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Update of the Advanced On-Site Wastewater Treatment and Management Market Study: State Reports Summary

by:

Amy Macrellis
Bruce Douglas
Stone Environmental, Inc.

Valerie Nelson
Coalition for Alternative Wastewater Treatment

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The organization that prepared this report:

- Principal Investigator: Valerie I. Nelson, PhD
  Coalition for Alternative Wastewater Treatment

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Any errors of fact and interpretation are those of the authors: the opinions expressed do not necessarily reflect the official position of any supporting agency.

Report Preparation

Princ ipal Investigator:
Valerie Nelson, Ph.D.
Coalition for Alternative Wastewater Treatment

Project Team:
Amy N. Macrellis, B.A., M.S.
Bruce F. Douglas, P.E.
Stone Environmental, Inc.

ABSTRACT AND BENEFITS

Abstract:

An update of a study of the market for distributed wastewater technologies and management, originally completed between 1997 and 2000, was conducted to provide updated information about the status of regulations, management, technology use, funding, training programs, and research and demonstration projects in each of the fifty states. A state-by-state literature review was completed and reports were updated for each of the 50 states.

The research revealed a decade of both incremental progress and missed opportunity. More decentralized systems are under management as compared to the late 1990s, and advancements in industry professionalism are continuing. In some areas, acceptance of advanced treatment systems corresponded with understanding of ongoing maintenance needs, and with implementation of management entities and programs. In others, adoption of advanced technology without adequate management resulted in environmental impacts and negative perceptions of decentralized systems. Future federal research and demonstration funding is uncertain, and the sector is losing capacity due to recent economic conditions and over-reliance on new housing development.

At the same time, new emphasis is being placed on creating "green jobs" and on sustainable infrastructure. Several case studies are included, which are offered as "building blocks" towards a stable future for the sector.

Benefits:

- Summarizes numerical information, management programs, technology acceptance, loan or grant funding, professional certification, research, and demonstration projects related to decentralized wastewater systems for all 50 states
- Describes challenges and opportunities facing the decentralized wastewater industry at the national level

Keywords: Onsite wastewater treatment, soft paths, integrated water infrastructure, decentralized wastewater, distributed infrastructure

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LIST OF ACRONYMS

ASAE	American Society of Agricultural Engineers
ATU	Aerobic Treatment Unit
CAWT	Coalition for Alternative Wastewater Treatment
CIDWT	Coalition of Institutes for Decentralized Wastewater Treatment
CWA	Clean Water Act
CWNS	Clean Watersheds Needs Survey
D.C.	District of Columbia
EPRI	Electric Power Research Institute
ETV	Environmental Technology Verification
HUD	Housing and Urban Development
LID	Low-Impact Development
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NAWT	National Association of Wastewater Transporters
NDWRCDP	National Decentralized Water Resources Capacity Development Project
NEHA	National Environmental Health Association
NODP	National Onsite Demonstration Project
NOWRA	National Onsite Wastewater Recycling Association
NRECA National	Rural Electric Cooperative Association
RME	Responsible Management Entity
TMDL	Total Maximum Daily Load
TWIST	The Wastewater Information System Tool
UIC	Underground Injection Code
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
WEF	Water Environment Federation
WEFTEC	Water Environment Federation Technical Exhibition and Conference
WERF	Water Environment Research Foundation

EXECUTIVE SUMMARY

This report summarizes an update to a study completed between 1997 and 2000 of the potential short-term and long-term opportunities for distributed wastewater technology and management across the United States. The goal of this effort is to provide updated information about the status of decentralized system regulations, management organizations, technology use, funding, training programs, research and demonstration projects, and public education campaigns in each of the fifty states, expand the state research to include information not previously considered, study the events of the intervening years as a means to assess the accuracy of previous predictions about short-term opportunities and changes, and to suggest additional recommendations for collaborative policy and industry initiatives. It is important to understand as much as possible both the accomplishments and the disappointments of recent years, if optimal strategies and approaches are to be developed and implemented in the future.

A comprehensive, state-by-state literature review was completed, as were updates to reports for each of the 50 states. It is clear that incremental progress towards improved industry professionalism is being made, and that more decentralized systems are now under management as compared to the late 1990s. In some areas, particularly in the Northeast, the upper Midwest, and the Pacific Northwest, increases in the acceptance and implementation of advanced treatment systems have corresponded with increased understanding of the need for appropriate levels of ongoing maintenance and management—and thus with significant implementation of management entities or programs.

The overall picture, however, is one of mixed progress—and, sometimes, of missed opportunity. In some states, such as Texas and Illinois, adoption of advanced technology without adequate management has resulted in environmental impacts and negative perceptions of decentralized systems. A major research and demonstration program funded by the U.S. Environmental Protection Agency is ending in 2009. Perceived concerns remain about the reliability and performance of decentralized wastewater technologies, particularly related to nutrient removal. The industry is losing capacity due to its over-reliance on new housing development during the last decade, while at the same time new emphasis is being placed on creating “green jobs” and on the implementation of sustainable infrastructure.

Nevertheless, the state-by-state research disclosed several success stories which can be considered “building blocks” towards a more stable and sustainable future for the sector. Six case studies highlight particularly relevant examples from Michigan, Rhode Island, Massachusetts, Minnesota, North Carolina, and Tennessee.

CHAPTER 1.0

INTRODUCTION

In 2000, the Electric Power Research Institute (EPRI) published the "Advanced On-Site Wastewater Treatment and Management Market Study", including Volume I: "Assessment of Short-Term Opportunities and Long-Run Potential" and Volume II: "State Reports", prepared by Valerie I. Nelson, Stephen Dix, and Frank Shephard. The study was jointly sponsored by EPRI, the National Rural Electric Cooperative Association (NRECA), and the Water Environment Research Foundation (WERF).

The purpose of the Market Study was to explore the short- and long-term opportunities for advanced on-site and cluster system technologies and management across the country. Two research projects were undertaken. First, a database was assembled with information on each of the counties in the U.S., including various risk-related factors as percentage of undeveloped soils with hydraulic or filtration failure problems, septic system density, average age of septic systems, expected population growth rates, and others. Second, surveys were mailed to two or more officials and experts in each of the states, including at least one state regulator and one other expert, such as a professional engineer or academic. The surveys included questions about numbers of new systems and repairs; the present status of on-site conditions, development pressures, and water quality; anticipated changes in on-site system regulation and management, use of alternative and advanced technologies; on-site funding; and various initiatives, including research projects, training programs, demonstration projects, and public education programs. Finally, a more in-depth exploration of key barriers and incentives for development of this approach was conducted.

The risk analysis and state-by-state surveys showed wide disparities among the states in terms of the need for advanced on-site system upgrades and new systems, and of the response of regulatory and other institutions in the state. The study concluded that the most likely future of the advanced on-site system and management approach was in concentrated use in areas of the country where drinking water or natural resources are threatened, such as in sole source aquifer areas, around lakes, and near coastal estuaries and shellfish beds. Other opportunities included a coupling of advanced on-site and cluster technologies with water reuse in arid parts of the country and in collaboration with developers in booming rural areas, where buyers of new homes are willing to accept innovative technologies and regular monthly maintenance fees.

Next steps were recommended for strategic action in the field, many of which would require unprecedented levels of collaboration, innovation, and outreach. Critical areas in the future development of the sector were identified as: significantly greater accommodation to the values and concerns of homeowners, municipal officials, regulators, and Smart Growth advocates; attention to the needs of entrepreneurs and venture capitalists for consistent standards of technology and practice; participation in the broader water quality initiatives of watershed assessments, total maximum daily load (TMDL) planning, and development of nutrient and pathogen water quality criteria; internalization of a risk management paradigm which targets on-site system upgrades and management where benefits exceed costs; and finally, a leap into the unfamiliar terrain of forming new construction companies, operation and maintenance service companies, and utilities, in order to facilitate the adoption of high-quality technologies and management.

The purpose of the Market Study Update is to update the information for each of the fifty states and update the analysis and recommendations of the original Market Study. This effort has four objectives:

1. Provide an eight-year update on (a) the status of decentralized system regulations, management organizations, technology use, funding, training programs, research and demonstration projects, and public education campaigns in each of the fifty states, and (b) the key barriers and incentives for development of advanced on-site and cluster system use and of management services;
2. Expand the state research to include information not considered or not yet underway in the earlier report, such as integration of decentralized wastewater systems with other "soft path" water resource sectors, including stormwater, low impact development, and reuse; the role of recent EPA onsite system management guidance and documents, NOWRA model code initiatives, and National Community Decentralized Wastewater Demonstration Projects and National Decentralized Water Resource Capacity Development Project research in promoting change; the impact of new Underground Injection Control (UIC) regulations, etc.
3. Study the events of the intervening years since publication of the initial report as a means to assess whether or not the issues and arguments presented in the report were accurate in predicting short-term opportunities and changes, and if not, what issues were poorly understood;
4. Review and analyze the recommendations of the prior report, including which strategies have and have not been implemented, and what additional recommendations can be made for collaborative policy and industry initiatives.

The rationale for this update rests in the following overlapping factors:

- There is a widespread belief that the "advanced" decentralized wastewater field is at a transition or turning point, potentially entering a new phase of significantly greater visibility and opportunity. A recent plenary panel and other discussions at the 2004 NOWRA conference reflected interest in understanding both what has been accomplished in recent years, and what new strategies will be required in the future if more progress is to be made;
- In the 1997 Response to Congress on Use of Decentralized Wastewater Treatment, EPA described a number of barriers and recommended initiatives in management, regulatory reform, etc. NOWRA has since the mid-1990's promoted a performance-based approach to management, and a range of training centers have been formed across the country. EPA has issued new management guidance manuals and revised its decentralized system design manual. The NDWRCDP project has completed its first phase of research, including 34 projects on environmental science and engineering, management and economics, regulatory reform, and training and education; and a second phase of projects is underway.
- EPA is turning to a strategy of dissemination of its guidance manuals and new partnerships to promote management. WEF and other engineering societies are increasingly open to concepts of "integrated" centralized and decentralized

infrastructure. NOWRA and other organizations are reaching out to stormwater/LID, planning, homebuilding, environmental, and related constituencies to see what common opportunities and synergies exist. An international "soft path" water resources conference was held in the U.S. in 2007, and there is increasing interest in international collaboration;

- Fiscal deficits and the ascendance of Bush administration policy approaches at the national level created new challenges and opportunities for innovation at the federal and state level, for example, in asset management, TMDLs, and market trading approaches. At the same time, federal funding for Clean Water State Revolving Funds and national demonstration projects appears to be declining.

It is important to understand as much as possible both the accomplishments and the disappointments of recent years, if optimal strategies and approaches are to be developed and implemented in the future. Findings of the Market Study Update can be a valuable component of this analysis. Eight years is a sufficient length of time to be able to observe changes in regulations, management, and technology across the country.

CHAPTER 2.0

METHODS

While the initial Market Study was based on surveys completed by two or more regulators and other experts in each of the fifty states, this approach is not allowable under EPA funding requirements. A research strategy was developed which more closely resembles a "meta-analysis" of a wide range of literature and other sources, supplemented by short, targeted telephone or email interviews to fill in gaps in information that remain after review of the literature. Information was collected for the period since data were gathered for the initial market study in 1997-1998.

The list of data sources included:

- Small Flows Clearinghouse information on state and county regulations
- Small Flows Clearinghouse survey of onsite management programs
- *State Authorities and Practices Regarding Management of Wastewater Systems*, by the Environmental Research Institute of the States
- *Strengths and Weaknesses of Great Lakes Onsite Sewage System Regulatory Programs* (report on onsite regulations in Great Lakes States, funded by the Joyce Foundation)
- NDWRCDP reports including *Solving the Barriers Associated with Evaluation and Use of Decentralized Wastewater Technologies and Management, Long Range Planning for Decentralized Wastewater and Stormwater Research: Literature Review, Pennsylvania Standards for Residential Site Development, Onsite Sewage Treatment in California and the Progression Toward Statewide Standards, Onsite Wastewater Regulator Outreach and Coordination Project, Onsite Wastewater Issue Papers Delivered to U.S. EPA by the State Regulators and Captains of Industry*, and others as appropriate
- Final reports and other information from EPA demonstration projects
- 2000 U.S. Census (for estimates of onsite systems by state)
- NOWRA conference proceedings (1999-2007)
- ASAE conference proceedings (2001, 2004, 2007)
- NEHA conference proceedings (1999-2007, as available)
- WEFTEC small community forum (1999-2007, as available)
- State Onsite Regulators Alliance and Captains of Industry conference proceedings (1999-2007, as available)
- State onsite conference proceedings, as available (Northeast and Northwest Onsite Wastewater Treatment Short Courses, North Carolina On-Site Wastewater Treatment Conference, etc.)
- State onsite wastewater professionals' association websites
- Newsletters, forums, other sources of information cited for each state in the original market study's State Reports, as available
- State onsite regulatory websites for information about rule revisions and changes

- Targeted internet and Lexis-Nexis (newspaper article) searches by state to fill gaps in literature and understand new developments at the state level that may not yet be reflected in the literature.

Each source document was indexed by state and by specific topic. The topical index was populated using the survey questions from the original market study as follows:

- Numerical information regarding onsite systems
- Present status of onsite conditions, development pressure, and water quality in the state
- Anticipated changes in onsite regulation and management
- Alternative, advanced, and best available technologies
- Onsite funding
- Leadership within the state
- Enforcement
- Role of cluster systems and package plants
- Role of rural electric cooperatives (and/or other utility entities) in starting O/M programs for household sewage disposal
- Other topics--for example, anecdotes about patterns of change or drivers toward change within a state that might not fit within the topics above

Each State Report, as provided in Volume 2 of the original Market Study, was updated with new information from the literature. A standardized format was used, based on the format provided in the original market study, to enable easy comparison between the two reports and between states within the current study. Upon completion of each State Report, comparisons were made between the status of regulations, etc. in 1999 and the information gleaned from the literature and website review, using the framework of the original Market Study to the greatest extent possible.

Six short case studies were developed that highlight particularly interesting and relevant models for regulatory reform, management initiatives, business formation, or other innovations. These include financing programs in Minnesota; “off-the-grid” projects in North Carolina; formal processes for testing and approving new technology in Massachusetts; community-based planning in Rhode Island; increasing awareness through broad coalitions in Michigan; and utility management in Tennessee.

An Advisory Committee provided guidance on development of the research strategy, literature citations and suggestions for website research, potential interviews to fill in missing information gaps, case study recommendations, and reviews of draft State Reports, summaries, case studies, and overall reports.

CHAPTER 3.0

AN UPDATED RISK ASSESSMENT PERSPECTIVE

This chapter provides an update to the risk assessment information provided in the original Market Study. The goal of this assessment is to understand, at a regional level, areas where existing conditions increase the likelihood that onsite systems will fail or where new development may be problematic. Selected information from the previous study was updated, where possible, for each of nine regions in the U.S. (plus Alaska and Hawaii).

Data, particularly those related to environmental changes or concerns at the national level, were updated where more recent information was available. In many cases, changes in how data were collected and how those data were reported precluded direct comparisons. Information from the state-by-state literature review and the detailed State Reports was the primary means used to understand where changes occurred.

3.1 Risk Assessment Factors

In addition to the State Reports, the following data were considered in assessing composite risks from onsite systems.

3.1.1 Soils

Maps of areas where soils have high filtration failure risk (defined as hydrologic soil Group A) and areas where soils have high hydraulic failure risk (defined as hydrologic soil Groups C and D), as created for the original Market Study, were considered in this assessment but were not updated.

3.1.2 Groundwater

The Risk Assessment perspective in the original Market Study did not explicitly consider groundwater or aquifer conditions as a factor, yet aquifer protection is a major consideration in onsite wastewater codes in some states. The U.S. Geological Survey monitors large-scale trends in ground water availability; the agency's efforts were recently summarized in USGS Circular 1323, *Ground-Water Availability in the United* States (Reilly et al., 2008). Figure 3-1 summarizes the current state of knowledge about water level declines on a national scale as compared to pre-development conditions in the U.S., as described in the circular. Other sections of the document also describe changes in aquifer recharge, ground water discharge, and ground water quality.

