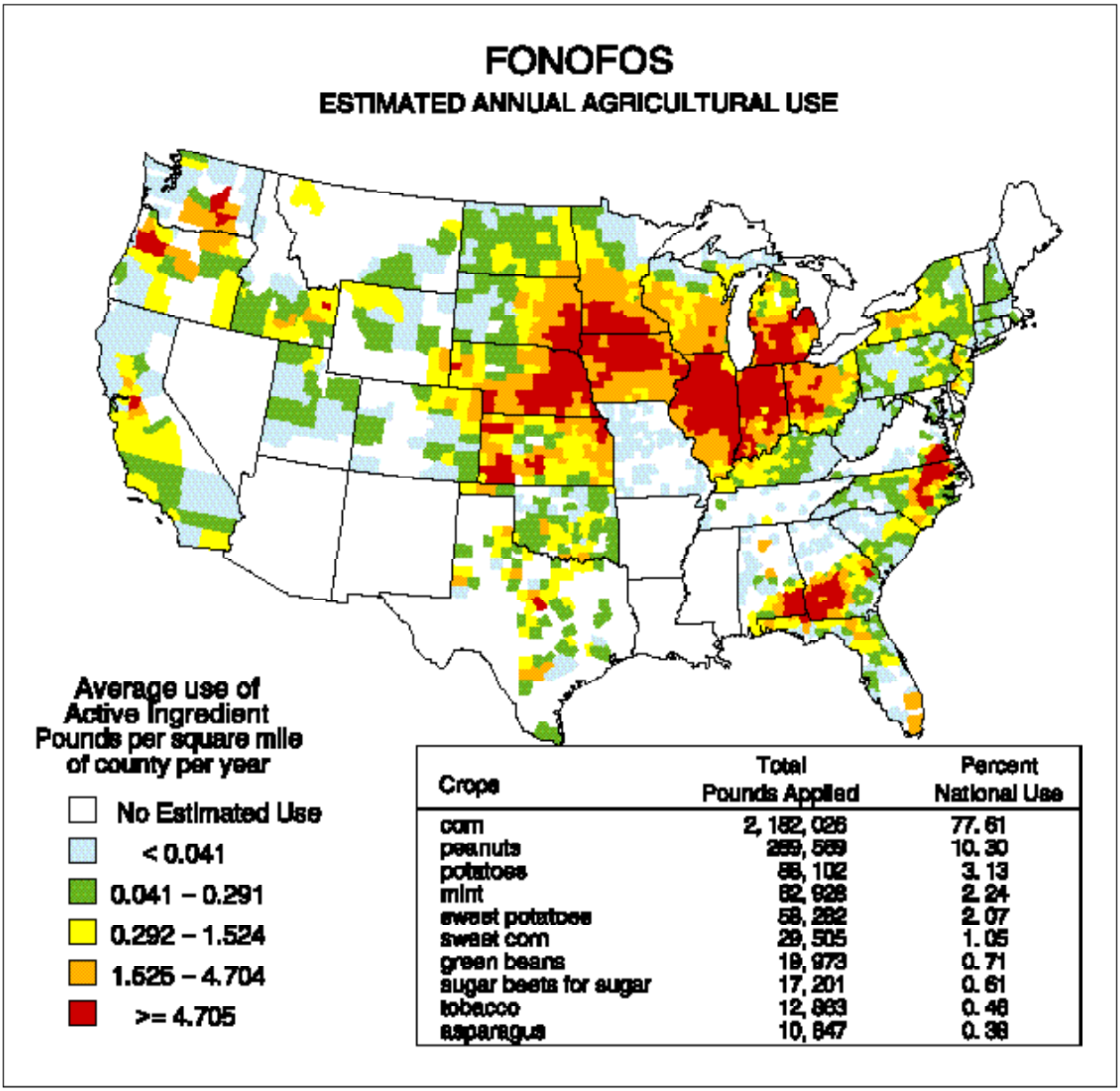


Figure 4.11. Diuron—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.



Crops	Total Pounds Applied	Percent National Use
corn	2,182,026	77.61
peanuts	289,569	10.30
potatoes	88,102	3.13
mint	62,928	2.24
sweet potatoes	58,282	2.07
sweet corn	29,505	1.05
green beans	19,979	0.71
sugar beets for sugar	17,201	0.61
tobacco	12,993	0.46
asparagus	10,847	0.38

Figure 4.12. Fonofos—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

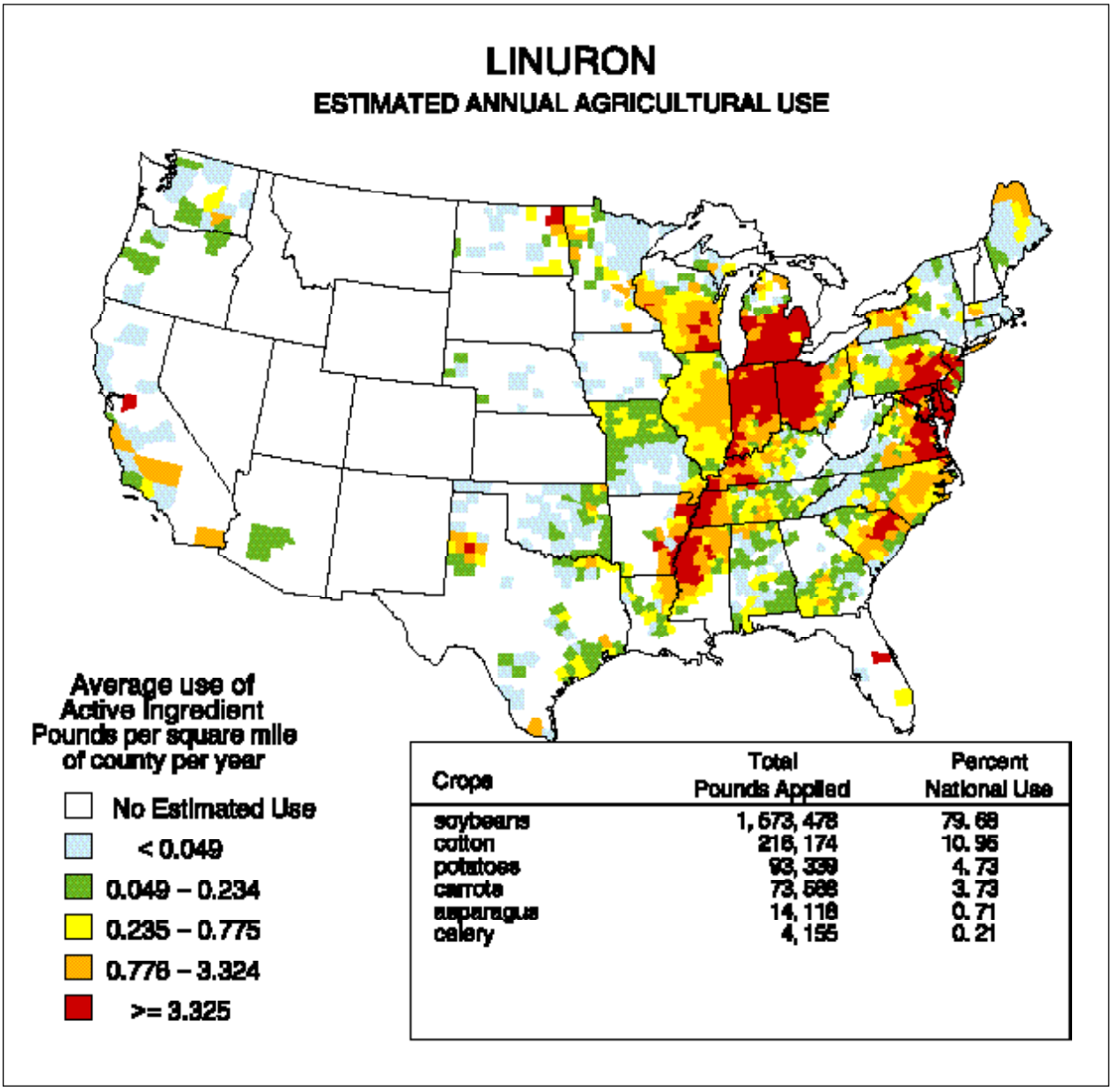


Figure 4.13. Linuron—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

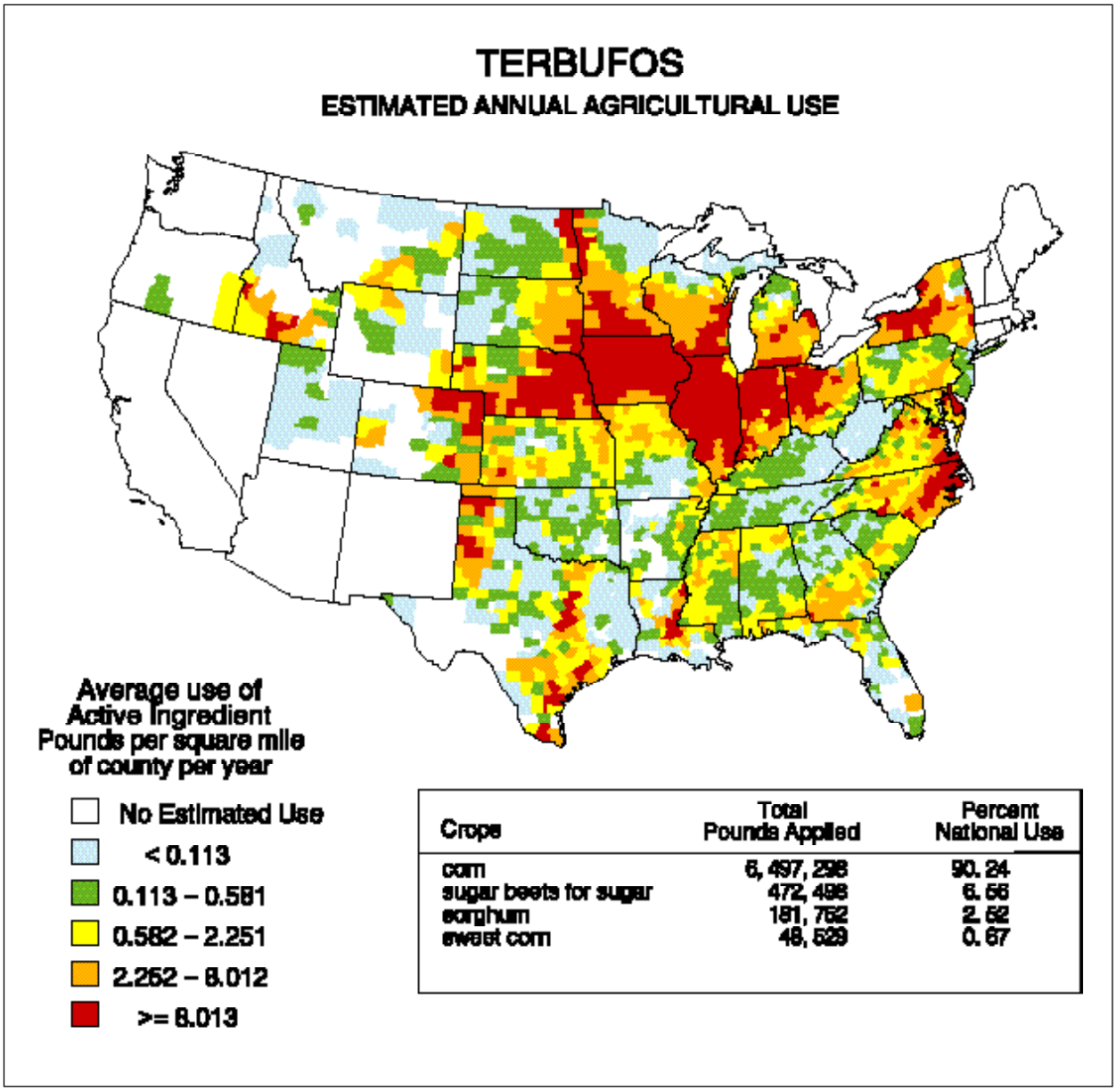


Figure 4.14. Terbufos—Estimated Annual Agricultural Use. National Pesticide Synthesis Project. *Maps of Annual Pesticide Use, 1992*. United States Geological Survey. National Water Quality Assessment Pesticide Program. Available on internet at http://water.wr.usgs.gov/pnsp/use92/.

