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ADVANCED DECENTRALIZED WASTEWATER SYSTEMS: UPDATED STRATEGIES FOR EXPANDED USE

by:

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ABSTRACT AND BENEFITS

In the year 2000, a report assessing the short-term opportunities and long-term potential for "advanced onsite wastewater technologies and management" was completed by the Coalition for Alternative Wastewater Treatment (CAWT). At the time a series of market drivers and federal actions appeared to offer great promise for expanded use of advanced technologies. The U.S. Environmental Protection Agency (EPA) had asserted that adequately managed onsite systems could be considered a permanent part of the infrastructure and could obviate the need for expensive sewer construction. Problems of aging infrastructure, inadequacy of conventional septic systems, pollution in environmentally-sensitive water bodies, and other issues could be addressed productively through the application of innovative decentralized approaches.

Through updated research on activities in each of the fifty states, this study has found that most of the market opportunities identified in the earlier work have not been realized. Successes have included the greater use of managed cluster systems in new home construction and the use of advanced onsite systems in a few leading states such as Rhode Island and Washington. Nevertheless, the percentage of the U.S. population connected to sewers has increased from about 77% to 80%.

In large part, lack of deep market penetration can be attributed to ineffective strategies by industry leaders and by government. Strong coalitions for institutional change were not forged, standards were not a high priority, and mistakes were made in understanding the structure of viable management entities. Ultimately, the challenge of change in a fragmented market of fifty states with different institutional and regulatory structures may have been too great for the industry to manage.

This White Paper updates the findings and conclusions of the earlier study and incorporates lessons and insights from a series of planning and research workshops convened by the National Decentralized Water Resources Capacity Development Project (NDWRCDP) and CAWT from 2000 to 2009. Strategies for expanded use of advanced decentralized designs include updates to recommendations from the earlier study:

- **Greater collaboration** of decentralized industry leadership with federal and state governments, engineers, environmental organizations, planners, scientific researchers, architects, energy specialists, ecologists, and others;
- **Advocacy for high standards** of practice, technology performance, management;
- **Targeting of innovation to meet the nation's pressing needs** for preserving and restoring water quality and quantity and healthy cities and towns, in particular through water reuse, nutrient removal, energy recovery, and green building.

In addition, the following new strategic initiatives are suggested:

- **Piloting** of integrated water, wastewater, reuse, stormwater, energy, and other resource designs and management at the building and neighborhood scales;
- **Development of learning and outreach programs** for change agents across the country to have access to information and tools for decentralized approaches;
- **Advocacy for progressive governance in several promising states** and for **renewed federal leadership** in research, funding and regulatory reform.

TABLE OF CONTENTS

Acknowledgements iii
Abstract and Benefits iv
1.0 Introduction 1-1
1.1 Three Scenarios of Expanded Use Predicted in 2000 1-2
1.2 Long-Run Potential – Needed Strategies Identified in 2000 1-3
1.3 The 2009 Market Study Update 1-4
2.0 The 2000 Market Study: Analytic Perspectives and Recommended Strategies 2-1
2.1 2000 Report: Factors Encouraging Growth In Use Of Advanced On-Site Technology And Management 2-1
2.2 2000 Report: Barriers to Advanced System Use 2-2
2.3 Technology Lock-in and Barriers to Innovation in Regulated Markets 2-3
2.4 Lessons from the Market Strategy Literature: Michael Porter's Work 2-4
2.5 2000 Findings and Conclusions 2-5
3.0 Retrospective: A Decade of Scattered and Incremental Progress 3-1
3.1 Overall Decline in Reliance on Decentralized Systems 3-1
3.2 Case Example in 2009: Cape Cod Towns March toward Sewers 3-2
3.3 Scattered, Incremental Reform Across the States 3-3
3.4 Changes in the Technology "Toolbox" Since 2000 3-3
4.0 **New Challenges and Opportunities in Water Management 4-1**
4.1 Urban Applications 4-1
4.2 Expanded Scope for Non-Potable Reuse 4-1
4.3 Green Building 4-2
4.4 The Energy-Water Nexus 4-2
4.5 Nutrient Recovery 4-2
4.6 Integrated Resource Management: Network Infrastructure and "Eco-Blocks" 4-3
5.0 Update on Market and Transition Strategies 5-1
5.1 NDWRCDP Workshops and Strategies: 2001-2009 5-1
5.2 2001 "Future Scenario" Exercise 5-1
5.3 2002 "Soft Path Integrated Water Resource Management" Retreat 5-2
5.4 2004 Lessons from Community Demonstration Projects 5-4
5.5 2005 Viable Business Models for Management Workshop 5-4
5.6 2007 Barriers to Evaluation and Use of Decentralized Wastewater Technologies and Management 5-5
5.7 2007 Federal Policies – CAWT Report 5-5
5.8 2007 Baltimore Charter for Sustainable Water Systems 5-6
5.9 2009 NDWRCDP Federal Agency Briefing – Smart, Clean, and Green 5-6
5.10 Common Themes from a Decade of NDWRCDP Workshops and Studies 5-7
6.0 Updated Market Strategies 6-1
6.1 A Decade of Untried Strategies and Unmet Market Potential 6-1
6.2 A Foundation of Small and Scattered Steps 6-1
6.3 Updated Recommendations for Market Strategies 6-2
6.4 Piloting of Integrated Resource Projects 6-7

6.5 Learning and Outreach 6-8
7.0 Progressive Governance: State and Federal Initiatives 7-1
7.1 Roadmap for a Progressive State Government 7-1
7.2 Can State Initiatives be Fast Enough and Bold Enough? 7-2
7.3 Absence of a Strong Federal Role in Decentralized Approaches 7-3
7.4 Federal-State-Local Relations Since the 1980's 7-4
7.5 A Profile of Renewed Federal Leadership for Sustainable Water Management 7-5
7.6 Short-Term Strategies and the Federal Government Role in Decentralized Wastewater Systems 7-7

References R-1

CHAPTER 1.0

INTRODUCTION

In 1997, the U.S. Environmental Protection Agency issued a report titled *Response to Congress on the Use of Decentralized Wastewater Systems* (EPA 1997), which stated that "adequately 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." This landmark report had the potential to alter the traditional view of septic systems as temporary, unreliable, and unmanaged solutions ideally replaced by central sewers.

In 2000, the *Advanced On-Site Wastewater Treatment and Management Market Study* (Nelson 2000), referred to in this document as the "2000 Market Study", was issued by the Electric Power Research Institute and co-sponsored by the National Rural Electric Cooperative Association and the Water Environment Research Foundation. The purpose of the Market Study, prepared by the Coalition for Alternative Wastewater Treatment (CAWT), was to assess the short-term opportunities and long-run potential for wastewater treatment systems that exceeded the performance of standard septic tank and soil dispersal approaches. These could be important both for upgrades of older systems on non-conforming lots and for enhanced removal of contaminants, particularly nitrogen and phosphorus. The study also examined the potential for a shift from homeowner maintenance to management services by professionals, with the intention of improving the performance of systems over time.

The 2000 Market Study was directed at onsite industry leadership, including small-scale system designers, installers, maintenance providers, manufacturers, and utilities. These groups could expect to see business expansion and profits from wider market openings for advanced onsite systems and management. However, the national interest could be advanced through market expansion as well. Benefits would be achieved if enhanced onsite solutions cost less than conventional sewers for comparable levels of treatment, were less disruptive to water flows and to ecosystems than sewers, and helped protect local community character. Recommendations were also, then, relevant to academic researchers and trainers, progressive government leaders, and advocates of right-scale or "soft path" solutions.

The primary research approach of the 2000 Market Study was a state by state survey of environmental problems related in a variety of ways to onsite system use and malfunctions, and of institutional structures in each of the states for regulation, financing, management, research, training, and certification. Out of the surveys emerged various patterns of market challenges and opportunities.

It is essential to note that markets for any wastewater treatment technology or approach depend fundamentally on whether regulations permit or exclude specific technologies and/or whether professional management is required. In the case of individual onsite and cluster systems discharging to groundwater, regulations and oversight are outside the federal NPDES program, at least as currently practiced, and regulatory requirements have been the

responsibility of state and local governments. As discussed later in the White Paper, federal leadership is likely to be required to accelerate reform of regulations.

The authors of the 2000 Market Study, Valerie Nelson, Steve Dix, and Frank Shepherd, stated that markets for advanced treatment units could open up substantially for both advanced technologies and management, but realization of this potential would depend on what Harvard Business School professor Michael Porter termed "the skill of participants and the luck of the draw" (Porter 1980). As described in the accompanying 2009 update of state by state research, progress has been scattered and incremental, suggesting that industry strategies have been inadequate. In particular, the creation of responsible management entities has been far less than both EPA and the industry had hoped. Detailed discussion on various measures of progress in each of the states is found in that accompanying report.

In this White Paper, the underlying analytic structure of the 2000 Market Study is updated, along with recommendations for future strategic actions by industry leadership. The earlier study approached the prediction of market trends from two interrelated perspectives or frames:

1. **Identification of the varied drivers and barriers** for expanded use of advanced technologies and management, in particular, emerging water quality challenges and the attitudes and concerns of critical stakeholders and constituencies
2. **Applications of lessons from the business and economics literature** on market evolution and strategies, in particular the problems of technology lock-in and failure of infant industries to mature

Based on this analysis, the 2000 Market Study suggested three major arenas for growth in advanced onsite treatment use and management, and recommended strategies to open these markets successfully. (Throughout this White Paper, quotes from the 2000 Market Study and other subsequent reports are shown in italics).

1.1 Three Scenarios of Expanded Use Predicted in 2000

Environmentally-sensitive zones:

The most likely future of the advanced system and management approach is 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, shellfish beds, etc. EPA and the states will be increasingly focused on nutrient impacts and microbial pathogen public health risks of conventional septic systems, and these concerns will intensify the search for cost-effective advanced on-site or cluster approaches. Most importantly, however, homeowners and municipal leaders will be particularly receptive to technology and management options in those parts of the country where water quality problems are highly-visible and serious.

Reuse in the arid Southwest:

A second opportunity is in a coupling of advanced on-site and cluster technologies with water reuse in areas of the country, such as the arid Southwest, where water supplies are scarce and increasingly expensive. If small-scale technologies to disinfect and to remove nutrients are developed which are reliable and meet high standards, wastewater can be

recycled for landscape irrigation, toilet flushing, aquaculture, groundwater replenishment, habitat restoration, and other reuses. Such benefits will help to offset the substantial additional costs of advanced treatment and management.

New construction:

A third promising opportunity for advanced systems and management is in booming rural areas, where conditions for conventional on-site wastewater disposal are poor. Much new housing development is in the coastal zone, but also in states such as Georgia, Kentucky, Missouri, Arizona, New Mexico, and Tennessee. In new subdivisions, homebuyers and developers are much more willing to accept innovative infrastructure approaches, such as cluster systems and regular monthly maintenance fees, than are residents in older communities. In many of these states, advanced technologies are being permitted to facilitate growth, but long-term professional management is either not required or is minimally enforced. In these areas, the role of rural electric and other utilities in raising standards for and taking over management functions could be crucial. Particularly promising are opportunities to provide wastewater infrastructure for cluster "village" development, while preserving open space.