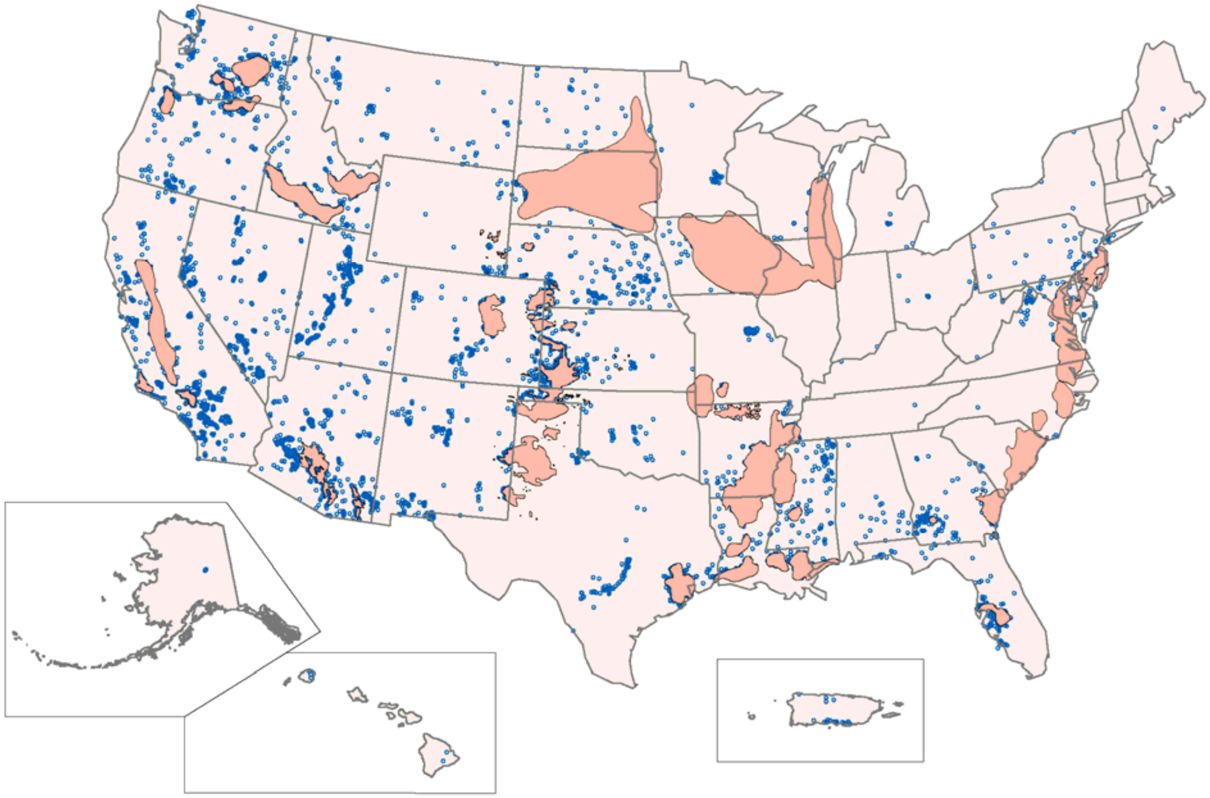


Figure 3-1. Water-level declines (reproduced from Reilly et al. 2008). Red regions indicate areas in excess of 500 square miles that have water-level decline in excess of 40 feet in at least one confined aquifer since predevelopment, or in excess of 25 feet of decline in unconfined aquifers since predevelopment. Blue dots are wells in the USGS National Water Information System database where the measured water-level difference over time is equal to or greater than 40 feet.

3.1.3 Development and Density of Housing

Unlike the 1990 U.S. Census, the 2000 U.S. Census did not collect information about household water supply type or wastewater service type (U.S. Census Bureau, 2007). The American Housing Survey, conducted for the U.S. Department of Housing and Urban Development every five years, contains information about water supply source and wastewater service type, but aggregates this information at the level of metropolitan areas, rather than states or counties (U.S. Department of Housing and Urban Development, 2006). This made it impossible to update county-level estimates or projections of septic system density included in the original Market Study.

3.1.4 Other Risks and Data

In 1998, the organization American Rivers created a national map showing locations of the eight most endangered watersheds, twenty most endangered rivers, eight most serious areas of fish advisories or warnings, and the five sites of *Pfiesteria* outbreaks (American Rivers, 1998). Table 3-1 compares the 1998 endangered rivers listing with the most current (2009) listing available. Some of the sources of threats to these rivers are related to decentralized wastewater and related resource issues (for example, water supply impacts or increasing phosphorus levels in streams), while others are not (resource extraction impacts and dams, for instance).

Table 3-1. Endangered Rivers.

The 20 Most Endangered Rivers in America in 1998	The 10 Most Endangered Rivers in America in 2009
1. Columbia River	1. Sacramento-San Joaquin River System
2. Missouri River	2. Flint River
3. Pocomoke River	3. Lower Snake River
4. Kern River	4. Mattawoman Creek
5. Blackfoot River	5. North Fork of the Flathead River
6. Colorado River	6. Saluda River
7. Chattahoochee River	7. Laurel Hill Creek
8. Lower Snake River	8. Beaver Creek
9. Apple River	9. Pascagoula River
10. Pinto Creek	10. Lower St. Croix National Scenic Riverway
11. Wolf River	
12. Potomac River	
13. Rogue / Illinois River System	
14. Taku River	
15. Crooked Creek	
16. Passaic River	
17. Mattaponi River	
18. Walla Walla River	
19. Uinta River	
20. Kansas River	

Source: American Rivers, 1998 and 2009.

The U.S. EPA's most recent national map of fish consumption advisories is shown in Figure 3-2, with the sites of major fish consumption warnings and advisories identified by American Rivers in 1998 shown in blue. Although sites of major fish consumption warnings and advisories were listed in the original Market Study, these advisories generally involve contaminants which are largely related to industrial sources or pesticide use, such as mercury, PCBs, chlordane, dioxins, and DDT.

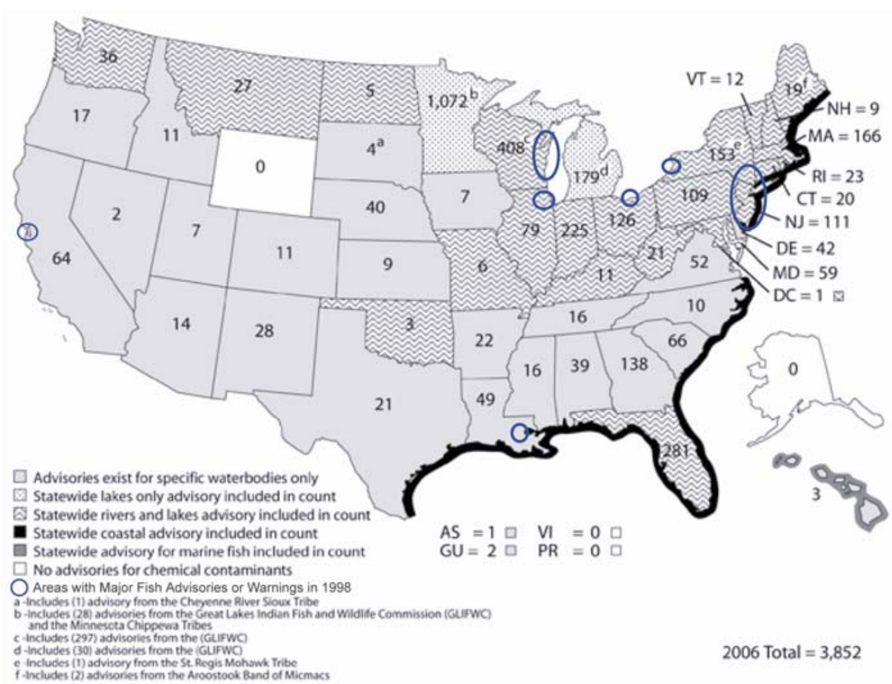


Figure 3-2. Distribution of Fish Advisories in the U.S. in 2006 (modified from U.S. EPA, 2007).

Unlike fish consumption advisories, shellfish advisories are generally due to wastewater and non-point source pollution inputs (sometimes including inputs from decentralized wastewater systems). Shellfish surveys and closings are generally based on monitoring and surveys for pathogens, microbial indicators, and pathogen sources. Figure 3-3 compares the listing of *Pfiesteria* outbreaks published by American Rivers in 1998 with a current map showing the general distribution of harmful algae blooms, including Pfiesteria, in rivers, lakes, and coastal waters of the U.S. as compiled by the staff of the Woods Hole Oceanographic Institute.

A current listing of “disappearing” rivers, such as the one published by the Global Water Policy Project in 1998 which included the Colorado River, was not available. However, Table 3-2 lists states where extreme or exceptional drought impacts have been experienced over the last decade as recorded by the National Drought Mitigation Center.

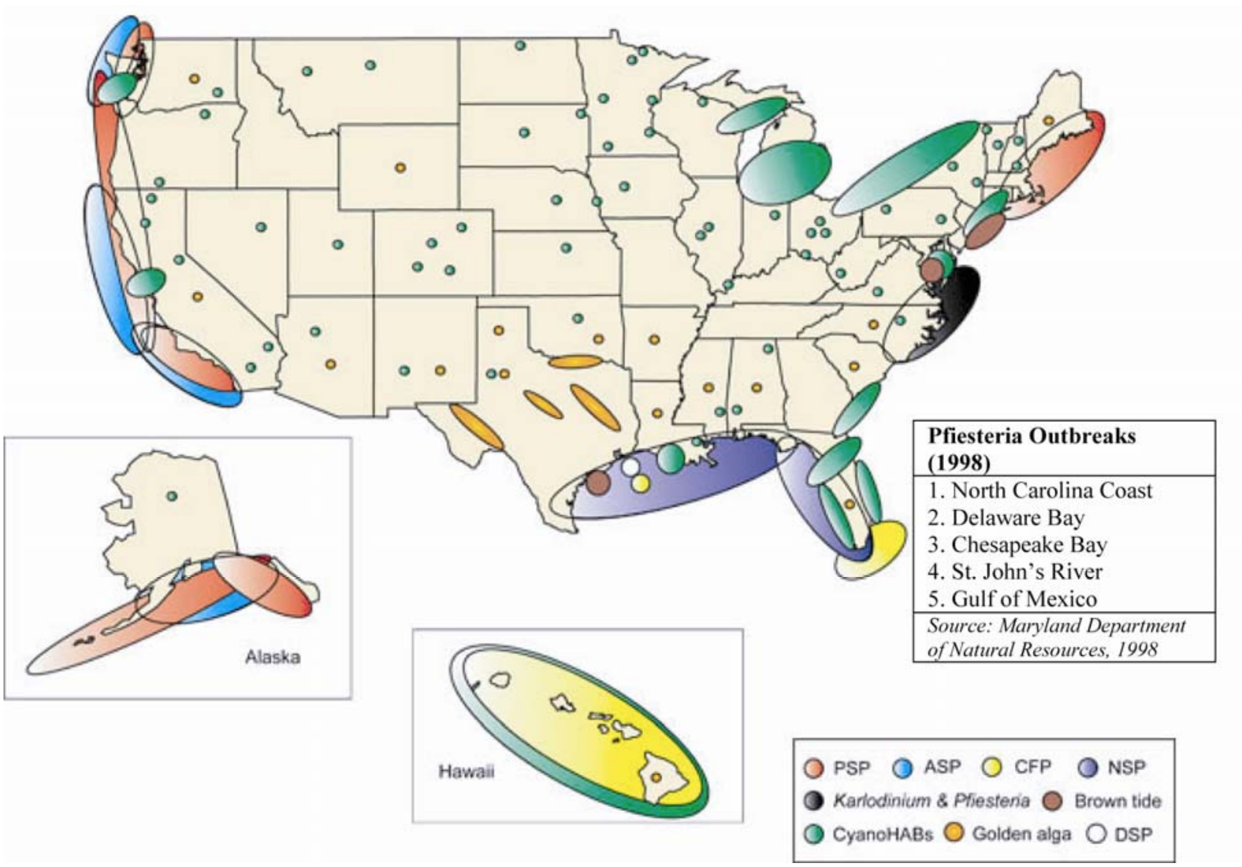


Figure 3-3. Generalized Distribution of Harmful Algae Blooms in the U.S. (modified from Woods Hole Oceanographic Institute, 2009). Notes: PSP: Paralytic shellfish poisoning, NSP = neurotoxic shellfish poisoning, ASP = amnesic shellfish poisoning, CFP = ciguatera fish poisoning, cyanoHABs = cyanobacteria, DSP = diarrhetic shellfish poisoning ("red tide").

Table 3-2. States with Two or More Years of Extreme or Exceptional Drought Impacts, 1998-2008

State Name
California
Colorado
Florida
North Carolina
Texas
Wyoming

Source: National Drought Mitigation Center, 2009.

The Sierra Club has not updated its 1998 identification of the twenty cities most threatened by sprawl. However, Figure 3-4 shows a map of the results of a recent analysis of domestic migration and population changes in major metropolitan areas (those with population over 1,000,000) between 2000 and 2008 (data from the U.S. Census Bureau, 2000-2008 and Wendell Cox Consultancy, 2009). It is included, as previously, to provide an indicator of where growth pressure in suburban, and potentially unsewered, areas is likely to be more intense.

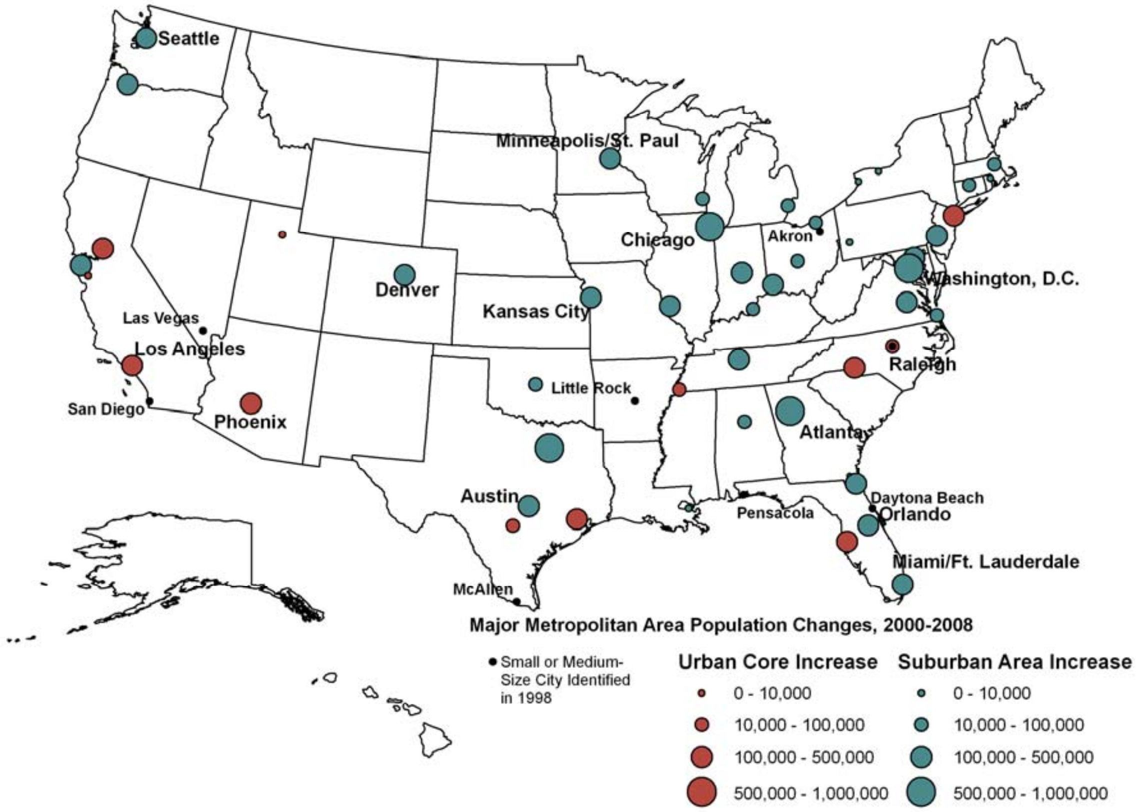


Figure 3-4. Population changes in major metropolitan areas of the U.S., 2000-2008. Labeled cities indicate those identified as "sprawl-threatened" by the Sierra Club in 1998.

3.2 Data Limitations

This analysis is clearly limited by the available data sources. Information about water quality and impairments is now reported electronically by the States to U.S. EPA, but this information remains incomplete. The 2004 National Water Quality Inventory Report to Congress was based on assessment of only 16% of stream or river miles, 39% of lake acres, and 29% of bay and estuarine square miles (U.S. EPA, 2009).

While a few states (notably North Carolina) have undertaken systematic studies to understand onsite system failure rates and underlying causes, rates determined in such studies cannot be applied to other areas. Definitions of "failure" still vary significantly between state codes, with some states defining "failure" only as surfacing effluent or back-up into structures, and others extending the definition to include contamination of ground water or surface water. Thus, failure rates remain an unreliable predictor of potential demand for advanced technologies or management.

For each of nine regions, summary interpretations are provided first of the information collected in the State Reports, then of the national maps and tables (Figures 3-1 through 3-3 and Tables 3-1 and 3-2). Together, this information provides a composite snapshot of the nature of risks and problems related to onsite systems in each region.

3.3 New England – Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut

The State Reports indicate that large areas of Vermont have problems due to combinations of dense development, antiquated systems, poor septic system hydrology, or jeopardy of water resources; the area surrounding Lake Champlain remains under development pressure. In Maine, sewage pollution from wastewater treatment plants and malfunctioning onsite systems remains a cause of local and long-term shellfish growing area closures. Several areas in New Hampshire, chiefly along river and lake fronts, have problems with dense development and older systems. Southeast New Hampshire is experiencing rapid development, with its population expected to increase 30% by 2025. Massachusetts, Rhode Island, and Connecticut all contain areas of dense, often aging, development and antiquated systems; those of particular concern are in coastal areas where shellfish beds have been closed and where nitrogen loading is increasingly problematic. Coastal waters off Cape Cod, Cape Ann, the islands of Martha's Vineyard and Nantucket, the salt ponds of Rhode Island, and Long Island Sound are all under evaluation for nutrient TMDL implementation, or TMDLs are being implemented.