Terbufos is an insecticide used on corn, sugar beet, grain, and sorghum crops. Terbufos appears on National Pesticide Synthesis Project maps in EPA Regions 2, 3, 4, 5, 6, 7, 8, and 10. (See Figure 4.14)

Aeromonas hydrophila, the only UCMR (1999) List 2 microbiological contaminant, is not reported in discharge data sources such as TRI. *Aeromonas hydrophila*, a bacterium that is indigenous to natural waters, is associated with human populations and fecal waste. Population density and wastewater discharge may affect prevalence, but its occurrence is considered to be ubiquitous in water distribution systems nation-wide.

4.2.3. UCMR (1999) List 3 Contaminants

There is one chemical contaminant and seven microbiological contaminants on the UCMR (1999) List 3. In general, the data available on the occurrence of the microbiological contaminants included on the final 1998 CCL are very limited. Thus, EPA listed all but two of the microbiological contaminants as occurrence priorities (the UCMR list). List 3 contaminants consist of lead-210 along with four viral and three other microbiological contaminants. [One other bacterial contaminant, *Aero-monas hydrophila*, is included in the UCMR (1999) List 2.]

Table 4.3. UCMR (1999) List 3 Contaminant Occurrence or Use by EPA Region

UCMR (1999) List 3 Contaminants		EPA Regions									
Contaminant	**Potential Environmental Source**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Chemical Contaminants											
Lead-210	Part of the uranium decay series; natural occurrence due to atmospheric fall out	Expected to occur in all Regions.									
Microbiological Contaminants											
Adenoviruses	Fecal or hand to mouth transmission	Expected to occur in all Regions.									
Cyanobacteria (blue-green algae), other freshwater algae, and their toxins	Bloom in surface water bodies; produce toxins	Expected to occur in all Regions.									
Caliciviruses	Contaminated food and water; raw shellfish	Expected to occur in all Regions.									
Coxsackieviruses	Fecal or hand-to-mouth transmission	Expected to occur in all Regions.									
Echoviruses	Fecal or hand-to-mouth transmission	Expected to occur in all Regions.									
Helicobacter pylori	Fecal or hand-to-mouth transmission	Expected to occur in all Regions.									
Microsporidia	Occur in rivers, ponds, lakes, and unfiltered water	Expected to occur in all Regions.									

The microbiological contaminants are not known to exhibit geographically restricted occurrence, although warmer regions may be susceptible to contamination for a longer period of time each year compared to cooler regions. All List 3 contaminants are considered to have the potential to occur throughout the United States.

Lead-210 (Pb-210) is an isotope in the uranium decay series along with polonium-210, radium-226, and radon-222. Lead-210, with a half-life of 22 years, has been found in drinking water. EPA is aware of the occurrence of these contaminant in shallow aquifers in Florida (Harada *et al.*, 1989; Upchurch 1991), and

in at least two other states. In addition, lead-210 is expected to occur naturally in essentially every part of the country as atmospheric fallout.

Adenoviruses are associated with respiratory and gastrointestinal illnesses. Some of these viruses may be spread via fecal-oral transmission. Adenoviruses discharged with sewage waste into lakes, rivers, and streams can survive to reach water intakes of downstream systems. If sewage or treated sludges are discharged to land, sufficient quantities of viruses may survive to contaminate the ground waters below. Adenoviruses are expected to occur in every EPA Region.

Caliciviruses are associated with gastrointestinal illnesses. These viruses are spread through contaminated water, food, and raw shellfish. Caliciviruses discharged with sewage waste into lakes, rivers, and streams can survive to reach water intakes of downstream systems. If sewage or treated sludges are discharged to land, sufficient quantities of viruses may survive to contaminate the ground waters below. Caliciviruses are expected to occur in every EPA Region.

Coxsackieviruses are associated with gastrointestinal illnesses. These viruses are spread through fecal transmission. Coxsackieviruses discharged with sewage waste into lakes, rivers, and streams can survive to reach water intakes of downstream systems. If sewage or treated sludges are discharged to land, sufficient quantities of viruses may survive to contaminate the ground waters below. Coxsackieviruses are expected to occur in every EPA Region.

Cyanobacteria (blue-green algae), other freshwater algae, and their toxins may appear in surface waters such as eutrophic lakes, rivers, streams, and reservoirs. Water systems using such sources are probably most susceptible to cyanobacteria contamination. However, given that States and EPA Regions have a wide diversity of water sources within them, this may be more of a local, rather than regional, issue.

Echoviruses are associated with gastrointestinal illnesses. These viruses are spread through fecal transmission. Echoviruses discharged with sewage waste into lakes, rivers, and streams can survive to reach downstream water intakes of downstream systems. If sewage or contaminated treated sludges are discharged to land, sufficient quantities of viruses may survive to contaminate the ground waters below. Echoviruses are expected to occur in every EPA Region.

Helicobacter pylori is a bacterium that has been identified as a causative agent of human gastritis and duodenal ulcers. *Helicobacter pylori* is spread through fecal or hand-to-mouth transmission and occurs ubiquitously throughout the U.S. surface waters and ground water under the direct influence of surface water are probably most vulnerable, so systems using these two sources may be more susceptible to contamination. However, this contaminant is nonetheless expected to occur in every EPA Region.

Microsporidia are waterborne unicellular obligate protozoon parasites. Microsporidia do not seem to have a restricted geographic distribution. Surface waters and ground water under the direct influence of surface water are probably most vulnerable, so systems using these two may be more susceptible to contamination. Because of possible zoonosis, regions with large animal stocks in their watersheds may be particularly susceptible to contamination, but there is no evidence as of yet to support this theory.

4.3. Conclusions

Few UCMR (1999) contaminants display a restricted, or ‘targeted’, geographic distribution. Almost every contaminant appears in at least seven of the ten EPA Regions, and even most of the exceptions are not restricted to one individual area. The herbicide molinate (List 1), which has the most restrictive geographic

distribution of the UCMR (1999) List contaminants, is used in four EPA Regions (although in Regions 4, 6, and 7 the areas of use are geographically conterminous).

4.4. References

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Section 5. The UCMR Sampling Rationale

As mandated by the 1996 SDWA Amendments, the purpose of the UCMR Program is to obtain occurrence data to support future regulatory decisions. The data required to make these decisions must be of high quality, and should provide an accurate reflection of the frequency of contaminant occurrence and the level of human exposure in public drinking water. To provide data of this caliber, EPA is requiring public water systems to monitor for UCMR (1999) List 1 contaminants over the course of a year, yet target sample collection for some samples to the period of greatest vulnerability. EPA believes that this approach will provide the most accurate data on possible human exposure to these contaminants given the budgetary and implementation constraints of the UCMR Program. The rationale for this approach is described below.

5.1. Sampling Plan for UCMR (1999) List 1 Contaminants

5.1.1. Sampling Locations

The nature and source of the chemical contaminant must be considered when designating a sampling location. The contaminants on List 1 of the UCMR (1999) List all have environmental sources related to various societal activities or waste disposal, such as the pesticides used for crop production, or MTBE used as a gasoline additive. If chemicals were included that were produced in the water treatment and distribution system, such as various disinfection by-products or lead (related to lead piping in parts of a water system) this would dictate a different sampling strategy. The sampling location for the chemicals on the UCMR (1999) List is at the entry point to the distribution system (EPTDS), i.e., a point after treatment where water enters the delivery system to be used by the public, or the compliance monitoring point monitoring point specified by the State or EPA under 40 CFR 141.24 (f)(1), (2), and (3).[1] This is the standard sampling location for drinking water chemical contaminants that originate in source water. The EPTDS is generally considered the preferred sampling location for a program such as the UCMR that needs to assess human exposure through drinking water. Concentrations in the raw source water may change through treatment, thus sampling at the source would not necessarily provide an accurate measure and could confound the analysis.

5.1.2. Temporal Variability and Vulnerability

A major factor considered in the design of the UCMR Program was the timing of sample collection, i.e., are there periods during the year that are more likely to find detections or greater concentrations of a contaminant than others. As the UCMR attempts to develop an initial evaluation of these emerging contaminants, it is important to optimize the sampling to maximize the likelihood of their detection. Yet the possible sampling scenarios must also fit within a reasonable cost and burden framework for the public water systems (PWSs), EPA, and the States. In addition, to the extent possible, the sampling strategy should be compatible with the compliance sampling already required of PWSs. List 1 of the UCMR (1999) List includes various synthetic organic compounds (SOCs; primarily pesticides), volatile organic compounds (VOCs), and a man-made inorganic compound (perchlorate). To assess possible sampling strategies for the List 1 contaminants, sampling strategies that accounted for the temporal variability of more widely studied non-UCMR SOCs and VOCs were examined, with the goal of deriving an analogous sampling strategy for the UCMR. The data reviewed below were compiled for EPA's considerations of revisions to regulated chemical monitoring requirements. Further background information is presented in *A*

Review of Contaminant Occurrence in Public Drinking Water Systems (1999; EPA 816-R-99-006), particularly for the State-PWSs data discussed below.

5.1.2.1. General Trends

Water quality studies and monitoring throughout the United States have clearly shown that occurrence and/or concentration for some contaminants may vary over time, both seasonally as well as from year to year. The seasonality of contaminant occurrence, or period of peak concentration, commonly varies with seasonal changes in the hydrologic cycle in relation to the source of contaminants and their fate and transport characteristics. Particularly for land-applied or land-disposed contaminants, the seasonal increase in the flux of water (e.g., spring rains) can mobilize contaminants and move them into surface or ground water flow systems. For the most vulnerable of water systems, such as surface waters, unconfined shallow ground water, and karst flow systems, for example, contaminant occurrence or peak concentrations typically occur during annual runoff and recharge periods. Targeting UCMR monitoring to these vulnerable time periods improves the accuracy of exposure estimates. However, there are concerns about the cost effectiveness of seasonal targeting approaches. If, for example, many of the List 1 contaminants exhibit different seasonal patterns, trying to seasonally target all the different contaminants could lead to a very complex and costly UCMR monitoring regimen.

For much of the United States east of the Rocky Mountains, many studies have shown the season of greatest vulnerability for contaminant occurrence is the late-spring, early-summer runoff-recharge period. This has been well established from detailed source water monitoring data, particularly for contaminants such as pesticides and nitrate (Larson *et al.*, 1997; Barbash and Resek 1996; Hallberg 1989a; Hallberg 1989b). For example, Figure 5.1 summarizes pesticide concentrations in streams from the USGS NAWQA studies. This national summary shows the concentration of pesticides in agricultural areas peaking from May through July. For streams draining urban areas the concentrations are lower, and they do not show such pronounced seasonality, though May through July would still include most of the peak period.

For deeper, more confined ground water systems, defining vulnerable periods is much more difficult. The exact flow path is more complex, and the time of travel much greater, and these are dependent on many factors unique to a particular well and aquifer setting (Hallberg and Keeney 1993). However, as depth of ground water increases (and vulnerability decreases), seasonal variability typically decreases (Barbash and Resek 1996). There is no seasonal generality that can be applied to these deeper ground water settings.

