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Innovative and Alternative Technology Projects

1987 Progress Report

SEPTEMBER 1987

INNOVATIVE AND ALTERNATIVE TECHNOLOGY PROJECTS
1987 PROGRESS REPORT

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MUNICIPAL POLLUTION CONTROL
WASHINGTON, D.C.

PREFACE

The Office of Municipal Pollution Control (OMPC) issues this annual summary to provide interested parties with an overview of progress in the implementation of innovative and alternative (I/A) technologies under provisions of the Clean Water Act. This report is based upon information from grant awards through April for the year of issue as provided by state agencies and EPA regional offices.

State, EPA region, and EPA headquarters' staffs have worked diligently to make the listings as accurate and helpful as possible. Any errors, omissions, or suggestions to improve the usefulness of the report should be reported to Marie Perez, EPA-OMPC, who is listed in Table 6.

Information on I/A technologies is available from a variety of sources. The National Small Flows Clearinghouse at West Virginia University in Morgantown, WV, maintains bibliographies of information on I/A technologies; and publishes periodic bulletins featuring case studies and information on current I/A activities. Included in the bibliographies are lists of manufacturers, I/A contacts and applicable regulations for each state, and literature articles. The Clearinghouse also has a data base available listing more than 2,000 I/A facilities. The Clearinghouse may be reached, toll free, at 1-800-624-8301. Other sources of information are listed in Table 7 of this report.

This report contains valuable information on I/A technology projects. Tables 1 and 2 provide information on funded innovative technologies. Table 3 provides information on alternative technology projects. The location and status of field test projects are listed in Table 4, and the location and status of 100 percent modification or replacement (M/R) requests are in Table 5. Table 6 gives the I/A technology coordinators for each state and EPA region. A list of technology fold-outs and other sources of information on I/A technologies is presented in Table 7.

The 1986 Progress Report included several innovative technology project descriptions and alternative technology case studies that may be of interest to the reader. The innovative technology project descriptions in the 1986 report include the following:

- Overland Flow
- Sequencing Batch Reactors
- Intrachannel Clarification
- Hydrograph Controlled Release Lagoons
- Vacuum Assisted Sludge Dewatering Beds
- Ultraviolet Disinfection
- Counter-Current Aeration Systems

The alternative technology case studies in the 1986 report include the following:

Vacuum Collection System; Cedar Rocks, West Virginia
Wetlands/Marsh System; Cannon Beach, Oregon
Spray Irrigation and Wastewater Recycling System;
Clayton County, Georgia
Overland Flow System; Kenbridge, Virginia
Sludge Composting System; East Richland County,
South Carolina
Methane Recovery System; Charlotte, Michigan

Copies of the 1986 report can be obtained by contacting Marie Perez, EPA-OMPC.

MENTION OF TRADE NAMES OR COMMERCIAL PRODUCTS DOES NOT CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

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PROGRAM OVERVIEW

An innovative/alternative technology program was first established by the Clean Water Act (CWA) of 1977, in the form of a three-year test program. The 1977 Act included provisions for a financial incentive, a mandatory reserve fund for innovative/alternative (I/A) technology projects, and the authority to federally fund correction of failures. The intent was to improve wastewater treatment technology and efficiency, to lower life cycle costs, and to reduce energy consumption.

The 1981 CWA Amendments continued and strengthened the program by extending the 1977 CWA provisions through 1985, increasing the financial incentive, and adding funding for field test projects. In addition, the mandatory reserve fund percentage was increased from 2 percent to 4 percent, with each state having an option to increase the set-aside up to a maximum of 7.5 percent. Not less than 0.5 percent is to be used for innovative technology funding.

The Water Quality Act of 1987 extended the program and the incentives. Incentives for choosing an I/A technology include a 20 percent increase in the federal grant share, the requirement for states to use a certain portion of construction grant funds for I/A technology projects, and the availability of 100 percent grants to modify or replace funded projects which fail (M/R grants). The I/A program also includes field testing projects to evaluate emerging technologies before committing funds to full scale facilities.

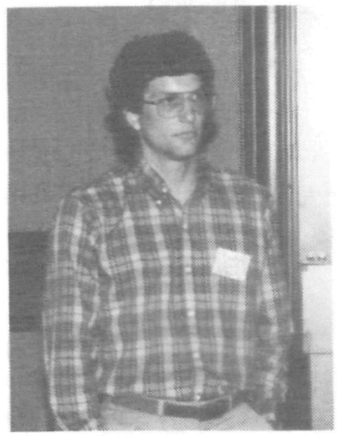
The I/A technology program has awarded over 4,340 grants at more than 1,980 municipal wastewater treatment facilities. Substantial savings have been realized based upon claimed energy savings and cost savings for construction and operation.

1987 ANNUAL I/A

REGISTRATION

Bob Blanco
Washington, D.C.

MEETING



Chris Haynes
Olympia, WA.

SHARING INFORMATION

The annual I/A coordinators meeting was held May 27-29 in Houston, Texas. All regions and 25 states were represented this year with a total attendance of 46.