From a national perspective, the soils maps indicate that Maine, New Hampshire, and Vermont are high-risk areas for relatively impermeable soils, while Cape Cod and some coastal areas and river valleys in Maine, Connecticut, and Massachusetts have more highly permeable soils. Only a few scattered incidences of significant water table decline in Maine were mapped by the USGS; however, ground water was mentioned as a concern in the detailed State Reports in Massachusetts, New Hampshire, and Rhode Island. New England areas do not appear on the American Rivers list of endangered rivers, but the entire Atlantic Coast of New has experienced episodes of paralytic shellfish poisoning; Long Island Sound and several inland lakes are marked by cyanobacteria blooms. The Boston and Hartford metropolitan areas experienced continued expansion of suburban populations over the last eight years, though neither of these areas appeared on the Sierra Club's earlier list of threatened areas.

3.4 New York, New Jersey, and Pennsylvania

Many areas throughout New York are potentially jeopardized by dense development and old systems, particularly along river and lake shores in upstate New York, in the New York City watershed, and in unsewered communities on Long Island (where a TMDL for dissolved oxygen sets a 58.5% reduction in baseline nitrogen loads from portions of New York and Connecticut). In New Jersey, isolated northern areas have shallow bedrock and the potential for eutrophication near densely developed lake communities, while the coast is marked by the potential for eutrophication of coastal inlets. The south-central New Jersey Pinelands Area has nitrogen restrictions in place to protect shallow groundwater and surface water resources. Problems are widespread throughout Pennsylvania due to the prevalence of older developments with antiquated systems, mountainous terrain, and poor soils, particularly in the northern third of the state and in the eastern mountains. Dense development is concentrated near Philadelphia and Pittsburgh, both areas with soil and hydrological limitations. Within its Chesapeake Bay watershed, Pennsylvania recently adopted a nutrient and sediment trading policy as part of its TMDL compliance strategy, but this program does not include advanced treatment systems or management.

The national soils maps indicate that all three states have large areas of soils at risk for hydraulic failure, while Long Island and south-central New Jersey have soils with filtration failure risk. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in central and southern New Jersey, and scattered incidences of water table decline were noted in all three states. Ground water was mentioned as a concern in the detailed State Reports in New Jersey. Laurel Hill Creek in Pennsylvania is on American Rivers' current list of endangered rivers, with water withdrawals for residential and tourism development constituting a major concern. (Additional threats to the river are related to current and potential resource extraction, such as bottled water production and hydrofracturing the Marcellus shale for natural gas production.) The coasts of New York and New Jersey have been the sites of brown tide and cyanobacteria blooms. Though no cities in these three states were listed as sprawl-threatened by the Sierra Club in 1998, the Philadelphia metropolitan area experienced significant suburban population growth between 2000 and 2008, and the Pittsburgh, Buffalo, and Syracuse areas also recorded smaller increases in suburban population relative to that in the "core" urban areas of those cities.

3.5 Mid-Atlantic – Delaware, Maryland, Virginia, and West Virginia

In Delaware and Maryland, coastal areas are most in jeopardy. Much of the Delaware coast is protected as a resource area, and a third of the state's watersheds have established TMDLs. The resource most in jeopardy in Maryland is the Chesapeake Bay and its shellfish beds. The Bay, and particularly shellfish harvesting areas within it, is being targeted for a higher level of onsite system inspection and enforcement. Isolated areas in the state have high nitrate levels in private wells because of older systems in densely developed areas. The fringes of the Washington, D.C. metro area, extending into Maryland and Virginia, are under increasing development pressure. In Maryland, there is increasing pressure to use alternative systems to support growth in unsewered, severely limited portions of this fringe as other areas reach build-out development density. In Virginia, the Norfolk–Virginia Beach metropolitan area and the Chesapeake Bay shore are also rapidly growing outside sewered areas. In all four states from east to west, shallow water tables and wetlands mark much of the coast, as well as highly permeable soils and Coastal Plain aquifers with poor filtration potential and ready transport of contaminants. Soils in the piedmont are highly variable and include clay and shrink-swell soils, and the Appalachians are marked by thin soils, bedrock, and steep slopes. In southwest Virginia and in large regions of West Virginia, pit privies, cesspools, and straight discharge pipes still exist. In West Virginia, there were efforts in the 1990s to replace such systems with ATUs, disinfection, and surface discharge to streams; however lack of maintenance and of enforcement resources resulted in malfunctions and water quality problems.

From a national perspective, West Virginia has a high percentage of soils at risk for hydraulic failure, while mountainous areas of both West Virginia and Virginia have limited areas of soils at lesser risk for filtration failure. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in the Northern Atlantic Coastal Plain aquifer system, which encompasses portions of central and northern Delaware, much of Maryland's Chesapeake Bay coastal area, and the entire eastern coast of Virginia. Ground water was mentioned as a concern in the detailed State Reports in Virginia. Three rivers in this region were previously listed as “endangered” by American Rivers, and their 2009 listing includes the Mattawoman Creek in Maryland for threats related to highway construction and consequent development. *Pfiesteria*, brown tide, and cyanobacteria blooms have been recorded in Chesapeake Bay or on the Atlantic coast. The suburban population in the Washington, D.C. metropolitan area continued to expand from 2000-2008, as did suburban populations surrounding Baltimore, Norfolk, and Virginia Beach.

3.6 Southeast – North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, and Tennessee

The State Reports indicate that in North Carolina, poorly drained soils and high water tables, marshes, and coastal inlets mark much of the coast, which is under strong development pressure. (Much of the southern Atlantic coastal plain has high permeability soils and geologic formations, with minimal filtration capability and high susceptibility to entry and transport of contaminants.) The central area of the state, including Charlotte and Greensboro, is marked by high development pressure and clayey, slowly permeable soils; development pressure is also increasing in the mountainous western part of the state, where thin soils and steep slopes predominate. South Carolina has a similar pattern of problem areas, with low-permeability soils in the center of the state and shallow water tables on the coastal plain; coastal areas in particular are experiencing continued development pressure, particularly outside of sewered areas. In both states, related resources that are potentially threatened include rivers, shellfish beds, and sounds that are restricted from flushing by coastal barrier islands. Tennessee has large areas of mountainous terrain, shallow bedrock, and karst topography, as well as significant growth in unsewered areas around Nashville and Knoxville; problems with contamination of surface and ground waters are widespread, though generally small in scale.

Georgia and Alabama both have problem areas scattered throughout the state, particularly related to areas of dense development, steep slopes, shallow soils, and floodplains. Alabama and Mississippi also have a central “Black Belt” of extremely low-permeability soils. Georgia is developing TMDLs for stream impairments caused mostly by non-point sources; much of this state has experienced increasingly severe drought periods. In all three states, most new development is outside centrally sewered areas; and, increasingly, it is situated in less suitable areas for onsite systems. Following Hurricane Katrina, many Mississippi residents relocated from the coast to rural and unsewered areas of coastal counties. Florida’s population continues to grow, but with few exceptions conditions severely limit the use of conventional onsite systems. Wetness, shallow bedrock, karst topography, and nutrient enrichment along the coast and in the Keys are all problems or potential problems. Testing in the Sarasota and Charlotte areas has shown enteric virus contamination in groundwater.

At the national level, large areas of the coasts of North Carolina, South Carolina, and Georgia, as well as most of eastern and southern Florida and the “Black Belt” of central Alabama and Mississippi, have significant percentages of low-permeability soils. Areas within the piedmont of North and South Carolina, extending through Georgia and into the Florida Panhandle, have moderate risk of filtration failure from high-permeability soils, as does the central-west portion of Florida. Additionally, there are extensive areas of karst in Florida and Alabama that are susceptible to groundwater contamination. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in the Northern Atlantic Coastal Plain aquifer system, encompassing portions of North Carolina's Atlantic coast, and in surficial aquifer systems along the eastern coasts of South Carolina and Georgia, as well as in the Floridian aquifer system (southwest Georgia and central Florida, near and southeast of Tampa). Ground water was mentioned as a concern in the detailed State Reports in North Carolina, Georgia, and Florida. The Flint River in Georgia, the Saluda River in South Carolina, and the Pascagoula River in Mississippi are all currently listed as endangered rivers; the threats to the Saluda River are due to wastewater impacts, while those to the Flint River are related to proposed water supply dams. (Threats to the Pascagoula River are related to new petroleum storage facilities.) *Pfiesteria* outbreaks are still recorded off the North Carolina coast; cyanobacteria blooms have occurred off South Carolina, Georgia, and Florida; and neurotoxic shellfish poisoning has been recorded all along the Gulf Coast. Florida and North Carolina have both reported two or more years of extreme or exceptional drought impacts to the Nation Drought Mitigation Center. Five Florida cities were listed as "sprawl-threatened" in 1998; of these, Miami/Ft. Lauderdale and Orlando, as well as Jacksonville, continued to experience significant population growth primarily in suburban areas in 2000-2008.

3.7 South Central – Texas, Louisiana, Arkansas, Missouri, Oklahoma, Kansas, Colorado, and New Mexico

The State Reports indicate that population growth throughout these states is occurring largely in areas with unsuitable soils. In New Mexico, nitrate contamination of wells and continued dense development in river valleys remain the primary concerns. Colorado has widespread areas of high water tables and shallow bedrock, and rapid development over the last decade (particularly around Denver and in resort areas) has increased instances of and concern about groundwater contamination. Kansas, Arkansas, Oklahoma, and Missouri share a range of problems including nitrate contamination in groundwater, areas of karst geology, dense lakeshore developments, thin soils and steep slopes in mountainous areas, and shallow water tables and flooding in the Mississippi and Missouri River valleys—aggravated by new development which is occurring primarily outside sewered areas. Texas has problem areas throughout the state, but particularly with clayey soils in the east and large areas of karst-related groundwater resources with potential for contamination from surface or near-surface sources permitting changes allowed rapid development in previously unsuitable areas over the last decade, though lax enforcement is resulting in water quality problems. In Louisiana, problems are widespread due to the low elevation of much of the state, with corresponding wetness and high water tables. Following Hurricanes Katrina and Rita in 2005, new development or reconstruction increased dramatically in unsewered areas.

From a national perspective, the USGS has mapped significant declines in aquifer-wide water tables since predevelopment in the Mississippi Valley alluvial aquifer (western Mississippi, eastern Arkansas, and northern Louisiana), as well as in the Coastal Lowlands aquifer system in southern Louisiana and around Houston, portions of the Ozark Plateaus aquifer system in northern Arkansas, significant areas of the High Plains aquifer from western Kansas stretching well into the Texas Panhandle. Ground water was mentioned as a concern in all of the detailed State Reports for these states. Brown tide, red tide, cyanobacteria blooms, and episodes of fish and shellfish poisoning have all been recorded off Louisiana and Texas, while golden algae blooms were noted in several Texas rivers. Colorado and Texas both reported areas with two or more years of extreme or exceptional drought within the last decade. Several cities that were previously identified as "sprawl-threatened" by the Sierra Club, particularly Denver, Kansas City, and Austin, experienced continued growth in suburban areas between 2000 and 2008.

3.8 Southwest – Utah, Nevada, Arizona, and California

Presently in Utah, there are only a few problem areas due to dense development and failing systems; however, rural populations are expanding primarily in areas that can only be served by onsite systems. Unsuitable or thin soils and high groundwater are the main concerns, particularly as they relate to nitrate or other chemical pollution of limited surface or groundwater resources. Nevada has scattered pockets with onsite problems, chiefly in old mining towns where small lots and antiquated technologies were common. Increasing development outside sewered areas is resulting in more incidences of increased nitrate levels in groundwater and in water supply wells; the area around Lake Tahoe has experienced particularly rapid growth outside areas served by public water and sewage systems. Arizona has similar problems, primarily due to older subdivision rules that permitted small lot development along rivers and along railroad rights-of-way; these densely developed pockets jeopardize surface and ground waters. Very few areas in the state have good site conditions, and rapid development compounds the situation. In California, problem areas occur along the coast and on the steep slopes of the Coast Range and the Sierra Nevada; dense development on the outskirts of cities also poses problems, and shallow aquifers are in jeopardy in the southern interior. Along the southern coast, shallow soils and expansive clays have caused significant numbers of onsite system failures.

From a national perspective, western Nevada and southern California have areas of high-permeability soils, while northeast Nevada and parts of Arizona have soils with relatively high risk of hydraulic failure. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment throughout California's Central Valley aquifer system, Tertiary sandstone aquifers near Santa Barbara, and Coastal Basin aquifers near Los Angeles, as well as in the Basin and Range basin-fill aquifers around Phoenix and Tucson in Arizona. Ground water was mentioned as a concern in all of the detailed State Reports for these states. The Sacramento-San Joaquin River System, in California, is listed by American Rivers as the most-endangered river in America due to water supply and water management issues—problems in part related to development pressures. Amnesic and paralytic shellfish poisoning have been reported along the California coast, while cyanobacteria blooms have been reported in San Francisco Bay. California and Colorado reported two or more years of extreme or exceptional drought conditions between 1998 and 2008. Cities previously listed as sprawl-threatened, including Phoenix and Los Angeles, appeared to have population increases occur primarily within urban areas rather than in suburbs.

3.9 Pacific Northwest and Northern Rockies – Oregon, Washington, Idaho, Montana, and Wyoming

The State Reports suggest that in Oregon, septic system problem areas, particularly due to shallow groundwater in sandy sole-source aquifers coupled with small lots created prior to state subdivision regulations, are located in the western portion of the state and along the Pacific coast. In Washington State, the densely populated Puget Sound Basin has had shellfish bed closures due in part to septic systems (though agricultural runoff is also problematic). In Idaho, Montana, and Wyoming, rugged conditions and poor soils are common, but population densities are low and problems generally occur in small pockets. Nutrient and pathogen loadings in lakeshore areas, and nitrate contamination of groundwater, are the primary concerns. Most recent development in these states has occurred in areas not served by sewers. Blaine County in south-central Idaho, around Helena, Missoula, Butte, and Bozeman in Montana, and western Wyoming and the Powder River Basin are all experiencing this type of growth.

At the national level, areas of soils with limited risk of filtration failure are located in southern Oregon and in pockets of central Idaho and western Montana. Soils with moderate risks of hydraulic failure are located in eastern Oregon, northern Montana, and near Puget Sound in Washington. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in portions of the Columbia Plateau basin-fill aquifers in central Washington, in the Willamette Valley basin-fill aquifer of northwestern Oregon, and in the Snake River Plain basin-fill and basaltic rock aquifers of southern Idaho. Ground water was mentioned as a concern in the detailed State Reports for Montana, Oregon, and Wyoming. The Lower Snake River in Idaho, Oregon, and Washington and the north fork of the Flathead River in Montana are both listed as "endangered" by American Rivers in 2009, primarily due to threats from hydroelectric dams and mining activities (the Lower Snake River was also listed in 1998). Cyanobacteria blooms, paralytic shellfish poisoning, and amnesic shellfish poisoning have all been recorded on the Pacific coast in Oregon and Washington. Wyoming reported two or more years of extreme or exceptional drought conditions between 1998 and 2008. The Seattle area, previously identified as "sprawl-threatened" by the Sierra Club, experienced continued suburban growth between 2000 and 2008.

3.10 Upper Midwest and Great Plains – North Dakota, South Dakota, Minnesota, Nebraska, and Iowa

The State Reports indicate that in North Dakota, South Dakota, and Nebraska, there are isolated problems with older subdivisions on riverbanks or lakeshores, and with clayey soils or shallow groundwater, but populations are relatively sparse and concerns about onsite system problems are generally minimal. In Iowa, although problems are generally isolated, there are several urban areas with dense concentrations of older systems. Areas around the cities of Davenport, Cedar Rapids, Iowa City and Des Moines are marked by high-density rural subdivisions without sewers, and over half of Iowa's onsite systems are now located in such areas. Minnesota has many areas of problems with high groundwater, karst topography, and poor soils, and rapid development of lakeshore areas in the north-central portion of the state is resulting in phosphorus and pathogen loading concerns and impacts.

From a national perspective, large areas of central Minnesota and central Nebraska have soils with high filtration risk, and areas of northern Minnesota and central South Dakota have soils with high hydraulic failure risk. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in much of South Dakota, in southeast North Dakota, in the Mississippian sandstone and carbonate rock aquifer of Iowa, and in scattered areas of the High Plains aquifer in western Nebraska. Ground water was also mentioned as a concern in the detailed State Reports for Nebraska. The Lower St. Croix National Scenic Riverway was listed as "endangered" by American Rivers in 2009, due to the loss of Wild and Scenic River status combined with local zoning decisions that are less protective of water quality. No states in this region reported extreme or exceptional drought over the last eight years. The Minneapolis/St.