5.1.2.2. Synthetic Organic Compounds (SOCs)

State SDWA occurrence data were analyzed for seasonal patterns which might provide some insight into possible UCMR monitoring schedules. Unraveling such patterns from data aggregated from many different water sources and systems is difficult, at best. The clearest examples are for the high occurrence pesticides. Figure 5.2 illustrates the typical seasonal pattern for atrazine (a regulated pesticide) occurrence with peaks in May-July, but the number of CWSs with high monthly means decreases slowly through the fall and winter. This is one way to examine occurrence patterns.

Figures 5.3 and 5.4 also illustrate seasonal patterns for pesticides, as well as the problems that can be encountered in using drinking water data for such analyses. These data are from a State of Ohio special study of pesticide/SOC occurrence in surface water systems (Ohio EPA 1998). May to July peaks in the percentage of systems with detections are evident, particularly for the pesticides that occur more intermittently. For atrazine, however, the months with the greatest percentage of systems with detections appear to be September and December. It was concluded that the September and December peaks are largely artifacts of the sampling regimen, and the systems required to sample. Not all systems sampled in

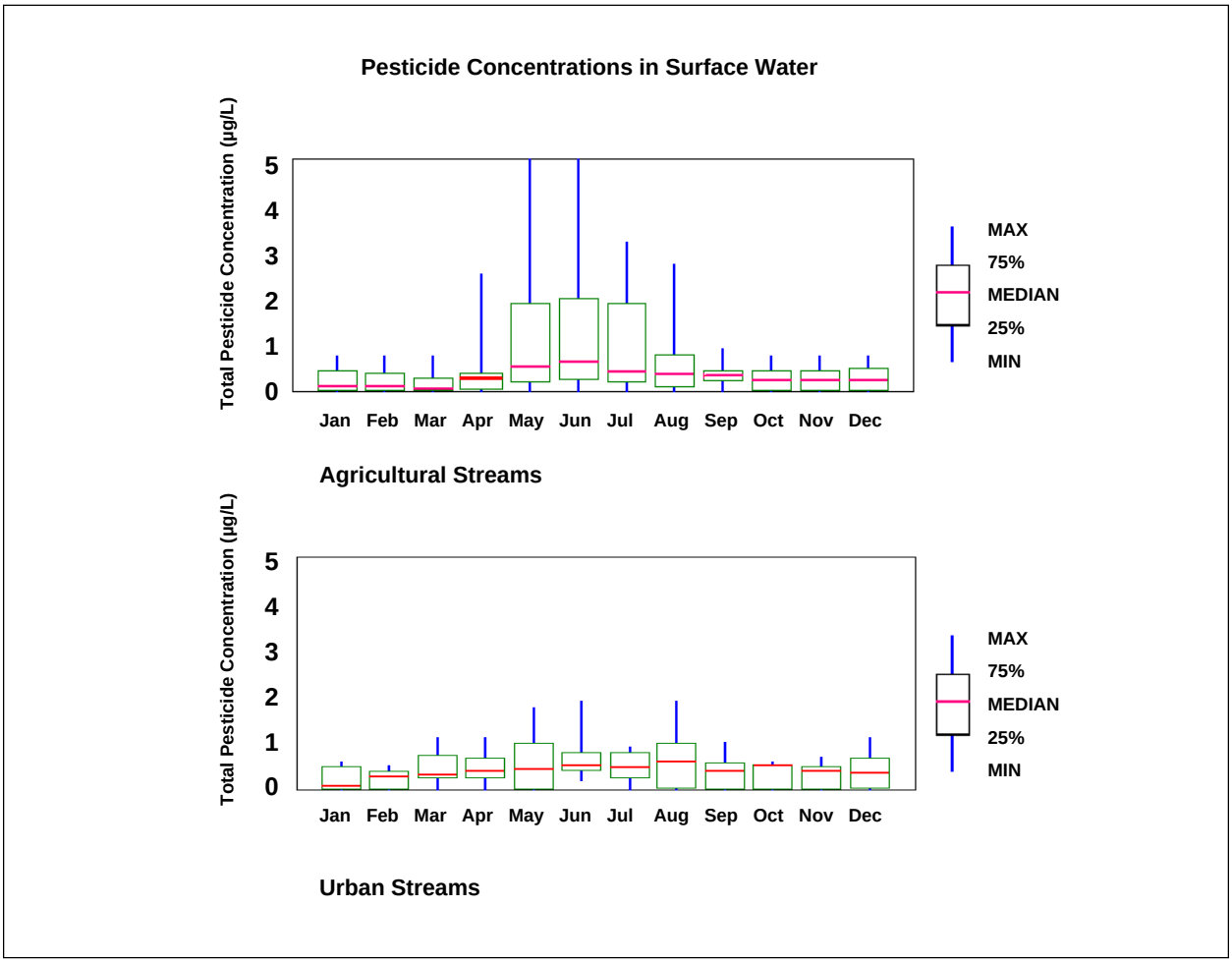

Figure 5.1. Pesticide Concentrations in Surface Waters. This figure presents a summary of total pesticide concentrations in streams samples monthly in the USGS NAWQA Program, for streams affected by runoff from agricultural and urban lands. Adapted from Larson, S.J., R.J. Gilliom, and P.D. Capel. 1999. Pesticides in streams of the United States — Initial Results from the National Water-Quality Assessment Program: USGS Water-Resources Investigations Report 98-4222, 92 p.

the fall and winter; only those systems that were known, or suspected to have year-round occurrence were required to sample. Hence, in September 100 percent of the systems sampling had detections. The seasonal occurrence pattern is more clearly defined looking at the maximum concentrations detected by month, where May, June, and July clearly stand out.

As illustrated by this example, analyzing State PWS data can be complicated because so many sources of variation have been aggregated. For example, State data include many different systems, with different source waters and sampling schedules, sampling over various years, all in relation to various contaminant source characteristics. This can result in "smoothing" out the seasonal variation (e.g., percentage of systems with atrazine, Figure 5.3), especially for persistent contaminants that may be present all year. The aggregation of systems and source characteristics particularly confound analysis of ground water systems, but also affects the analysis of surface water systems. For example, detailed studies by the USGS and others have shown that the seasonal response in reservoirs may be very different than in streams, and these are both typically identified simply as surface water sources in the PWS databases.

Small streams are more immediately affected by runoff events, and therefore contaminant concentrations are generally greater in small streams than in large streams (which integrate a greater area). While this changes the details of temporal patterns (at the daily-weekly level), the broader seasonal patterns are

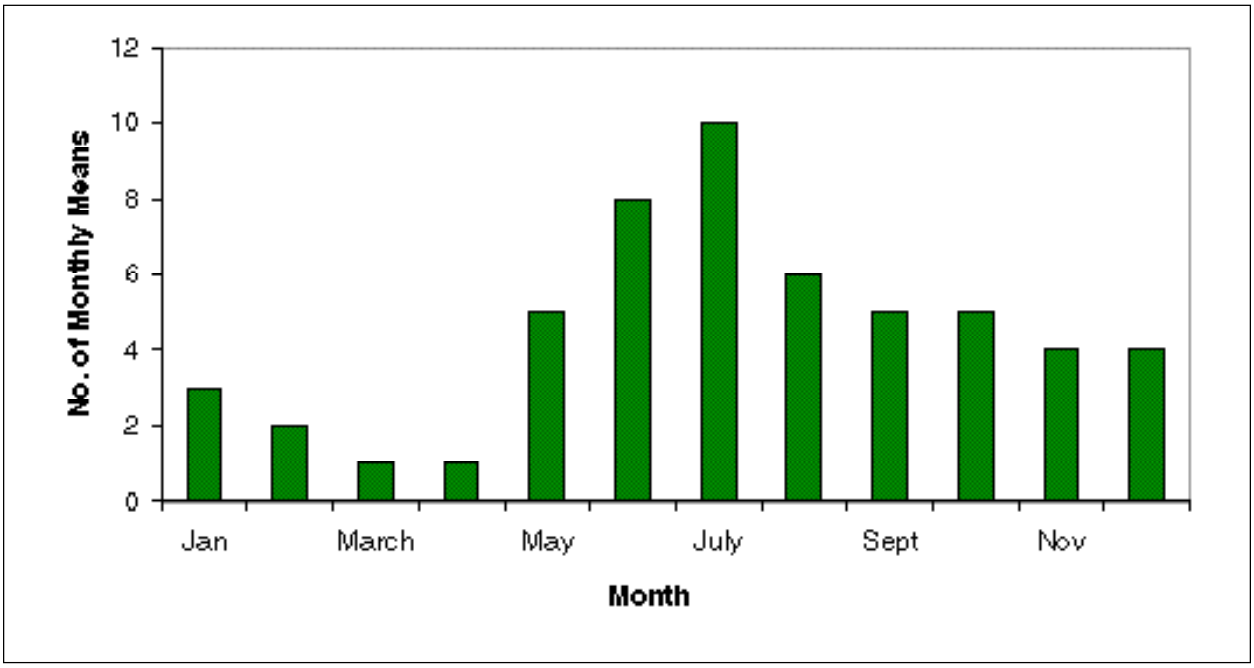

Figure 5.2. Number of CWSs with Monthly Mean Atrazine Concentrations Above 3.0 µg/L. Data reflect monthly mean atrazine concentrations in raw water. Data are from a special sampling study in Iowa, by Novartis Crop Production (Novartis 1997; Clarkson *et al.*, 1997).

similar. Reservoirs, however, store these runoff-related events, and contaminant variations appear to be dampened. The high concentrations that enter during runoff may be stored for some time (e.g., months), and year-to-year variation may be more important than seasonal variations in reservoirs and lakes, depending upon reservoir size, land use in the watershed, and the reservoir turnover rate (Battaglin and Goolsby 1998; Scribner *et al.*, 1996).

Some studies have also shown secondary peak concentrations of some pesticides in fall and winter months with discharge from urban areas, but these are of much lesser magnitude than the spring period occurrence peaks (Coupe *et al.*, 1995). Also, seasonal patterns are different in the Pacific west, for example, where fall and winter are important rainfall and recharge periods and patterns can be complicated by irrigation schedules or release from irrigation storage reservoirs in the arid west (Larson *et al.*, 1997; Kuivila and Foe 1995).

5.1.2.3. Volatile Organic Compounds (VOCs)

Many SOCs, the pesticide compounds in particular, exhibit strong seasonal occurrence patterns because their application, or discharge into the environment, is concentrated seasonally. Particularly for pesticides used in broad-scale grain production, the application season is relatively focused in the spring and early summer and coincides with annual runoff and recharge periods. This coincidence is optimal to produce seasonal patterns of pesticide occurrence in vulnerable waters. In contrast, VOCs do not typically show such seasonality in source or discharge into the environment. Studies of individual water systems, or hydrologic settings sometimes show patterns that parallel seasonal hydrologic patterns, but on a large scale, no clear, general patterns emerge.