Jon C. Vanden Bosch, Director of Public Works for Houston, welcomed us to the city and provided an informative discussion of their wastewater treatment program.

COORDINATORS MEETING

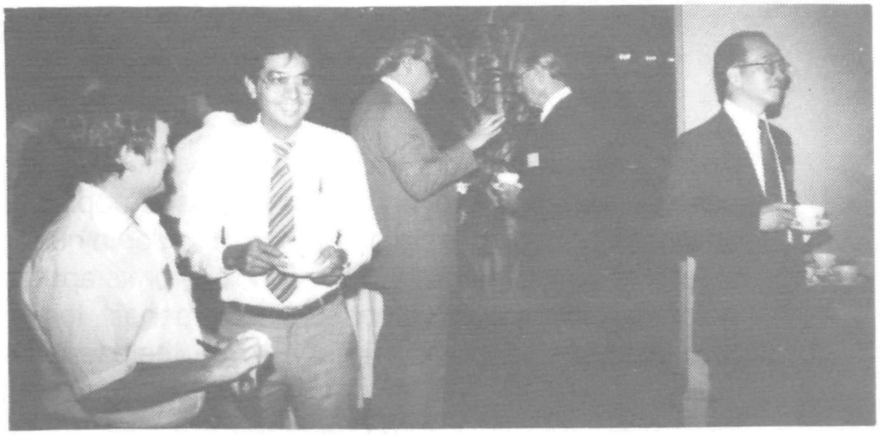
Bob Freeman
Atlanta, GA

Jim Kreissl
Cincinnati, OH

Bob Blanco, Director for the Municipal Facilities Division, gave the keynote address and resolved many problem issues that concern the I/A program.

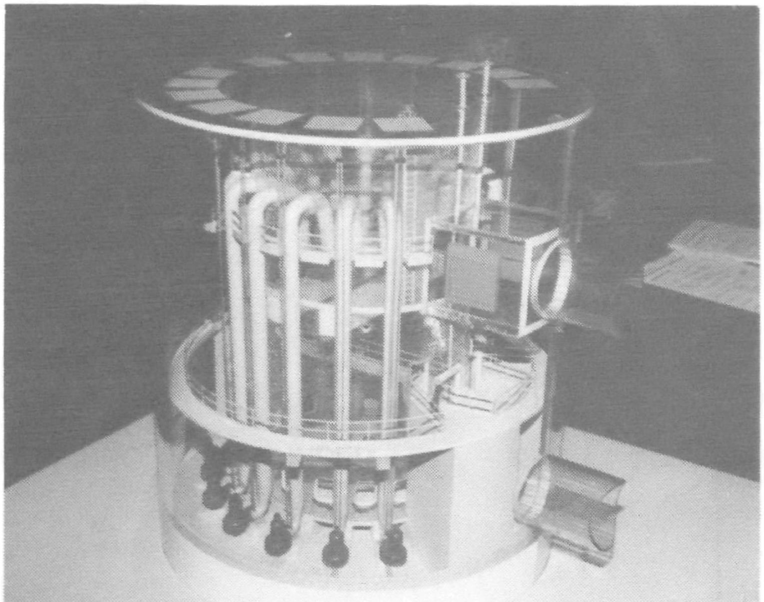
Speakers for the remainder of the two-day program included participants from several states and regional offices. Everyone's contribution made this year's meeting a success.

The tour was of Houston's 69th Street Wastewater Treatment Facility. The sludge handling facilities and the influent pumping station received innovative technology funding.



INFORMAL

ON TOUR



PUMP STATION MODEL

INNOVATIVE TECHNOLOGIES AND PROJECTS

An innovative technology is defined as a wastewater treatment process or technique which has not been fully proven for the proposed application and which offers a significant advancement over the state of the art. In order to qualify as innovative, a technology must meet two conditions. First, the technology or its application must include an inherent risk which is outweighed by a corresponding benefit, thereby making the risk acceptable. If a technology or its application is fully proven, there would be no "risk" involved and it could not qualify as innovative. However, if a specific application of a proven technology is not proven, the specific application may qualify as innovative.

The second condition is that the technology must meet at least one of 6 established criteria that represent significant advancement over the state of the art. The criteria are: (1) cost reduction (in the range of 15 percent of life cycle costs), (2) net primary energy reduction (in the range of 20 percent), (3) improved management of a toxic substance, (4) improved operational reliability, (5) improved environmental benefits, and (6) improved joint industrial/municipal treatment.

Several specific innovative technologies and projects are discussed in the following sections. Only a small representation of the total number of innovative projects are discussed in this report. The breakdown of the areas of innovative technology funding is shown in Figure 1.