1.2 Long-Run Potential – Needed Strategies Identified in 2000

The 2000 Market Study summarized critical strategies for industry leadership to pursue, in the following categories:

Collaboration with stakeholders;

The long-run potential for advanced on-site and cluster technologies and management will be determined to a large degree by the response to concerns of key constituencies, including homeowners, municipal officials, regulators, and Smart Growth advocates. Homeowners are particularly concerned about the additional costs and intrusiveness of advanced systems and inspections. Municipal officials and regulators are cautious about new, risky technologies and the additional bureaucratic requirements for oversight. Smart Growth advocates are troubled by the implications for new development in areas previously considered unbuildable.

High-performance products and services:

The ability of industry participants to develop cheaper and more reliable systems, remote monitoring equipment, private or utility management, cluster systems, and community demonstration projects will to a large extent determine how successful the field is in breaking down these barriers. However, the on-site market is highly-fragmented, is lacking in clear standards and complementary products and services, and therefore, is a poor risk for investment. Such an "infant industry" may fail to expand if participants lack the skills or willingness to respond to the challenges set by various constituencies.

Recommendations for Market Strategies

To reach a future of more widespread utilization of advanced technologies and management, strategic actions need to be taken by the advanced on-site system field, many of which will require unprecedented levels of collaboration, innovation, and outreach. Critical areas in the future development of the sector are:

Collaboration

- *significantly greater accommodation to the values and concerns of homeowners, municipal officials, regulators, and Smart Growth advocates;*
  Standards
- *attention to the needs of entrepreneurs and venture capitalists for consistent standards of technology and practice;*

  Defining the contributions of decentralized systems

- *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;*

  Risk management

- *internalization of a risk management paradigm which targets on-site system upgrades and management where benefits exceed costs;*

  Innovative services and institutions

- *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.*

It was suggested in the report that several national organizations were in a position to take the lead in implementing these strategies. These included associations and research projects formed in the 1990's, including the National Onsite Wastewater Recycling Association (NOWRA), the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT), and the Coalition for Alternative Wastewater Treatment (CAWT). The State Onsite Regulators Alliance (SORA) was formed several years later. Congress had initiated funding for research and curriculum development by the partners in the National Decentralized Water Resources Capacity Development Project (NDWRCDP) and for community-based demonstration projects in the National Community Wastewater Demonstration Project. EPA had also established by then an onsite and decentralized wastewater system program, which had begun to issue guidance on technologies and management.

1.3 The 2009 Market Study Update

This White Paper summarizes in Chapter 2 the analytic framework for the predictions and recommended strategies of the 2000 Market Study. Chapter 3 describes the scattered and incremental market openings and missed opportunities in the intervening years. Chapter 4 describes a rapidly-widening market potential for decentralized systems in urban applications, green buildings, reuse, and other arenas. Chapter 5 updates the analytic framework. Chapter 6 presents revised recommendations, and Chapter 7 suggests strategies for targeting several promising states for progressive reform. In addition, a significantly stronger federal role may be required for a more robust and high-capacity market to emerge for advanced decentralized technologies and management.

As Michael Porter had suggested generically, market expansion depends in part on skills of participants and in part on luck. While decentralized wastewater industry strategies may have been inadequate in the last decade, nevertheless the "luck of the draw" has opened even more widespread opportunities for advanced decentralized systems and management in the future. Industry profitability and the public interest in implementing cheaper and better wastewater alternatives can both be enhanced. Going forward, it is important that industry leadership both learn from recent history and actively pursue more collaborative and thoughtful market strategies.

CHAPTER 2.0

THE 2000 MARKET STUDY: ANALYTIC PERSPECTIVES AND RECOMMENDED STRATEGIES

The 2000 Market Study addressed the following four structural factors:

- drivers for expanded use of advanced onsite wastewater treatment and management;
- barriers to expanded use;
- lessons from the business and economics literature on market evolution;
- actions by industry leaders that could capitalize on opportunities and break down barriers.

Text from the 2000 Market Study and later reports is shown in italics.

2.1 2000 Report: Factors Encouraging Growth In Use Of Advanced On-Site Technology And Management

Declining Federal Subsidies For Sewer Construction

Beginning with the Clean Water Act in 1972, the federal and state governments provided grants for 75-90% of the cost of construction of central treatment plants and sewer lines (under the Construction Grants Program). Since these grants were phased out in the mid- to late 1980s and replaced by low interest subsidies on loans (the State Revolving Loan Fund or SRF), the cost of treating local water pollution problems in many rural areas has become prohibitive. Municipal officials and concerned citizens are seeking to determine if on-site approaches and management can provide a cheaper solution than sewers. Typically, sewer lines are 60-80% of the total cost of a central sewerage approach. Those costs could be avoided with continued on-site treatment.

High Population Growth Rates In Rural Areas With Poor Soils

In the 1990's, the long-term population shift off of farms and into urban and suburban areas began to reverse. Soon, some of the fastest growing counties in the U.S. were rural areas, particularly in the South and West. However, many of these high-growth areas had poor and shallow soils not suitable for conventional septic system installation. These growth demands can only be met by construction of costly sewers or by more flexible permitting of advanced or alternative on-site systems.

Sensitive Environmental Resources Increasingly Affected By Unsewered Housing Developments

Conventional septic systems were not designed to remove nitrogen, which can degrade drinking water supplies leading to public health concerns and degrade coastal waters resulting in eutrophication and loss of resources. Depending on its travel pathway, nitrogen can take years to pass through soils and groundwater to coastal estuaries. As septic system densities

have increased over time, the cumulative impacts on groundwater, surface waters and sensitive ecosystems have become more noticeable. One way to remediate these problems, other than sewering, is to retrofit existing systems to reduce nitrogen pollution and/or to require that all new systems meet advanced effluent standards for nitrogen.

New Emphasis On Watershed Analysis And Protection

As more and more of the nation's point-source treatment plants and industrial sources were upgraded to meet national standards, environmental agencies turned their attention to nonpoint sources of water pollution, such as farms, stormwater runoff, timber and logging operations, and septic systems. A major component of this effort since 1990 has been to identify sources and establish priorities based on a watershed analysis of all pollution sources. In the past several years, there have been lawsuits against states for not meeting provisions in the Clean Water Act for total maximum daily load (TMDL) allocations among various point and nonpoint sources.

Increasing Attention to Drinking Water Quality And Source Water Protection Programs

Following the increased occurrence in drinking water supplies of the pathogens, Cryptosporidium and Giardia, both Congress and the EPA decided to make protection of safe drinking water the highest priority of the EPA Office of Water. Increasing emphasis on wellhead protection and source water assessments were instituted in various Amendments to the Safe Drinking Water Act and septic system contributions to other pollutant problems were spotlighted in the these programs.

Treatment Plants At Capacity and Building Moratoria

As US metropolitan areas grow, and treatment plants reach capacity, many communities face the expense of major plant expansion and upgrades or building moratoria. And, throughout the country, older sewer lines are leaking and contaminating groundwater or streams. Replacement or repair of these sewers will also be expensive. Advanced on-site or cluster systems and management might be a better alternative.

2.2 2000 Report: Barriers to Advanced System Use

Despite growing interest in the use of advanced on-site and cluster systems, there has always been a great deal of inertia or resistance to change. The following hindrances are commonly cited.

Regulatory Resistance to Permitting Advanced Systems or to Requiring Management

State and county on-site regulators have continued to rely on a uniform, prescriptive code of simple, conservatively-designed and built systems maintained by the homeowner. Doing so requires fairly low-level skill in design and construction, is clear and equitable to homeowners, and is low-cost until the system fails. Regulators are influenced by political opposition to change, but also have legitimate reasons for caution. Many alternative systems are new and unproven; regulators cannot afford to take the risk that large numbers of systems would fail throughout the state. The more advanced systems require more time-consuming oversight and on-site departments are often understaffed and under-funded.

Homeowner Resistance to Intrusive and Costly Regulations

Homeowners have typically resisted any additional charges or government involvement in their on-site wastewater system, particularly for remedial retrofits on systems they have used and maintained for years. This concern can be so serious that communities choose non-intrusive sewer systems, even when more expensive. Developers also resist expensive on-site systems for new construction, arguing that these additional costs substantially reduce their market for homebuyers.

High Costs of Advanced Systems Relative to Conventional Systems

One of the advantages of conventional septic tank/leachfield systems is their relatively low cost. By contrast, advanced systems entail additional equipment such as filters, pumps, and controls. Unless required to install this equipment, the homeowner likely will not pay the extra costs. (If the advanced system is a pre-condition for building a house on a previously-unbuildable lot, that is another matter entirely.)

Fears of Exploding Growth and Sprawl in Rural Areas

Landowners, builders, and regulators may be willing to permit advanced systems when such systems could facilitate development on non-conforming lots, for example with steep slopes, fractured rock, or poorly-draining soils. However, environmental and anti-sprawl advocates have often been successful in stopping such use by describing the severe ramifications for loss of open space and farmland, transportation gridlock and air pollution, increasing costs of municipal services, and increases in stormwater runoff that such permitting would engender.

Bureaucratic and Information Barriers

In a landmark report in the decentralized field, the 1997 Response to Congress on Use of Decentralized Wastewater Treatment Systems, EPA described a number of barriers to more widespread use of decentralized approaches, including: lack of knowledge and public misperception; legislative and regulatory constraints; lack of management programs; liability and engineering fees; and financial barriers.

2.3 Technology Lock-in and Barriers to Innovation in Regulated Markets

The 2000 Market Study summarized literature from a variety of federal agencies on regulatory impediments to innovative technologies. A 1994 Clinton-Administration report, *Technology for a Sustainable Future* (National Science and Technology Council 1994) summarized the following concerns:

- *Standards based on current technology* – environmental laws are largely technology-based standards based on demonstrated approaches. "There are few incentives to develop or deploy innovative technologies that exceed the performance standard set by the regulatory agency."
- *Technological lock-in* – "Even when engineers develop improved technologies that satisfy higher performance goals, they may be unable to find buyers of their technologies, who fear risking noncompliance with the statutory requirements."
- *Market segmentation* – "When control standards differ geographically, the technologies that satisfy a given requirement vary. The result is that innovators must develop and sell their products in a large number of sub markets with differing performance requirements

rather than servicing a unified national market. These segmented markets may not be large enough to justify investment in new technologies."

- *Double jeopardy* – "Users of new technologies must pay penalties for noncompliance as well as the cost of installing conventional technology if an innovative approach fails."
- *Inadequate venture capital* – Many venture capitalists cite uncertainty about the regulatory process as a central reason for reluctance to invest in the environmental industry. Uncertainty about whether a particular technology will be approved or endorsed by regulators adds a significant and difficult-to-analyze dimension to the riskiness of investment projects."

2.4 Lessons from the Market Strategy Literature: Michael Porter's Work

Michael Porter, a Harvard Business School expert on industry and competitive analysis, described a wide range of underlying factors in market growth in his widely-referenced book, *Competitive Strategy: Techniques for Analyzing Industries and Competitors* (Porter 1980). Porter pointed out in this work the possibility for an industry to get "stuck" in a fragmented and infant state because existing small firms fail to make the right strategic moves or are complacent, and because large outside firms with appropriate skills or resources miss opportunities for diversification into the new industry.