Figures 5.5 through 5.8 summarize various occurrence data by month and water source. The VOC data were analyzed in a number of ways, ranging from the monthly number or percent of samples and systems with detections (greater than the minimum reporting level [MRL], greater than one-half the maximum contaminant level [MCL], and greater than the MCL), the percentage of detections per month as

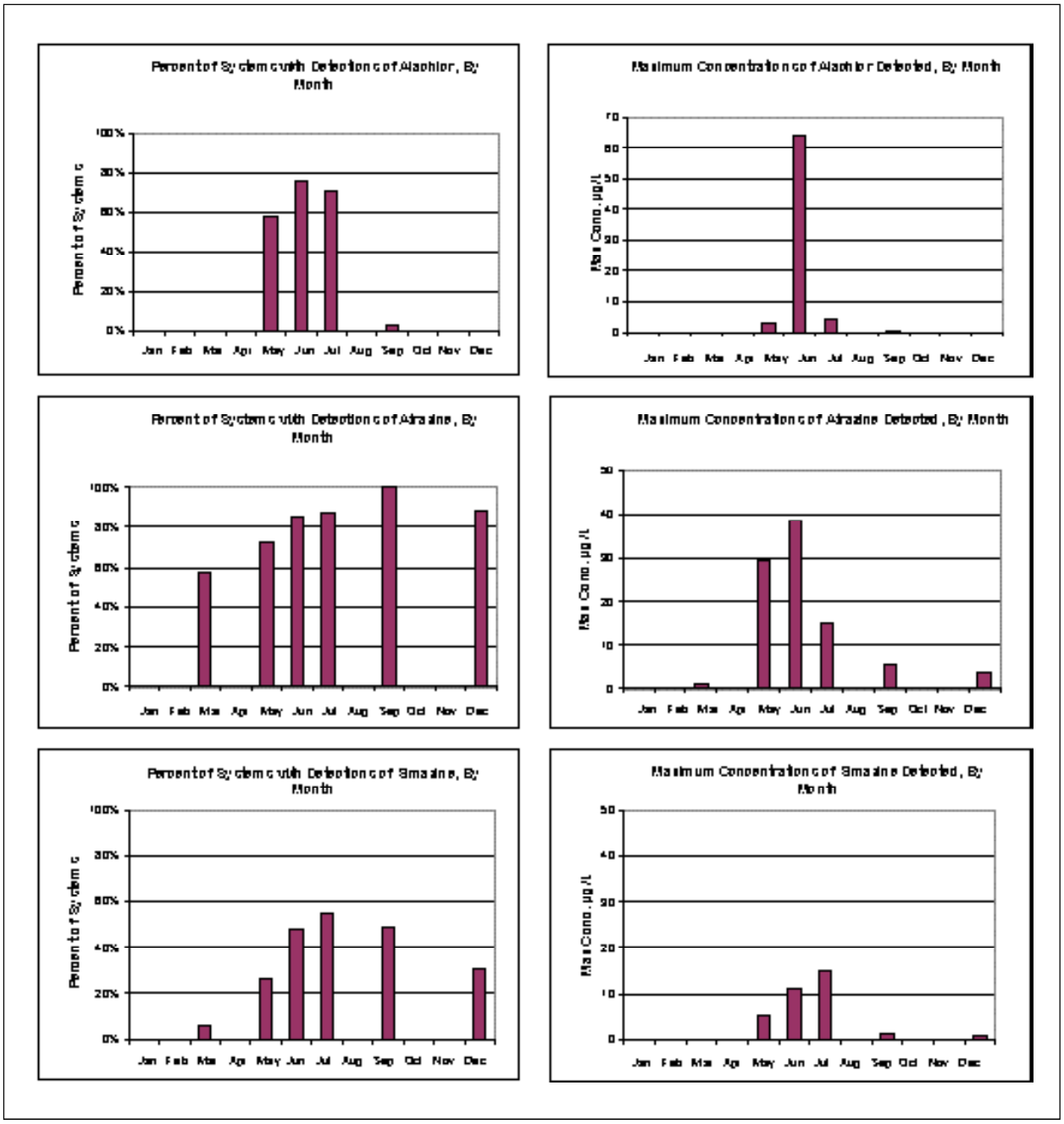

Figure 5.3. Percentage of Surface Water Systems with Detections and Maximum Concentration Detected, by Month, for Alachlor, Atrazine, and Simazine, in Ohio (Ohio EPA 1998).

a function of all detections and the portion of systems sampling per month, as well as monthly concentrations (median, 95th percentile, maximum). Even individual systems with common occurrence were isolated to assess possible temporal trends.

No systematic trends were apparent. All the results look similar to the examples in Figures 5.5 through 5.8. There are no consistent seasonal patterns that emerge for VOCs. Figure 5.5 shows monthly charts for xylene for several States. From the ground water systems from Illinois and the surface water systems from Michigan a 'bell-shaped' occurrence pattern, peaking in mid summer might be surmised. However, the Illinois surface water systems alternate peaks and declining values. Oregon shows a peak in December, but this could be a function of Oregon's different climatic regimen.

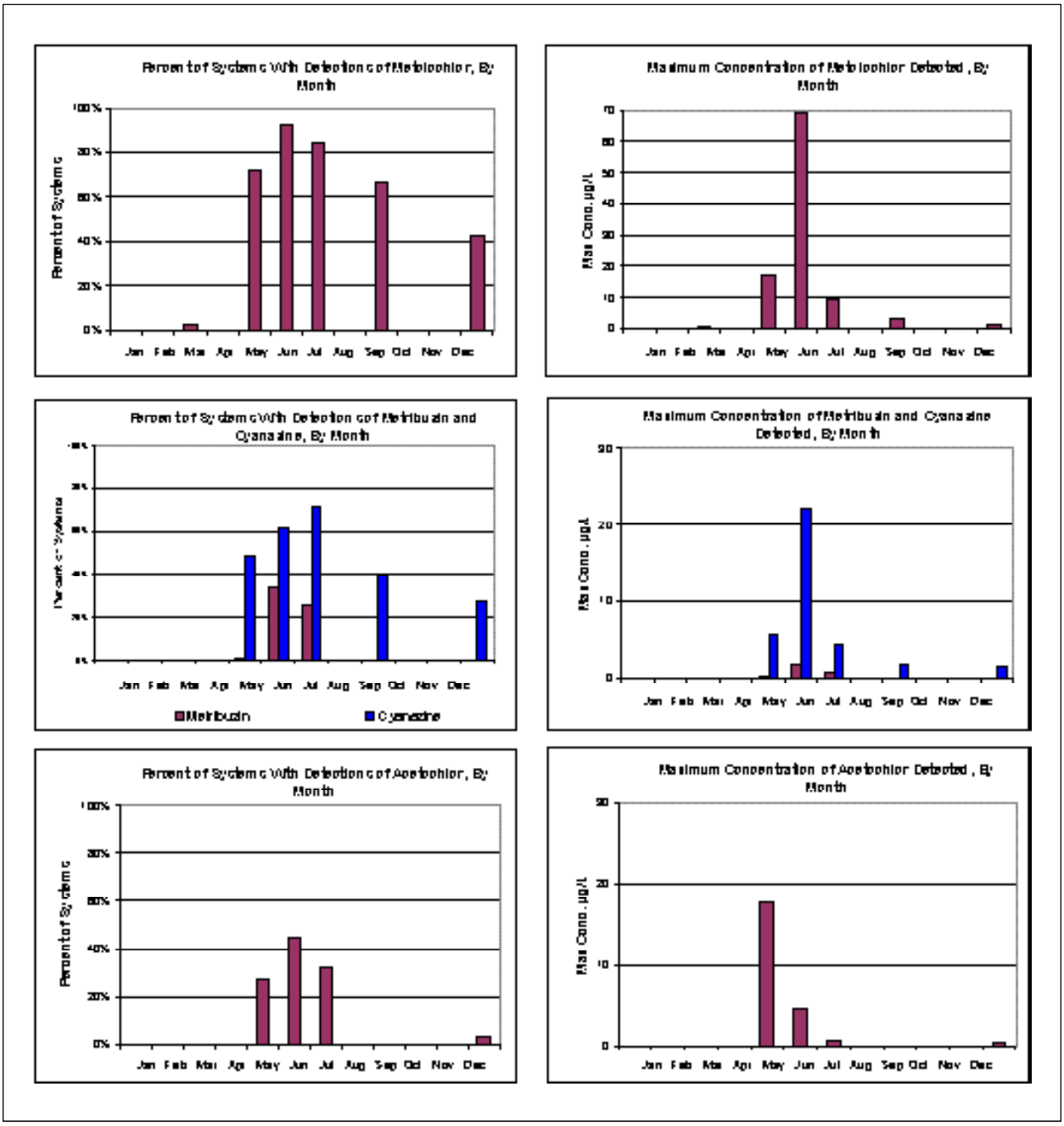

Figure 5.4. Percentage of Surface Water Systems with Detections and Maximum Concentration Detected, by Month, for Metolochlor, Metribuzin, Cyanazine, and Acetochlor, in Ohio (Ohio EPA 1998). (In the Metribuzin and Cyanazine chart, Cyanazine is depicted in the gray/striped column.)

Other analysis in these States suggest that the patterns are more related to what systems are sampling, rather than a seasonal pattern, especially when groups of related contaminants are viewed. For example, Figure 5.6 shows several related VOC contaminants for one State. (These VOCs are light molecular compounds that are constituents of gasoline and other petroleum distillates and generally show similar behavior.) Hints of seasonal patterns for one contaminant are out of phase with others. For ground water systems, for xylene, an overall "bell-shaped" pattern occurs, except that the lowest month is in the middle of the bell. Figure 5.7 and 5.8 show a similar lack of pattern for the heavier VOCs (tetrachloroethylene and trichloroethylene), and all VOCs aggregated.

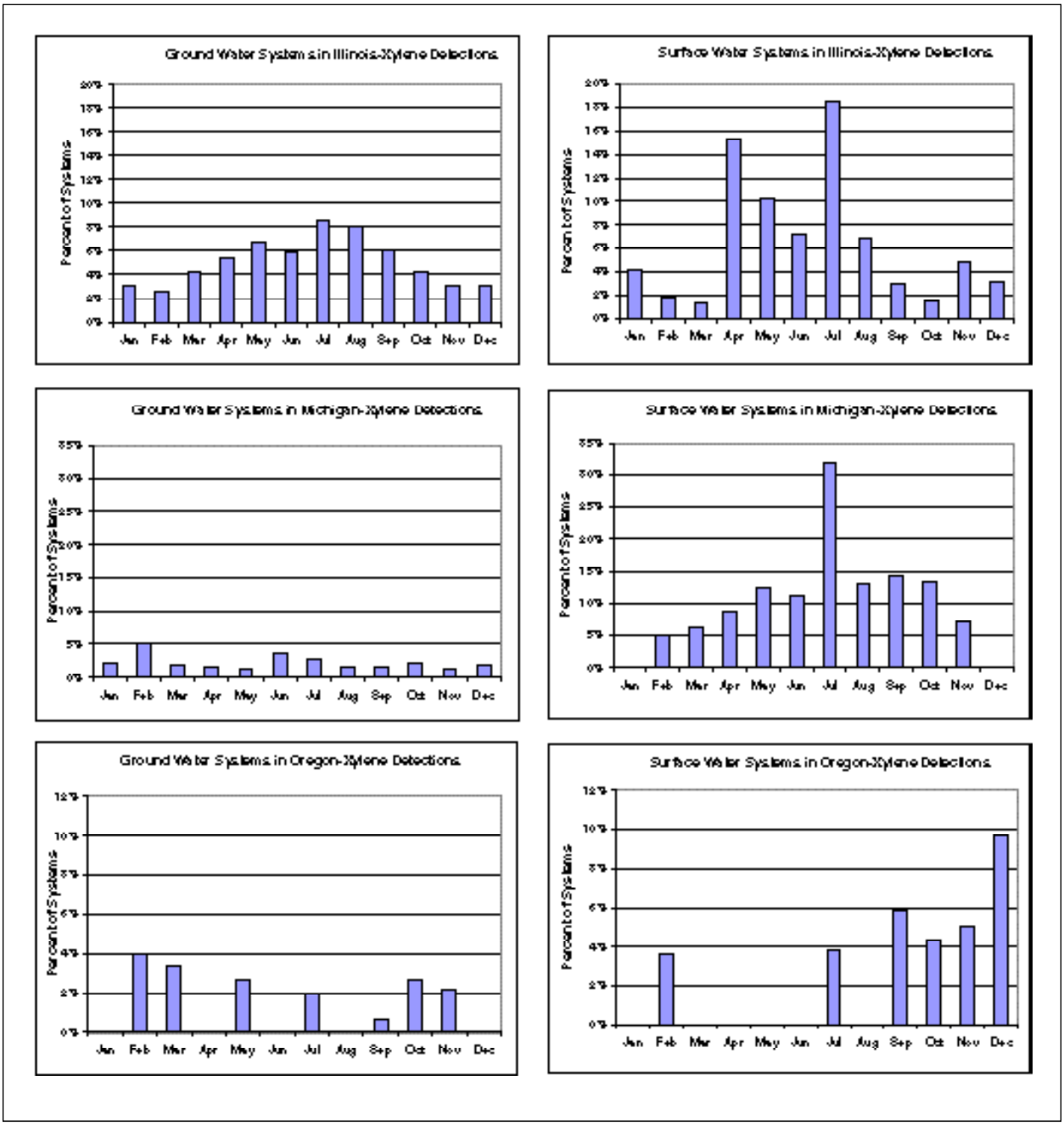

Figure 5.5. Percentage of Systems with Detections of Xylene, by Month and Water Source, for Three States.