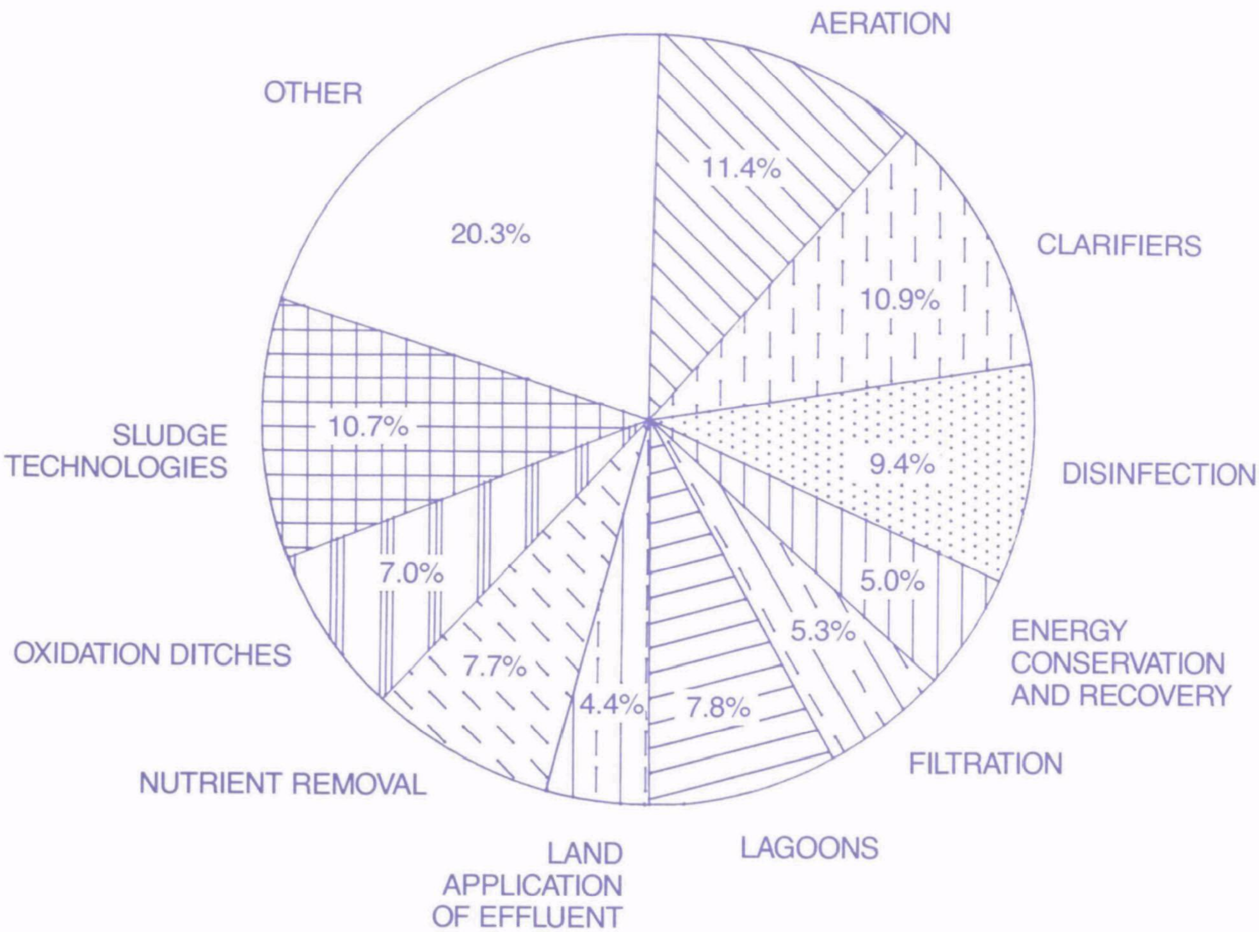


FIGURE 1. INNOVATIVE TECHNOLOGIES FUNDED.

BARDENPHO* PROCESS

Description: The Bardenpho* process was originally developed as a four stage system for BOD and nitrogen removal from wastewater where partial removal of phosphorus also occurs. In order to maximize phosphorus removal, an anaerobic stage is added to the front of the four-stage process. Nitrogen and phosphorus removal are achieved by carefully controlling the concentration of oxygen in each of the five stages. Nitrogen removal is by biological denitrification, while phosphorus removal is by microbial uptake into the waste activated sludge.

Application: The Bardenpho* process is applicable to wastewater systems that have a phosphorus and/or a nitrogen discharge limit. The basic four-stage system can be used when the discharge is nitrogen, but not phosphorus, limited. By adding the fifth stage, the system can be used where the discharge is phosphorus limited.

Benefits: Chemicals do not have to be added to remove the nitrogen and phosphorus. Capital costs and maintenance costs are reduced since chemical handling facilities are not required. Operating costs may be reduced because chemicals are not used. The waste activated sludge is relatively stable, reducing the need for additional digestion equipment; and thereby potentially lowering capital, operating, and maintenance costs of sludge handling. Operation of the process is claimed to be similar to conventional activated sludge system operation. The long solids retention time provides process stability.