Stalled infant industries: absence of "rules of the game" or "standards"

In the early phases of an emerging industry, Porter pointed out, growth may be stalled by the absence of "rules of the game" or "standards" among the players. He points out the typical lack of agreement on technical or product standards, "usually caused by the high level of product and technological uncertainty that still remains in an emerging industry." As long as there is a profusion of product approaches, technological variations, and conflicting claims and counter-claims by competitors, industry sales will be limited by the perceived risks. In this case, it is the cautious regulator who refuses to permit new advanced onsite technologies.

It is usually in the best interest of equipment manufacturers, therefore, to "help promote standardization, police substandard quality and fly-by-night producers, and present a consistent front to suppliers, customers, government and the financial community." Industry trade organizations, in collaboration with government agencies and experts, could take a leading role in setting high standards and collecting performance data on technologies, as well as initiating labeling and certification programs. The problem with achieving cooperation is that individual firms may resist such efforts, "needed to aid ease of repair and promote customers' confidence" in hopes that their own product will win out and become the industry standard in its own right.

Unified standards for new technologies across the nation can be a huge boost to venture capital investment and product sales, but currently the state permitting authorities have widely-divergent approaches to effluent standards and technologies. Another difficulty is the diversity of opinion within the decentralized sector as to whether the target of effluent standards should be prior to release into the soil, or after soil treatment. If soils are not included in the "treatment train", then the market will favor investment in "black box" technologies. Such standardization could save on site-based design costs and drive manufacturing costs down for pre-treatment technologies. Alternatively, soil can provide substantial and valuable pollutant removal, which arguably should be given credit in a permit. However, consideration of soil treatment adds to the costs of design at the site and results in more confused signals for effluent standards for the

pre-treatment unit. (Effluent standards can vary with the quality of soil treatment provided at the site.)

Need for Complementary Products or Services

Porter and other analysts of market growth have suggested that a new product on the market may not be selling because "secondary services and products" are not available. Examples are specialized personnel, such as computer programmers for the computer industry, or store rental of VCRs along with tapes, until most homes eventually had their own VCRs.

In the decentralized wastewater sector, advanced technology companies cannot expand sales until the following are in adequate supply: management oversight to assure continued high performance of installations; models for community wastewater management plans utilizing decentralized approaches; highly-trained designers and installers; and information, telemetry, and control systems.

Threatened entities will respond

Porter suggested out that, "Some entity is almost always threatened by the advent of an emerging industry, and will fight back, often in the regulatory or political arena… It may be the industry producing a substitute product, labor unions, distribution channels with ties to the old product and preferring the certainty of dealing with it, and so on."

Markets may evolve through the entry of new and large firms

Porter commented that it is common for larger firms to sit out the early stages of an emerging market. "Most new industries are initially characterized by a great deal of uncertainty about such things as the potential size of the market, optimal product configuration, nature of potential buyers and how they can best be reached, and whether technological problems can be overcome. … Over time, however, there is a continual process by which uncertainties are resolved. Technologies are proven or disproven, buyers are identified, and indications are gleaned from the industry's growth about its potential size. … Reduced risk may attract larger, established firms with lower-cost profiles than the newly created companies so common in emerging industries."

2.5 2000 Findings and Conclusions

It was clear in the analysis of the 2000 Market Study that advanced on-site and cluster system technologies and management would improve water quality protection in unsewered areas. Strategic recommendations for opening these markets included:

Management

- *Make a strong collective statement that continuous, high-quality inspection and maintenance programs by professionals be a pre-condition for permitting of advanced technologies*
- *Define from a risk-management perspective, cost-effective maintenance and inspection protocols*
- *Develop remote monitoring and SCADA technologies and systems*
- *Create new management entities*
- *Create new financial mechanisms*

Participation in Community Demonstration Projects

- *Community demonstration projects assemble and field-test elements of technology and risk-management in new and different ways at the community level, and create new markets for technology developers and entrepreneurs throughout the country.*

Complementary Products and Services

- *The refinement of engineering practices in community decentralized wastewater districts*
- *The development of water quality models and agreement on the relative risks of pollutants in various settings*
- *Formation of construction companies that can cost-effectively coordinate the installation of on-site and cluster systems*
- *Support for capacity development in the areas of education and training, research, technology verification, standard-setting, and information dissemination*

Collaboration with and among regulators

- *A national organization of state regulators could help reduce fragmentation in the field and provide for productive dialogue with other participants in the industry.*

Stronger state role in advanced systems and management

- *State governments need to play a much more substantial role in developing cost-effective and environmentally sound decentralized practices, and in providing financial assistance to communities that will benefit from such approaches.*

Proactive utility management

- *Utilities cannot single handedly reshape the field, but they can provide the management and financial stability that would help regulators and municipal officials move forward.*

CHAPTER 3.0

RETROSPECTIVE: A DECADE OF SCATTERED AND INCREMENTAL PROGRESS

The 2000 Market Study predicted expanded use of advanced technologies to upgrade older septic systems around sensitive lakes, ponds, and estuaries and above sole-source aquifers; to provide for wastewater reuse in the arid Southwest; and to facilitate new construction in booming rural areas. The promise of cluster systems was also highlighted. The high value of professional maintenance in terms of enhancing the long-term system performance suggested that management services would become widespread, at least for advanced systems. Related to these predicted market changes was an expectation that state regulations and staffing would, over time, be transformed to permit and otherwise support the capacity of the decentralized wastewater field.

The reality in all these dimensions has been less than advocates and industry had hoped. Cluster system use and utility management in new construction has likely been the fastest-growing niche market, but widespread expansion in use of advanced decentralized systems has not occurred. Institutional changes that might have opened up broader markets across the country have been scattered and incremental.

States such as Rhode Island and Washington have been leaders in requiring advanced treatment in upgrades and new construction around estuaries and shellfish beds. Nevertheless, the primary mechanism for dealing with drinking water or surface water quality concerns still rests in the construction of central sewers and treatment plants. Wastewater reuse has only recently emerged as a likely factor in water-short areas of the country. Anecdotally, the greatest advance in the use of onsite treatment is in new high-growth areas, for example, in Texas with ATUs for individual homes, or in Tennessee, Alabama, and North Carolina with cluster systems for new residential subdivisions.

3.1 Overall Decline in Reliance on Decentralized Systems

In the years surrounding EPA's landmark 1997 Response to Congress, onsite systems served approximately a quarter of American homes and 37% of new home construction. Yet, as the accompanying State Reports Summary (Macrellis 2009) describes, the U.S. Census Bureau's American Housing Survey suggests the percentage of homes on septic systems fell from 23% in 1995 to 20% in 2005. This decline was in contrast to expectations in the industry in 2000.

Cornell University professor Rolf Pendall provided analysis for the 2000 Market Study suggesting that the percentage of homes using onsite systems would expand, simply as a result of the larger shift in population. Americans have been moving out of sewered Northeastern and Midwestern cities and into unsewered rural and suburban areas, particularly in western and southern states such as Washington, Florida, and North Carolina. Pendall calculated that in high-growth rate counties, 31.4% of the housing units used septic systems in 1990, while in

population-loss counties, 14.5% of the units had septic systems. If these patterns of population movement and septic system use continued, then the overall utilization rate for onsite systems would increase over time.

The 2000 Market Study pointed out, however, that these trends could be offset by a process of conversion from septic systems to sewers in a large number of rural and suburban communities. Professionals surveyed in the 1996 Clean Water Needs Survey, indeed, predicted that 88.2% of the population would be covered by sewers if all clean water needs were met, reflecting "continuing efforts to extend wastewater collection and treatment to small communities" (EPA 1997).

The 2004 EPA Clean Water Needs survey results highlight the continuation of this process. Category IV projects are new interceptors and sewer lines. As the report indicates, 827 small-community sewer systems were predicted to be built. EPA's Clean Water State Revolving Fund, USDA Rural Utilities Service, Economic Development Agency, Housing and Urban Development, and other federal agency grants and loans facilitated this construction program.

The implication from this history is that while EPA asserted the value of decentralized systems as a permanent part of the nation's infrastructure in its 1997 Response to Congress, the full weight of EPA's permitting, enforcement and funding activities continued the push to construct and extend sewers throughout the country.

3.2 Case Example in 2009: Cape Cod Towns March toward Sewers

The process of wastewater management planning in Cape Cod towns is currently exhibiting many of the drivers for and barriers to expanded use of advanced technology and management described in the 2000 Market Study. EPA's predicted concerns about nutrient enrichment and eutrophication in coastal waters and its expansion of TMDL enforcement measures are forcing towns to contract for comprehensive wastewater planning with a particular focus on nitrogen removal. Conventional sewering is emerging as the recommended solution, in spite of anticipated costs in the hundreds of millions of dollars in town after town and amid concerns that the cost of living on Cape Cod will become unaffordable to all but the upper-middle and upper-income classes.

Massachusetts-based small system engineers calculate that the nitrogen problems on the Cape could be addressed at about half the cost of conventional sewering, through the application of onsite and cluster systems that achieve nitrogen removal and that are managed properly. The lack of consideration of these alternatives on the Cape appears, at base, to stem from lack of familiarity by consultants, town officials and citizens of the high-performance capabilities of onsite and cluster systems used in neighboring states, in other parts of the U.S., and internationally. This "technical illiteracy" in the hinterlands is a sign of continued complacency and conservatism in state agencies and lack of effective education and outreach strategies in the national wastewater treatment industry. The conventional sewering sector, of course, benefits from this conservatism and inertia.

3.3 Scattered, Incremental Reform Across the States

The accompanying State Summary Report presents detailed information on changes among the states. The conclusions of that report state, in part:

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.

3.4 Changes in the Technology "Toolbox" Since 2000

For the 2009 Market Study Update, five experts responded to a brief questionnaire on trends in technology and research in the last decade. These respondents included James Kreissl, formerly of EPA; Mary Clark, Orenco Systems, Inc.; Anish Jantrania from Northwest Cascade; Victor D'Amato of Tetra Tech; and Ed Clerico of Alliance Environmental.

In general, the five suggested that technology improvements since 2000 had been "incremental" rather than new "breakthrough" designs. Modifications had been made in enhanced nitrogen removal, soils treatment, and membrane bioreactor (MBR) use in cluster systems. Work is ongoing to cut energy costs (such as developing dosing devices that do not use electricity and high-performance pumps) and in telemetry systems. Systems for nitrogen and phosphorus recovery are being tentatively broached. Leading-edge research in Europe is in high efficiency distillation, and in the U.S., applications of nano-technology are emerging, though these last are far removed from the practical application stage.

The respondents described a number of research findings since 2000 that have had a positive impact on onsite system "practice". Useful information has emerged on the performance and costs of onsite systems, case studies have been conducted of successful management entities, watershed models with quantitative assessments of onsite systems' contributions were constructed and tested, planning guidance for cluster system use was

documented, and demonstration projects were useful in developing new approaches and in outreach.

