Appendix D

Typical Recommendations for
Decentralized Wastewater Systems

Typical Recommendations for Decentralized Wastewater Systems

DNREC could develop a strategy for reducing environmental of public welfare impacts associated with existing individual septic systems in the state, while ensuring that other state goals are met, by conducting GIS-based inventories, mapping, and system impact (impact could include, for example, nitrogen loading to surface waters) and reduction analyses of existing septic systems state-wide. In such an analysis, each septic system would individually assessed as to its potential for malfunction and to determine the most appropriate management approach for reducing associated environmental impacts, given the characteristics of each system and statewide planning and water quality priorities and policies. Impact reduction approaches assigned to each system may include clustering for advanced treatment, management of advanced individual treatment systems, and connection to existing adjacent sewers.

System impact analysis indicators might include readily available information from state records or national geospatial datasets including system age, soil suitability (depth to restrictive layer, saturated hydraulic conductivity, and drainage class), watershed vulnerability, proximity to streams, proximity to lakes and ponds, housing density, and proximity to tidal waters. Impact reduction analysis indicators could include parcel size, proximity to existing collection systems, and proximity to large parcels that could potentially host cluster systems.

U.S. EPA guidance on model decentralized management programs and for managing wastewater from federal facilities in the Chesapeake Bay Watershed provides a solid basis for designing appropriate impact reduction strategies for Delaware septic systems. Existing systems with a low potential for impacts should be monitored and periodically inspected by certified personnel, with maintenance and repairs made as needed. Malfunctioning and new systems should be encouraged or required to use advanced treatment technologies and be professionally managed, depending on their relative risk, based on their location within the watershed as well as other factors. Homeowner outreach and education could be enhanced. Higher risk systems should be aggressively retrofit to individual or clustered advanced treatment systems or connected to existing sewer systems, depending on their relative impact risk and their reduction analysis results.

Prior to implementing an impact reduction management program, the following steps may be warranted:

- Conducting a high level, statewide analysis of existing septic systems based on state parcel maps and other readily available geospatial data (for example see Maryland Department of Environment Chesapeake Bay Watershed Implementation Plan)
- Refining the state-level GIS analysis with county-scale GIS analysis and mapping
- Collaborating with local personnel and mining other data sources to collect more specific, updated information about systems serving specific parcels in presumed high risk areas
- Conducting field investigations of systems as needed
- Identifying existing or potential entities that could manage decentralized systems
- Developing specific implementation plans for various management options
- Building additional state and local capacity for managing decentralized systems

Overview

A key to the performance of any wastewater system, from decentralized individual septic systems and small community cluster systems, up to large regional centralized wastewater treatment plants is appropriate management. Although a management program may be structured differently depending on the types of systems being operated, some elements are common to all sustainable wastewater infrastructure management programs. The essential components of a decentralized wastewater management program include (USEPA, 2005):

- Public education and participation
- Planning
- Performance requirements
- Site evaluation
- Design
- Construction
- Operation and maintenance
- Residuals management
- Training and certification/licensing
- Inspections/monitoring
- Corrective actions and enforcement
- Recordkeeping, inventorying and reporting
- Financial assistance and funding

In its voluntary guidance, U. S. EPA (2005) describes five model decentralized wastewater management programs that can be adapted to meet the context-specific needs of a community, region, or watershed. The management models and their main features are described in Table D-1.

Table D-1. Decentralized Wastewater Management Program Elements (USEPA, 2005)

Typical Applications	Program Description	Benefits	Limitations
1. Homeowner Awareness Model			
Areas of low environmental sensitivity where sites are suitable for conventional onsite systems	Systems sited and constructed based on prescribed criteria • Maintenance reminders • Inventory of all systems	• Code-compliant system • Ease of implementation • Inventory of systems that is useful for tracking and area-wide planning	• No compliance ID mechanism • Sites must meet siting requirements • Cost to maintain database
2. Maintenance Contract Model			
• Areas of low to moderate environmental sensitivity where sites are marginally suitable for conventional onsite systems due to small lots, shallow soils or low-permeability soils • Small cluster systems	• Systems properly sited and constructed • More complex treatment options (mechanical, clusters of homes) • Service contracts must be maintained • Inventory of all systems • Contract tracking system	• Lower risk of treatment system malfunctions • Homeowner's investment protected	• Difficulty tracking and enforcing compliance due to reliance on the owner or contractor to report a lapse in services • No mechanism provided to assess the effectiveness of the maintenance program