Status: There are nine wastewater treatment facilities in the U.S. using the Bardenpho* process. Worldwide, there are another forty systems in operation. At present, there are six facilities under construction and another eight being designed. The operating systems consistently report good removal of nitrogen and phosphorus. However, alum must be added to enhance phosphorus removal in cases where effluent standards require consistent phosphorus levels at or below 1.0 mg/L.

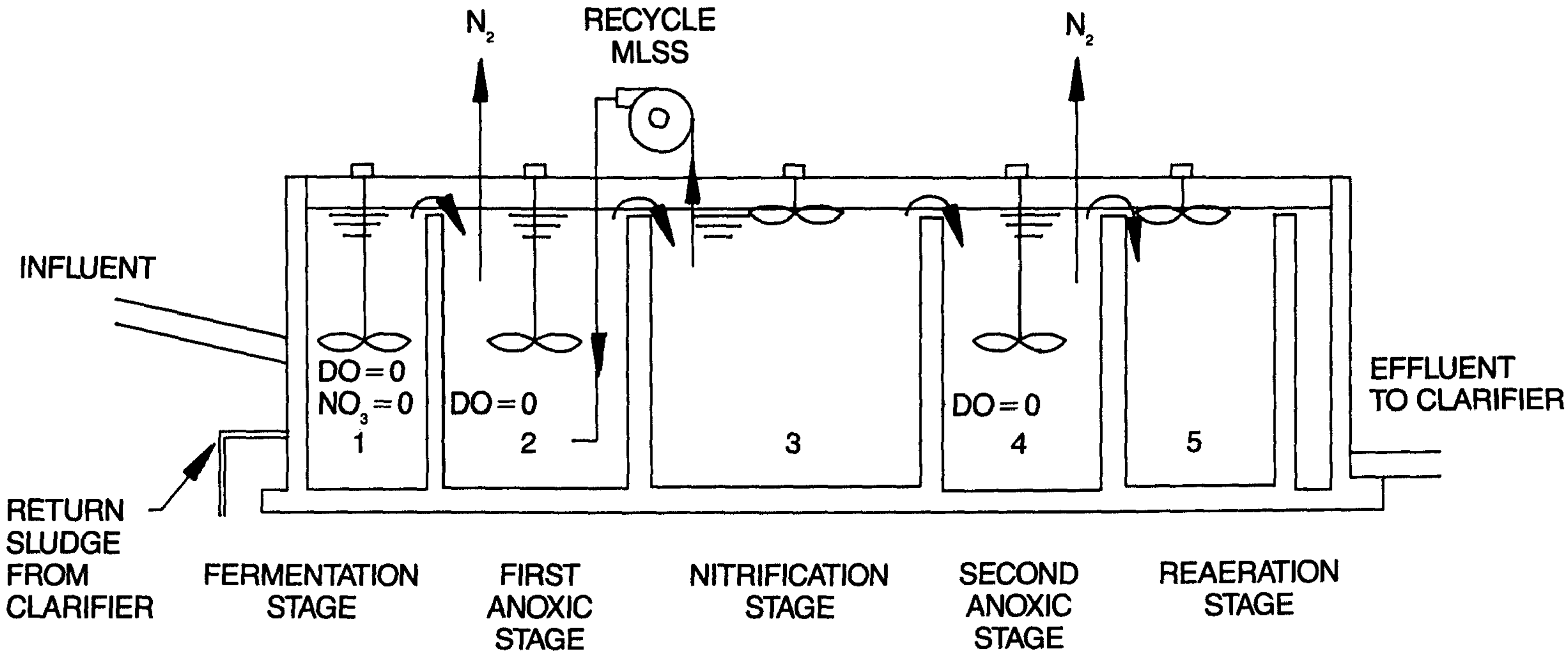


FIGURE 2. BARDENPHO® PROCESS FLOW DIAGRAM.

BIOLOGICAL AERATED FILTERS®
ONEONTA, AL

Description: Prior to the addition of the Biological Aerated Filters® (BAF®), the Oneonta, AL, treatment system was a single lagoon. The BAF® units were added to achieve effluent limits that are BOD, ammonia-nitrogen, and suspended solids limited. The treatment system is a 2.2 mgd system consisting of two pond cells, an aerated channel, eight BAF® units, and chlorination prior to discharge. It serves a population of approximately 4,500. The BAF® units are high rate, attached growth, aerobic treatment units which use a patented catalyst bed to remove soluble and suspended organic material.

Benefits: Capital costs are saved because secondary clarifiers and effluent filters are not required, expensive aeration basins are not required, and labor for installation is reduced. BAF® units require less land than conventional systems, providing another potential savings. O&M cost savings are claimed because energy requirements are potentially less than for conventional systems; there are no chemical requirements; and personnel requirements are reduced by automating process cycling. BAF® units can reduce BOD to below 10 mg/L and effluent ammonia to 1 mg/L, when properly designed according to influent BOD loading. Effluent suspended solids are generally less than 10 mg/L. BAF® systems are simple to operate.