The relative lack of investment in innovative technologies can be explained in part by the absence of a substantial federal research program and in the fragmented signals continuing to be sent to venture capitalists and entrepreneurs, suggesting that there are no strong market openings yet for advanced onsite technologies in the US. One expert suggested that the decentralized sector suffers from reactive rather than forward thinking and proactive market planning, with the end result being risk aversion and continued incremental responses.

Looking to the future, these experts suggested that substantial education and outreach efforts were needed across the country, including to mainstream wastewater engineers, planners, municipal officials, and to the public. Renewed funding for demonstration projects and training centers was proposed. Promising market areas, they suggest, are in reuse and recycling of wastewater, resource recovery, and integrated water management, including in metropolitan areas.

CHAPTER 4.0

NEW CHALLENGES AND OPPORTUNITIES IN WATER MANAGEMENT

In the 2000 Market Study, a variety of drivers for expanded use of advanced technologies and management were identified for rural and suburban communities, including the need for lower-cost systems than conventional sewers, and for decentralized systems to achieve higher performance in sensitive environmental zones. In the intervening years, these opportunities have generally not been seized by the industry. However, important new drivers and potential markets have emerged.

4.1 Urban Applications

America's cities have been served, in some cases since the mid-1800's, by underground sewer pipes. Construction of treatment plants and incremental upgrades to higher treatment capabilities prior to discharge occurred largely after World War II, and with federal funding assistance after the 1972 Clean Water Act was passed. Within these large urban sewer networks, however, the prospect is emerging for widespread installation of wastewater treatment and reuse at the building or neighborhood scale. These systems could help cities in several ways: by avoiding very expensive new water supply projects and reservoirs; by reducing water demand and replenishing water in ecosystems; and by extending the life and capacity of aging sewers and treatment plants. A leading-edge opportunity may also be to co-locate decentralized wastewater treatment and solid waste energy recovery at the neighborhood scale.

Example: The residential Solaire building in Battery Park in southeastern Manhattan, has a membrane bioreactor-based wastewater and stormwater treatment unit in the basement. Non-potable uses for the treated water within the neighborhood envelope include toilet flushing, drip irritation of gardens, laundry, and cooling towers. Favorable water rates are charged by the City as an incentive to reduce potable water usage and flows into the aging combined sewers. Potable water use within the building is reduced by about half as compared to typical new construction (Clerico 2009).

4.2 Expanded Scope for Non-Potable Reuse

In the 2000 Market Study, a market potential was suggested for small-scale wastewater reuse systems in the arid Southwest. Instead, water-efficiency measures, including removal of conventional lawns in communities such as Las Vegas, have been the preferred approach to droughts in the Southwest, since western water law and water rights rely on the return of maximum flow to the Colorado and other rivers. However, since 2000, there have been a surprising number of droughts and water supply shortages in the Southeastern U.S. and even in relatively water-rich states such as Maryland. Predictions are for 34 states to experience water supply concerns in coming years. In Eastern Massachusetts, water shortages and reduced

streamflows have been artificially created by the infiltration of groundwater into centralized wastewater collection systems, which transport wastewater through the massive Deer Island treatment plant and outfall pipe to the ocean (Nelson 2002).

Example: As described in the accompanying Building Blocks report, North Carolina's regulatory programs have enabled the development of several new waterfront communities in eastern North Carolina, where water generated onsite is treated and utilized onsite. The reclaimed water has a variety of on-site uses, including maintaining water levels in amenity lakes and water features, and irrigation of common areas. Senate Bill 1946, passed by the North Carolina Legislature in 2008, also mandates water and energy efficiency measures in all new and remodeled publicly owned higher education facilities.

4.3 Green Building

Since 2000, the concept and framework for sustainable "green" buildings has emerged as a significant arena for incorporating new energy-saving technologies and designs. Water use and wastewater treatment have so far been less of a focus of the US Green Building Council's Leadership in Energy-Efficient Design (LEED) certification system and other rating systems. Relatively minimal points are awarded for water-efficient appliances, for onsite stormwater management, and for innovative wastewater treatment. Collaborative efforts to bring water issues into various ratings systems would be a significant market strategy.

Example: The green building federal facilities program within the General Services Administration incorporates requirements for a 2% reduction in potable water use per year, which can be met by either installation of water-efficiency appliances and landscaping practices or by non-potable reuse (The White House 2009).

4.4 The Energy-Water Nexus

A variety of studies and Congressional hearings have focused on the nexus of energy and water, both the use of energy to transport, treat, and heat water and wastewater, and conversely, the use of water in power plants and farms for bio-fuels. A piece of this discussion is about the opportunities for energy and water conservation at the site or neighborhood scale.

Example: Dockside Green, a residential and retail complex in Victoria, B.C. incorporates an energy recovery system on the site (Lucey 2009).

4.5 Nutrient Recovery

Several recent conferences in Vancouver and Copenhagen have focused on prospects for nutrient (nitrogen and phosphorus) recovery from wastewater. Benefits of nutrient recovery approaches include both the reduction in nutrient pollution and eutrophication of lakes and estuaries and the enhanced supply of phosphate, which is needed in agriculture and which is in increasingly short supply worldwide. "Eco-sanitation" is a term for return of nutrients to neighboring farm fields in villages in developing countries.

4.6 Integrated Resource Management: Network Infrastructure and the "Eco-Block"

Recently, there has been an integrated resource perspective emerging among community leaders discussing urban infrastructure and sustainability. A birds-eye view of the city of the future would reveal "networks" of decentralized and repurposed centralized systems for water, energy, and other urban services. Some of the innovative treatment and resource recovery technologies would be "embedded" in subdivisions, apartment complexes, or individual homes, stores, and offices. Other functions would be taken over by vegetative "green infrastructure", such as green roofs and walls, trees, and swales along roads and restored streams, riparian areas, and wetlands. Water and sewer lines might be slip-lined for potable or reclaimed water, water storage, and heat recovery. Networks of telemetry and control technologies would be key elements in managing these systems and in protecting public health and the environment.

For example, an "eco-block" incorporating architectural innovations, wind and solar power, green roof and wall cooling, rainwater harvesting, water reuse and energy recovery, and nutrient recycling into community gardens, can be nearly "off-the-grid" in both energy and water, and can be located at transportation "hubs". These new and efficient designs may cost less in dollars than traditional centralized systems, in part because valuable resources are recovered and in part because long-distance transport costs are avoided. They will also improve the quality of life and work in urban communities and, by virtue of their lighter "footprint", begin to restore the ecological Commons in surrounding watersheds, oceans, and climate patterns.

Examples: Seattle and Los Angeles have both been exploring integrated infrastructure planning at the neighborhood or sub-watershed scale (Moddemeyer 2009 and Lipkis 2009). The University of California-Berkeley is also hoping to build a model "eco-block" in Qingdao, China.

CHAPTER 5.0

UPDATE ON MARKET AND TRANSITION STRATEGIES

In 2000, the analytic frame for understanding market potential for advanced decentralized technologies and management was from the business and economics literature on technology "lock-in" and market evolution, in particular the work of Michael Porter. As outlined earlier, this literature suggested the important role of industry strategies, in particular in establishing high standards and in developing complementary products and services, such as management, engineering, training, and planning systems. The varied drivers and barriers to advanced treatment and management also suggested that strategies of collaboration with non-industry stakeholders and accommodation of products and services to the needs of homeowners, elected officials, and Smart Growth advocates would be important.

This Chapter describes a decade of subsequent efforts to understand decentralized system opportunities and barriers. A series of workshops and reports have considerably widened and deepened the understanding of market strategies.

5.1 NDWRCDP Workshops and Strategies: 2001-2009

Between 2000 and 2009, the NDWRCDP partners convened a number of workshops and retreats to identify important research needs and strategies for decentralized water resource management. These included two planning exercises, a workshop on viable management entities, and a workshop series on science and technology, policy, and public outreach approaches. The early gatherings focused on decentralized wastewater systems, while later events evolved into a more integrated water perspective, including wastewater, stormwater, water-efficiency, and other decentralized water and energy technologies and practices. The NDWRCDP also funded a planning retreat in 2007 following the Water for All Life: A Decentralized Infrastructure for a Sustainable Future held in Baltimore, which led to the signing of the Baltimore Charter for Sustainable Water Systems and a follow-up research planning retreat at a federal agency briefing in February 2009.

Throughout the decade, Porter's perspective on market evolution predictors and strategies would resurface, in particular in his emphasis on the need for high standards and in an application of his framework to assessing the viability of business models for management services. In addition, two other analytical frameworks emerged: the concept of "future scenarios", or endstates, which would blend drivers, stakeholder actions, and issues in different paths forward; and the innovation-dissemination model, which highlights the role of "early adopters".

5.2 2001 "Future Scenario" Exercise

Chris Serjak from Nervewire and later consulting firms, led two retreats for the NDWRCDP that were based on the business planning methodology of "future scenarios". The approach was to identify several bold tracks or futures for use of decentralized systems, to

assess the likelihood of precipitating events, and to identify the necessary steps and strategies that would have to be taken for each scenario to become a reality. Participants in the retreats included a range of academics, manufacturers, regulators, environmental activists, and government officials.

The four scenarios that emerged in the first retreat included, in the order of their predicted likelihood (NDWRCDP 2002):

- *Watershed Management* – Large public utilities manage central sewer systems, cluster systems, and individual onsite systems. The driving forces behind watershed management are total maximum daily load requirements, a crisis in decaying wastewater infrastructure, and water shortages.
- *Community-based Management* – A local orientation allows for holistic, sustainable approaches to emerge that integrate watershed and land use planning with cost-effective infrastructure. Innovation is supported, because flexible experimentation at the local level allows successful models to be developed. Community activism is the primary driver.
- *Utility/Business Management* – Both consumers and regulators understand that a responsible management entity is needed as a single point of contact that can be held responsible for water quality infrastructure in an affected area. Public and private utilities build on their management and financial capabilities to develop business approaches for decentralized wastewater management, and property owners pay the "true cost of services."
- *Risk-Based Research and Regulation* -- Increased public perception of public health risks from failing septic systems would lead to better research, which in turn would lead to higher standards of treatment and to tighter regulations and enforcement for monitoring and maintenance of decentralized technologies.

Research needs identified in this retreat and in an earlier NDWRCDP workshop framed the subsequent research priorities for the NDWRCDP in the areas of Environmental Science and Engineering, Management, Regulatory Reform, and Education and Outreach.

5.3 2002 "Soft Path Integrated Water Resource Management" Retreat

With funding from the NDWRCDP and the Joyce Foundation, the CAWT worked with Chris Serjak on a second retreat the following year (Nelson 2002). The intent was to find possible joint scenarios and strategies that were in common between decentralized wastewater and distributed stormwater management, or what is now more commonly termed "green infrastructure".