Paul metropolitan area was listed as “sprawl-threatened” by the Sierra Club in 1998, and experienced continued population growth in its suburban fringe from 2000-2008.

3.11 Great Lakes – Michigan, Wisconsin, Illinois, Indiana, Ohio, and Kentucky

The State Reports indicate a diversity of problems in the Great Lakes states. Michigan has scattered areas with problems either because of dense development, antiquated systems, or unsuitable soils or hydrology. Development is primarily concentrated in unsewered areas of southeast, southwest, and northwest Michigan, where areas with high onsite system densities already exist. Wisconsin has high water tables and wetlands in the center and northeast, and shallow bedrock in the southwest, north-central, and northeastern areas; however, problems are few, due in part to dense population in the southeast where onsite conditions are generally good. Out-migration in Wisconsin is raising concerns about the conversion of agricultural land to recreational and residential use. Illinois has areas of shallow bedrock in the northeast, which is also the most heavily populated area, and significant areas of karst topography in the south and southwest; inadequately maintained surface-discharging aerobic systems are also resulting in environmental impacts. Indiana has wide problem areas associated with dense development and straight pipes, along with wetness, seasonally high water tables, and hydrologically poor soil types and geomorphologies. Ohio and Kentucky also have large areas of dense, unsewered development and attendant concerns for surface and groundwater impacts. Central and western Kentucky have significant areas of karst geology. Eastern Kentucky also has problems related to mountainous terrain and substandard onsite systems, similar to those in other Appalachian states e.g., Virginia, West Virginia, and eastern Tennessee/western North Carolina.

From a national perspective, northern Michigan and northeast Wisconsin have large areas of soils with moderate to high risk of filtration failure, while much of Ohio and Indiana have soils with high risk of hydraulic failure. The USGS has mapped significant declines in aquifer-wide water tables since predevelopment in the Silurian-Devonian carbonate rock aquifers along the coast of Lake Michigan in Wisconsin, and continuing south into northern Illinois and the northwest corner of Indiana. Ground water was mentioned as a concern in the detailed State Reports for Indiana, Michigan, Ohio, and Wisconsin. The Lower St. Croix National Scenic Riverway, which reaches into Wisconsin from Minnesota, was listed as “endangered” by American Rivers in 2009. Cyanobacteria blooms were recorded in Lake Michigan, Lake Huron, and Lake Erie. Cincinnati, Akron, and Chicago were all listed as “sprawl-threatened” by the Sierra Club in 1998; these and other major metropolitan areas throughout the Great Lakes states experienced continued population growth in suburban areas from 2000-2008.

3.12 Alaska and Hawaii

The State Reports indicate that problems are limited in Alaska; where they occur problems are related to aging developments or permafrost and harsh winter conditions. Concerns are primarily with nitrate contamination of groundwater, and thus with drinking water protection. In Hawaii, isolated areas, chiefly on the coast, have problems because of antiquated systems, dense development, unsuitable conditions, or jeopardized ground- or coastal waters. Hawaii experienced a quadrupling of onsite system permit requests between 2002 and 2006, indicating increasing development primarily in rural areas not served by sewer systems.

At the national level, Beaver Creek in Alaska is on the 2009 “endangered” rivers list, though the threat to this river is from proposed oil and gas field development. Cyanobacteria and ciguatera fish poisoning were recently recorded in the waters off Hawaii. Episodes of paralytic and amnesic shellfish poisoning were recorded in the waters off Alaska's southern coast. None of the other national maps or tables included information relevant to Alaska or Hawaii.

CHAPTER 4.0

ACTIVITIES AND DEVELOPMENTS IN THE STATES

This chapter summarizes significant changes in activities within the States that have occurred since the data collection effort for the original Market Study was completed in 1997-1998. The Comparative Analysis of the States from that study was used as a jumping-off point to investigate shifts—both positive and negative—over the last decade at the level of individual states.

4.1 Numerical and Cost Information

Some states, such as North Carolina, Michigan, and Florida, have made marked improvements regarding the tracking and reporting of numbers of permits issued, systems installed, repairs or replacements completed, and/or the types of technologies being installed. Others, such as Maine and Wisconsin, have continued to maintain reliable systems for tracking this information. In many other states, however, this information is not readily available. Table 4-1 provides estimates of permitted systems by state, including estimates of new installations and repairs/replacements as available, and descriptions of trends in permitting where sufficient information existed for analysis.

Table 4-1. Total Permitted Systems, Estimates of Permits for New Installations, Repairs, and Replacements, and Permitting Trends

State Name	Total Permitted Systems	Annual Permits for New Installations	Annual Permits for Repairs and Replacements	Permitting Trends
Alabama	750,000	25,000	3,200-3,700	NA
Alaska	30-40% of households	1200-1500	3,000	NA
Arizona	325,000	11,000-16,000	2,500	NA
Arkansas	400,000	10,000	NA	NA
California	1,300,000	5000-10,000	3,000-4,000	NA
Colorado	260,000	7,000-8,000	NA	NA
Connecticut	400,000	NA	NA	NA
Delaware	80,000-90,000	3,000	600	NA
Florida	2,300,000	35,000	NA	NA
Georgia	600,000-1,000,000	NA	9,000	NA
Hawaii	75,000	1500-4000	50	NA
Idaho	145,000	7,000	14,500	NA
Illinois	700,000	13,000	NA	NA
Indiana	800,000	15,000	6,000	NA
Iowa	265,000	5,000	NA	NA
Kansas	200,000	2,500	3,500	NA
Kentucky	800,000	20,000	NA	NA
Louisiana	405,000	18,000	10,000	NA
Maine	500,000	6,350	3,200	New installations declining 2005-2008
Maryland	420,000	7,500	5,000	NA
Massachusetts	660,000	NA	NA	NA

State Name	Total Permitted Systems	Annual Permits for New Installations	Annual Permits for Repairs and Replacements	Permitting Trends
Michigan	1,400,000	14,000	5,500	Dramatic decline in new installations from high of 37,000 in FY99-00.
Minnesota	500,000	20,000	6,000	NA
Mississippi	425,000	5,000	NA	NA
Missouri	600,000	4,500	1,400	NA
Montana	300,000	NA	NA	NA
Nebraska	200,000	2,000	NA	NA
Nevada	NA	NA	NA	NA
New Hampshire	350,000	4,000	500	From 1997-2004, new installations increased to high of 10,000 systems per year; from 2005-2008 new installations declined back to about 4,500 installations in 2008
New Jersey	360,000	2,200	NA	NA
New Mexico	241,000	6,000	1,600	NA
New York	1,500,000	NA	50,000	NA
North Carolina	2,000,000	25,000-30,000	4,000	NA
North Dakota	65,000	600	1,600	NA
Ohio	1,000,000	10,000-17,000	2,000-3,000	NA
Oklahoma	270,000	4,000	1,000	NA
Oregon	560,000	6,000	2,700	NA
Pennsylvania	1,300,000	12,000	4,000	NA
Rhode Island	150,000	800	1,000	NA
South Carolina	1,000,000	25,000	NA	NA
South Dakota	80,000	NA	NA	NA
Tennessee	780,000	NA	6,000	NA
Texas	1,800,000	42,600	NA	NA
Utah	120,000	3,400	150	NA
Vermont	NA	3,000	1,500	NA
Virginia	1,000,000	23,000	4,000	NA
Washington	700,000	25,000	3,500	NA
West Virginia	590,000	9,000	59,000	NA
Wisconsin	780,000	6,000-13,000	6,000-9,000	Highest number of new installations in 2003, declined slightly each year 2004-2006, marked declines to 6000-7500 permits issued per year in 2007-2008.
Wyoming	60,000	1,000	200	NA
Total	29,721,000	463,550	227,950	

Notes: N/A = not applicable; no information available
Source: State Reports and references therein.

The State Reports indicate that there are now at least 29,721,000 onsite systems installed in the United States. This estimate is higher than, but agrees reasonably well with, the most recent information available from the U.S. Census Bureau's 2005 American Housing Survey, which indicated that a total of 24,290,000 year-round housing units relied on septic tanks or cesspools for wastewater disposal (Table 4-2). Table 4-2 also shows a longer view of how wastewater service to year-round housing has changed over the last 30 years. Although the number of houses served by onsite systems continues to increase, the proportion of housing stock served by such systems has declined steadily since the mid-1970s (Eggers and Thackeray

2007. This change corresponds to the increased share of housing located in metropolitan and urbanized areas—and it also reflects the continued expansion of centralized sewers into non-metropolitan and rural areas (Eggers and Thackeray, 2007).

Table 4-2. Source of Wastewater Disposal, Year-Round Housing Units, 1975-2005

Type of Wastewater Disposal	1975	1985	1995	2005
Public Sewer	56,484,000 (72.8)	73,230,000 (75.7)	82,086,000 (77.1)	96,037,000 (79.7)
Septic Tank/Cesspool	19,694,000 (25.4)	22,985,000 (23.8)	24,115,000 (22.7)	24,290,000 (20.2)
Other	1,375,000 (1.8)	534,000 (0.6)	203,000 (0.2)	204,000 (0.2)

Notes: Numbers in parenthesis indicate percentages.
Source: Eggers and Thackeray 2007.

Only a few states reported permitting information that was specific enough to infer over-arching changes (Table 4-1). In all cases, however, these states reported increases in permits issued for construction of new systems in the late 1990s and through about 2003, stable or slightly declining numbers of permits for new construction issued in 2004-2005, and marked declines in permits issued from 2005-2008.

Unlike the 1990 U.S. Census, the 2000 Census did not collect information about household water supply type or wastewater service type. The American Housing Survey, conducted for HUD every 5 years, also contains no state-level specific information about water supply source or wastewater service type. This made it impossible to accurately update estimates of system numbers which were derived originally from the 1990 Census.

Likewise, cost information for conventional systems, as well as that for centralized sewer connections, was rarely reported in the formal or informal literature in sufficient detail to allow accurate comparisons between states. Where such information was discovered, it was recorded in the State Reports.

4.2 Comparative Analysis of the States

As each draft State Report update was completed, updates were made to the state-by-state comparative analysis from the original Market Study, using the ranking criteria developed during that study. The analysis categories and criteria are summarized in Table 4-3.

Table 4-3. Categories and ranking criteria for comparative analysis.

Category	Ranking: High (H)	Medium (M)	Low (L)
Severity of Conditions	Many small areas where dense, older development; physiography; or jeopardy to resources poses present or imminent future problems—or a smaller number of sizable geographic areas where one or more of these conditions apply	Several small or a few large geographic areas with limitations	Few problems, or problems in limited areas, now or in the future
Concern with Conditions	An impression of how actively the state, or large areas within it, are addressing the problems perceived to exist, or how high those problems are ranked internally relative to other nonpoint pollution problems such as agricultural runoff		
Management Entities	Several entities exist, and more are planned or their creation is being seriously considered; or entire state is bringing on-site systems under a proactive level of management.	Isolated areas may have management entities, or discussion is underway, typically at local levels	Little attention given to management entities
Loans and Grants	Well-funded, state-level programs, available to most homeowners with demonstrated on-site problems; or large cities or counties in the state have programs.	One or more individual counties may have programs	No programs or only limited funding to low-income families available through more general economic assistance programs
Training and Certification	Several categories of on-site professionals require training and certification at the state level, or a training center exists	Active local programs exist that do not apply state-wide, or a training program is anticipated	Programs are spare, and perhaps voluntary
Receptivity to New Technology	Ready and readily used mechanisms exist to put new technologies into routine or general use, regulatory support is fairly strong	Greater difficulty for putting new technologies into routine or general use (and typically fewer available alternatives)	Code is very restrictive, all or most alternatives are strictly by variance (often requiring set-asides for possible mitigation); regulatory interest or support is low
Research Activity	At least one active state or academic research program (frequently associated with training activities) designed to evaluate, and perhaps to develop, new technologies	Limited field work or projects, possibly at local level	Research confined to pilot or experimental projects permitted by variance
Demonstration Projects	Several smaller or a large-scale national demonstration project is/are underway	One or two state-sponsored projects exist	Only local, or private, efforts exist.

Note: Rankings and criteria presented here are derived directly from the original Market Study (EPRI, 2000)

The updated Comparative Analysis of the States is shown in Table 4-4. The discussion and maps that follow are based on the results of this analysis. In a few cases, states already ranked "high" in all categories have continued to make marked improvements; these are denoted with the ranking "HH" in the summary analysis.

Table 4-4. State-by-state comparative summary.

	Severity of conditions	Concern with conditions	Management Entities	Loans or Grants	Training and Certification	Receptivity to New Technology	Research Activity	Demonstration Projects
Alabama	H	M	H (L)	L	H (M)	H	H	H
Alaska	L	M	L	M (L)	H (M)	M (L)	L	L
Arizona	H	H	H (M)	L	M	H	L	L
Arkansas	M	L	L	L	H (L)	M	L (M)	L (M)
California	H	H	H	M (L)	M	H	L (M)	L (M)
Colorado	M (L)	M (L)	M	L	L	L	H (M)	L
Connecticut	H	H	H	L (M)	M	M (L)	L	L (M)
Delaware	M	M	H	H	H	H	L (M)	M
Florida	H	H	H (M)	M	H	H	H	H
Georgia	M	M	M (L)	L	L	M	L	L
Hawaii	L	L	L	L	L	M	L	L
Idaho	L	M	H (M)	L	H (M)	H (M)	L	L
Illinois	M	M	L	L	M	H	L	L (M)
Indiana	H	M	M (L)	L	M (L)	M	M	M
Iowa	L	M (L)	H (L)	H (L)	M (L)	H	L	M (L)
Kansas	M	M	M	H	L	L	H	H
Kentucky	M	H (M)	M (L)	M	H	L	M	H
Louisiana	H	M	L	L	M (L)	H	L	L
Maine	M	M (L)	L	M	H	L	L	L
Maryland	M	H (M)	M	H (M)	H	M	M	M
Massachusetts	M	H (M)	H (M)	H	M	H (M)	H (M)	H
Michigan	M	M	M (L)	L	M	M	M (H)	H (M)
Minnesota	M	H	HH (H)	H	H	H	H	H
Mississippi	H	M	M (L)	L	M	H	L	M
Missouri	H	H	H	M (L)	H (L)	H	M	H (M)
Montana	M	M (L)	M (L)	L	L	M (L)	M	L
Nebraska	M	M	L	M (L)	H (L)	L	M (L)	L
Nevada	L	M (L)	L	L	L	L	L	L
New Hampshire	M	H	L	L	H	M (L)	L	L
New Jersey	M	M	M (L)	M	M	M	L	L
New Mexico	M	M	H (M)	L	M (L)	H	H	H
New York	M	M	H	H	H (M)	M	H (M)	H (M)
North Carolina	H	H	H	M	H	H	H	H
North Dakota	L	L	L	H (L)	M (L)	L	L	L
Ohio	M (L)	M (L)	M	H	M (L)	M	H (M)	M
Oklahoma	M	M	L	H (L)	H (L)	H	M (L)	L
Oregon	H	H	M	L	H (M)	H	H (M)	H
Pennsylvania	H	H	H	M	M	H (M)	H	H
Rhode Island	H	H	HH (H)	H	H	HH (H)	H	H
South Carolina	H	M (L)	M	L	H (M)	M	L	L
South Dakota	L	L	L	L	M	L	L	L
Tennessee	M	M	M (L)	M (L)	M (L)	L	H (L)	M (L)
Texas	M	H	M	M	H	H	H	H
Utah	L	M (L)	M	M	H (M)	M (L)	M (L)	M (L)
Vermont	H	L	M	M (L)	M	H (L)	L	H
Virginia	M	H	H	M	H (M)	H	H	M (L)
Washington	H	H	HH (H)	HH (H)	H	HH (H)	H	H
West Virginia	M	M	M	H (L)	M	H	M	H
Wisconsin	H	H	HH (H)	H	H	HH (H)	M (H)	H
Wyoming	L	M (L)	L	M (L)	L	L	M (L)	M (L)

Notes: Criteria for each category and ranking are described in Table 4-3.
Rankings in parentheses indicate the ranking in the original market study (EPRI, 2000).
If no ranking in parentheses is shown, no significant change was noted.

Within each category of the comparative analysis, several important changes were noted. The following sections further describe these changes.