Status: The system has been achieving effluent concentrations which are better than the required limits since start-up. Studies are being conducted to optimize performance and reduce power costs. Systems have been successfully operated in France since 1978. In the United States, there are four BAF® systems in operation, one under construction, and one in design.

Applications: The BAF® process could be used in many systems where improved BOD and suspended solids removal is required, especially where low effluent limits are required. BAF® units may also be applicable where nitrification is required. If land is limited, BAF® units can be especially attractive.

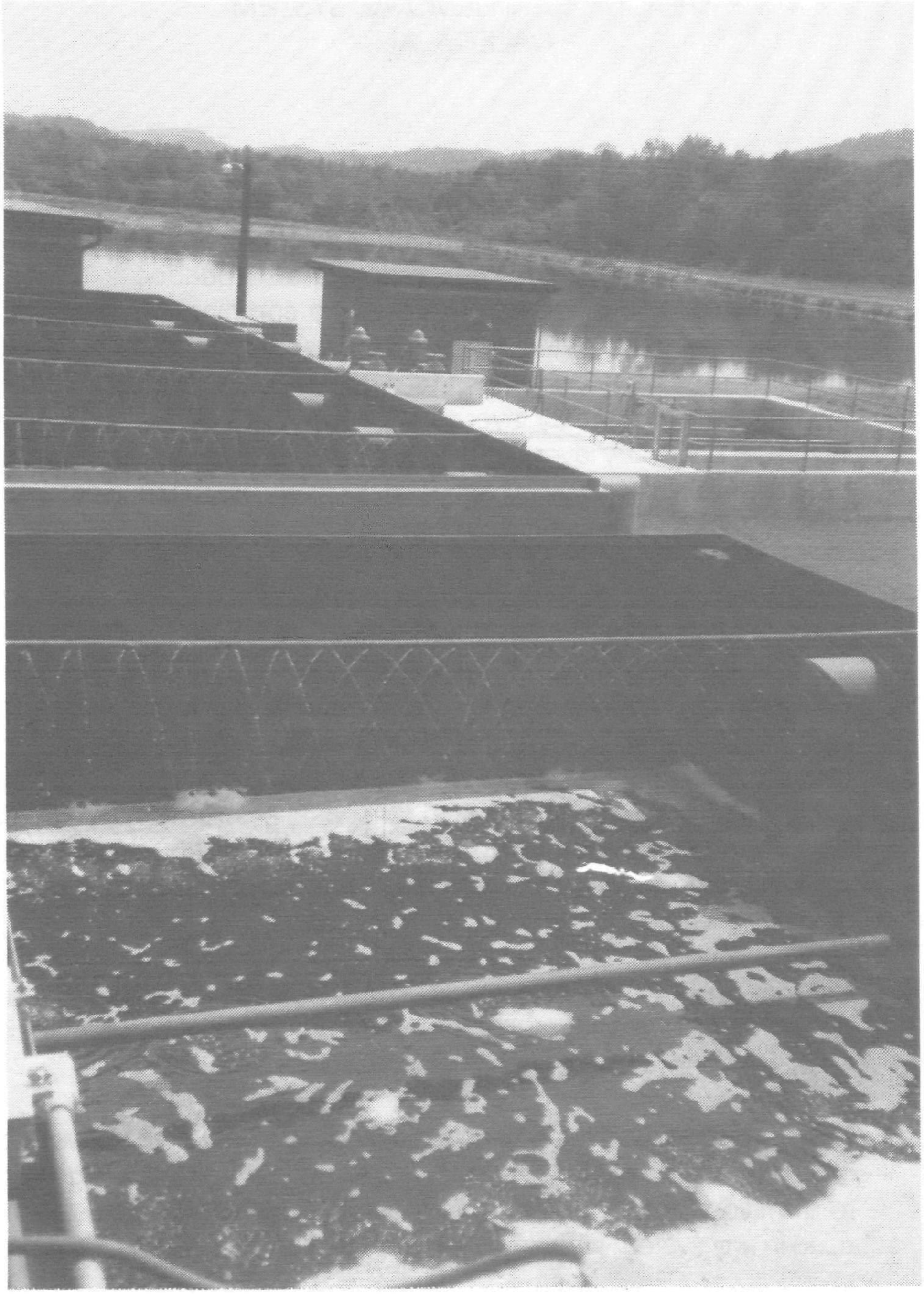


FIGURE 3. BIOLOGICAL AERATED FILTERS;
ONEONTA, AL.

TEACUP GRIT REMOVAL SYSTEM
CALERA, AL

Description: The wastewater treatment system at Calera, AL consists of twin Teacup solids classifiers with stacked static screens, counter-current aeration, clarification, and chlorination. The system has a design flow of 750,000 gpd. The effluent is BOD, ammonia-nitrogen, and suspended solids limited. The Teacup solids classifier removes grit by a combination of centrifugal and gravity forces. Flow enters tangentially near the top, creating a free vortex, and resultant centrifugal forces. Grit particles settle toward the bottom, where the free vortex boundary layer sweeps them to a central well. Acceleration within the boundary layer separates the particles by density. The denser grit particles are separated and removed, while the less dense organics tend to remain with the wastewater.