Future scenarios developed by participants included, in the order of their predicted likelihood:

- *Urban Mass Balance* – Major metropolitan centers have learned to adapt, refit, and modify their water and wastewater systems to fit better within the natural hydrologic regime and to restore/preserve the natural "mass balance" of water in the local geography. Precipitation is captured, and wastewater reused, thereby meeting much of current and future water demand. Groundwater recharge with stormwater and treated

wastewater is commonplace (this scenario closely followed the Watershed Management model of the first retreat);

- *Technology at Site Scale* – The philosophy of keeping water local emerges when a comprehensive and widely accepted understanding of micro-scale wastewater and stormwater treatment and management leads to the development of safe and reliable systems, particularly for potable and non-potable reuse at the site-level. Wherever and whenever possible, builders, engineers, and technology manufacturers push for the tightest, shortest, closed loop systems possible (this scenario followed from the Risk-Based Research and Regulation model in the first retreat).
- *Integrated Planning and Regulations* – Under an overarching framework of "sustainability", a wide range of separable fields are merged, including water quality, water quantity, habitat protection, landscape and community character, economic well-being, and social/cultural health. Both federal and state governments expand their tools beyond traditional regulatory and financial subsidization to include technical assistance to local communities and watershed partnerships and a shift towards performance goals, so that maximum flexibility is provided for cost-effective and innovative technologies and practices;
- *Small Community Pragmatism* – Small communities do not have the economic resources to build large centralized transport and treatment systems for water, wastewater, stormwater, and flood control. Communities deploy solutions that build on the existing infrastructure of individual septic systems and solve more than one problem at a time, such as simultaneously addressing both stormwater and wastewater (this scenario carried forward themes from the Community-Based Management scenario in the first retreat);
- *Preservation and Reliance on Natural Systems* – This scenario relies upon the power of the public and the environmental community to act as catalysts for change. The public has come to recognize that there is no better way to ensure clean, safe, and plentiful water than to rely on, and work within, the carrying capacity of natural systems. The expanding field of "bio-mimicry" provides scientific support for this view.

It is interesting to note that the utility/business management model fell by the wayside in the second retreat, largely because of opposition to "privatization" concepts. A new scenario also emerged for natural system restoration and services, perhaps because environmental organizations were represented in the second retreat, but not the first.

High-priority research needs were recommended (Nelson 2003):

- Micro-scale designs and technologies at the site or cluster level
- Macro-scale cumulative impact models
- True cost calculations comparing monetary and non-monetary costs
- Utility and other management models and approaches
- Innovative policy, regulatory and management mechanisms, including sustainable community initiatives, TMDL and other market incentives, environmental stewardship projects, and innovative utility and management structures
- Approaches to engaging the public and key stakeholders, such as engineers, realtors and builders, elected officials, environmental organizations, and others in building a strong water quality ethic and stewardship.

Federal policy recommendations included:

- Change standards of practice – certification, standardized designs, models
- Financial incentives – eligibilities, performance, true cost pricing, market reform
- Planning and regulatory reform – new building code models, allowance for pilots, integrate water resource planning, shift government to coaching locals
- Outreach and advocacy – mobilize environmental community, educate regulators and elected officials, clearinghouse, encourage public/community participation
- Public health impacts – assessments of soft path, reuse in particular
- Research and development – demonstration projects, benefits and costs, management, integrated water paradigms, basic science, technology development

5.3.1 Retrospective

A comparison of the five scenarios from the 2002 soft path workshop and the current conversations about water management is instructive. Probably the greatest impact on national discussion has been the environmental movement's focus on green infrastructure and ecosystem services, which was considered the least-likely scenario at the time. Environmental non-governmental organizations (NGO's) have not yet, however, fully embraced decentralized wastewater treatment and reuse approaches.

The scenario voted most likely was the Urban Mass Balance path -- a perspective which is increasingly mobilizing interest in the "Cities of the Future" conferences of the International Water Association and Water Environment Federation. Small community innovations have lagged, as expected, perhaps because the technical expertise at the local level is insufficient to deal with complex innovative projects, as "pragmatic" as they may appear to citizens.

In terms of the federal policy recommendations, there has been a steady increase in Congressional attention to assuring eligibilities and incentives for decentralized technologies. EPA has not, however, mounted a major research and development or outreach program that would address the recommendations made in 2002.

5.4 2004 Lessons from Community Demonstration Projects

In 2004, the NDWRCDP convened a discussion with participants in a number of the National Community Decentralized Wastewater Demonstration Project sites, including from Vermont, Rhode Island, Alabama, and other states (Nelson 2004). The attendee recommendations for federal policymakers and researchers included: a need to focus on integration of water, stormwater, and wastewater planning; the importance of management; and the need for help from a variety of federal agencies in financing decentralized infrastructure.

5.5 2005 Viable Business Models for Management Workshop

The NDWRCDP supported a CAWT-run workshop in 2005 on viability of management entities from a business perspective (Nelson 2006). Already, it had become apparent that municipal utility-style management of decentralized systems was not emerging to the degree that EPA and the industry had hoped. Chris Serjak facilitated this workshop as well and the work of Michael Porter was once again used as a frame for understanding the industry.

Conclusions of this project were that cluster systems can relatively easily be managed by public or private utilities, because they are on public property and "mimic" sewer collection and treatment models at smaller scales. Individual home systems would likely continue to be managed by small private companies chosen by the property-owner, in effect paralleling the competitive local markets for electricians, roofers, gardeners, etc. that work on private property. Public agencies would oversee comprehensive wastewater planning, establish sewer districts for oversight of technologies of all scales, set performance standards, structure financial assistance, develop inspection requirements, certify installers, and keep records of these technologies on private property.

5.6 2007 Barriers to Evaluation and Use of Decentralized Wastewater Technologies and Management

The NDWRCDP funded a consultant team led by Stone Environmental to identify barriers to the evaluation and use of decentralized systems and to recommend strategies to overcome these barriers (Etnier et al 2007). Five key groupings of barriers emerged in that research:

- *Engineers' financial reward for using centralized systems*
- *Engineers' lack of knowledge of decentralized systems*
- *Engineers' unfavorable perception of decentralized systems*
- *Unfavorability of the regulatory system for decentralized systems*
- *Lack of systems thinking applied to wastewater issues*

Recommendations included ensuring equity in funding streams, increased education and outreach, more even-handed requirements for alternatives analysis, greater uniformity in and science-based regulation of decentralized treatment, and encouragement of integrated resource management approaches.

5.7 2007 Federal Policies – CAWT Report

In 2005-2006, CAWT, with funding assistance from NDWRCDP and the Joyce Foundation, convened a four-workshop series on science, policy, and outreach strategies for soft path water approaches (Nelson 2008). The premise of the workshops was that lessons and insights could be gleaned from the efforts of scattered pilot projects by "early adopters" across the country.

The assembled participants, including engineers, government officials, architects, utility managers, and environmental activists, recommended six short-term actions as priorities to move soft path water management forward:

- *Support demonstration projects and research*
- *Develop green building links*
- *Create a network of local advocates and experts – for education, tools, capacity-building*
- *Identify champions in federal agencies and professions*
- *Research full costs and benefits of alternatives*
- *Analyze integrated water supply and water quality planning approaches*

CAWT also published a report on federal policy measures, which included long-term recommendations for national leadership (Nelson 2007). In general, the federal government needs to:

- *create spaces for local models to emerge;*
- *support multi-stakeholder conversations, research, and collaborative design;*
- *begin to research and explore major government policy and funding shifts to support new approaches to water management.*

The complete list of recommendations is included in Chapter 7 of this White Paper.

5.8 2007 Baltimore Charter for Sustainable Water Systems

Following NOWRA's 2007 international conference in Baltimore, Maryland, the NDWRCDP sponsored a long-range research priorities planning workshop. Participants developed a research agenda and a vision statement which became known as the "Baltimore Charter for Sustainable Water Systems" (Nelson 2008). Excerpts from the Charter included:

New and evolving water technologies and institutions that mimic and work with nature will restore our human and natural ecology across lots, neighborhoods, cities, and watersheds. We need to work together in our homes, our communities, our workplaces, and our governments to seize the opportunities to put these new designs in place.

We commit to implementing more sustainable water systems by expanding uses and opening new markets for small-scale treatment processes, advancing research on micro-biological and macro-ecological scales, inventing new technologies based on nature's lessons, creating new management and financial institutions, reforming government policies and regulations, and elevating water literacy and appreciation in the public.

5.9 2009 NDWRCDP Federal Agency Briefing – Smart, Clean, and Green

In February, 2009, the NDWRCDP convened a briefing on 21st Century Water Infrastructure for federal agencies. A planning meeting the next morning updated the research agenda from the 2007 Baltimore workshop (Serjak 2009). Key themes include:

- *Emphasize the natural link between water and energy*
- *Consider the context (economic, political) in which we are building new infrastructure*
- *Define the value of services that the decentralized or clean, green infrastructure provides*
- *Develop methods to qualify and/or quantify value of new infrastructure to the public and a means to communicate that value*
- *Define a management model that includes both traditional infrastructure and new, innovative assets*
- *Consider both urban and rural settings—there are common lessons from building effective infrastructure in both environments*

- *Conduct research on use of on-site systems in conjunction with sewer system (such approaches might be packaged for consumer market and be catalyst for effective change)*
- *Be cognizant of environmental justice, and the importance of GREEN JOBS in the current political climate*
- *Understand the role of procurement processes to enable and drive change toward a new definition of infrastructure which includes decentralized and green approaches*
- *Define a strategy for scale-up and implementation of new infrastructure (training, jobs)*
- *Conduct research, communicate benefits of 21st century water management on global warming and other ecosystem-scale issues*

5.10 Common Themes from a Decade of NDWRCDP Workshops and Studies

While decentralized wastewater technologies and management remained the focus of NDWRCDP projects, there has been nevertheless a continuously expanding understanding of the "context" for these systems and of potential markets over the last decade. In particular, these shifts in thinking have occurred:

- **From siloed to integrated** – wastewater should be viewed in conjunction with water use, stormwater management, non-potable water reuse energy consumption, and other infrastructure services;
- **All scales** – water management should be understood at all progressively nested scales, from the building to the neighborhood to the community to the watershed, and ultimately to the global water commons;
- **Urban applications** – decentralization can play an important role in urban areas with aging centralized infrastructure;
- **Multiple benefits** – analysis needs to shift from meeting wastewater treatment requirements alone to understanding the full range of public health, community revitalization, ecosystem restoration, green economy, and other goals that can be achieved through better water management;
- **Escalating risks of the status quo** – while in early years the foremost argument for advanced decentralized systems was in cost-savings compared to centralized systems, it is now understood that continued reliance on conventional siloed and centralized infrastructure is wasting water and disruptive of ecosystems, and potentially beyond the carrying capacity of the planet;
- **Institutional challenges** – institutional reform is as important as improvements in technology;
- **Role for science** – while practitioners initially believed that existing decentralized technology was adequate for most uses, scientists looking at emerging public health and ecosystem crises have asserted the need for scientific breakthroughs and applications;
- **Positive change models** – it is less important to understand the "barriers" or impediments to innovation and more important to support pilot projects and dissemination strategies.