Typical Applications	Program Description	Benefits	Limitations
3. Operating Permit Model			
• Areas of moderate environmental sensitivity such as wellhead or source water protection zones, shellfish-growing waters, or bathing/water contact recreation areas • Systems treating high-strength wastes, or large-capacity systems	• Performance and monitoring requirements • Engineered designs allowed but may provide prescriptive designs for specific sites • Regulatory oversight by issuing renewable operating permits that may be revoked for noncompliance • Inventory of all systems • Tracking of operating permit and compliance monitoring • Minimum for large-capacity systems	• Systems can be located in more environmentally sensitive areas • Regular compliance monitoring reports • Noncompliant systems identified and corrective actions required • Less need for regulation of large systems	• Higher level of expertise and resources for regulatory authority to implement • Requires permit tracking system • Regulatory authority needs enforcement powers
4. Responsible Management Entity (RME) Operation			
• Areas of moderate to high environmental sensitivity where reliable and sustainable system operation and maintenance is required (sole-source aquifers, wellhead or source water protection zones, critical aquatic habitats, and outstanding value resource waters) • Cluster systems	• System performance and monitoring requirements • Professional O&M services through RME (public or private) • Regulatory oversight by issuing operating or NPDES permits directly to RME (system ownership remains with property owner) • Inventory of all systems • Tracking system for operating permit and compliance monitoring	• O&M responsibility transferred from the system owner to a professional RME that holds the operating permit • Problems identified before malfunctions occur • Onsite treatment in more environmentally sensitive areas or for treatment of high-strength wastes • One permit for a group of systems	• Enabling legislation might be necessary to allow RME to hold the operating permit for an individual system owner • RME must have owner's approval for repairs; might be conflict if performance problems are identified and not corrected • Need for easement/right-of-entry • Need for oversight of RME by the regulatory authority
5. RME Ownership Model			
• Areas of greatest environmental sensitivity, where reliable management is required. Includes sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, and outstanding value resource waters • Preferred management program for cluster systems serving multiple properties under different ownership	• Establishes system performance and monitoring requirements • Professional management of all aspects of decentralized systems • RMEs own or manage individual systems • Trained and licensed professional owners/ operators • Regulatory oversight through NPDES or other permit • Inventory of all systems • Tracking of operating permit and compliance monitoring	• High level of oversight if system problems occur • Model of central sewerage that reduces the risk of noncompliance • Onsite treatment in environmentally sensitive areas • Effective planning and watershed management • Potential conflicts between the user and RME removed • Greatest protection of environmental resources and homeowner investment	• Enabling legislation or formation of special district might be required • Might require significant financial investment by RME for installation or purchase of existing systems or components • Need for oversight of RME by the regulatory authority; might limit competition • Homeowner associations may not have adequate authority

In addition to this general guidance for developing management programs for decentralized wastewater systems, recent federal guidance for reducing nutrient loading associated with decentralized wastewater systems in the Chesapeake Bay Watershed includes the following recommendations (USEPA, 2010):

D-1. Specify the following risk-based, N-removal performance standards[1] *for all new and replacement individual and cluster systems:*

- *20 milligrams per liter (mg/L) total nitrogen (TN) standard for all new subdivisions and commercial and institutional developments and all system replacements throughout the Chesapeake Bay Watershed.*
- *10 mg/L TN standard for all new developments and all system replacements in sensitive areas—i.e., between 200 and 1,000 feet of the ordinary high water mark of all surface waters, or between 200 and 500 feet of an open-channel MS4.*
- *5 mg/L TN standard for all new developments and system replacements in more sensitive areas—i.e., between 100 and 200 feet of the ordinary high water mark of all surface waters, or between 100 and 200 feet of an open-channel MS4.*
- *100-foot setback from surface waters and open channel MS4s for all effluent dispersal system components.*

D-2. Ensure wastewater treatment performance effectiveness and cost efficiency by using cluster systems with advanced N-removal technology sufficient to meet the standards specified above for all newly developed communities and densely populated areas.