Benefits: If grit is not effectively removed from wastewater before it enters a treatment system, it adds sludge volume, additional sludge solids, and abrasives which cause excessive wear on mechanical equipment. All of these increase operation and maintenance costs. Removal of grit decreases costs and maintenance time. The Teacup solids classifier removes 95 percent of the grit under peak flow conditions. The grit removed is less than 15 percent organics, which reduces odor and disposal problems. The Teacup solids classifier is all hydraulic, which saves energy and reduces maintenance. The Teacup has no moving parts, which reduces maintenance costs. The aerated discharge maintains dissolved oxygen levels.

Status: The Teacup solids classifier at Calera is performing as designed. The system is removing greater than 95 percent of the grit in the influent. There are no odor problems in the grit removal.

Applications: The Teacup solids classifier is applicable to a variety of wastewaters, including municipal treatment systems, food processing wastewater reclamation, and industrial cooling waste reclamation. The system can be used in any system where grit accumulation and/or damage is a problem.

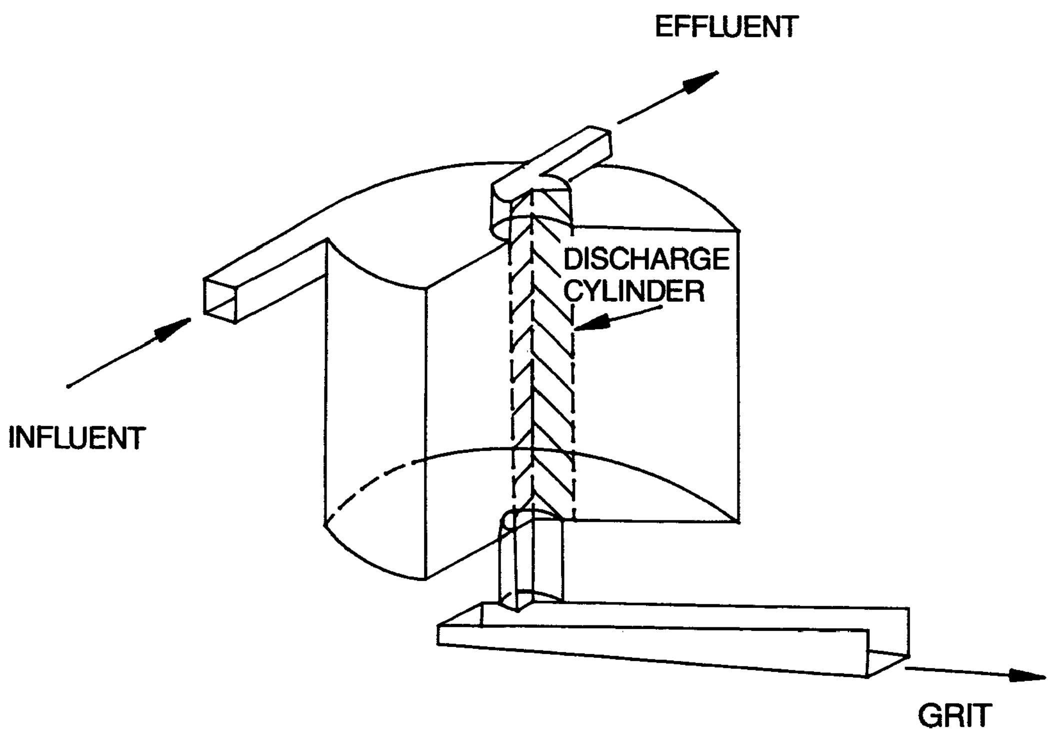


FIGURE 4. TEACUP GRIT REMOVAL/SOLIDS CLASSIFIER.

ALTERNATIVE TECHNOLOGIES AND PROJECTS

An alternative technology is a fully proven method of wastewater or sludge treatment that 1) provides for the reclaiming and/or reuse of water, 2) productively recycles wastewater constituents, 3) eliminates the discharge of pollutants, or 4) recovers energy. The alternative technology portion of the program emphasizes land treatment of wastewaters and sludges, sludge handling and disposal techniques that reuse or reclaim pollutants, on-site methods of disposal, and alternative conveyance systems that are especially applicable to small communities. Because a greater portion of available funding goes to large communities, the alternative technology portion of the program has been particularly beneficial for small communities. Set-asides of available grant funds help focus a portion of these funds on small community projects.

Composition of sludge and land treatment of wastewater and sludge are perhaps the best known alternative technologies. Some other technologies, although proven, are less known because of infrequent use. Effluent treatment alternative technologies include aquifer recharge, aquaculture, revegetation of disturbed lands, horticulture, direct reuse (non-potable), and total containment ponds. Energy recovery alternative technologies include self sustaining incineration and anaerobic digestion with greater than 90 percent methane recovery and use. For small community systems, alternative technologies include individual or cluster on-site treatment, septage treatment, small diameter collection and conveyance systems such as pressure sewers, and some centralized treatment systems.