CHAPTER 6.0

UPDATED MARKET STRATEGIES

6.1 A Decade of Untried Strategies and Unmet Market Potential

Few of the broad and bold strategies recommended in the 2000 Market Study or in a subsequent decade of NDWRCDP and CAWT-sponsored workshops and studies have been aggressively pursued in the decentralized wastewater sector. In particular, these goals or aspirations have not yet been accomplished:

- High standards of practice, performance and training have not been adopted widely by the industry;
- Management districts and individual system permit requirements have not been implemented in large numbers;
- Investment by venture capitalists into new technologies has not increased dramatically;
- Mainstream engineers have not typically acknowledged the benefits and reliability of decentralized approaches in facilities plans for communities;
- An education and outreach program to assist local communities, engineers, planners, and activists has not been established;
- Federal "champions" of decentralized systems across agencies have not been identified;
- EPA permitting and enforcement programs have not explored in depth the changes needed for true inclusion of decentralized systems;
- Integration of decentralized wastewater systems into federal energy, green jobs, and urban infrastructure agendas has not occurred;
- Federal funding of decentralized water system research and demonstration projects has been cut;
- Convergence or standardization of regulatory approaches across states has not occurred;
- Attitudes that decentralized systems are temporary, unreliable and unmanaged approaches have not changed among key stakeholder groups and the public.

6.2 A Foundation of Small and Scattered Steps

Nevertheless, small and scattered steps have been taken since 2000 and these can serve as a foundation for opening markets in the future. Measures involving EPA and NDWRCDP partners include:

- Incremental improvements in technology and documented performance have been made;
- Quality training materials for installation and maintenance of onsite systems have been developed by CIDWT (www.onsiteconsortium.org);
- Case studies and models for decentralized management districts, utility management of cluster systems, and small company management of onsite systems have been published;
- Decentralized systems are included as eligible approaches for additional subsidization in the 2009 stimulus package's "Green Reserve";

- As described in the accompanying report, a number of building blocks for how the industry can promote collaboration, better planning, financing, testing and permitting, reuse, and utility management are already in place in several states;
- With NDWRCDP funding, EPRI has sponsored a study linking water issues to the green building movement (report forthcoming);
- A national decentralized reuse "Think Tank" has been formed at North Carolina State University (mike_hoover@ncsu.edu);
- Clean Water Action and CAWT have partnered to research multi-stakeholder concerns and interests in integrated 21st Century water management and decentralized approaches (report forthcoming);
- Individuals in engineering leadership positions in the Water Environment Federation (WEF) and the International Water Association (IWA) are emphasizing the need to develop and professionalize decentralized systems, both in rural and urban settings, through new committees and conferences (www.worldwaterweek.org/documents/WWW_PDF/Media/convenors_pr/CoF_media_release.pdf);
- Decentralized systems have been introduced into the WEF and IWA visions for "Cities of the Future" (www.wef.org/CitiesoftheFuture/).
- Legislation has been introduced in Congress to promote inter-agency collaboration and increased funding for water research (H.R. 1145);
- Net-zero energy buildings approaches have incorporated green infrastructure and water-efficiency and reuse.

The key question in this chapter is how to build on these incremental improvements and efforts, and how to do so in the context of the significant new market potential for decentralized reuse, urban applications, green building, resource recovery, and community revitalization.

6.3 Updated Recommendations for Market Strategies

6.3.1 Collaboration – Include More Stakeholders

The 2000 Market Study recommended the following:

To reach a future of more widespread utilization of advanced technologies and management, strategic actions need to be taken by the advanced on-site system field, many of which will require unprecedented levels of collaboration, innovation, and outreach.

And, specifically:

- *significantly greater accommodation to the values and concerns of homeowners, municipal officials, regulators, and Smart Growth advocates;*

Collaboration between advanced system manufacturers, designers, and installers and these other constituencies is vital, both to fine-tune products and services to the needs of "customers" and to engage and persuade powerful constituencies to support the use of high-quality decentralized technologies and management. NDWRCDP workshops since 2000 identified an expanded list of stakeholders important to advancing the decentralized wastewater

field, including mainstream engineers, scientists, architects, environmental organizations, clean energy experts and advocates, and urban and rural revitalization experts and advocates more generally.

Looking ahead, "collaboration" and "accommodation" are both important themes. Collaboration is necessary for accomplishing a variety of initiatives and for reaching a critical mass of support for a change in the status quo of government funding and regulatory programs. Accommodation is an important theme as well, since stakeholders must both find their goals and objectives reflected in the new water paradigm and must have an opportunity to participate in the definition of public benefits and services.

Homeowners, in particular, continue to be a challenge to the decentralized wastewater sector. They are comfortable with low-cost, low-maintenance septic systems in their backyards. But, with the increasing sophistication and costs of advanced systems come increasing demands for reliability and service. Some of the better-known "visionaries" in the field have advocated such approaches as composting toilets, which appeal so far only to the most committed environmentalists. Urine separating systems offer great potential for nutrient recovery, but must be designed in a style acceptable to the average customer and without odors and maintenance problems. Similarly, residents must be convinced that localized dispersal in parks or other public spaces is safe and that non-potable reuse systems pose minimal risks to public health.

6.3.1.1 Lessons for Green Building and Green Infrastructure Advocates

The decentralized field also has unique knowledge and expertise as well to contribute to the advancement of distributed approaches in other parts of the infrastructure. The decentralized wastewater industry has struggled for years with questions about how to manage a distributed network of installations, including developing better approaches to O&M, financing, monitoring, training, etc. The field is familiar with the challenges of treatment on private property, and dealing with individual customers and their oft-idiosyncratic behaviors. A range of private utilities and companies have been formed and decentralized business models have emerged to meet these challenges. The green infrastructure and green building worlds could learn much from this experience.

6.3.1.2 Collaboration among Water Professionals

Several opportunities for closer collaboration between decentralized wastewater leadership and other water professionals have recently opened, including:

- **coordination between the Water Environment Federation and NOWRA**;
- **joint EPRI research and pilot projects** among water experts and the green building and clean energy sectors;
- **expanded conversations with the international community**, including participation by CAWT and NOWRA in designing international conferences in Beijing and in Boston;
- **initiation by EPA of a new partnership with WEF and NOWRA** to produce education and training materials.

6.3.1.3 Collaboration with Stakeholders in the Broader Water Sector

Decentralized industry leadership should also reach out and engage stakeholder groups involved in a broad range of water management perspectives and contributions:

- **efforts by universities and research institutes** to apply emerging scientific findings in nano-tech and biotech to the development of new treatment technologies, including at small-scales, and to increase federal funding for water research (US Strategic Water Initiative -- www.watercampws.uiuc.edu);
- **advocacy by venture capitalists and clean-tech water companies** for increased federal funding of research and pilot-testing (Water Innovations Alliance -- www.waterinnovations.org);
- **interest by the green building world** in more fully incorporating sustainable water practices (US Green Building Council neighborhood ratings);
- **incorporation of reuse of treated wastewater into a water-efficiency agenda** for national standards, labeling, certification and incentives (Alliance for Water Efficiency -- www.allianceforwaterefficiency.org and Water Smart Innovations -- www.watersmartinnovations.com);
- consideration of the energy-water nexus at the building and neighborhood scale (Groundwater Protection Council -- www.gwpc.org);
- **advocacy by the environmental justice community** for urban infrastructure projects and funding that revitalize urban neighborhoods, improve public health, and create green jobs (Jones 2008);
- **proposed formation of a new Water Alliance** of all stakeholder groups, to promote media coverage, public awareness campaigns, and federal legislation (CAWT).

6.3.2 Standards – Establish as a High Priority

The 2000 Market Study recommended:

- *attention to the needs of entrepreneurs and venture capitalists for consistent standards of technology and practice*

Michael Porter stressed the necessity, at key points in the evolution of an industry, for individual companies to put aside their self-interests and to work together in establishing high standards of technology and services. The absence of this approach has caused problems for the market of advanced onsite wastewater technologies, since poor field performance by poorly-maintained treatment units, in particular activated sludge-based systems, reinforces the traditional view of onsite systems as unreliable.

In addition, the absence of a concerted effort by the industry to set high performance standards and encourage research and technology development for nutrient removal has left the industry ill-prepared to meet the challenges of eutrophication of lakes and estuaries and of contamination of aquifers from nutrients in places such as Cape Cod.

Industry leadership should consider the following initiatives:

- **aspire with high-performing and reliable systems and management** to meet water and other ecosystem and community development challenges;

- **streamline and implement the Model Code** developed by NOWRA, which establishes standards for design, installation, maintenance, management, and certification;
- **document and synthesize information** on the performance of new technologies and management and don't hesitate to publicize data on technologies that perform poorly;
- **promote research and development** leading to breakthrough treatment modalities that achieve higher standards of treatment;
- **link public health risks** to the necessary performance targets, in particular for different types of non-potable reuse systems;
- **disseminate information** on high-quality products and services throughout the country;
- **work with the clean tech investment community** to expand permitting opportunities in the states.

6.3.3 Defining the Benefits and Values in Decentralized Systems

The 2000 Market Study recommended the following:

- *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;*

This strategy rested on several of the anticipated areas of EPA policy and enforcement actions and the understanding that decentralized systems could be integral to solutions. The recommendation suggested that the decentralized field should develop models for onsite system contributions to water quality at the watershed level, should anticipate and proactively provide solutions for TMDL-based enforcement of nonpoint source loads, and should work collectively on improving systems to remove nitrogen and phosphorus, as well as viruses

The NDWRCDP has sponsored watershed modeling projects, which are helpful for completing watershed assessments and assigning goals for TMDLs. However, the case for onsite and cluster system technologies as effective solutions for removing nitrogen and phosphorus has not been well-articulated. This absence of research and documentation explains, in part, the lack of a credible alternative to sewering of Cape Cod towns dealing with nitrogen contamination of coastal waters and imminent court cases to enforce TMDLs.

Going forward, it will be important for industry leadership to tailor and articulate the benefits of decentralized solutions in wider discussions about the need for a water paradigm shift. The following high-level conversations at EPA and in the water field more generally should include decentralized experts and advocates:

- **integration of water quantity concerns into water quality management under the Clean Water Act** – decentralized systems can keep water local and restore or maintain groundwater levels;
- **climate change impacts on water systems** – increasing drought conditions will require implementation of non-potable reuse and recycling, much of which can be done at the building or neighborhood scale;
- **energy savings and renewable energy** – substantial amounts of energy can be recovered from wastewater, in particular in biogas digesters at neighborhood scale, thereby avoiding costs of high-energy pumping stations;

- **emerging contaminants** – soil-based treatment units can effectively remove some pharmaceuticals and endocrine disruptors and decentralized treatment of domestic wastewater flows can help keep toxins out of water bodies;
- **new water** – decentralized systems can provide significant opportunities for non-potable reuse or what is now being called "new water";
- **ecosystem services** – increased non-potable reuse at the building and neighborhood-scale can release water for replenishing natural ecosystems and services;
- **great waters and watersheds** – decentralized systems in greenfield developments and cities alike can be one of the most important measures in restoring the great waters of the U.S., including Chesapeake Bay, Puget Sound, Great Lakes, and others;
- **resilience of urban systems** – decentralized systems can more quickly be restored than sewer systems after hurricanes, flooding, earthquakes, etc.;
- **community revitalization and green jobs** – installation and management of decentralized systems can stimulate economic development and create new jobs;
- **cities and towns of the future** – decentralized systems are integral to rebuilding of cities and towns to achieve substantially lighter water and energy "footprints".

Decentralized industry leadership should engage in these conversations, learn more about the perspectives and needs of stakeholders, point out the benefits of decentralized technologies and management, and promote research and piloting of new designs that can better address these problems over time.