D-3. Sustain treatment system performance in perpetuity through management contracts with trained and certified operators for all advanced N-removal systems, and responsible management entity (RME) operation and maintenance (O&M) for all cluster and nonresidential systems. RMEs include sanitation districts, special districts, and other public or private entities with the technical, managerial, and financial capacity to assure long-term system performance.

D-4. Preserve long-term treatment system performance with management practices designed to protect system investments, by doing the following:

- *Conducting GIS-based inventories of all individual and cluster (i.e., decentralized) wastewater systems in all areas that drain into the Chesapeake Bay or its tributaries. Inventory information includes system location (i.e., latitude/longitude), type, capacity, installation date, owner, and relevant information on complaints, service (including tank pump-out), repairs, inspections, and dates. Inventory data is stored electronically in a format amenable for use in watershed studies, system impacts analyses, and supporting general management tasks. EPA offers The Wastewater Information System Tool (TWIST) (USEPA 2006) as a free resource for managing that information in a user-friendly database. Health departments, state agencies, RMEs and others can adapt, amend, or otherwise modify TWIST without restriction or obligation.*
- *Requiring inspections for all systems on a schedule according to wastewater type, system size, complexity, location, and relative environmental risk. At a minimum, qualified inspectors inspect all systems at least once every 5 years and inspect existing systems within sensitive*

[1] *Effluent standards can be met by either system design or performance, as verified by third-party design review or field verification. Except in sandy or loamy sand soils, a 5 mg/L N reduction credit is given when using time-dosed, pressurized effluent dispersal within 1 foot of the ground surface and more than 1.5 feet above a limiting soil/ bedrock condition.* [From original text]

areas at least once every 3 years. Inspect advanced treatment systems, cluster systems, and those serving commercial, institutional, or industrial facilities at least semiannually and manage such systems under an O&M agreement or by an RME. Inspections are consistent with EPA management guidelines for individual and cluster systems. A service professional or other trained personnel conducts routine monitoring of all systems, and periodic effluent sampling for cluster and nonresidential systems, on the basis of system type, operating history, manufacturer's recommendations, and other relevant factors.

- *Repairing or replacing all malfunctioning systems when discovered, with new or replacement technologies capable of meeting the N-removal standards specified above.*
- *Requiring reserve areas for installing a replacement soil dispersal system that is equal to at least 100 percent of the size of the original effluent dispersal area. Treatment systems using effluent time-dosing (i.e., not demand-dosing) to the soil can have reserve areas equal to at least 75 percent of the total required drainfield area. Systems with pressurized drip effluent dosing or shallow pressurized effluent dispersal and those with dual drainfields operated on active/rest cycles (i.e., alternating drainfields) can have reserve areas equal to at least 50 percent of the original required dispersal area.*

D-5. Remove nitrate in subsurface effluent plumes that enter surface waters by using effective, low-cost technologies such as permeable reactive barriers (PRBs). PRBs are low-cost, pH-controlled trenches filled with sand and a degradable carbon source, such as sawdust, shredded newspaper, or wood chips, designed to intercept groundwater plumes and reduce the TN concentration via denitrification.

The characteristics of EPA's five suggested management models and this federal guidance on reducing Bay nutrient loading can be used along with the results of the GIS analysis suggested above to inform the design of appropriate impact reduction strategies for existing Delaware septic systems. The GIS-based analysis would essentially yield four classifications of existing septic systems: low risk systems, and high risk systems to be managed by upgrades, clustering, and sewer connection. These system types are described in more detail in the following subsections along with recommendations for moving forward to plan and implement appropriate impact reduction strategies and available technical resources that can be applied to continue to fill gaps in current knowledge about the management of septic systems in Delaware.