4.2.1 Severity of and Concern about Conditions

For the majority of states, acknowledgement of environmental issues or constraints related to onsite systems remained consistent (Figure 4-1). On the Atlantic Coast, in Massachusetts, Maryland, and South Carolina, increased concern was noted about the impacts of existing unsewered development on sensitive coastal waters. In Massachusetts, water quality issues—primarily nitrogen limitations—have resulted in some towns and inter-municipal districts (such as the Tri-Town Groundwater Protection District on Cape Cod), which were examining the onsite wastewater management district concept in the 1990s, to instead plan centralized treatment plants to meet stringent water quality standards (e.g., Town of Orleans, 2008). Contrastingly, in Maryland, the use of advanced (nitrogen reducing) treatment systems is increasing due in part to Chesapeake Bay restoration efforts where system upgrades within 1,000 feet from the shoreline of any tributary to the bay are being prioritized (Brzozowski, 2007). These upgrades are funded through the Bay Restoration Fund; fees paid to this fund by residents on centralized systems go towards upgrading sewage treatment plants, while the fees paid by owners on individual systems go partly to the cost of upgrading septic systems to

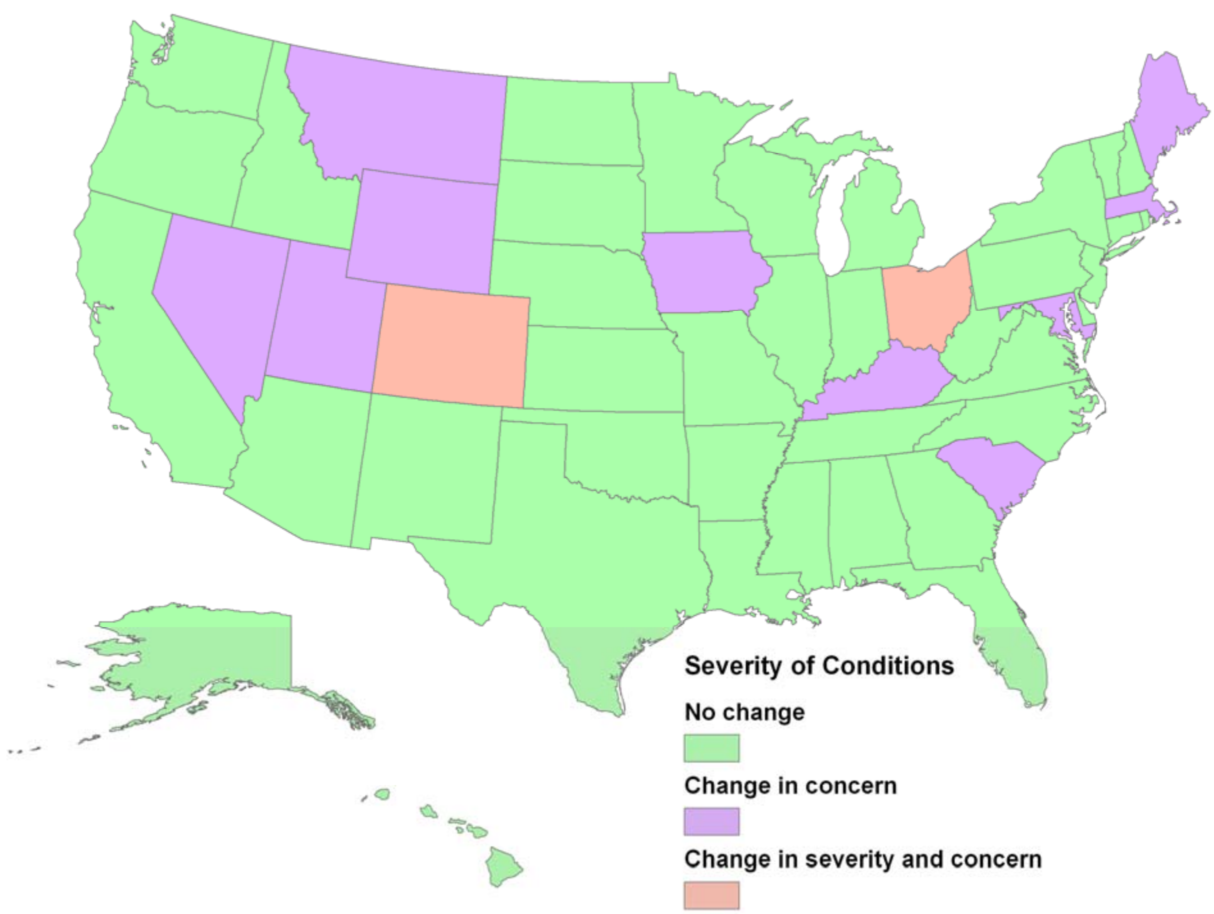


Figure 4-1. Changes in severity of conditions and concern with conditions since the original Market Study.

denitrification units, and partly to cover crop programs (Maryland Dept. of Environment, 2008; Grenoble, 2007; Summers, 2008).

In Maine, concerns are related more to long-term changes in land use patterns—particularly increasing rural development outside sewered areas (Maine State Planning Office 2008). In the Midwest, particularly in Kentucky and Ohio, increases in concern center primarily on increased awareness of both difficult conditions for onsite systems and of problems with historic siting, installation, and maintenance practices (e.g., Ohio Department of Health 2008). In the western Mountain states (particularly in Colorado), the overwhelming area of increasing concern is with impacts of explosive unsewered development surrounding metropolitan and resort areas (Dano et al., 2004).

4.2.2 Management Entities

Interest in and implementation of management entities has increased in a number of states, particularly in the Midwest, the Ohio River Valley, and the several Southwest and Northwest states (Figure 4-2). Two states—Iowa and Alabama—made particularly significant progress on the implementation of management entities in the last decade. In Alabama, regulations requiring financially viable Responsible Management Entities (RMEs) for all multi-user systems were enacted in 2004, and at least seven such entities are operating in the state

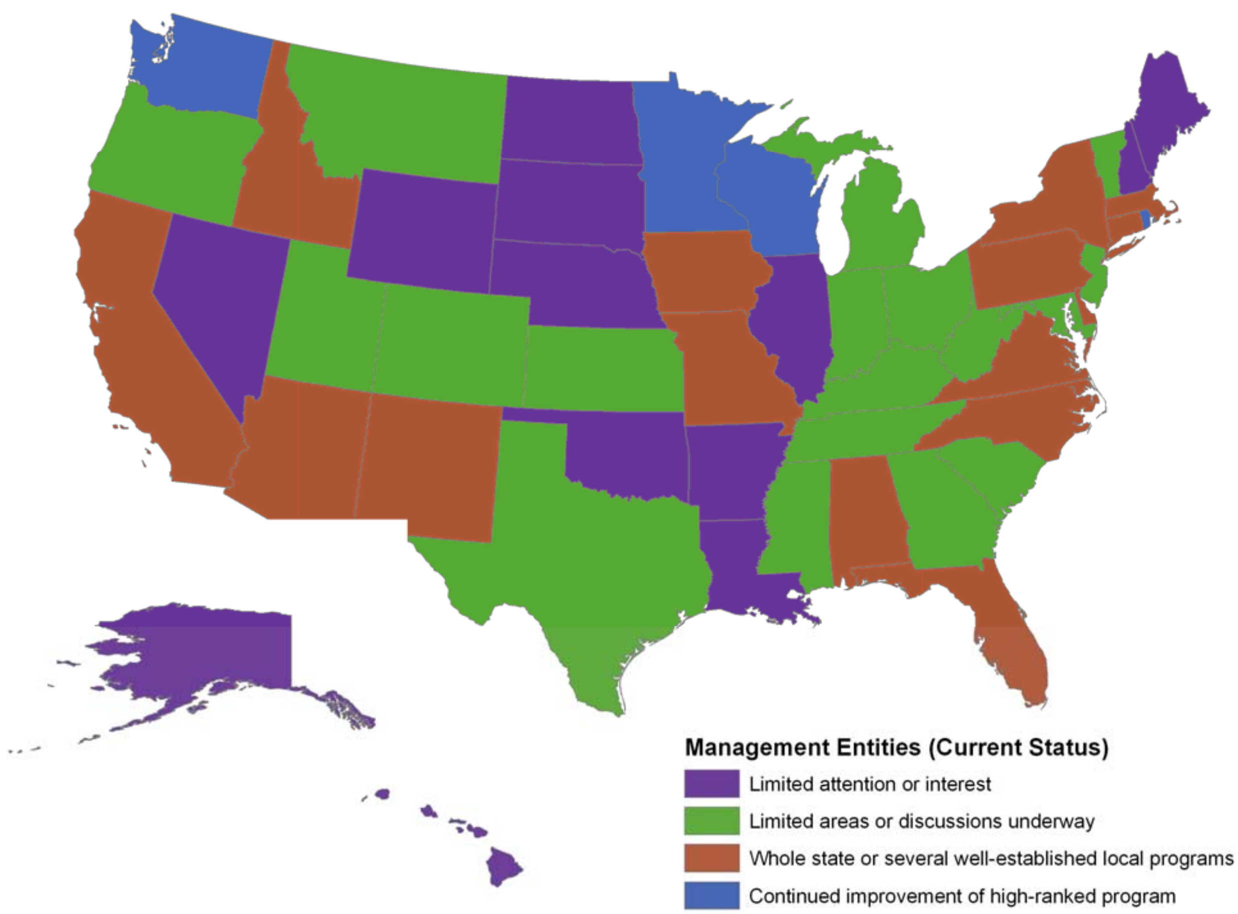


Figure 4-2. Current Status of Interest in and Implementation of Management Entities.

(Alabama Dept. of Public Health, 2008 and James Coles, pers. comm., 2009). In Iowa, there are at least two well-known, successful responsible management entities and (more importantly) a concerted effort by state regulators to implement RMEs for unsewered communities (Yeager et al., 2006).

Several states where management entities were already well-established in the late 1990s have continued to improve management of decentralized systems. For example, in Rhode Island, since the mid-1990s, at least eight unsewered communities have adopted onsite management program ordinances and implemented programs, and 21 (78% of unsewered communities in the state) have completed wastewater planning processes (Chateauneuf, 2002). The state of Wisconsin has required management plans for all systems installed since July 2000, and required maintenance contracts whenever service is required more than once per year (Wisconsin Department of Commerce, 2008). Additionally, recent changes to Wisconsin's onsite systems code require all counties to inventory all systems in their jurisdictions within 3 years, and implement and enforce a comprehensive maintenance program for all of these systems within 5 years (ibid. and Roman Kaminski, pers. comm., April 2009).

4.2.3 Loan Programs and Grants

The implementation of loan programs or grants for onsite system repairs or replacements has increased in about a quarter of the States in the last decade (Figure 4-3). Four states (North Dakota, Iowa, Oklahoma, and West Virginia) now have some form of state-wide loan or grant program to fund onsite system repairs or upgrades where no program existed previously. A particularly interesting example of a targeted funding program can be found in Maryland, where the Bay Restoration Fund has been implemented; money from citizens served by centralized systems goes to funding centralized treatment plant upgrades, while money from citizens with septic systems goes to a fund that pays (in part) for onsite system upgrades to use nitrogen removal technology within critical areas of the Chesapeake Bay watershed (Maryland Dept. of Environment, 2008). Just to the north in Connecticut, however, a previously documented funding program for repairs has been discontinued (Connecticut DEP, 2008).

4.2.4 Training and Certification

More than a third of the States have increased the levels of certification and training needed by professionals in the decentralized wastewater industry since the original Market Study was conducted (Figure 4-4). Four states (Arkansas, Missouri, Nebraska, and Oklahoma) now require most or all decentralized wastewater professionals to be certified, and in three of these states the certifications or licenses are renewable and require continuing education as a condition of renewal. In other states, incremental improvements have been made in either certification levels or the classifications of professionals required to be certified. Almost half (24) of the States now have state-level certification or licensing requirements for most or all practices within the decentralized wastewater profession (designers, soil evaluators, installers, pumpers, and sometimes maintenance providers). Only seven states remain where few or no licensing programs are in effect, or where little training is available to professionals in the decentralized industry.

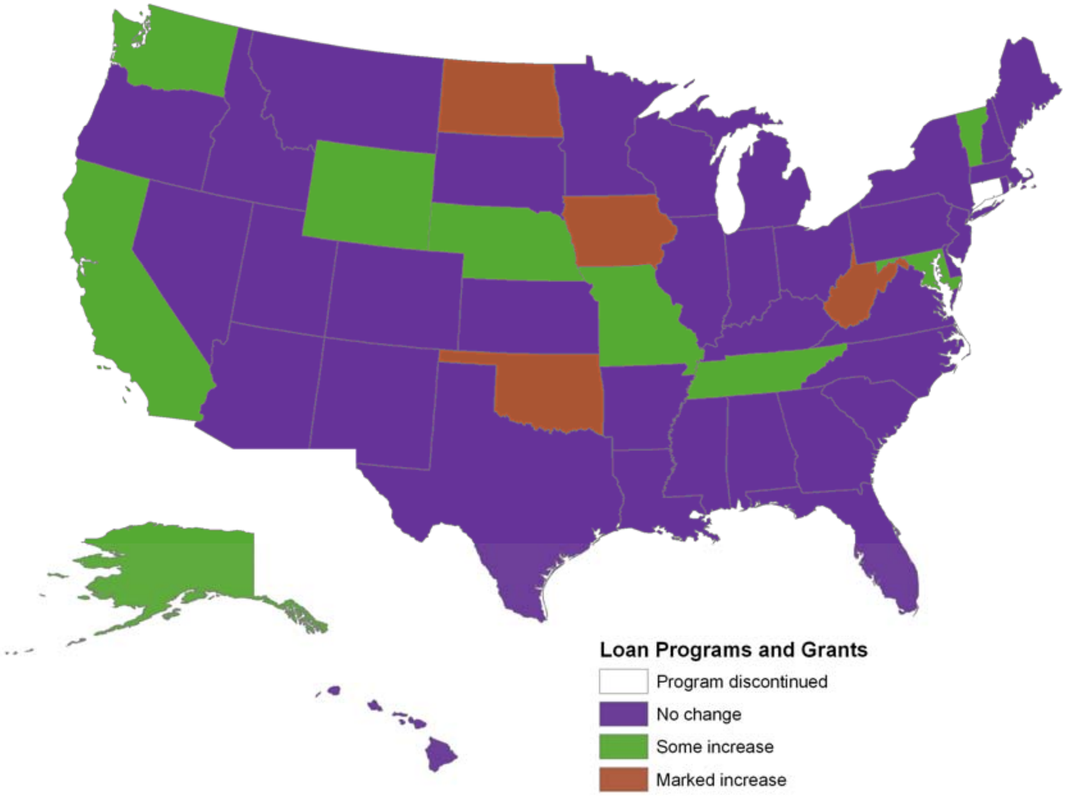


Figure 4-3. Changes in Implementation of Loan or Grant Programs for Repairs, Upgrades, or Replacements.

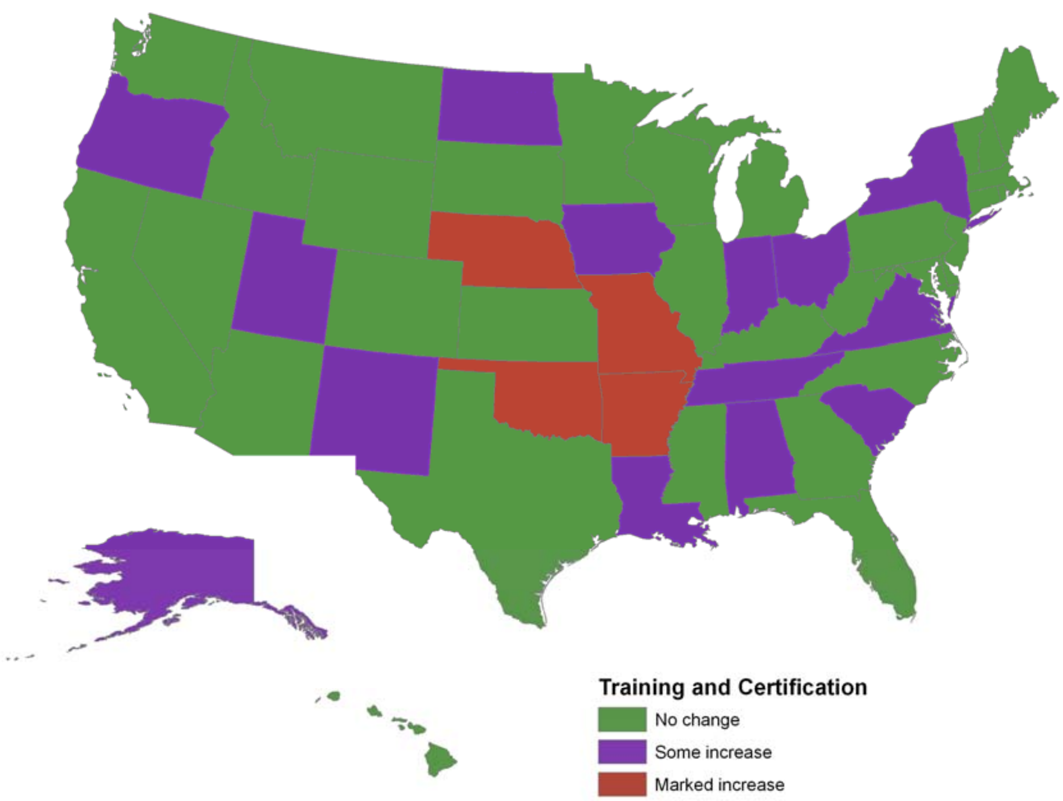
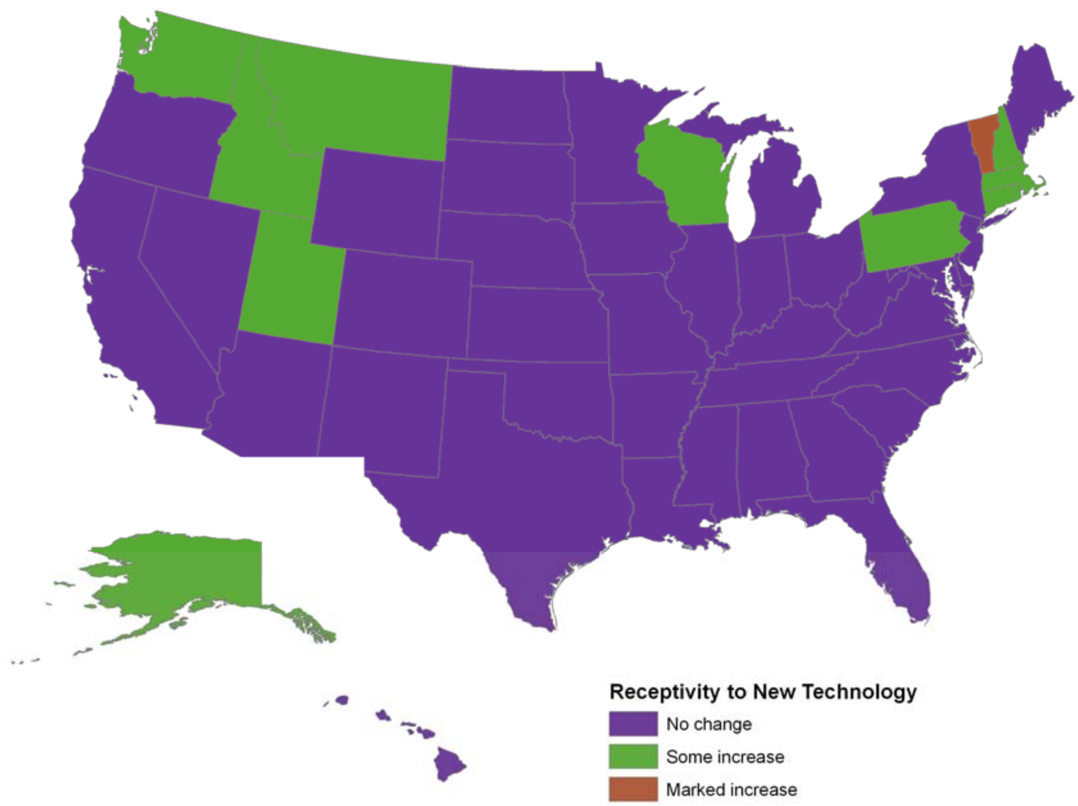