While there are undoubtedly individual water systems or watersheds where seasonal patterns could be productively targeted, this would need to be developed by individual States and systems, from detailed, local information. Unlike many SOCs, there are no general patterns for VOCs that are evident on a regional, let alone a national basis.

5.1.3. Implications For UCMR Monitoring

The impetus to target UCMR monitoring to vulnerable time periods is based on the recognition that simple quarterly monitoring often does not provide adequate sampling coverage for exposure estimates of contaminants with seasonal peak concentrations. Figure 5.9 shows a schematic annual concentra-

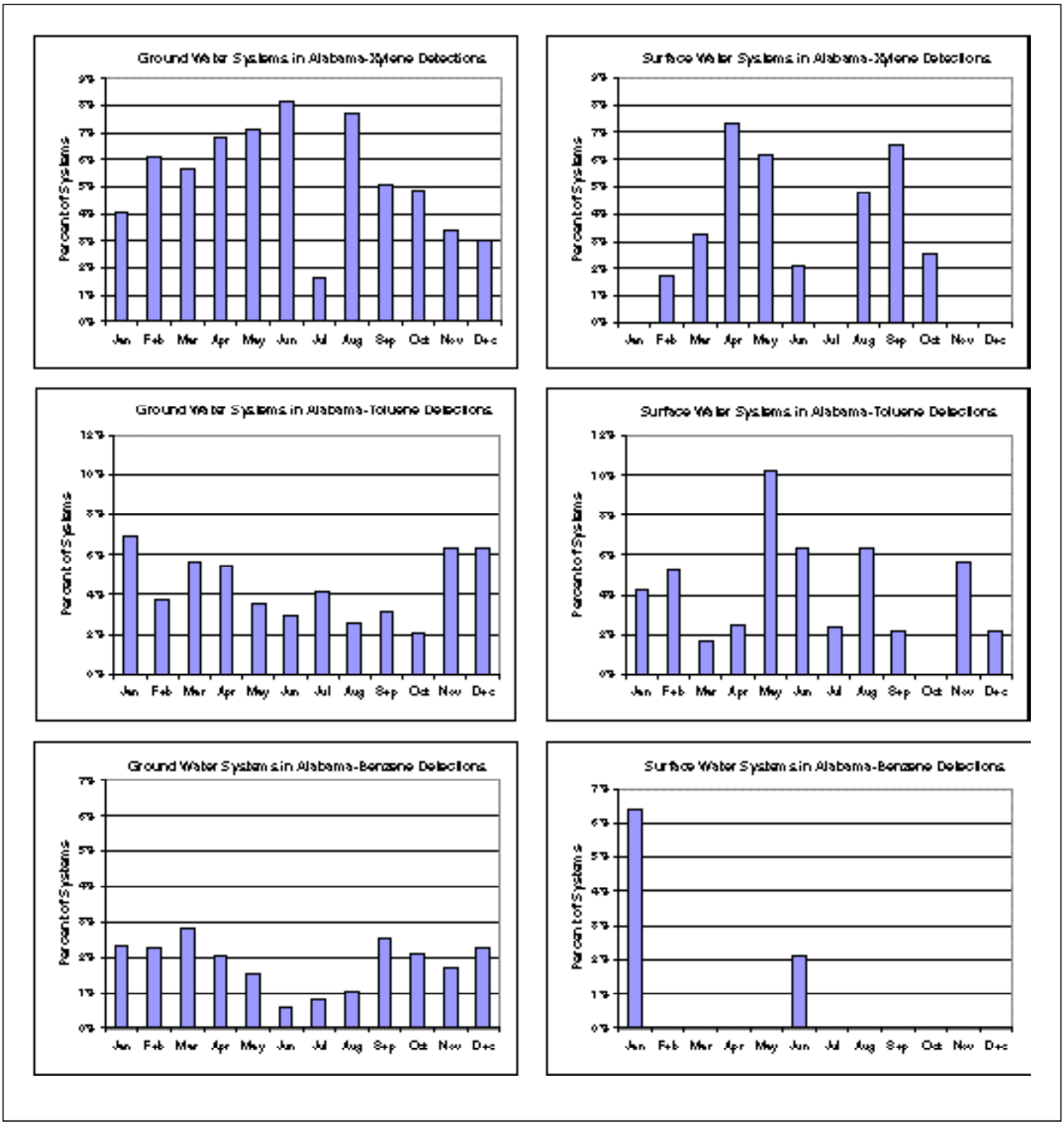

Figure 5.6. Percentage of Systems with Detections of Xylene, Toluene, and Benzene, by Month and Water Source, for Alabama.

tion record (generated from herbicide concentration data from a Midwestern river with high-ground water baseflow), and three sampling scenarios. This concentration distribution is typical of strong seasonal contaminant occurrence patterns commonly found in agrichemical impact studies. Without special treatment, such a concentration pattern would also be apparent in finished drinking water derived from this type of source (Hallberg 1989a; Hallberg *et al.*, 1996).

In one scenario, quarterly water samples could be collected at times labeled **A** during the year. This sampling regimen would, by chance or by choice, significantly underestimate the annual average concentration. In scenario **B**, which collects one quarterly sample during the May-July peak period, an

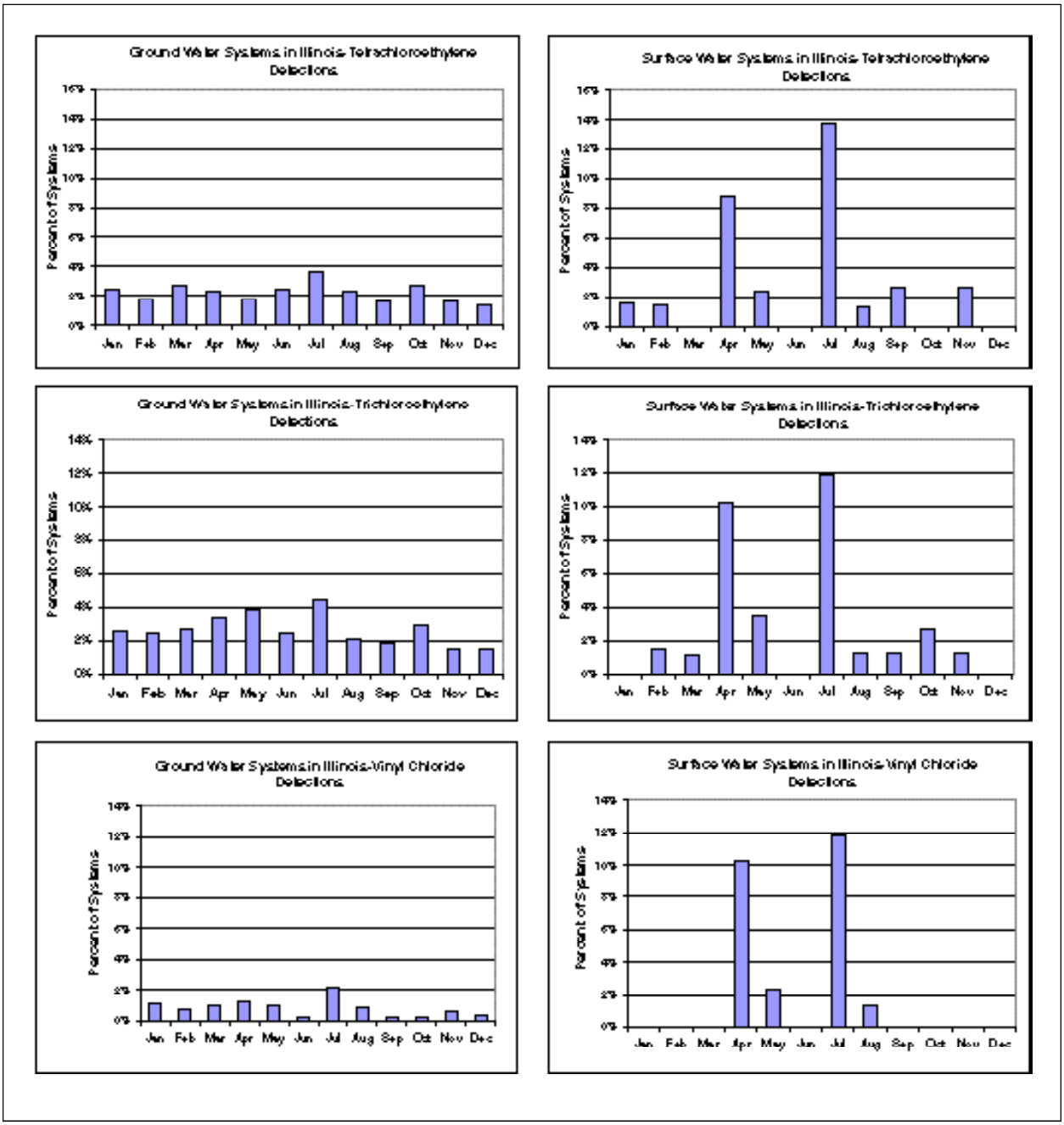

Figure 5.7. Percentage of Systems with Detections of Tetrachloroethylene and Trichloroethylene, by Month and Water Source, for Illinois.

underestimation of occurrence may still occur, but the sampling scenario would generate data with a better representation of the peak season of contaminant occurrence.