Low Risk Systems

For systems believed to present low potential for negative environmental or public welfare impacts, the following activities could be considered:

For existing septic systems

- Develop or enhance existing data management systems and continue collecting additional information that can help inform a refined GIS analysis and potential future impact reduction strategies that enhance system performance and longevity. Georeferenced system inventory information should include system location (i.e., latitude/longitude), type, capacity, and other design details, installation date, owner, and relevant information on complaints, service (including tank pump-out), repairs, and inspections, and the dates of these events.
- Increase homeowner outreach and education efforts with regard to preventative measures to improve system longevity and performance, frequency of system maintenance, ways to identify system malfunction, availability of technical and financial resources to assist in upgrading substandard system performance, etc.

- Require periodic system inspections by appropriately certified personnel. Substandard systems should be replaced with repaired or advanced systems, prioritized based on their relative impact risk. Non-residential, cluster, and advanced treatment systems should be operated by an RME with an oversight frequency dictated by the size, complexity, and associated risk of the system. Where an RME is not available, an Operation and Maintenance (O&M) contract with a certified operator should be required.

For new systems

- All new and replacement individual and cluster systems should meet the risk-based performance standards, be operated under an O&M contract and/or by an RME, and include the data management and owner outreach provisions indicated for existing systems above. Cluster systems with advanced treatment should be used where appropriate for all newly developed communities and densely populated areas.

High Risk Systems

In addition to the general recommendations for low-risk systems described in above, higher risk septic systems should be aggressively retrofit to individual or clustered advanced treatment systems, or connected to existing systems, depending on their impact potential and other system characteristics. Field confirmation of system condition and (to the extent possible) performance is needed. Accordingly, the following course of action is recommended for high risk systems:

- Use county-scale GIS mapping to identify specific areas of relatively high-loading potential systems; overlay with georeferenced transportation layers to identify neighborhoods or sections of each county to prioritize for field investigation.
- Collaborate with county (e.g., local health department) staff to mine existing records (e.g., permits, inspection reports) in an effort to collect more specific, updated information about systems serving specific parcels in presumed high risk areas. Conduct field investigations as needed to better determine system characteristics and condition. Re-run GIS analyses at county-scale if needed to refine analysis prior to field investigations.
- Use updated county-scale system information to prioritize systems for various upgrade options. Work with system owners on voluntary or mandatory upgrades, by making financial assistance (e.g., programs like Maryland's BRF-OSDS program) available, and identifying specific areas where clusters or sewer connections may be more cost-effective and preferable to individual system upgrades.
- Where available, RMEs should be identified to manage all new and existing systems using advanced treatment. However, in areas where public or private RME capacity does not exist, individual systems may be operated under contract with a properly certified operator, provided that local oversight entities have sufficient capacity to ensure compliance. Cluster and other, more centralized systems must be operated by an RME. Since these systems will typically be located in or near population centers, it is anticipated that the required management capacity will exist.

Individual System Upgrades

Areas characterized by low housing densities not in close proximity to existing cluster or centralized systems should implement a robust management program focused on enhancing the performance of individual onsite systems. High risk septic systems within these areas should be retrofit with advanced treatment systems, prioritized based on need and the capacity of local entities to support management. Opportunities for clustering in these areas should also be identified and pursued.

Additional technical resources:

- The Decentralized Water Resources Collaborative (DWRC; www.ndwrcdp.org) has sponsored more than 70 research projects over the past decade. A guide to the DWRC research and a Frequently Asked Questions (FAQ) guide can be found at: http://www.werf.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/HTMLDisplay.cfm&CONTENTID=14406
- The DWRC project *Update of the Advanced On-Site Wastewater Treatment and Management Market Study* provides a number of case study examples of decentralized best management practices as well as a state-by-state decentralized wastewater management status report. http://ndwrcdp.werf.org/research_project_05-DEC-3SG.asp
- The U.S. EPA compiled an inventory of federal and state sources available for funding decentralized wastewater projects and management. http://cfpub.epa.gov/owm/septic/septic.cfm?page_id=272

Advanced Cluster Systems

Areas characterized by higher housing, but not in close proximity to existing centralized systems, should focus on identifying opportunities to use cluster systems to cost-effectively retrofit multiple septic systems.