Several specific alternative technologies and projects are discussed in the following sections. Only a small representation of the total number of alternative projects/technologies are discussed in this report. The breakdown of alternative technology funding is shown in Figure 5.

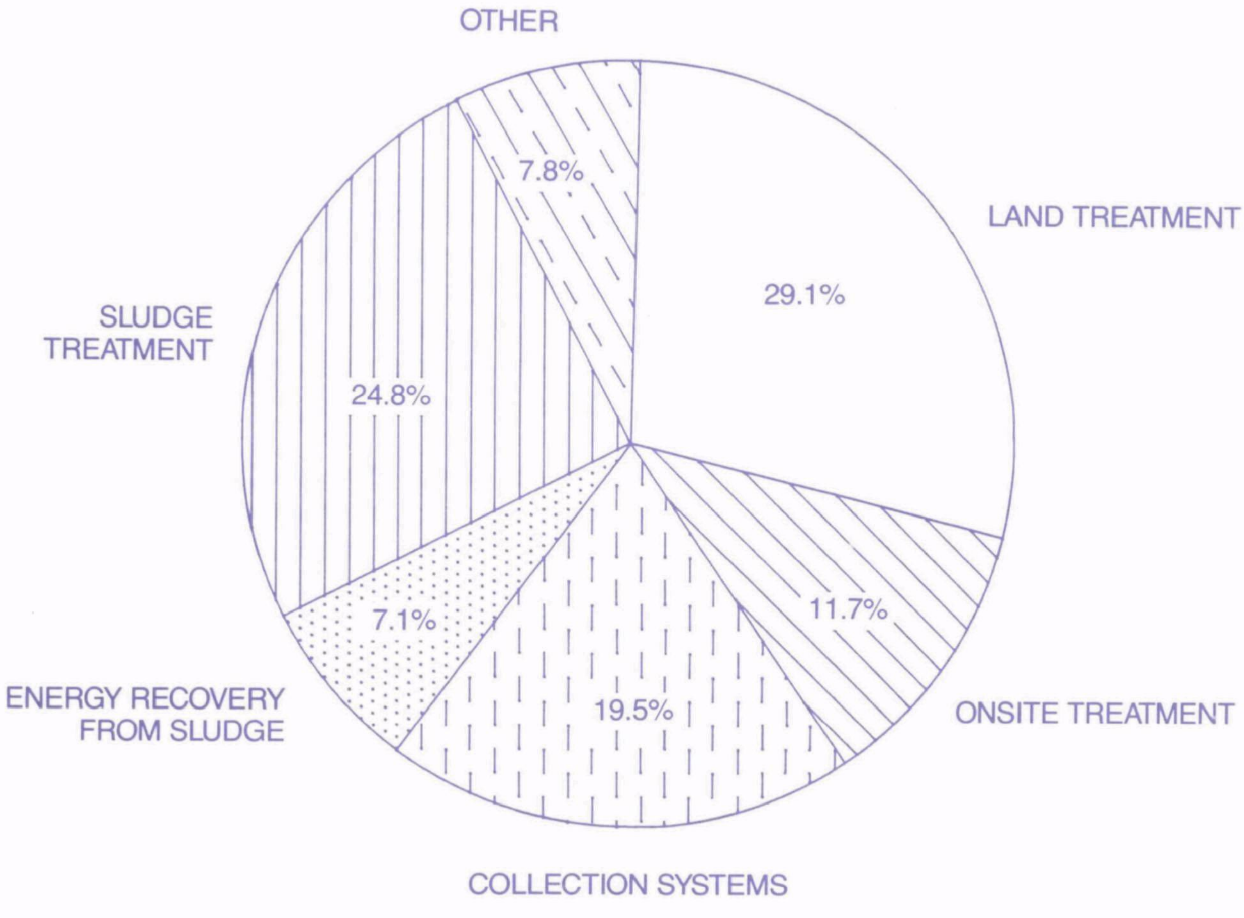


FIGURE 5. ALTERNATIVE TECHNOLOGIES FUNDED.