Statistical studies of surface water sampling strategies (e.g., Battaglin and Hay 1996) show that a strategy which incorporates sampling during spring and early summer runoff periods provides a more accurate representation of annual occurrence than does random quarterly sampling (that can miss or avoid these runoff-period months, as in scenario **A** in Figure 5.9). In these studies, the USGS evaluated how ten different sampling strategies affected the accuracy of the estimates of annual mean concentration of herbicides. The accuracy of a particular strategy's estimate was computed by comparing time-weighted annual mean concentrations calculated from detailed water sampling at 17 locations with the annual mean

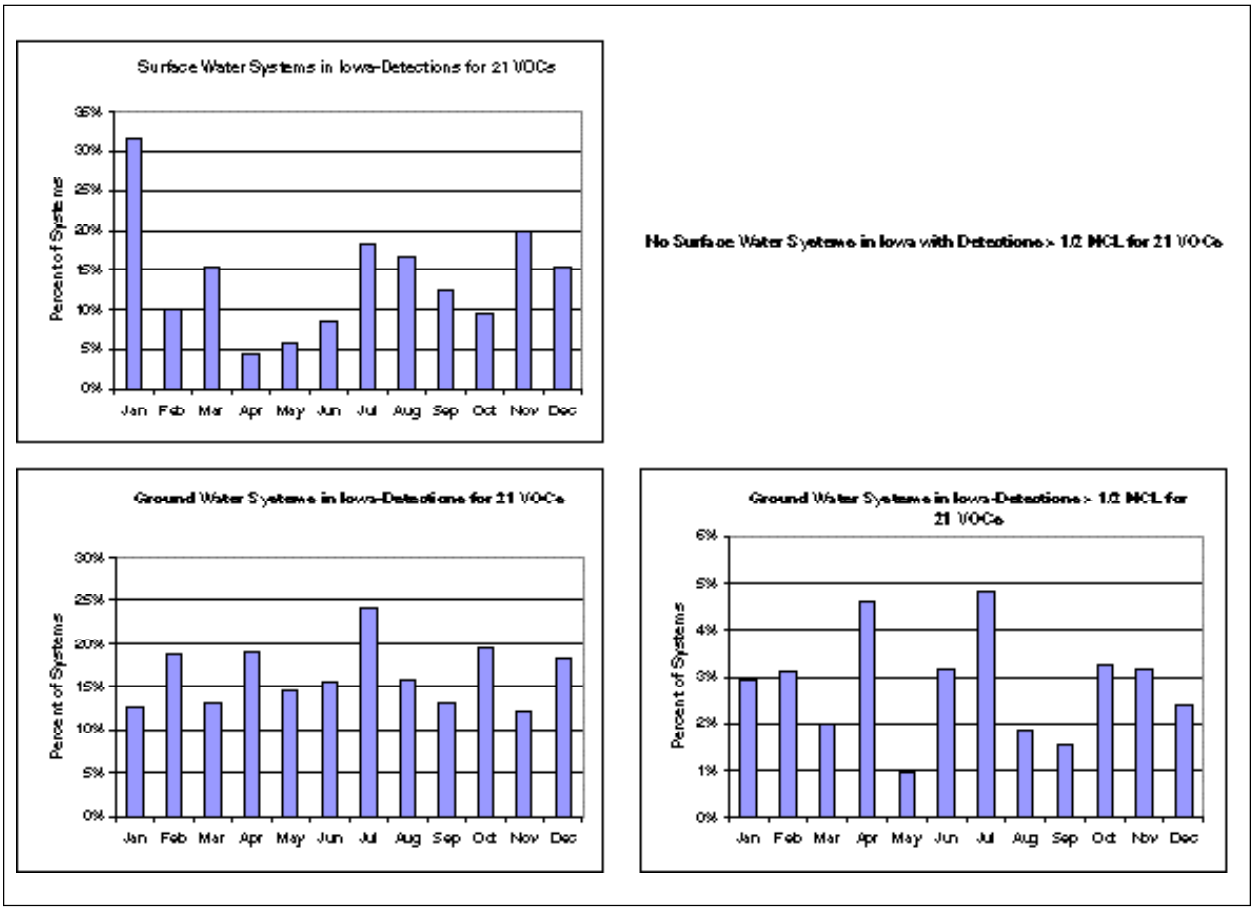

Figure 5.8. Percentage of Systems with Detections (>MRL, >0.5MCL) of Any of the 21 Regulated VOCs, by Month and Water Source, for Iowa.

estimated by each sampling strategy, using 1000 Monte Carlo simulations for each strategy. In other words, each sampling strategy was simulated using 1000 different combinations of sampling times throughout the year. The results were compared to a tolerance value around the actual mean from the detailed water-quality data. Pertinent results are summarized in Table 5.1. A value of ± 0.75 µg/L around the actual annual concentration mean was used for the tolerance.[2] The table summarizes the percentage of sampling simulations within tolerance (i.e., over or under the actual mean plus or minus the tolerance value). A result over or under the tolerance value indicates that a sampling strategy overestimates or underestimates, respectively, the actual mean concentration.

Quarterly sampling underestimated the mean in 20 percent of the random simulations, and was within the tolerance 63 percent of the time, assuming a random distribution. The quarterly results appear much more accurate than Scenario **A** would imply because the random simulation results in at least one-third of the simulations collecting samples during the peak months. Monthly sampling was the most accurate, but such a sampling strategy for the UCMR would be particularly burdensome both with respect to cost and burden to the PWSs that will be collecting samples. However, three scenarios are nearly as accurate as monthly, and would not require as high a frequency of sampling.

Strategies which sample once each in May and June (and consider the other 10 months as zeros), or once in April, May, and June (with 9 zeroes), or once each in April, May, June, and July (with 8 zeros), range from 81 percent to 84 percent within the tolerance of the actual annual mean. A sampling scenario such as **C**, in Figure 5.9, could provide a more accurate view of drinking water quality, while still only requiring four samples per year. This sampling strategy targets three samples in the identified vulnerable

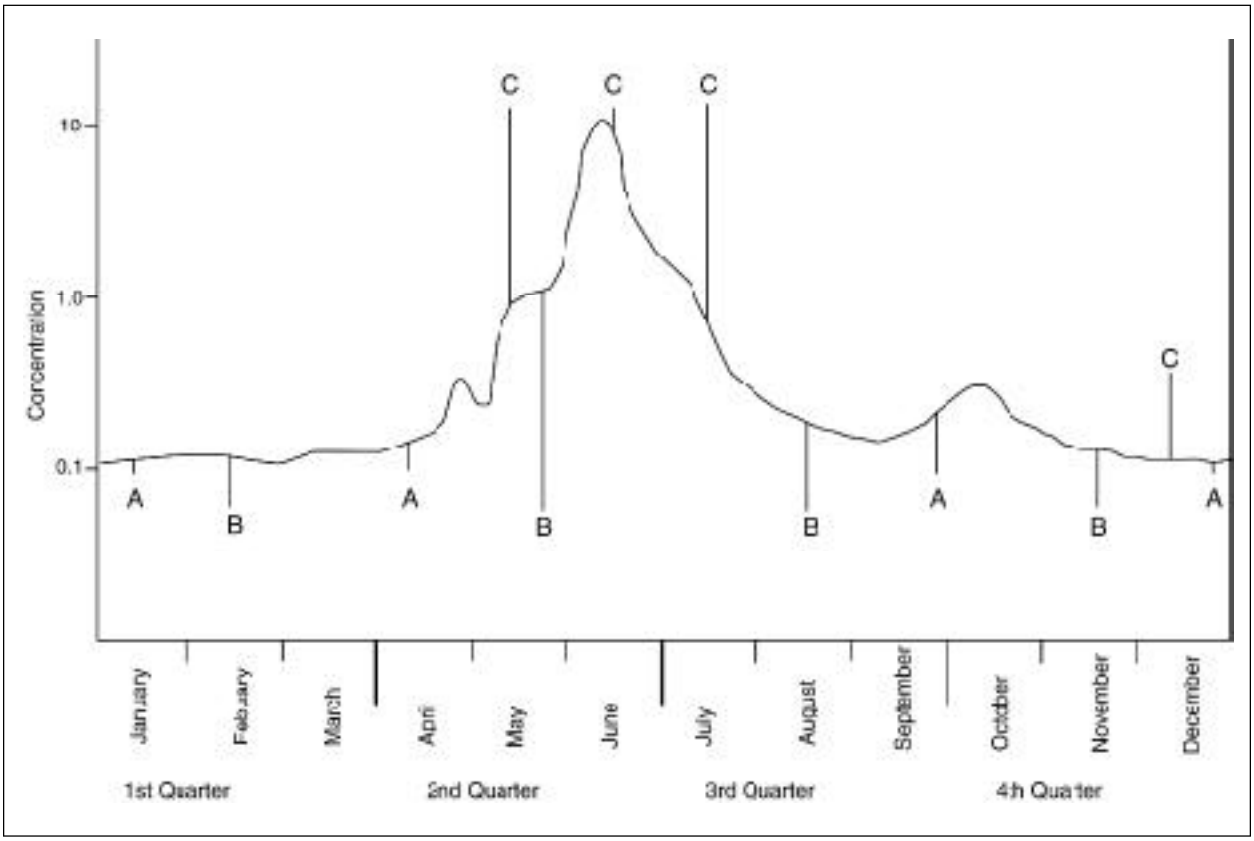

Figure 5.9. Schematic Annual Contaminant Concentration Profile, with Three Sampling Scenarios (A, B, and C). The schematic profile is derived from actual herbicide concentration data from a Midwestern stream.

months, and collects a fourth sample during the off-season to provide a more complete record. With the strong seasonal contaminant occurrence patterns, the fall-winter background sample would have a similar numerical effect as the "zero" assumption in the simulations, but would provide a more continuous record.

One ground water study suggests that the more vulnerable aquifers also show seasonal contaminant occurrence peaks during these periods (Pinsky *et al.*, 1997). Targeting the peak periods would also be

Table 5.1. Percentage of Monte Carlo Simulations Within, Over, or Under ± 0.75 µg/L of theTime-weighted Annual Mean Atrazine Concentration.

Sampling Strategy	Percentage of Simulations withing Tolerance of ±0.75 µg/L of the MCL		
	Within	Over	Under
1 each, April, May, June, July	39%	53%	7%
Quarterly	63%	16%	20%
1 in June w/ 11 zeros	58%	1%	40%
1 each in May, June, w/ 10 zeros	81%	5%	14%
1 each in April, May, June w/ 9 zeros	82%	5%	13%
1 each in April, May, June, July w/ 8 zeros	84%	6%	9%
Monthly	85%	7%	8%

Note: Annual mean atrazine concentrations in the study were time-weighted. There were 1000 simulations generated for each of the seven sampling strategies listed here, and were conducted for all sites. The 0.75 µg/L is equivalent to 25% of the atrazine MCL (Battaglin and Hay 1996).

appropriate for such aquifers. From the data and literature reviewed, such a targeting strategy for List 1 SOCs would be adequate for exposure estimates. Most of the data suggest that most organic contaminants will vary in the same seasonal pattern, or, as with many VOCs, will show little systematic variance. Hence, List 1 VOCs might be sampled on a similar schedule and perhaps not lose resolution. However, this sampling strategy will always be most effective if States and systems use their knowledge of local conditions and activities to define seasonal vulnerability patterns, and to adjust sampling schedules accordingly. For example, in the Pacific west, some pesticides show peak concentrations in fall-winter because of the use of pesticides on orchards during their dormant season. The fall-winter months comprise the rain/runoff season in this climate, and, in some cases, dictate reservoir release schedules (Kuivila and Foe 1995; Larson *et al.*, 1997).

There is no simple, single guideline that addresses all contaminant and water source situations and yet keeps in balance the frequency and burden of monitoring. Current contaminant source and fate knowledge is incomplete, particularly for many of the new contaminants included in the UCMR. Also, considering the variety of List 1 contaminants (various pesticides, VOCs, and an IOC) and scheduling constraints (both laboratory capacity and compatibility or coordination with current compliance monitoring), a highly targeted seasonal approach may not be feasible or warranted. Alternatively, requiring PWSs to collect samples for UCMR contaminants monthly would be particularly burdensome both with respect to cost and burden to the PWSs conducting sampling. Given these considerations, EPA is requiring that PWSs using surface water, or ground water under the influence of surface water, sample for UCMR (1999) List 1 contaminants four times per year, and that systems using ground water sample two times per year.

For all systems, one of the sampling events must fall between May 1 and July 31, or an alternative period of greatest vulnerability, as specified by the State or EPA (§141.40(a)(5)). An example of an alternative period would be September 1 to November 30 for States in the Pacific Northwest. For systems using groundwater, the other sampling event must be between 5 and 7 months either before or after the sampling event during the May-July vulnerable period, or other vulnerable period as specified by the State or EPA (§141.40(a)(5)). Surface water systems must sample in the same month of each of four consecutive quarters (i.e., January, April, July, and October) to ensure that one sample is collected during the May-July vulnerable period, or other vulnerable period as specified by the State or EPA (§141.40(a)(5)). By requiring that some samples are targeted to the most vulnerable May through July period, EPA hopes to ensure representation of the peak vulnerable period for many UCMR (1999) List 1 contaminants. Also, as exposure estimates do not have to be based exclusively on an average of four measures per year, EPA is requiring systems using ground water to sample only two times per year (§141.40(a)(5)). All UCMR data can be evaluated to construct a more accurate model of seasonal occurrence that would allow additional considerations to be included.