The use of cluster systems will demand enhanced management by an RME, which could include an existing, adjacent public utility, a private water service provider, or new entities created to serve the specific needs of the management area.

Additional technical resources:

- The DWRC project *Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems* provides detailed cost and performance data for 341 systems with design flows between 5,000 and 50,000 gpd, covering 13 states. http://ndwrcdp.werf.org/research_project_04-DEC-9.asp
- The DWRC project *Creative Community Design and Wastewater Management* provides a number of case studies showing how decentralized management and cluster systems go hand-in-hand with sound community planning and low impact design. http://ndwrcdp.werf.org/research_project_WU-HT-00-30.asp
- The DWRC project *Cluster Wastewater Systems Planning Handbook* provides factual information on how cluster systems can be planned and implemented, including case study examples of cluster system successes and unmet challenges. http://ndwrcdp.werf.org/research_project_WU-HT-01-45.asp
- The DWRC project *Guidance for Establishing Successful Responsible Management Entities* provides guidance for successfully establishing and running organizations that manage decentralized wastewater systems using a series of 11 fact sheets that are useful for existing RMEs seeking to improve their operations, prospective RMEs considering setting up, and individuals and organizations looking to enter the decentralized wastewater field. http://ndwrcdp.werf.org/research_project_DEC5R06.asp
- The Coalition for Alternative Wastewater Treatment developed a *Catalogue of Federal Water-Related Programs and Organizations* to provide an easily-accessible description of a wide range of national public and private programs that conduct and/or provide financial assistance for projects relating to decentralized and integrated water quality, wastewater, stormwater, and

watershed research, technology development, and management.
http://sustainablewaterforum.org/fed/cat.pdf

Sewer Extension

Areas characterized by relatively high housing/system densities and relatively close proximity to existing sewer systems should focus on cost-effective opportunities for connecting to existing sewers.

In addition to sewering, other non-traditional options should be explored, including existing public utilities assuming RME responsibility for managing decentralized systems in or near their service areas, as well as the increased use of localized water reclamation and reuse systems using decentralized satellite systems, sewer mining systems, and even building-scale water reclamation systems that allow for efficient water reuse in developed areas where traditional, dual-piping of reclaimed water might be infeasible. State and local comprehensive and infrastructure funding planning processes should take advantage of the latest tools available to make water service and infrastructure decisions based on full, life-cycle costing that considers secondary environmental and societal impacts of decisions, avoids costs associated with alternatives, and to the extent practical, the value of natural resources and ecosystem services.

Additional technical resources:

- The DWRC project *When to Consider Distributed Systems in an Urban and Suburban Context* provides decision-support guidance (along with an MS Excel-based multi-criteria decision analysis tool) and 20 case studies highlighting utilities and communities that selected a decentralized approach to water service in lieu of traditional sewer extension. www.werf.org/distributedwater
- The DWRC project *Case Studies of Economic Analysis and Community Decision Making for Decentralized Wastewater Systems* provides real-life examples and guidance for communities wrestling with wastewater infrastructure decisions, by investigating how communities consider and value different wastewater options in monetary and non-monetary terms. http://www.ndwrcdp.org/research_project_WU-HT-02-03.asp
- The Rocky Mountain Institute report (developed under contract to U.S. EPA) *Valuing Decentralized Wastewater Technologies: A Catalog of Benefits, Costs, and Economic Analysis Techniques* presents a "catalog" of the economic advantages and disadvantages of decentralized wastewater systems relative to larger scale solutions, in order to inform wastewater facility planning and assist communities in making better choices among their many technology options. http://www.rmi.org/rmi/Library/W04-21_ValuingDecentralizedWastewater
- Volume 2 of the DWRC project *Sustainable Water Resources Management* evaluates the relationship among green building practices, green building rating systems, and water resource sustainability based on case studies of three diverse commercial green building projects. Volume 3 explores a new paradigm for sustainable water resource management at the community level based on a workshop that reviewed the water management practices and strategies of two very different communities. http://www.ndwrcdp.org/research_project_DEC6SG06.asp
- The DWRC project *Non-traditional Indicators of System Performance* helps RMEs decide how to use real-time sensors and supervisory control and data acquisition (SCADA) systems to effectively monitor multiple decentralized wastewater treatment systems. http://www.ndwrcdp.org/research_project_DEC2R06.asp

Monetary Costs of Advanced Treatment Options

Various tools and datasets can be used to estimate the monetary costs for individual systems, as well as cluster, and larger centralized systems.