6.3.4 Risk Management

The 2000 Market Study recommended the following:

- *internalization of a risk management paradigm which targets on-site system upgrades and management where benefits exceed costs;*

At the time of the 2000 Market Study, EPA had been attempting to reorient its programs and policies around a risk management framework for determining priorities and for allocating resources. Applications of risk management to the decentralized field included zoning for advanced treatment standards in environmentally-sensitive areas and variable scheduling of maintenance and inspection requirements depending on the needs of particular technologies.

Going forward, the risk management paradigm should be incorporated into work on:

- **non-potable reuse** – set public health-based standards for the different categories of reuse, including toilet flushing, cooling towers, irrigation of green roofs and community gardens, laundry, and recharge;
- **targeting of hot spots** – develop comprehensive planning and permitting approaches, including in TMDLs, for onsite and cluster systems in environmentally-sensitive zones;
- **adaptive management of innovation** – develop templates for managing "risky" installations of new technologies, through piloting, testing, and eventual permitting of a variety of technologies and designs;
- **public health and water management** – continue to research the direct and indirect public health benefits of improved water management, including clean water free of toxins, improved air quality, ecosystem benefits, green space in cities, and others.

- **stresses on ecosystems** – research the stresses on ecosystems and services of current and alternative approaches to water management.

6.3.5 Innovative Services and Institutions

- *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.*

A number of new market models have developed since the 2000 Market Study, including: the expansion of small installation companies into the business of long-term operation and maintenance; the formation of private utilities to manage dispersed cluster systems; the incorporation of cluster system management into the municipal utility portfolio; the formation of public and private utilities that manage water reuse; and the blending of decentralized wastewater and stormwater design, installation, and maintenance in the same companies.

In the future, there are three additional market models to consider:

- design-build-operate companies that are able to bring modular units quickly into use in communities;
- integrated "green building" design teams that include architects, energy experts, and water, stormwater, and wastewater engineers;
- utilities or companies that manage wastewater and solid waste for biogas generation and heat recovery.

6.4 Piloting of Integrated Resource Projects

The CAWT workshops in 2006-2007 highlighted the important role of early adopters in jump-starting change in products and institutions. Change agents across the country can be found in private companies developing and installing new equipment, universities competing for facilities with the lightest environmental "footprint", green developers stretching the sustainability envelope in new buildings and subdivisions, and municipal leaders and community activists arguing for innovative systems in municipal buildings and demonstration neighborhoods. Decentralized industry leadership needs to work more actively with these innovators, wherever they can be found.

The National Community Decentralized Wastewater Demonstration Project, for which Congressional funding has lapsed in recent years, supported community-scale projects in about twenty-five locations. The project evolved over the years from a focus on decentralized wastewater technologies and management to include distributed stormwater innovations, green building in urban areas, community revitalization, and integrated water management. This gradual expansion of scope reflected the broader evolution in thinking described in Chapter 3.

Going forward, demonstration projects should be federally-funded for cities and towns to explore the "eco-block" concepts of integrated water, reuse, stormwater, wastewater, energy, solid waste, transportation development in cities and towns. As in earlier projects, these pilots should include consideration of technologies, planning, management, financing, and public oversight. Results should be monitored and benefits assessed. Non-government support and guidance for such integrated projects is also being developed by the Clinton Foundation in its

Climate Positive program (www.clintonfoundation.org) and One Planet Living (www.oneplanetliving.org).

6.5 Learning and Outreach

The need for an education and outreach program was mentioned, almost in passing, in the 2000 Market Study category of "complementary products or services". The necessity for such a program has become more apparent in the intervening years. In Cape Cod towns, for example, citizens and stakeholder groups are having an exceedingly difficult time locating information on high-performance decentralized technologies and management.

Scattered examples of best practice exist across the country, but are not assembled into clear and concise guidance documents and case studies for a wide variety of audiences. The National Decentralized Wastewater Community Demonstration Project was designed to provide federal funding for multi-faceted community projects around the country. However, EPA has not funded a summary of lessons learned from these projects nor published case studies of successful models. Industry has also not developed a process for continuous learning from these and other pilot initiatives around the country.

Typically, the best transfer of information to communities is by an individual presentation, rather than a written document. Person to person work with stakeholder groups in communities also offers the opportunity for industry to "learn" about the values and needs of the citizenry and of elected officials, and in particular about regulatory challenges and adaptations needed.

A learning and outreach program should be a high priority for industry leadership. Possible arrangements could include:

- US Department of Agriculture incorporation of decentralized wastewater into the land-grant college extension program under its Cooperative State Research, Education, and Extension Service (CSREES));
- EPA funding of a new education and outreach program for decentralized wastewater systems and management;
- Industry sponsorship of website distribution of materials, along with periodic conferences for diverse audiences and the public, and availability of speakers to travel the country as needed;
- Restoration of the National Community Decentralized Wastewater Demonstration Project, along with a mandate for EPA to assemble lessons learned and to develop guidance for communities in the emerging best practices for technology use and management.

NOWRA, in particular, should take the lead in articulating the need for an effective learning and outreach program and should work with the NDWRCDP, with EPA, and with the proposed Water Alliance to design an effective approach. A key first step will be the identification of relevant topics, including performance and cost of existing and emerging technologies, elements of comprehensive wastewater planning, and financing and permitting issues.

CHAPTER 7.0

PROGRESSIVE GOVERNANCE: STATE AND FEDERAL INITIATIVES

One of the most striking aspects of updating the 2000 Market Study was to look back at the unquestioned assumption that the primary institutional framework for the industry would always rest with the states. The study recommended a stronger state role in developing cost-effective and environmentally sound decentralized practices, and in providing financial assistance to communities that will benefit from such approaches, but was largely silent on what measures could be incorporated into a stronger, more muscular federal role.

7.1 Roadmap for a Progressive State Government

Progressive governance or "framing" of local wastewater decision making can in principle be provided at either the state or the federal level. Currently, permits and enforcement for decentralized and nonpoint source systems are the responsibility of state, and derivatively, local authorities. States have been incrementally engaged in professionalizing and upgrading the capacity of the decentralized wastewater sector. The accompanying "building blocks" report describes how Minnesota has attempted to redesign its funding program to give early preferences to decentralized solutions and how Massachusetts has established a pilot and testing program to stream in new onsite system technologies.

It is apparent from the Cape Cod and other cases that state or federal governments need to be proactive in a host of other ways. A progressive government would:

- **actively seek information on the leading edge** of technology development and design across the country and the rest of the world;
- **provide this information to engineers, towns, non-profits, and citizens groups;**
- **fund research and demonstration projects**;
- **require towns to fairly and completely study the alternatives** both for achieving TMDL compliance and for receiving CWSRF and state funding;
- **provide guidelines for adaptive management**, experimentation and enforceable deadlines for compliance with outcomes in a town;
- **work through the permitting ramifications** of encouraging adoption of innovative approaches over time.

Looking farther ahead, a progressive state government could also begin to move in the direction of requiring integrated resource planning by communities, including not only wastewater, but water use, stormwater, energy, solid waste and other resource materials. State governments could:

- **require cities and towns to complete integrated resource plans**;

- **provide financial assistance only for projects that were consistent with such integrated plans**;
- **require public investments in schools, municipal buildings, state parks, and other public facilities to be "green";**
- **fund community and subdivision demonstration projects of integrated resource designs and services;**
- **set standards and incentives** for a continuous "lightening" of the water and energy footprint;
- **provide tax incentives and rebates** to homeowners and developers and incentives for clean tech investors in green building and water technologies.

Isolated examples of emerging sustainability standards include discussions in Massachusetts about requiring cities and towns to reduce per capita water consumption and North Carolina mandates that new buildings and subdivisions meet strict energy and water use standards.

7.2 Can State Initiatives be Fast Enough and Bold Enough?

One strategy for industry leadership could be to target several promising states for reform. An effective strategy would follow the recommendations of the prior chapter:

- **build alliances** with other stakeholder groups working on water issues at the state and local level;
- **assert the goal of high standards** of technology, management, and practice;
- **direct efforts at critical problems** in the state, including water shortages, water quality impairment, energy portfolio mandates for renewables;
- **reach out to communities** struggling with wastewater and other resource crises;
- **tap into national networks** of experts and advocates for advice and information, lectures and briefings.

The common goal would be to work collaboratively with the state to adopt a progressive water agenda, and ultimately an integrated resource agenda, and policy framework as described above. These state initiatives could then be the models for decentralized industry leadership and their partner stakeholder groups to push in other states. Promising states include:

- **Massachusetts**, where CAWT and Clean Water Action have already partnered to create a multi-stakeholder alliance for "Smart, Clean, and Green" water management and have identified critical water concerns in the state, including high costs of conventional treatment in Cape Cod towns;
- **Vermont**, where there have been a series of state task forces and nationally-funded demonstration projects, and where a number of progressive engineering firms and environmental NGO's are located;
- **Washington**, where the Washington Onsite System Association has been a national leader in advanced systems design, permitting, and training, and where onsite systems are contributors to pollution in Puget Sound, Hood Canal, and other important ecosystems;

- **California**, where recent droughts have led state agencies and advocates to work on reforming reuse regulations, concepts of integrated resource management, and green infrastructure.

Undoubtedly, collaborative efforts to reform state policies and regulations would be worthwhile. However, the accompanying state reports show the danger in this approach as an exclusive industry strategy. In the last decade, various states have led the way in incremental reform of decentralized system oversight, but dissemination to other states has been slow and varied. Just because one state adopts an approach does not seem to lead to quick and easy adoption by other states. Arguably, states collectively cannot move fast enough to respond to the severity of emerging challenges in water management.

7.3 Absence of a Strong Federal Role in Decentralized Approaches

EPA's passivity toward decentralized systems is seen throughout its programs. EPA has ruled that Clean Water SRF loans are allowed for decentralized projects on private property, but not required that states make funding available to such projects. Cluster systems for over twenty homes often require Underground Injection Control (UIC) groundwater discharge permits, but EPA has generally left the details of these permits to the states. TMDLs, anti-degradation limits, and source water protection programs generally put pressure on the infrastructure sector, but leave states and communities the authority to choose their preferred solutions. The weight of past practice in using sewers persists in one community wastewater management plan after another, and EPA has no presence whatsoever in these local discussions or in shifting them towards equitable consideration of all alternatives.

For about fifteen years after passage of the 1972 Clean Water Act, EPA did have a stronger role in water infrastructure research and in funding innovative, local projects. In 1977 an additional 15% subsidy was added to infrastructure grants when innovative and alternative (I&A) systems were built. But in 1987, the state Clean Water State Revolving Fund legislation removed the I&A provision. Simultaneously, the Reagan Administration cut back research funding, with the argument that research was more properly the responsibility of states and the private sector. Similarly, EPA considers education and outreach to cities and towns as the responsibility of the states.

This structure of federal-state-local relations leaves EPA in the odd position of advocating for the benefits of decentralized solutions in its rhetoric and guidance documents, while doing virtually nothing substantive to advance their use at the local level.