5.2. Sampling Plan for UCMR (1999) List 2 Contaminants

This document is intended to provide technical background information for the UCMR, with a focus on the UCMR (1999) List 1 contaminants. However, some information is available that may be used in developing sampling plans for the Screening Survey and Pre-Screen Testing components of the revised UCMR Program. EPA is currently developing the sampling plan for the Screening Surveys. Additional information will be made available upon promulgation of the Screening Survey component of the UCMR Program. Included below is a brief discussion of issues related to the development of a sampling plan for the UCMR (1999) List 2 contaminants.

5.2.1. Sampling for List 2 Chemical Contaminants

As discussed above, EPA is currently developing the sampling plan for the UCMR (1999) List 2 contaminants. At this time, EPA has not evaluated various sampling strategies specifically for the List 2

chemical contaminants. However, EPA anticipates that the sampling plan for List 2 chemicals will be very similar to that developed for the List 1 contaminants, at least with respect to frequency, timing, and location of sampling. Nearly all of the List 2 chemicals are either agricultural SOCs or industrial VOCs. Thus, many of the issues discussed above are relevant to List 2 chemicals as well. The only naturally-occurring chemical contaminant on List 2 is polonium-210, an alpha-emitting decay product of radon-222 and part of the uranium decay series. Data are limited with respect to the temporal variability of occurrence of this contaminant, but it is unlikely, given the other contaminants to be included in the Screening Surveys, that a different sampling plan would be necessary for monitoring polonium-210.

5.2.2. Sampling for *Aeromonas hydrophila*

As EPA had originally proposed to include *Aeromonas hydrophila* on List 1 of the UCMR and thus monitor for it under Assessment Monitoring, preliminary data have already been collected and evaluated for use in developing a monitoring strategy for this contaminant. A summary of this information is provided below. However, it is important to note that EPA is reevaluating these data and continuing to develop an appropriate sampling plan for *Aeromonas*. Additional information on the UCMR sampling strategy for *Aeromonas* will be made available at the time of promulgation of the Screening Survey component of the UCMR Program.

5.2.2.1. Initial Occurrence Data

Aeromonas hydrophila is a bacterium that is indigenous to natural waters. It has been implicated as a cause of traveler's diarrhea and other types of infection. Transmission of *Aeromonas* is suspected to occur via a waterborne route, although a definite link has not been established (Holmes *et al*., 1996). *Aeromonas* has been observed in drinking water distribution systems, especially in locations with low residual chlorine levels (Holmes *et al*., 1996). Because of the possible occurrence of *Aeromonas* in treated drinking water and its potential health effects, EPA feels it necessary to obtain more information about the occurrence of *Aeromonas* in drinking water and the factors responsible for its presence.

Some research has been done on *Aeromonas* occurrence and factors that influence its occurrence in water distribution systems. Gavriel and colleagues detected *Aeromonas* in 21 of 31 treated water reservoirs in Scotland (Gavriel *et al*., 1998). These authors found that, in general, the likelihood of recovering *Aeromonas* in the reservoirs decreased as chlorine levels increased. However, three reservoirs that were positive for *Aeromonas* in more than 10 percent of samples had residual chlorine levels in excess of 0.2 mg/L. This study concluded that maintenance of a chlorine residual in the distribution network is insufficient on its own to control aeromonads. Holmes and Nicolls (1995) found that *Aero-monas* was controlled by a residual chlorine level of 0.2 mg/L in the Severn Trent area of the United Kingdom, although *Aeromonas* was detected when the residual chlorine level was below 0.2 mg/L. For example, data in this paper indicated that 200 *Aeromonas* /100 mL were found in a sample that had a chlorine residual of 0.15 mg/L. Holmes and colleagues (1996) reported that *Aeromonas* aftergrowth was more common in the end of a water distribution system where the age of the water after treatment was more than 72 hours. Similarly, Stelzer and colleagues (1992) found higher *Aeromonas* counts at locations greater than 6 km from the water treatment facility. Havelaar and coworkers (1990) also reported that the greatest amount of *Aeromonas* regrowth occurred in the peripheral parts of the distribution system. Other studies reporting the presence of *Aeromonas* in chlorinated drinking water include LeChevallier and colleagues (1982), Burke and colleagues (1984b), and Kühn and colleagues (1997).

5.2.2.2. Factors Affecting Aeromonas Occurrence

While these studies reported *Aeromonas* in chlorinated drinking water (often with reduced levels of residual chlorine), Hernández and coworkers (1997) found that residual chlorine levels of 0.29 to 0.47 mg/L were effective in controlling *Aeromonas*. In fact, Holmes and colleagues (1996) stated that the free

chlorine level was one of the major factors that influence the growth of *Aeromonas* in drinking water supplies.

Another major factor that influences *Aeromonas* growth in treated drinking water is water temperature (Holmes *et al.*, 1996). Data from Burke and colleagues (1984b) show that water temperature is a determining factor for *Aeromonas* populations in untreated surface water or treated water from service reservoirs where there is a consistently low level of chlorine residual. Furthermore, Burke and colleagues (1984a) state that *Aeromonas* was generally found in unchlorinated drinking water at temperatures greater than 14.5° C. Holmes and Nicolls (1995) found *Aeromonas* to be more abundant in treated water during the warmer months in England (especially July through October) when temperature was higher and residual chlorine levels were lower.

Holmes and colleagues (1996) have speculated that *Aeromonas* may be introduced into treated water distribution systems when *Aeromonas* is abundant in source water and when water is ineffectively treated. Meheus and Peters (1989) reported different removal efficiencies of *Aeromonas* by different treatment processes. *Aeromonas* was isolated from 34 percent of samples from a distribution system where ground water was used and water treatment consisted of sedimentation and rapid sand filtration, but not chlorination (Burke *et al.*, 1984a).

Once in the distribution system, *Aeromonas* may maintain itself in treated water by growth in biofilms. Mackerness and colleagues (1991) found that *Aeromonas* could become a member of a bacterial biofilm. The biofilm appeared to protect *Aeromonas* since it was not killed by 0.3 mg/L of mono-chloramine. Holmes and Nicolls (1995) examined *Aeromonas* in biofilms from pipe sections using the methods of LeChevallier and coworkers (1987), in which the biofilm was scraped off the walls of the section of pipe. *Aeromonas* was detected in 30 percent of the biofilms examined at an average density of 118 CFU/g wet weight of biofilm. The biofilm in the pipe was exposed to a solution of 1 mg/L of chlorine for 30 minutes. After this treatment, *Aeromonas* was still detected in 10 percent of the pipe section biofilms.

These reports indicate that *Aeromonas hydrophila* is likely to occur in drinking water, and even chlorinated drinking water. Detections of *Aeromonas* tend to be more common at the distal ends of distribution systems (i.e., when the residual chlorine level is low), and at elevated ambient water temperatures (i.e., above 14.5° C). These findings also indicate that higher levels of residual chlorine may be effective in controlling *Aeromonas*. However, *Aeromonas hydrophila* may enter a distribution system despite treatment, and once in a system may grow in biofilms where it may be protected from chlorine. These data suggest that a monitoring program for *Aeromonas* in water distribution systems is merited.

5.2.2.3. *Aeromonas* Sampling

Although no microbiological contaminants are included on List 1 of the UCMR (1999) List, EPA identified two locations that could be used for sampling microbiological contaminants under the UCMR. These location are:

(1) a site below a representative EPTDS that is used for taking total coliform samples, and

(2) a site in the distribution system that has the maximum residence time or lowest disinfectant residual.

The first sampling location would presumably give negative results most or all of the time in chlorinated distribution systems. This sample location would indicate what normal exposure levels for *Aeromonas* are for most of the population when a system is functioning properly. The second sample from a site in the distribution system that has the maximum residence time or lowest disinfectant residual would represent *Aeromonas* exposure by a subset of the population of water consumers that had a greater likelihood of

using water with a reduced chlorine residual. Reports such as Stelzer and colleagues (1992) and Havelaar and colleagues (1990) present evidence that *Aeromonas* could occur in treated water under this condition. EPA will consider monitoring for *Aeromonas* at these sampling points when developing an appropriate sampling strategy.

One suggestion being considered for the UCMR Program is to enumerate *Aeromonas* in biofilms in water distribution pipes in a study similar to that conducted by LeChevallier and coworkers (1987). While this might indicate whether water distribution systems were harboring populations of *Aeromonas*, it would not represent exposure of those consuming water since most *Aeromonas* cells would remain in biofilms. Additionally, the effort and expense of obtaining pipe sections would limit the size of a sample that could be taken.

Factors that could affect *Aeromonas* presence in treated water include water temperature and operation of water treatment processes. Since changes in water temperature during the annual cycle could have a considerable effect on the size of *Aeromonas* populations encountered in water, EPA may require the collection of several samples over the course of a year to document these changes in population size. Additionally, a higher frequency of sampling in a given system is more likely to detect events where there may have been a change in the effectiveness of water treatment.

Samples to be analyzed for *Aeromonas* may be accompanied with information on water temperature, pH, turbidity, free disinfectant residual, and total disinfectant residual. These data, in addition to information on source water type, method of treatment, and other information will assist in the interpretation of the *Aeromonas hydrophila* occurrence data collected under this regulation. With these data, EPA intends to ascertain which factors are important in determining whether *Aeromonas* occurs in drinking water.

5.3. Sampling Plan for UCMR (1999) List 3 Contaminants

While EPA has begun to develop a monitoring strategy for the UCMR (1999) List 3 contaminants, this development is still in the very early stages of planning. Information on known occurrence and possible analytical methods to be used for monitoring the List 3 microbiological contaminants has been collected and summarized in the draft report entitled *Methods and Occurrence Information for the UCMR List 3 Microbiological Contaminants*, available from Rachel Sakata of US EPA's Office of Ground Water and Drinking Water. As with the List 2 contaminants, EPA will provide additional information on a sampling plan for the List 3 contaminants when the Pre-Screen Testing component of the UCMR Program is promulgated.

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Notes

[1]If the compliance monitoring point for a particular system is for source water, and any contaminant on the UCMR (1999) List is detected, the systems must then sample at the EPTDS unless the State or EPA determine that sampling at the EPTDS is unnecessary because no treatment was instituted between the source water and the distribution system that would affect measurement of the contaminant (§141.40(5)(ii)(C).

[2]The value of 0.75 µg/L is equivalent to 25 percent of the MCL of 3 µg/L, the MCL for atrazine.