Figure 4-4. Changes in State-Level Certification Requirements and Availability of Training Programs.

4.2.5 Receptivity to New Technology

Since 1997-98, about a quarter of the States have changed rules and processes to be more receptive to new technologies (Figure 4-5). In Vermont, the state's onsite wastewater system rules were updated in 2002 to include, for the first time, a consistent process for new technology review and approval (Vermont Dept. of Environmental Conservation, 2007). In most other states where receptivity to new technology increased, such changes were more incremental—and were generally formalizations in state rules of processes for approving technologies new to the states. Half of all states now have a formal program in rule for approving new technology; however, inclusion in rule does not always mean that the use of such technologies is encouraged as a matter of state policy. In Utah, for instance, state regulators have a formal process for evaluating and approving new technology, but do not have the authority to mandate its ongoing maintenance or management--and thus are reluctant to advocate the use of technologies, such as textile filters, that require regular maintenance to



function properly (Utah Division of Water Quality 2009).

Figure 4-5. Changes in Receptivity to New Technology.

In some cases, notably in such states as Minnesota, Rhode Island, Washington, and Wisconsin, relatively high levels of technology acceptance and implementation correspond with well-established (and often long-standing) local or state programs for decentralized system management (Table 4-2). However, there are also a number of states (for example, Illinois, Louisiana, and Oklahoma) where technology acceptance is high, yet interest in management entities is limited.

4.2.6 Research Activity

Research activity in universities and in state agencies has remained relatively consistent overall the last eight years (Figure 4-6). At the level of individual states, however, progress has been quite variable. The research program at the Colorado School of Mines, which was just being established in the late 1990s, is now highly successful and nationally known; a new research program and training center has also been established at the University of Tennessee. A number of states, notably Rhode Island, North Carolina, and Minnesota, have continued to maintain strong research programs, usually in coordination with training activities at land-grant universities. However, a few long-running research programs, including the Small Scale Waste Management Project at the University of Wisconsin-Madison, have concluded with the retirement or career change of their leading faculty members (University of Wisconsin-Madison, 2006).

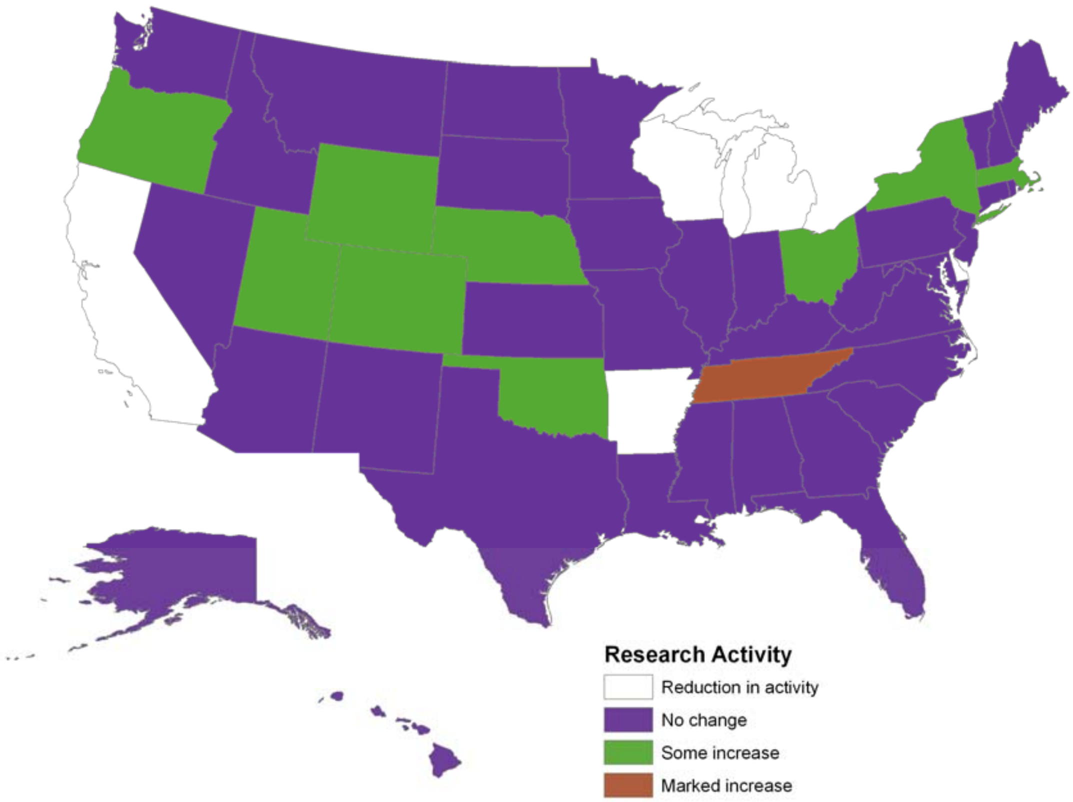


Figure 4-6. Changes in Research Activity.

4.2.7 Demonstration Projects

As it was for research activity, the implementation of demonstration systems or projects has remained relatively consistent overall, but varies significantly from one state to the next (Figure 4-7). Several well-reported national demonstration projects, including projects at Skaneateles Lake in New York and Table Rock Lake in Missouri, have been initiated since the completion of the original Market Study (Murdoch and Vanderlyn, 2007; Casaletto and Borchelt, 2007). In several states, demonstration projects have concluded and, if follow-on activities have been conducted, they are not evident. In Illinois, for instance, a demonstration project that enabled four villages to install alternative community systems as replacements for failing individual systems concluded as a success (Illinois Community Action Association, n.d.), but no follow-on work or further demonstrations appear to have occurred. Also, Figure 4-7 does not account for a number of successful national demonstration projects, for example, in Rhode Island, Oregon, and Vermont, whose beginnings were recorded during the original study.

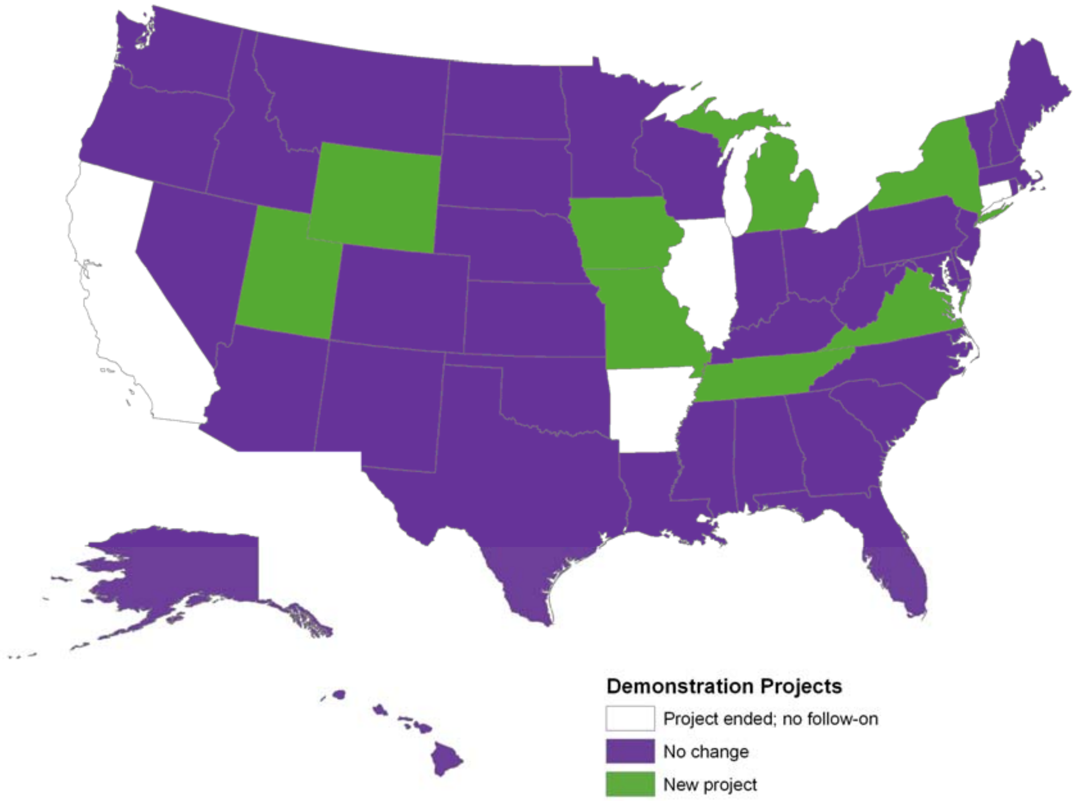


Figure 4-7. Changes in Demonstration Projects.

CHAPTER 5.0

PROGRESS AND CHALLENGES AT THE NATIONAL SCALE

5.1 U.S. EPA Decentralized Systems Policies and Programs

At the time the original Market Study was published, the U.S. EPA was beginning to support the development of onsite and cluster systems as a permanent wastewater treatment solution. In 1997, the much-cited *Report to Congress on Use of Decentralized Wastewater Treatment Systems* was published—a major conclusion of which was that "[a]dequately managed decentralized wastewater treatment systems can be a cost effective and long-term option for meeting public health and water quality goals, particularly for small, suburban and rural areas." The report described benefits of and barriers to the successful implementation of decentralized wastewater systems and management, and explained U.S. EPA's plans for (among other activities) funding programs; outreach, training, and education, and technology and demonstration projects (U.S. EPA, 1997).

5.1.1 Guidance and Resources

Since the publication of the Report to Congress, U.S. EPA has developed and released several important national guidance documents and tools related to decentralized wastewater treatment systems:

- The *Onsite Wastewater Treatment Systems Manual*, published in 2002, provides supplemental and new information for wastewater treatment professionals in the public and private sectors. The manual describes recent developments in treatment technologies, system design, and long-term system management with a particular focus towards onsite systems.
- The *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*, published in 2003, was intended to provide guidance towards proper management of decentralized systems, including implementation of more comprehensive programs designed to provide appropriate oversight throughout the life cycle of such systems. The Management Guidelines describe five different management models, ranging from Model 1 "Homeowner Awareness" (programs including outreach and basic tracking, intended for widely scattered systems in low-risk environments) to Model 5 "RME Ownership" (programs analogous to centralized sewerage, where the responsible entity owns, operates, and manages the system, intended for high-risk systems and/or extremely sensitive environments).
- The *Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems*, released in 2005, is intended to be a practical resource for

communities interested in implementing management models described in the U.S. EPA's 2003 Management Guidelines. It includes a step-by-step process, many examples and case studies from communities throughout the U.S., and provides links to extensive resources.

- The Wastewater Information System Tool (TWIST) was first released in 2006. TWIST is an "off-the-shelf, user-friendly management tool that will allow state and local health departments to effectively inventory and manage small wastewater treatment systems in their jurisdictions. It is designed to track information related to homes and facilities served, permits, site evaluations, types of systems, inspections and complaints" (U.S. EPA, 2006).

5.1.2 Decentralized Memorandum of Understanding

In 2005, the U.S. EPA and 14 other organizations entered into a Memorandum of Understanding (MOU) to "help focus efforts on better planning, design, and long-term operation, maintenance and management of septic systems on a national level" (U.S. EPA, 2008). The MOU was renewed in November 2008, and six additional organizations signed on at that time (Table 5-1).

Table 5-1. U.S. EPA Memorandum of Understanding Partners (U.S. EPA 2008)

2005 MOU Partners	2008 MOU Partners
Consortium of Institutions for Decentralized Wastewater Treatment	Association of State Drinking Water Administrators
National Association of Towns and Townships	Association of State and Interstate Water Pollution Control Administrators
National Association of Wastewater Transporters	Consortium of Institutions for Decentralized Wastewater Treatment
National Environmental Health Associations	Groundwater Protection Council
National Environmental Services Center	National Association of Towns and Townships
National Onsite Wastewater Recycling Association	National Association of Wastewater Transporters
Rural Community Assistance Program	National Environmental Health Associations
Water Environment Federation	National Environmental Services Center
	National Onsite Wastewater Recycling Association
	Rural Community Assistance Program
	State Onsite Regulators Alliance
	The Association of State and Territorial Health Officials
	Water Environment Federation
	Water Environment Research Foundation

The partnership between organizations involved in the MOU has reportedly resulted in better cooperation, collaboration, consultation, and communication among the various organizations (U.S. EPA, 2008a). A recent summary of MOU partners' activities credits the partners with—for example—increasing the availability of and attendance at training activities and workshops, improved consistency of training curricula, development and implementation of a national installer credentialing program, workshops in support of a model performance code, development of a decentralized wastewater glossary, and continuance of the annual State Onsite Regulators' Conference (U.S. EPA, 2008a). The Decentralized MOU partners' website, hosted by the National Onsite Wastewater Recycling Association at http://www.us-epamoupartners.org, has more information about the MOU partners and their activities.

Despite continuing to promote the Decentralized MOU, over the last two years U.S. EPA has appeared to pull back from its former emphasis on "decentralized" systems and management. The portion of the U.S. EPA's website that provides information on such systems has gone through several redesigns and now refers primarily to "septic" or "onsite" systems (U.S. EPA, 2009a). This development was reportedly a result of a marketing study commissioned by the Office of Water (Hudson, 2009). Although such allocation of effort and resources it is at odds with efforts towards increased professionalism in terminology by Decentralized MOU partners and others throughout the industry, it appears to be in line with U.S. EPA's 2006-2011 Strategic Plan, which gives only the barest mention to "encouraging state, tribal, and local governments to adopt voluntary guidelines for managing on-site/decentralized sewage treatment systems and using Clean Water Revolving Loan Funds to finance systems where appropriate" (U.S. EPA, 2006a).