The Reagan Administration was not wrong its understanding that change happens at the local level. Creativity and innovation are incorporated into new buildings and infrastructure by progressive engineers, entrepreneuers, planners and others, and not by "command and control" bureaucrats. Some communities are the innovators, while others later follow. What was not sufficiently understood was that higher levels of government need to provide support for this innovation and dissemination and to establish the proper balance of incentives and mandates. Preferably these are "performance" and "outcome-based" and not "prescriptive" and reflect a broad range of environmental, economic, and social goals.

7.4 Federal-State-Local Relations Since the 1980's

As a practical matter, EPA's relatively passive stance towards innovation misses two key points. First, most local governments will typically not permit private pilots or fund municipal demonstration projects, because of the high costs and insufficient benefits to outweigh the risks. Early adopters have to invest in more expensive planning, design and regulatory approval procedures, and cover the predictably higher costs of early-stage technologies and construction. And there is a high price for failure, in terms of public reputation and potential lawsuits.

States could set aside funds for research and pilot projects, as a few have done in the renewable energy sector. However, it is at the national level that the long-term benefits of successful pilot projects across the entire country will far exceed the costs. National investments in pilot and demonstration projects will more properly align the calculations and absorb the risks.

A second and more serious problem is that federal funding and regulations might still stand in the way of progressive state reform. In the funding arena, for example, a state may structure its own grants and loans and the federally-seeded Clean Water SRF to mandate decentralized alternatives be considered first, as Minnesota has done, or to mandate sophisticated alternatives analysis and integrated resource planning.

However, there are a host of other federal agencies with funding streams that are much less flexible than the CWSRF. Specifically, USDA, HUD, EDA, Army Corps, and Bureau of Reclamation funding is largely restricted to conventional infrastructure under public ownership. What this means is that local communities can approach federal agencies and the Congress directly for grant and loan awards and appropriations, and can bypass the state incentives. When they do, the guidelines for the programs disfavor decentralized solutions.

Second, the federal Clean Water Act is the dominant regulatory framework for wastewater treatment in the country. Typically, in unsewered communities, EPA and the relevant state DEP will identify straight-pipe discharges into surface water bodies and force communities to clean them up. In the end, the town will usually decide to hire a consultant to design a sewer collection system and wastewater treatment plant for most or all of the town, and will eventually sign a consent decree and NPDES permit for this conventional system.

Models for enforceable permits to clean-up distributed stormwater under the TMDL framework have been recently developed by EPA, in particular in the Charles River Watershed in Massachusetts. But minimal thought has been put by EPA into the parallel issue of septic system inputs into TMDLs, as would be relevant to Cape Cod towns, for example. If the state of Massachusetts were to propose a TMDL with decentralized systems as the solution, that approach might be opposed by EPA.

EPA is currently involved in questions about green infrastructure alternatives to CSO problems. In particular, EPA Headquarters is considering a response to Philadelphia's proposal for a citywide green roof, green street, tree planting approach instead of conventionally-engineered underground tunneling. Green infrastructure would deliver multiple benefits quickly to the city, but these factors are not considered under the Clean Water Act.

Any large-scale effort in a city to institute decentralized treatment and reuse might also require an amendment to an existing NPDES permit and consent decree. An even more radical

approach to separating potable and non-potable water systems might require a revised drinking water permit from EPA.

It is vital for decentralized industry leadership, therefore, to increase the intensity of their efforts to reform state policy and regulations in a few key states, but also to engage federal funding bureaucracies and EPA in discussions about transitioning into a new water paradigm.

7.5 A Profile of Renewed Federal Leadership for Sustainable Water Management

The decentralized wastewater industry should begin to work with other "soft path" or decentralized infrastructure stakeholder groups in articulating the need for a more robust federal role in reform. The 2007 CAWT reports outlined major initiatives in research, funding, and regulations for decentralized wastewater, green infrastructure, water-efficiency and other onsite infrastructure, including:

National Leadership

- ***Establish a national, inter-agency project*** *to articulate a vision for federal action to achieve long-term sustainability in the water resource infrastructure sector;*
- ***Establish an approach that properly supports and partners with local and private sector initiatives****, but which also recognizes the indispensable role of the federal government in research, financing incentives, and regulatory reform.*

Research

- ***Fund comprehensive surveys of emerging research and new applications*** *of integrated and decentralized infrastructure in developed countries, such as in Europe, Australia and Japan, and in developing "leap frog" economies, such as China and India;*
- ***Fund the formation of several Centers of Excellence*** *at universities or research institutes, for the purposes of coordinating basic and applied research in soft path water infrastructure;*
- ***Initiate research in water, wastewater, and reuse applications*** *of bio-mimicry, bio-technology, nano-technology and other leading edges of science;*
- ***Study a broad range of potential institutional reforms****, including integrated water management, privatized system management and financing structures, and local performance-based codes and ordinances;*
- ***Research infrastructure options that integrate some or all systems across the "water chain"*** *(source, use, treatment, reuse, disposal), at "multiple scales" (individual site, neighborhood, city, watershed), and in diverse settings (rural Greenfield development, suburban areas, and cities);*
- ***Stimulate private and non-profit foundation investments*** *in technology-related research, by helping to create large national markets based on voluntary national standards and by signaling a long-term commitment to greater efficiencies and a lighter footprint in the infrastructure;*
- ***Develop 50-year projections on water supply and quality****, and explore the likely impact of alternative infrastructure paths, including the use of soft path infrastructure both to complement and substitute for hard path projects.*

Financing Reform

- ***Focus on how to rebuild an ethic and practice of innovation*** *in the sector and shift some of the policy and budget discussions away from the current preoccupation with how much the federal government should contribute to fixing the aging hard path water and wastewater infrastructure;*
- ***Create financial incentives for use of soft path approaches*** *in all federal subsidy programs, including EPA's Clean Water and Drinking Water State Revolving Funds, and USDA, HUD, Commerce, and other grant or loan programs;*
- ***Expand eligibilities for federal funding to include support for systems on homeowners' private property****, including water conservation technologies, advanced onsite wastewater treatment, rain gardens and other stormwater retention designs, and graywater and wastewater reuse;*
- ***Prohibit use of federal funds for infrastructure projects that promote land development*** *in water-sensitive areas;*
- ***Incorporate soft path water systems in any new federal tax incentive programs for green buildings****;*
- ***Collaborate with progressive financing institutions****, such as the World Bank, insurance companies, real estate mortgage companies and others, in setting standards for investments in sustainable infrastructure and Green Building projects;*
- ***Implement an integrated water resource planning requirement*** *for all recipients of federal water infrastructure subsidies, including both water supply and water quality projects from a variety of agencies.*

Regulatory Reform

- ***Fund a study group to identify problems in the current regulatory structure****, which is based in hard path approaches and which divides authorities into separate spheres of water quality, water quantity, surface water and groundwater, flood control, endangered species, etc. This group should consider alternatives for both incremental reform and significant new federal legislation;*
- ***Develop mechanisms for incorporating soft path technologies into municipal point-source wastewater and stormwater permits****, through such requirements as "soft path technology portfolios" similar to renewable energy portfolios;*
- ***Incorporate "adaptive management" and "performance-based" approaches*** *into the federal permit process so that higher-risk new approaches can be tried without penalties (SEP);*
- ***Explore new enforcement points and standards****, such as mandated water use and reuse "efficiencies" and reduced discharges;*
- ***Explore ways to coordinate and integrate enforcement actions*** *in surface water quality, source water protection, drinking water, groundwater, sediment and flood control, coastal zone management, estuary protection and endangered species, and streamline the processes by which local communities can meet the requirements;*
- ***Develop models for state and local design codes****, as well as for oversight of pricing and service by new design-build-operate companies, so that expanding private markets are equitable and consistent with broader water resource plans;*
- ***Appoint a new Water Commission*** *to study and recommend to the Congress better mechanisms for promoting sustainable infrastructure development programs across a*

wide variety of agencies and Committees, including natural resources, environmental protection, public infrastructure, science, housing, and economic development.

7.6 Short-Term Strategies and the Federal Government Role in Decentralized Wastewater Systems

Decentralized industry leadership, including in NOWRA and related organizations, can also begin to amplify their role in developing a 21st Century water management paradigm through the following incremental steps:

- **Ask to "take a seat at the campfires of conversation"** in the water field, including: multi-stakeholder discussions about integrated water quantity/quality permitting, climate change impacts, energy savings and renewables, emerging contaminants, new water, ecosystem services, great waters and watersheds, resilience, community revitalization and green jobs, and cities and towns of the future;
- **Join The Water Alliance** and support its attempts to reform the federal role in water infrastructure management;
- **Begin to provide technical information** to federal agencies and Congressional committees;
- **Join in identifying solutions in the local and regional "flashpoints"** or crises that eventually rise to the national level of concern and awareness, such as nutrient management on Cape Cod, water shortages in the Atlanta area, community revitalization and sustainable infrastructure in low-income communities along the Anacostia River, or restoring Chesapeake Bay and Puget Sound;

Incremental recommendations for EPA and other federal agencies include:

- **Push EPA's Office of Water** to expand its decentralized wastewater program to include collaboration with the WaterSmart program for water-efficiency, the green infrastructure initiative, ecosystem restoration and sustainable utility research, and other programs.
- **Approach both EPA's new Livable Communities and Urban Waters initiatives**, which have been largely focused on green infrastructure and transportation initiatives, and request that water use and reuse, wastewater treatment, energy, solid waste, and other infrastructure be included;
- **Track the development of a renewed Chesapeake Bay program** and other "Great Waters" initiatives and ask that 21st Century approaches to infrastructure in cities and towns be included;
- **Advocate for additional funding for Sustainable Infrastructure research**, in particular in a second round for WERF's new $10 million award, and include funding for work of the Decentralized Water Resources Collaborative (NDWRCDP);
- **Urge EPA to reengage in non-potable reuse concerns**, including an update to national standards and technologies;
- **Approach EPA's permitting and enforcement offices** and request a review and development of new models for UIC groundwater discharge permitting and TMDL protection of surface waters;
- **Request that USDA expand grant and loan eligibilities** to include financing of decentralized systems on private property;

- **Urge USDA to expand research, education, and extension** approaches under CSREES;
- **Initiate conversations with CDC's environmental health division** and recommend consideration of the full range of direct and indirect benefits of better water management;
- **Approach the General Services Administration** and offer to assist in the implementation of decentralized wastewater treatment and reuse in federal facilities;
- **Contact the Department of Energy Net-Zero Energy Building initiative** and explore the potential for research and implementation of water-efficiency, reuse, stormwater, and wastewater treatment goals;
- **Encourage DOE** to pursue actively the potential for energy recovery from wastewater and solid waste sources and from sewer mining.

Incremental recommendations for working with Congress include:

- **Identify the benefits of the water research bill** (H.R. 1145) pending in the U.S. Senate;
- **Articulate the need for non-potable reuse provisions** in climate and energy bills;
- **Explain the positive impacts of additional subsidization** for innovative decentralized approaches in Clean Water State Revolving Fund reauthorization and Clean Water Trust Fund legislation.

These initial efforts at collaboration will challenge industry leadership to think through more carefully the potential markets for advanced systems and management. Over time, the capability of the industry to break down institutional rigidities and inertia that block market openings will also be enhanced. The full potential for decentralized and integrated infrastructure to better serve the public interest and to lighten the footprint of cities and towns on the environment will also be realized.

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