Appendix A. Abbreviations and Acronyms

2,4-DNT	- 2,4-dinitrotoluene
2,6-DNT	- 2,6-dinitrotoluene
4,4'-DDE	- 4,4'-dichloro dichlorophenyl ethylene, a degradation product of DDT
Alachlor ESA	- alachlor ethanesulfonic acid, a degradation product of alachlor
AOAC	- Association of Official Analytical Chemists
APHA	- American Public Health Association
ASDWA	- Association of State Drinking Water Administrators
ASTM	- American Society for Testing and Materials
BGM	- Buffalo Green Monkey cells, a specific cell line used to grow viruses
CAS	- Chemical Abstract Service
CASRN	- Chemical Abstract Service Registry Number
CCL	- Contaminant Candidate List
CCR	- Consumer Confidence Reports
CERCLA	- Comprehensive Environmental Response, Compensation & Liability Act
CFR	- Code of Federal Regulations
CFU	- colony forming unit
CFU/mL	- colony forming units per milliliter
CWS	- community water system
DCPA	- dimethyl tetrachloroterephthalate, chemical name of the herbicide dacthal
DCPA mono- and di-acid degradates	- degradation products of DCPA
DDE	- dichloro dichlorophenyl ethylene, a degradation product of DDT
DDT	- dichloro diphenyl trichloroethane, a general insecticide
DNA	- deoxyribonucleic acid
EDL	- estimated detection limit
EDSTAC	- Endocrine Disruptor Screening and Testing Advisory Committee
EPA	- Environmental Protection Agency
EPTC	- s-ethyl-dipropylthiocarbamate, an herbicide
EPTDS	- Entry Point to the Distribution System
ESA	- ethanesulfonic acid, a degradation product of alachlor
FACA	- Federal Advisory Committee Act
FTE	- full-time equivalent
GC	- gas chromatography, a laboratory method
GLI method	- Great Lakes Instruments method
GW	- ground water
GUDI	- ground water under the direct influence (of surface water)

HPLC - high performance liquid chromatography, a laboratory method

ICR - Information Collection Request / Rule
IRFA - initial regulatory flexibility analysis
IMS - immunomagnetic separation
IRIS - Integrated Risk Information System
IS - internal standard

km - kilometer

LLE - liquid/liquid extraction, a laboratory method

MAC - *Mycobacterium avium* complex
MOA - Memorandum of Agreement
MCL - maximum contaminant level
MDL - method detection limit
MRL - minimum reporting level
MS - mass spectrometry, a laboratory method
MS - sample matrix spike
MSD - sample matrix spike duplicate
MTBE - methyl tertiary-butyl ether, a gasoline additive

NAWQA - National Water Quality Assessment Program
NCFAP - National Center for Food and Agricultural Policy
NCOD - National Drinking Water Contaminant Occurrence Database
NDWAC - National Drinking Water Advisory Council
NERL - National Environmental Research Laboratory
NIRS - National Inorganic and Radionuclide Survey
NPS - National Pesticide Survey
NTIS - National Technical Information Service
NTNCWS - non-transient non-community water system
NTTAA - National Technology Transfer and Advancement Act

OGWDW - Office of Ground Water and Drinking Water
OMB - Office of Management and Budget
OPP - Office of Pesticide Programs

PAH - Poly-aromatic hydrocarbon
PA - Partnership agreement
PB - particle beam
PBMS - Performance-Based Measurement System
pCi/L - picocuries per liter
PCR - polymerase chain reaction
^{210}Pb - lead-210 (also Pb-210), a lead isotope and radionuclide; part of the uranium decay series
^{210}Po - polonium-210 (also Po-210), a polonium isotope and radionuclide; part of the uranium decay series
PWS - Public Water System
PWSF - Public Water System Facility

QA - quality assurance
QC - quality control

RDX - royal demolition explosive, hexahydro-1,3,5-trinitro-1,3,5-triazine
RFA - Regulatory Flexibility Act
RPD - relative percent difference
RSD - relative standard deviation

SBREFA - Small Business Regulatory Enforcement Fairness Act
SD - standard deviation
SDWA - Safe Drinking Water Act
SDWIS - Safe Drinking Water Information System
SDWIS FED - the Federal Safe Drinking Water Information System
SIC - Standard Industrial Classification
SM - Standard Methods
SMF - Standard Compliance Monitoring Framework
SOC - synthetic organic compound
SPE - solid phase extraction, a laboratory method
SRF - State Revolving Fund
STORET - Storage and Retrieval System
SW - surface water

TBD - to be determined
TNCWS - transient non-community water system
TRI - Toxic Release Inventory

UCMR - Unregulated Contaminant Monitoring Regulation/Rule
UCM - Unregulated Contaminant Monitoring
UMRA - Unfunded Mandates Reform Act of 1995
URCIS - Unregulated Contaminant Information System
USEPA - United States Environmental Protection Agency
UV - ultraviolet

VOC - volatile organic compound

µg/L - micrograms per liter

Appendix B. Definitions

Assessment Monitoring means sampling, testing, and reporting of listed contaminants that have available analytical methods and for which preliminary data indicate their possible occurrence in drinking water. Assessment Monitoring will be conducted for the UCMR (1999) List 1 contaminants.

Index Systems means a limited number of small CWSs and NTNCWSs, selected from the Assessment Monitoring systems in State Plans, that will be required to provide more detailed and frequent monitoring for the UCMR (1999) List 1 contaminants (§141.40(a)(6)). The Index Systems will be selected to geographically coincide with watersheds and areas studied under the United States Geological Survey's National Water Quality Assessment program. In addition to the reporting information required for Assessment Monitoring, the Index Systems must also report information on system operating conditions (such as water source, pumping rates, and environmental setting) (§141.40(a)(6)). These systems must monitor each year of the 5-year UCMR cycle, with EPA paying for all reasonable monitoring costs (§141.40(a)(4)(i)(A)). This more detailed and frequent monitoring will provide important information with which EPA can more fully evaluate the conditions under which small systems operate.

Listed contaminant means a contaminant identified as an analyte in Table 1, §141.40(a)(3) of the Unregulated Contaminant Monitoring Regulation (UCMR). To distinguish the current 1999 UCMR listed contaminants from potential future UCMR listed contaminants, all references to UCMR contaminant lists will identify the appropriate year in parenthesis immediately following the acronym UCMR and before the referenced list. For example, the contaminants included in the UCMR (1999) List include the component lists identified as UCMR (1999) List 1, UCMR (1999) List 2 and UCMR (1999) List 3 contaminants.

Listing cycle means the 5-year period for which each revised UCMR list is effective and during which no more than 30 unregulated contaminants from the list may be required to be monitored. EPA is mandated to develop and promulgate a new UCMR List every 5 years.

Monitored systems means all community water systems serving more than 10,000 people, and the national representative sample of community and non-transient non-community water systems serving 10,000 or fewer people that are selected to be part of a State Plan for the UCMR. (Note that for this round of Assessment Monitoring, systems that purchase their primary source of water are not included in the monitoring.)

Monitoring (as distinct from Assessment Monitoring) means all aspects of determining the quality of drinking water relative to the listed contaminants. These aspects include drinking water sampling and testing, and the reviewing, reporting, and submission to EPA of analytical results.

*Most vulnerable systems (*or *Systems most vulnerable)* means a subset of 5 to not more than 25 systems of all monitored systems in a State that are determined by that State in consultation with the EPA Regional Office to be most likely to have the listed contaminants occur in their drinking waters, considering the characteristics of the listed contaminants, precipitation, system operation, and environmental conditions (soils, geology and land use).

Pre-Screen Testing means sampling, testing, and reporting of the listed contaminants that may have newly emerged as drinking water concerns and, in most cases, for which methods are in an early stage of development. Pre-Screen Testing will be conducted by a limited number of systems (up to 200). States will nominate up to 25 of the most vulnerable systems per State for Pre-Screen Testing. The actual Pre-Screen Testing systems will be selected from the list of nominated systems through the use of a random number generator. Pre-Screen Testing will be performed to determine whether a listed contaminant occurs in sufficient frequency in the most vulnerable systems or sampling locations to warrant its being included in future Assessment Monitoring or Screening Surveys. Pre-Screen Testing will be conducted for the UCMR (1999) List 3 contaminants.

Random Sampling is a statistical sampling method by which each member of the population has an equal probability (an equal random chance) of being selected as part of a sample (the sample being a small subset of the population which represents the population as a whole).

Representative Sample (or *National Representative Sample*) means a small subset of all community and non-transient non-community water systems serving 10,000 or fewer people which EPA selects using a random number generator. The systems in the representative sample are selected using a stratified random sampling process that ensures that this small subset of systems will proportionally reflect (is “representative” of) the actual number of size- and water type-categories of all small systems nationally. In finalizing State Plans, a State may substitute a system from the replacement list for a system selected as part of the original representative sample, if a system on the representative sample list in the State Plan is closed, merged or purchases water from another system.

Sampling means the act of collecting water from the appropriate location in a public water system (from the applicable point from an intake or well to the end of a distribution line, or in some limited cases, a residential tap) following proper methods for the particular contaminant or group of contaminants.

Sampling Point means a unique location where samples are to be collected.

Screening Survey means sampling, testing, and reporting of the listed contaminants for which analytical methods are recently developed and have uncertain potential for occurrence in drinking water by a subset of approximately 300 systems from all monitored systems selected through use of a random number generator for public water system identification numbers. These systems must conduct the Screening Survey for the contaminants on UCMR (1999) List 2 as will be further described in the List 2 Rule (§141.40(a)(7)). Two Screening Surveys may be conducted for the UCMR (1999) List 2 contaminants.

State means, for the purposes of this section, each of the fifty States, the District of Columbia, U.S. Territories, and Tribal lands. For the national representative sample, Guam, the Commonwealth of Puerto Rico, the Northern Mariana Islands, the Virgin Islands, American Samoa, and the Trust Territories of the Pacific Islands are each treated as an individual State. All Tribal water systems in the U.S. which have status as a State under Section 1451 of the Safe Drinking Water Act for this program will be considered collectively as one State for the purposes of selecting a representative sample of small systems.

*State Monitoring Plan (*or *State Plan)* means a State’s portion of the national representative sample of CWSs and NTNCWSs serving 10,000 or fewer people which must monitor for unregulated contaminants (Assessment Monitoring, Screening Survey(s) and Index Systems) and all large systems (systems serving greater than 10,000 people) which are required to monitor for Screening Survey contaminants. A State Plan may be developed by a State’s acceptance of EPA’s representative sample for that State, or by a State’s selection of systems from a replacement list for systems specified in the first list that are closed, are merged, or purchase water from another system. A State Plan also includes

the process by which the State will inform each public water system of its selection for the plan and of its responsibilities to monitor. A State Plan will also include the systems required to conduct Pre-Screen Testing, selected from the State's designation of vulnerable systems. The State Plan may be part of the Partnership Agreement (PA) between the State and EPA.

Stratified Random Sampling is a procedure to draw a random sample from a population that has been divided into subpopulations or strata, with each stratum comprised of a population subset sharing common characteristics. Random samples are selected from each stratum proportional to that stratum's proportion of the entire population. The aggregate random sample (compiled from all the strata samples) provides a random sample of the entire population that reflects the proportional distribution of characteristics of the population. In the context of the UCMR, the population served by public water systems was stratified by size (with size categories of 500 or fewer people served, 501 to 3,300 people served, and 3,301 to 10,000 people served) and by water source type supplying the water system (ground water or surface water). This stratification was done to ensure that systems randomly selected as nationally representative sample systems would proportionally reflect the actual number of size and water type categories nationally.

Testing means, for the purposes of the UCMR and distinct from *Pre-Screen Testing*, the submission and/or shipment of samples following appropriate preservation practices to protect the integrity of the sample; the chemical, radiological, physical and/or microbiological analysis of samples; and the reporting of the sample's analytical results for evaluation. Testing is a subset of activities defined as *monitoring*.

Unregulated contaminants means chemical, microbiological, radiological and other substances that occur in drinking water or sources of drinking water that are not currently regulated under the federal drinking water program. EPA has not issued standards for these substances in drinking water (i.e., maximum contaminant levels or treatment technology requirements). EPA is required by Congress to establish a program to monitor for selected unregulated contaminants in public water systems to determine whether they should be considered for future regulation to protect public health. The selected contaminants are listed in §141.40(a)(3), Table 1, the UCMR List.

Vulnerable time (or *vulnerable period*) means the time (or, in some cases, the 3-month quarter) of the year determined as the most likely to have the listed group of contaminants present at their highest concentrations or densities in drinking water. The vulnerable determination, in the case of the UCMR, is made by the EPA or by the State (under arrangement with the EPA) for a system, subset of systems, or all systems in a State. The vulnerable determination is based on characteristics of the contaminants, precipitation, system operations, and environmental conditions such as soil types, geology, and land use. This determination does not indicate or imply that the listed contaminants will be identified in the drinking water with certainty, but only that sampling conducted during the vulnerable period presumably has the highest likelihood of identifying those contaminants in higher concentrations relative to other sampling times of the year, if and when the contaminants occur.