Table D-2 presents average national costs for individual decentralized system components. Costs for cluster systems can be estimated using established equations for estimating economies of scale.

Table D-2. Average Costs of Individual, Decentralized Wastewater Systems (Tetra Tech, 2007)

Treatment Method	Technology	Capital Cost	Annual O/M Cost
Conventional	Septic Tank and Gravity Soil System	$5,000–$6,000	$40 per year ($200 pumpout/5 years)
Suspended Growth System	Suspended Growth Aerobic Treatment Unit	$6,000–$8,000	$1,000*
	Attached Growth Aerobic Treatment Unit	$9,000–$13,000	$300*
Attached Growth System	Intermittent Media Filter	$6,500–$11,500	$200*
	Recirculating Media Filter	$8,000–$11,500	$300*
	Vegetative Submerged Bed	$7,500–$10,500	$250*
Soil-based Effluent Dispersal	Pressure Distribution	$7,000	$160*
	Drip Dispersal	$7,800–$9,300	$200–$370*
Cluster System	Conventional Sewer	$14,000**	
	STEG	$7,500**	$230/EDU
	STEP	$10,000**	$260/EDU
	Vacuum	$10,000**	$130–$160/EDU
	Grinder Pump	$9,500**	$280/EDU

Note: Given that the costs are quite variable owing to the variation in local labor rates, climates, and raw material prices, the capital and O/M costs are representative of average reported and recommended costs with adjustments for cost items that were either omitted or added in error. The data in some cases are reported as ranges. It should be noted that in some areas of the country, such as New England and sites with significant construction constraints, costs could be two or more times higher than average costs.

*Basic unit processes can be modified for specific commercial designs. Permitting costs and other add-ons are not included. All systems are assumed to include components of the conventional onsite system, such as the pretreatment (septic) tank. Capital costs are adjusted to January 2006 with ENR of 7865.

**Based on 100 Equivalent Dwelling Units (EDU) in flat terrain. An EDU represents a single-family residence.

The University of Minnesota provides similar estimates on their website, as indicated in Table D-3.

Table D-3. Per-residence Unit Costs Estimates for Decentralized Unit Processes (University of Minnesota, 2010)

Treatment Option	Design and Installation	Annual Operation	Total Cost*
Aerobic tank	$8,000—$12,000	$600–$1,000	$30,000
Peat filter	$8,000—$12,000	$200–$500	$22,000
Single-pass sand filter	$8,000–$12,000	$200–$500	$22,000
Recirculating media filter	$8,000–$12,000	$200–$500	$22,000
Constructed wetland	$10,000–$12,000	$200–$500	$30,000
Trench	$3,000–$6,000	$50–$200	$6,300
Mound	$5,000–$10,000	$80–$300	$12,800
Drip dispersal	$8,000–$12,000	$200–$500	$22,000
Municipal collection	$5,000–$10,000+	$200–$400	$14,000

* Assuming a 20-year life and average design, installation, and operations costs.

Additional technical resources:

- WAWTTAR (Water and Wastewater Treatment Technologies Appropriate for Reuse) is a predictive program intended to assist planners in selecting suitable water and wastewater treatment options appropriate to the material and manpower resources available to particular communities throughout the world. The localized performance and cost of a large number of possible systems can be estimated with WAWTTAR for any location and condition for which basic information on the problem to be solved is available. http://firehole.humboldt.edu/wawttar/wawttar.html
- The DWRC project *Performance and Costs for Decentralized Unit Processes* can help decision-makers conduct equitable and informed cost analyses for different types of systems at various scales. The products of this project include an MS Excel-based cost estimation tool and fact sheets about different unit processes for decentralized systems. http://www.ndwrcdp.org/research_project_DEC2R08.asp

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