5.1.3 Technology and Demonstrations

Several technology and/or demonstration programs funded or administered by the U.S. EPA have been completed over the last decade or are now near completion, representing over $35 million worth of projects in 25 states (U.S. EPA, 2009a). Many of these projects have been completed and their results are available in the Demonstration Projects portion of the U.S. EPA's website (U.S. EPA 2009a). These projects are funded through four EPA-sponsored programs:

- The National Onsite Demonstration Project (NODP) demonstrated "the use of alternative, onsite wastewater treatment technologies to protect public health, ensure water quality and sustain the environment in small and rural communities" (U.S. EPA 2009a). The project was administered by the National Environmental Services Center at West Virginia University and was completed in 2002 (National Environmental Service Center 2006).
- The National Community Decentralized Wastewater Demonstration Project targets communities for demonstrations of decentralized wastewater technologies and management, and is funded by congressional appropriations. Many of the demonstration projects described in Section 4.2.7 were funded through this program—and most, if not all, are now completed. It is not clear whether future projects will be funded.
- The National Decentralized Water Resources Capacity Development Project (NDWRCDP) "supports research and development to improve our understanding and strengthen the foundations of training and practice in the field of onsite/decentralized wastewater treatment" (U.S. EPA, 2009a). This project is now managed by the Water Environment Research Foundation (WERF). Over 40 projects have been completed through this program, many of which are included in the updated State Reports. The NDWRCDP-funded projects have resulted in significant advances in the state of training activities and university and practitioner curricula, risk assessment and integrated planning for decentralized systems, understanding of the treatment performance of onsite and cluster systems, application of numerical models to understand environmental impacts of decentralized systems and aid in decision making. More recently, projects funded have included assessments of green roof performance and sustainable water management (NDWRCDP, 2009). The funding cycle for this program ends in December 2009, and it is not clear whether further authorizations will be funded (Jeff Moeller, Water Environment Research Foundation, pers. comm., April 2009).

- ♦ The Water Quality Cooperative Agreement program "provides assistance agreements with nonprofit institutions funded under the authority of section 104(b)(3) of the Clean Water Act to promote the coordination of environmentally beneficial activities" (U.S. EPA 2009a).

In addition, one part of the U.S. EPA's Environmental Technology Verification (ETV) Program, within the Water Quality Protection Center, is dedicated to verifying market-ready onsite wastewater technologies using protocols developed by manufacturers (U.S. EPA 2009a). This Center is operated in cooperation with NSF International. Although not a certification program, it seeks to obtain credible operating data that can be widely distributed and accepted by regulators and others. Several nitrogen removal technologies for residences have been tested through the ETV program (U.S. EPA, 2007a). Detailed performance results for each technology that undergoes ETV testing are publicly accessible in verification reports (U.S. EPA, 2007a).

5.2 U.S. EPA Clean Watersheds Needs Survey

The Clean Watersheds Needs Survey (formerly Clean Water Needs Survey) is prepared by U.S. EPA using data on documented wastewater treatment needs submitted by 48 States and the District of Columbia, to meet the requirements of section 516 of the Clean Water Act (CWA). Although needs related to non-point source pollution are not required to be reported in section 516, U.S. EPA elects to include non-point source pollution control needs as well because of their associated water quality problems.

Two Clean Water Needs Surveys (CWNS) have been completed since the publication of the original Market Study. The 2000 Clean Watersheds Needs Survey Report to Congress presented, for the first time, only documented needs for centralized wastewater collection and treatment systems (prior surveys relied on a combination of documented needs and modeling) (U.S. EPA 2003a). The total documented funding needs for centralized systems reported in the 2000 CWNS was $167.4 billion, while another $13.8 billion of documented non-point source pollution control needs were identified (U.S. EPA, 2003a). The 2000 CWNS acknowledged the difficulties states faced in attempting to document needs related to non-point pollution source control, including those related to onsite wastewater treatment systems. In the 2000 CWNS, needs related to onsite systems were not documented except as part of "urban" sources.

The 2004 CWNS reported documented needs of $202.5 billion for centralized wastewater collection and treatment systems, with another $ 38.3 billion in documented non-point source pollution control needs (U.S. EPA, 2008b). This survey marked the first time that needs related to "individual/decentralized sewage treatment" were documented separately; 31 states reported a total funding need of $3.0 billion (U.S. EPA, 2008b). The 2004 CWNS Report to Congress acknowledges continued under-reporting of non-point source pollution control needs; for example, they report "[a]lthough the current individual septic system population reported in the CWNS has nearly doubled from 7.7 million in 2000 to 15.6 million in 2004, this represents only approximately one-fifth of the current U.S. population being served by onsite systems" (U.S. EPA, 2008b).

5.3 National Development Trends and Impacts

As indicated in the State Reports and in Section 4.1, the development market over the last decade has been first a major opportunity—and then a major liability—for the decentralized wastewater industry. At the national level, this is perhaps best illustrated by statistical data on new housing starts collected by the U.S. Census Bureau (U.S. Census Bureau, 2009). Figure 5-1 shows annual total privately owned new housing starts by region from 1960 through 2008. From the mid-1990s through 2000, annual new housing starts generally increased, continuing a trend that began in the early 1990s. For two years, total starts were slightly lower, and then climbed markedly from about 1.5 million in 2001 to a high of 2.1 million in 2005 (Figure 5-1). After 2005, new housing starts dropped dramatically in each subsequent year. In 2008, less than 1 million new housing starts were reported for the first time since the U.S. Census Bureau began the construction survey in 1959.

The regional information reported in Figure 5-1 is similar to numerical and anecdotal information regarding development and permitting trends recorded in the State Reports. The number of new housing starts in the Northeast has remained relatively steady since about 1990. The number of starts in the Midwest, after years of incremental increases, dropped considerably from 2006-2008, consistent with reports of declining annual permit totals for new construction from regulators in Michigan (Michigan Department of Environmental Quality, 2008). The majority of recent new housing construction has been concentrated in the South and West. While about half of all new housing starts were located in the South and West regions in 1990, by 2005 fully three-quarters of all new housing starts were in these regions and the South alone accounted for half of all new housing starts.

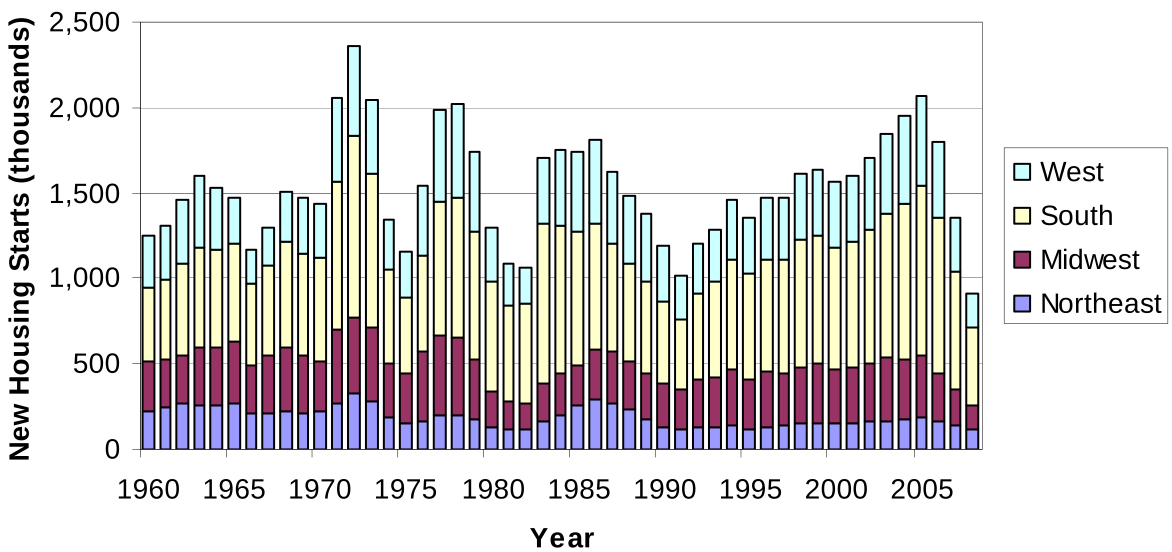


Figure 5-1. New privately owned housing units started, 1960-2008 (U.S. Census Bureau 2009).

The downturn in the national housing market has particularly impacted sectors of the decentralized wastewater industry that had, in the early 2000s, profited from the rise in new housing construction. This is indirectly evidenced in, for instance, reduced attendance at and manufacturer sponsorship of national industry conferences such as the National Onsite

Wastewater Recycling Association's Annual Technical Education Conference, and reduced membership dues paid to such organizations (Hanifin Bonner, 2007; Gale, 2008)—or the disappearance of industry publications from the marketplace, such as the *Onsite Water Treatment* magazine, which relied primarily on advertising revenue (Forester Publications 2008).

5.4 Nationwide Changes and Trends in States' Activities

The figures below continue the Comparative Analysis of the States presented in Chapter 4 at the national level, highlighting changes since the overall comparative analysis of needs and activities in the states was evaluated in the late 1990s. The original goal of this analysis was to identify states where high-quality use and demonstrations of advanced on-site and cluster systems and/or management might productively be pursued. Figure 5-2 highlights the composite potential of the states as presented in the original Market Study. Rankings within each factor were rated: High, 3 points; Medium, 2 points; or Low, 1 point; and summed for each state. At that time, the highest short-term potential for development of advanced systems and management were the coastal states of Rhode Island, Delaware, North Carolina, Florida, Texas, Washington, Oregon, and California; the Great Lakes states of Minnesota and Wisconsin; and Pennsylvania.

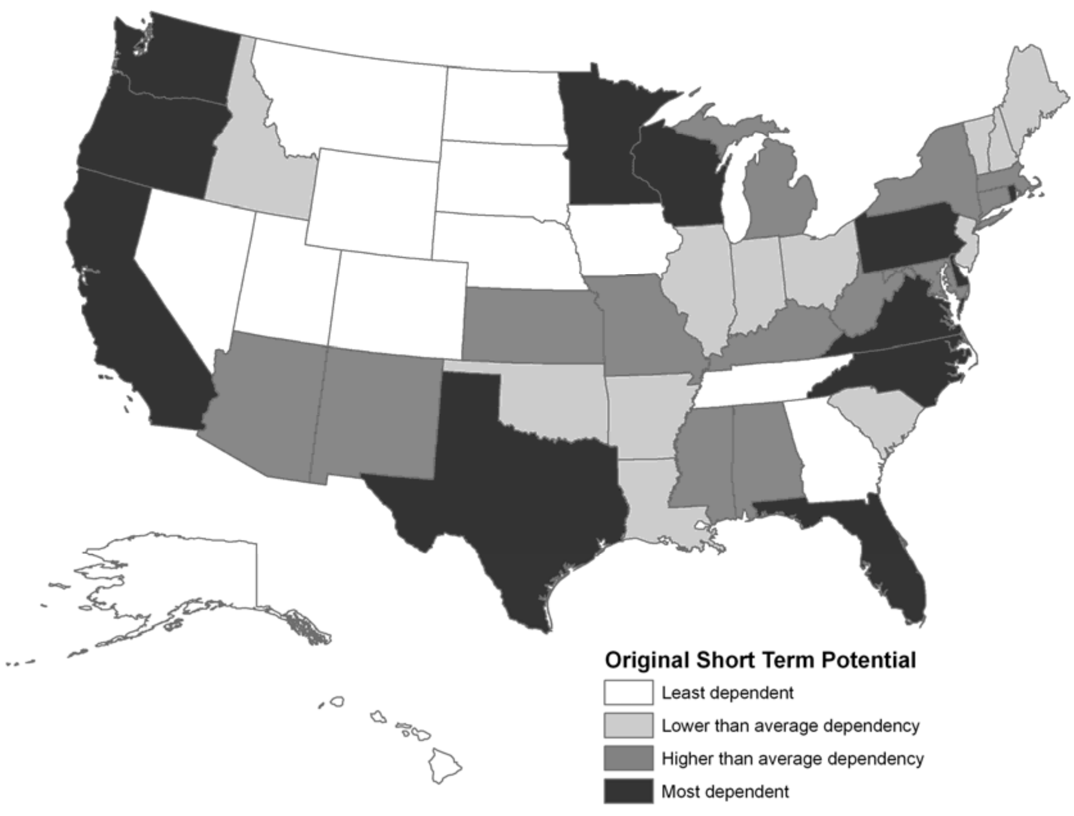


Figure 5-2. Composite Potential of the States (adapted from EPRI 2000).

Figure 5-3 was created by applying the same methodology (and the same numerical ranking ranges) to the updated rankings for each state that are shown in Table 4-2. The new ranking of Very High / HH was assigned 4 points.

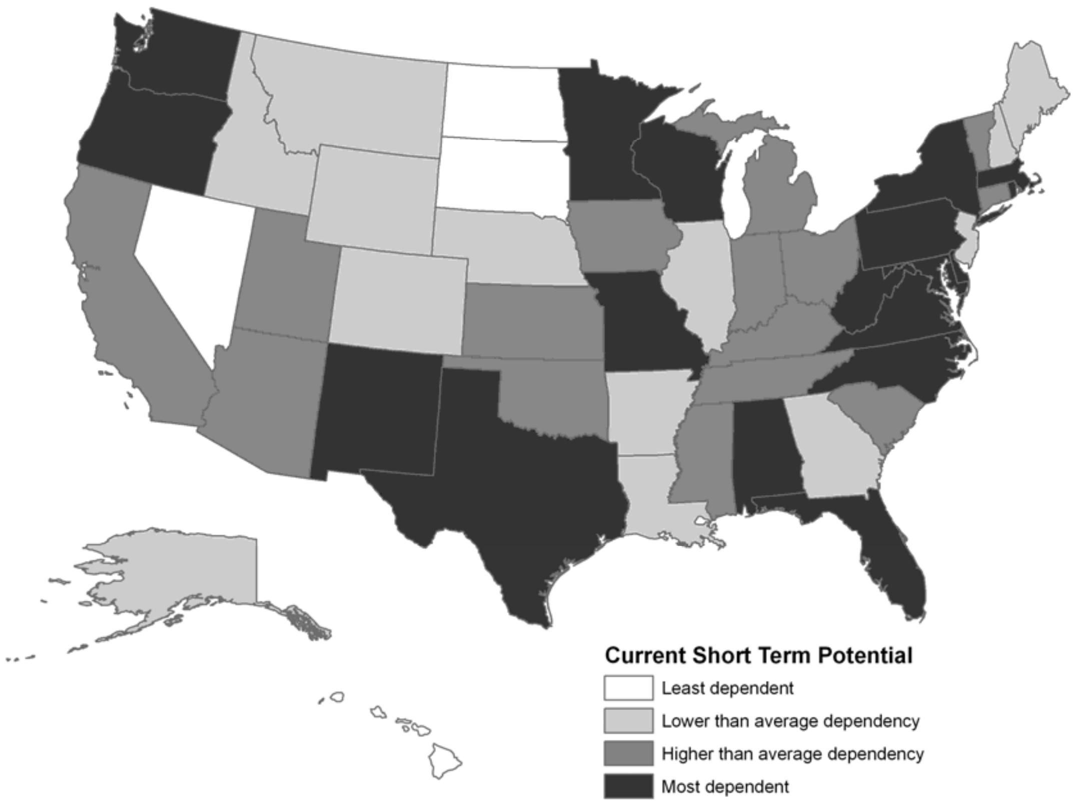


Figure 5-3. Composite Potential of the States, Based on Updated Rankings.

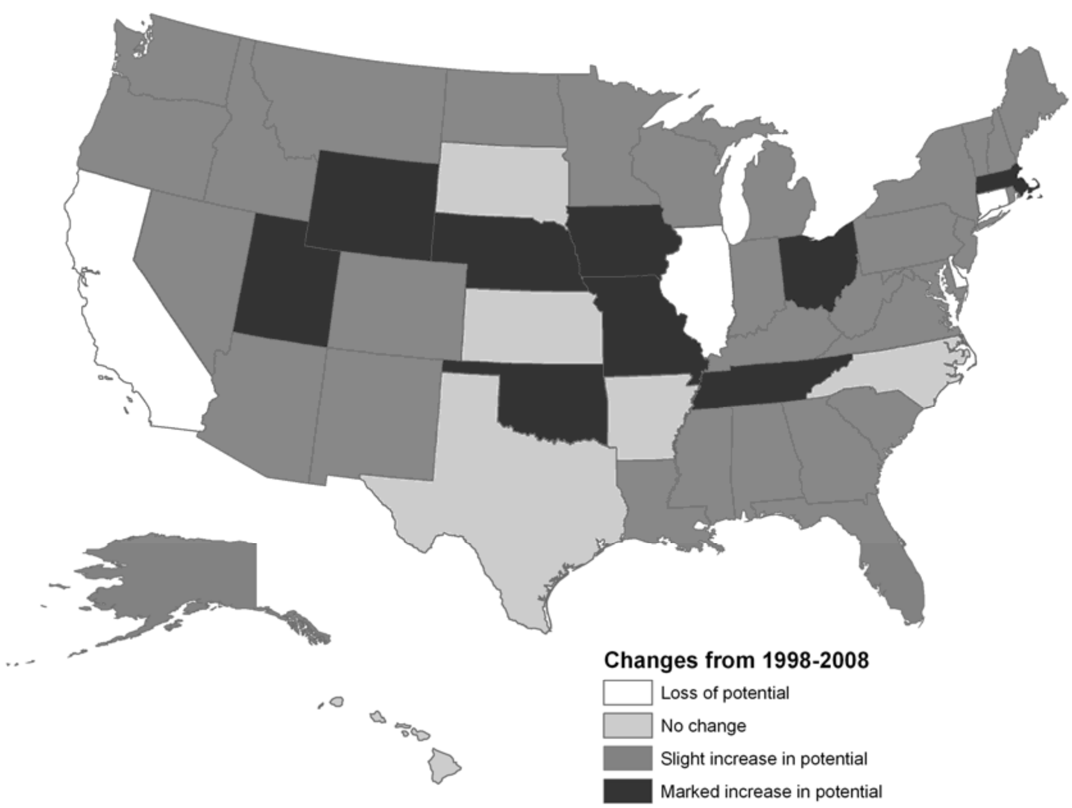


Figure 5-4. Changes in Composite Potential Rankings from 1998-2008.

Generally, states where potential was previously high maintained or increased their overall ranking. Losses in potential, in California, Illinois, and Connecticut, were primarily due to lapsed research activities or to demonstration projects that ended (Table 4-2 and Figure 5-4). The map is now considerably darker, with over 80% of the states showing some increase in overall potential. The most marked increases in overall potential occurred in interior states (Figure 5-4). While the underlying causes varied between states, overarching themes included continued development pressure outside sewered areas (particularly in Tennessee, Missouri, Iowa, Utah, and Wyoming) and incremental increases in training and certification of onsite professionals (Section4.2.4), improvements to funding programs (Section 4.2.3), and the implementation of new demonstration projects or research programs—nearly all of which were driven to some extent by increased concern about the impacts of unsewered development on drinking water or other sensitive environmental receptors. Throughout the Mountain West, it is highly likely that the primary driver of increased potential has been explosive population increases and new development occurring around major urban centers and resort areas (see Chapter 3 and Section 4.2.1), a significant proportion of which has been accommodated in unsewered areas.

In New England and the mid-Atlantic, from Massachusetts south through North Carolina, overall potential has also increased (Figure 5-4). In Rhode Island and Massachusetts, where concerns about existing conditions and high reliance on decentralized systems were already established in the late 1990s, existing management programs, code improvements, research, and demonstration projects have continued to improve and to be implemented. In both states, however, despite the presence of strong technology approval programs, supportive onsite regulators, and extensive research and demonstration projects related to onsite systems and their management, concern remains that decentralized systems are not an adequate solution in the face of stringent requirements for nitrogen removal (Section 4.2.1).

In states bordering Chesapeake Bay and Long Island Sound, where nitrogen TMDLs are being implemented, the attention given to the role of onsite systems (and/or to the role of upgrades or repairs as part of the solution) varies widely. In Maryland, for example, a state-wide tax is being used to fund both upgrades to wastewater treatment plants and, significantly, for reduction of non-point sources of nitrogen through funding upgrades of conventional systems to Best Available Technology, and the first five years of maintenance for such systems (Sections 4.2.1 and 4.2.3). Meanwhile, Pennsylvania recently adopted a nutrient and sediment trading policy in its Chesapeake Bay watershed—where stormwater BMPs and other non-point source protection initiatives are eligible through Conservation Districts, but onsite management programs are not (Pennsylvania DEP, 2008).

In the Southeast (particularly North Carolina, Virginia, Tennessee, and Alabama) the use of cluster systems, particularly to serve new subdivisions outside sewered areas, has increased. In Tennessee and Alabama, a significant proportion of these systems are owned and managed by privately owned, publicly regulated companies which correspond to the U.S. EPA's "Level 5 Responsible Management Entity Ownership" model (Yeager et al. 2006; also see respective State Reports). The use of RMEs for management of advanced technologies and cluster systems is also increasing in portions of the Midwest (Missouri and Iowa, for example). However, in these states the business structure of the RME is more likely to be a cooperative or regional utility authority rather than a for-profit entity.

5.4.1 Management Programs, Maintenance Contracts, and Enforcement

Some interesting trends and contrasts are apparent in the comprehensiveness of management programs and the variability of enforcement efforts between states. Figure 5-5 begins to draw out some of these contrasts by plotting the current status of states' interest in and implementation of management entities as shown in Figure 4-2, overlain with symbols indicating each state's current receptivity to new decentralized wastewater technology (based on the information in Table 4-4).

A few states (notably Delaware, Florida, Minnesota, Massachusetts, North Carolina, Rhode Island, Washington, and Wisconsin) have well-established and often long-running local or state programs for decentralized system management, coupled with relatively high levels of technology acceptance and implementation (Figure 5-5). In these states, there appears to be a general perception in the regulatory and professional communities that decentralized systems, especially those that incorporate advanced technology, require ongoing, perpetual maintenance and management—and those management requirements are usually codified in state-level regulations.

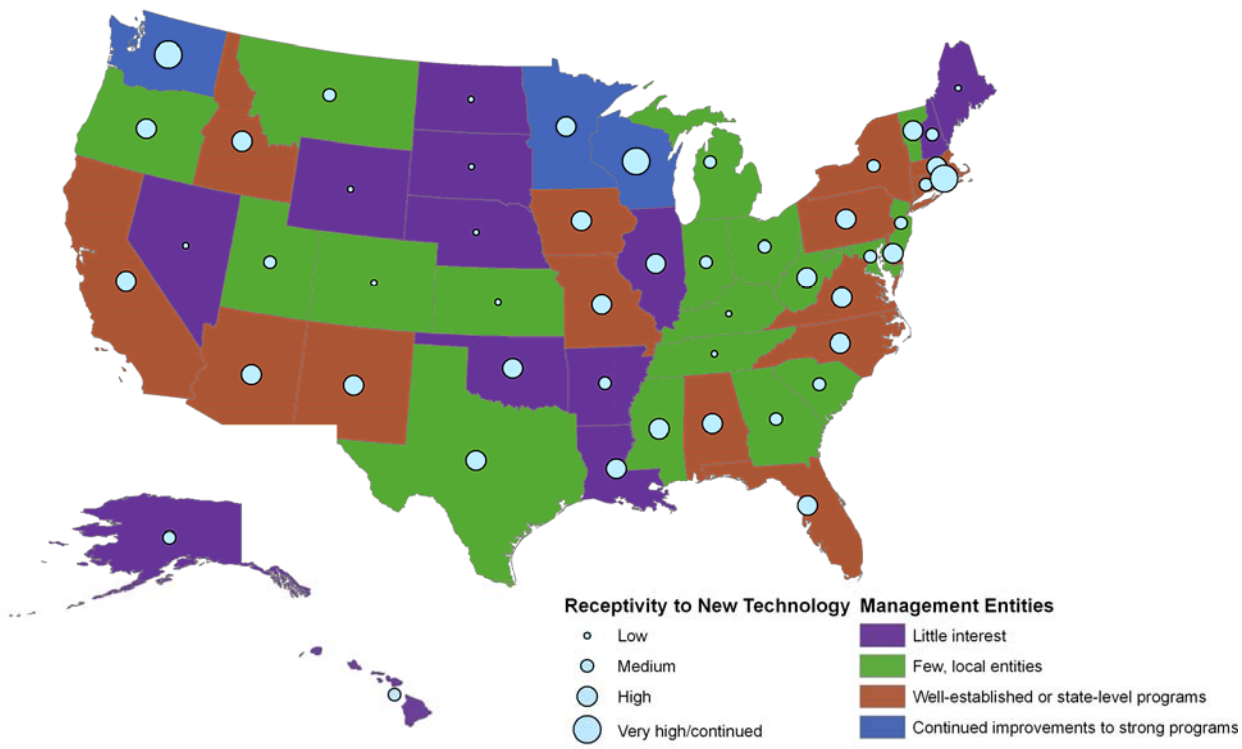


Figure 5-5. Current Status of Management Entities as Compared to Receptivity to New Technology.

By contrast, in several states--particularly Illinois, Louisiana, Oklahoma, and West Virginia--technology acceptance is high, yet interest in management entities is limited (Table 4-4 and Figure 5-5). In these situations, maintenance contracts are often mandated in state-level rules but enforcement resources are often scarce, with the result that ongoing maintenance is often left to the property owner or is not performed. In West Virginia, for instance, in the 1990s there was a statewide push to replace failing systems with aerobic treatment units, disinfection, and surface discharge to streams. A survey of over 400 such units in 1998 found that 92% of the systems appeared to be discharging effluent of unacceptable quality and that disinfection and maintenance problems were common; the authors recommended that lifetime maintenance should be mandatory for West Virginia ATU systems (Sexstone et al., 2000). Despite this, no mandatory maintenance requirement has appeared in state rule—and even if it did, it is not clear from the literature that adequate resources or political will exist in the state to enforce such a requirement. In Texas, implementation of new regulations in 1997 resulted in a significant increase in the permitting of aerobic units followed by chlorination and spray irrigation. While such systems receive operating permits with specific maintenance conditions and maintenance is required in state rules, a lack of effective enforcement, adequate property owner education, and lack of records continue to result in chronically malfunctioning systems (Reed, Stowe, and Yank 2001). Additionally, due to these shortcomings, homeowners do not perceive the value of having a maintenance contract (Lesikar, 2004). In 2007, a new Texas statute allowed rural residents to maintain their own systems instead of relying on service companies to inspect them three times a year; additionally, homeowners no longer have to file periodic county reports to prove that the systems are working properly (Dayton, 2008).

Given these notable examples of both success and failure with regard to decentralized wastewater technology acceptance and management, the question may be fairly asked: which states have truly comprehensive and adequately enforced maintenance and management programs? How often are maintenance provisions required by rule, or by virtue of NSF or other technology certification, but not enforced beyond the initial permitting stage or the initial term of a contract with a maintenance provider?

Such information was difficult to decipher from the literature reviewed. Though in 48 states, regulations are promulgated at the state level, often the rules are administered and enforced—and records are maintained—at the county or municipal health department level. The updated State Reports do, in some cases, provide information about how regulations are enforced and whether that enforcement is perceived as adequate in a general sense. Often, however, information about whether maintenance contracts were renewed or their conditions enforced was not available.

Table 5-2 compares the status of states' interest in and implementation of management entities, receptivity to new technology, and a qualitative assessment of enforcement adequacy—both overall, and with particular regard for the enforcement of ongoing maintenance requirements. Only states for which sufficient information was available in the State Report to determine the status of enforcement efforts are included in this table. The following criteria were used to qualify the adequacy of enforcement efforts in a given state:

- A "high" (H) ranking was assigned if enforcement efforts and resources appeared to be generally adequate.
- A "medium" (M) ranking was assigned if enforcement activities or resources were reported to be variable or locally inconsistent.
- A "low" (L) ranking was assigned if enforcement efforts and/or resources appeared to be generally considered inadequate across a state.

In six of the states described above, where both interest in and implementation of management entities and acceptance of new technologies are both relatively high (Delaware, Florida, Massachusetts, North Carolina, Rhode Island, and Washington), enforcement efforts

Table 5-2. Adequacy of Enforcement Efforts and Resources as Compared to Management Entities and Technology Acceptance.

State Name	Management Entities	Receptivity to New Technology	Overall Enforcement Adequacy	Maintenance Requirement Enforcement Adequacy
Alaska	L	M	L	L
Arkansas	L	M	H	M
California	H	H	H	M
Delaware	H	H	H	H
Florida	H	H	H	H
Idaho	H	H	H	L
Illinois	L	H	M	L
Iowa	H	H	H	L
Kentucky	M	L	L	L
Massachusetts	H	H	H	H
Michigan	M	M	M	M
Minnesota	HH	H	M	M
Mississippi	M	H	L	L
Montana	M	M	M	H
Nebraska	L	L	H	H
New Jersey	M	M	H	M
New Mexico	H	H	L	L
New York	H	M	M	M
North Carolina	H	H	H	H
Ohio	M	M	L	L
Oregon	M	H	L	L
Rhode Island	HH	HH	H	H
Texas	M	H	L	L
Vermont	M	H	H	L
Virginia	H	H	M	L
Washington	HH	HH	H	H
West Virginia	M	H	L	L
Wisconsin	HH	HH	H	M

Notes: Ranking criteria for management entities and receptivity to new technology are described in Table 4-3. For enforcement adequacy: H = generally considered adequate across the state; M = reported to be variable or locally inconsistent; L = enforcement efforts and/or resources generally considered inadequate.

and resources are also considered to be generally adequate (Table 5-2). In a few other states, such as Minnesota and Wisconsin, there are very strong state-level programs, but officials acknowledge some variability in the success of enforcement efforts at the county or local levels. In contrast, a number of states (for instance, Illinois, Mississippi, Oregon, Texas, and Vermont) have high levels of receptivity to new technology, yet few resources devoted to enforcement of maintenance contracts or performance of maintenance activities (Table 5-2 and detailed State Reports). The reasons for this relationship are unique to each state, but it often appears, as illustrated above for aerobic treatment systems in West Virginia and Texas, that the result is a perception that such technology is not a viable, long-term wastewater treatment solution.

CHAPTER 6.0

BUILDING BLOCKS FOR THE FUTURE OF SMALL-SCALE WASTEWATER TECHNOLOGIES AND MANAGEMENT

Despite the relatively bleak picture facing portions of the decentralized wastewater sector due to the recent collapse of the housing market, opportunities and openings for progress still exist—for instance, in decentralized water reuse, urban infill developments in sewered areas, and energy recovery and nutrient recycling. Models already exist around the country for ways to capturing these new markets, and for expanding or improving existing markets, around the country. Some of these models are highlighted in six case studies developed for this project, which are available as a download from the NDWRCDP website at www.ndwrcdp.org. Taken together, the case studies represent "building blocks" towards a more stable and sustainable decentralized wastewater sector—one that may be more diversified and better able to grasp future market opportunities.

The case studies include:

- Michigan: A non-profit organization builds broad coalitions to tackle issues related to public health, decentralized systems, and water quality.
- Rhode Island: Planners, regulators, and researchers work together to connect land use planning and wastewater management planning.
- Minnesota: Regulators mandate an alternatives analysis process that ensures decentralized solutions are considered fairly by engineers and others.
- Massachusetts: Regulators administer a clear, fair process for approving new onsite wastewater treatment technologies.
- North Carolina: Engineers and developers are working under risk-based water reuse regulations to integrate distributed wastewater with stormwater and other water treatment and reuse systems.
- Tennessee: Privately owned, publicly regulated utilities provide full-service management for development-scale distributed wastewater treatment systems.

CHAPTER 7.0

KEY CONCLUSIONS

It is clear that incremental progress towards improved industry professionalism is being made, and that more decentralized systems are now under management as compared to the late 1990s. This is particularly true in the Northeast, the upper Midwest, and the Pacific Northwest, where increases in the acceptance and implementation of advanced treatment systems have corresponded with increased understanding of the need for appropriate levels of ongoing maintenance and management—and thus with significant implementation of management entities or programs. However, the State Reports also reveal that adoption of advanced technology without adequate management requirements can result in both environmental impacts and a negative perception of decentralized systems and practitioners by the general public, as exemplified by experiences in Illinois and Texas.

A number of states have continued, over the last decade, to create or to build upon strong overall programs related to decentralized systems that include code improvement, significant attention to ongoing management, consistent permitting and enforcement by engaged regulators, academic or governmental research programs, continued investment in training and professional development programs, and strong participation by private-sector decentralized wastewater professionals and organizations. Examples of such states include Rhode Island, North Carolina, Minnesota, and Wisconsin—where, in all cases, the research and training programs are based in land-grant colleges and universities. At a broad scale, the practical grounding of research related to decentralized systems in the land-grant colleges—and the devotion of the individuals working within those colleges—generates significant dividends for the decentralized wastewater industry, particularly within the states those colleges serve.

Despite EPA's assertion over a decade ago that "[a]dequately managed decentralized wastewater treatment systems can be a cost effective and long-term option…", the proportion of U.S. households served by onsite systems has decreased in the last ten years—even in the face of increasing development pressure observed in the suburban and rural areas of many states. Though it is possible that in some states, such as Alabama, North Carolina, Virginia, Tennessee, Iowa, and Minnesota, development-scale decentralized systems are being counted as "sewers" due to their high standards of management, much of this continued proportional shift represents the continued expansion of centralized systems to previously unsewered areas.

Organizations related to the decentralized wastewater industry, such as NOWRA, the Consortium of Institutes for Decentralized Wastewater Treatment, the State Onsite Regulators Alliance, the National Association of Wastewater Transporters (NAWT), and WERF, have increased efforts towards inter-organizational coordination. This collaboration has had significant benefits—for instance, in the publication and dissemination of the Decentralized Wastewater Glossary and the implementation of a national installer certification program through NAWT. Similar collaborations with organizations that seem on the surface to be natural allies of the decentralized wastewater sector, such as the U.S. Green Building Council or the Low Impact Development Center, remain elusive despite the apparent environmental and energy-efficiency benefits that decentralized systems can offer.

The downturn in the national housing market has particularly impacted sectors of the decentralized wastewater industry that had, in the early 2000s, profited from the rise in new housing construction. The downturn also indirectly impacts state and local regulatory agencies which depend on permitting fees, rather than budget appropriations from general state or local governmental budgets to fund their operations. These declines in capacity come at a particularly inopportune time—as the federal government sets aside economic stimulus funds for "green jobs", and awareness of the advantages of decentralized wastewater infrastructure and integrated water management approaches is being advanced by organizations like WERF. The case studies, and the many other examples throughout this report, are resources that members of the decentralized wastewater profession can use to continue to shape the future of the field.

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