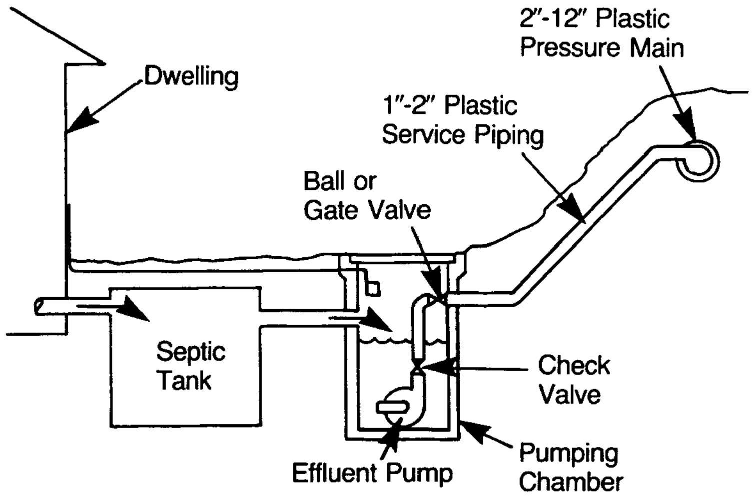
PRESSURE SEWER TECHNOLOGY

Description: There are two basic variations of on-site pressure sewer systems: septic tank effluent pump (STEP) units and grinder pump (GP) units. STEP systems consist of a septic tank, a wet well with an effluent pump, and accessories such as valves and level control system. GP systems have a pumping chamber storage tank and a grinder pump with accessories similar to a STEP system. Both system variations pump wastewater into small diameter, sealed sewer lines. The STEP systems produce a wastewater with lower organic loading than conventional sewers due to pretreatment in the septic tank; whereas, GP systems produce a wastewater with higher than normal organic loading due to little or no dilution from I/I.

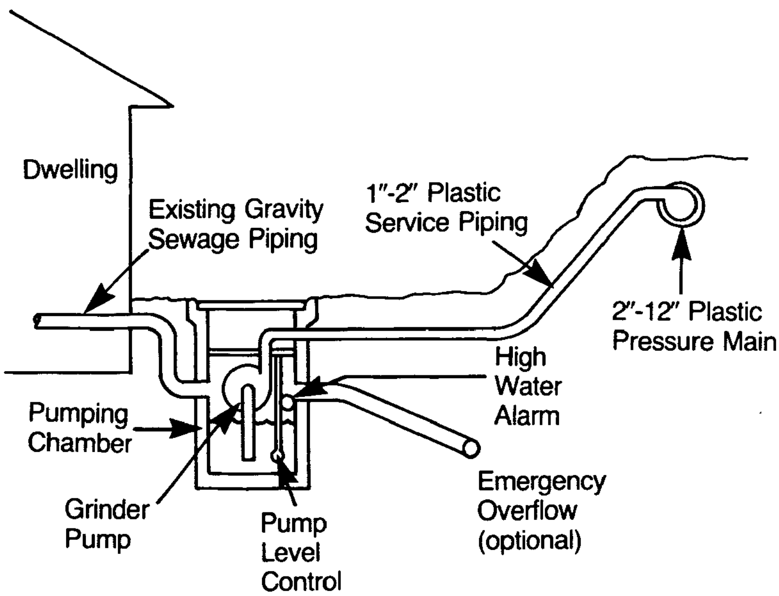
Applications: Pressure sewers allow small or widely dispersed communities to add collection/generation areas as sporadic growth occurs. This type of system is well suited to systems where the treatment plant is uphill of the collection system, but can also be used effectively in areas of slight or widely varying topography. Pressure sewers are very advantageous in areas with shallow bedrock or high ground water tables.

Benefits: Initial costs are lower due to easier installation using smaller diameter pipe; shallower, narrower trenches; and non-critical variable grade which can be adjusted for specific site conditions. System expansion can be accomplished on a one house at a time basis without the need to install large collector lines based on future expansion projections. The sealed pipe system reduces I/I which may result in smaller treatment system sizing, thereby saving capital costs. Systems can be designed to avoid environmentally sensitive areas without adding significantly to costs.

Status: Pressure sewer systems are applicable in numerous communities throughout the U.S. where conditions are not conducive to gravity systems, and/or the growth of the area warrants this type of system. Capital costs must be low enough to offset slightly higher operating costs. Construction with corrosion resistant valves, water level sensors, and switches should increase long-term reliability and ultimately decrease O&M costs.



Pressure Sewer System
Using Septic Tank (STEP)



Pressure Sewer System
Using Grinder Pump (GP)

FIGURE 6. PRESSURE SEWER TECHNOLOGY.

GRINDER PUMP WASTEWATER COLLECTION SYSTEM
GREENE COUNTY, VA

Description: The Greene Mountain Lake Subdivision is located in a rough terrain area downhill from an existing wastewater collection system. To connect the two systems, a small low pressure system with individual grinder pumps at each residence was designed. Each residential station has a sixty-gallon storage tank which is pumped at a predetermined tank capacity by a two-horsepower packaged grinder pump. The collection system includes 1.5-inch to 4.0-inch low pressure mains connected to a central pump station which discharges to the existing gravity collection system. The system is designed to serve approximately 120 residences.

Benefits: The grinder pump/low pressure wastewater collection system reduces the number of major pump stations required by a gravity collection system. The collection lines can also be located in existing road rights-of-way at shallow depths avoiding stream channels. Small shallow lines following the mostly uphill topography provide a cost savings to the project. The closed nature of the system also reduces inflow and infiltration, providing an additional cost savings to the system operation.

Status: The Greene County wastewater collection and treatment facilities is currently in the construction bid phase. Construction should start by September 1987 with an expected completion date of September 1988.

Applications: Any area of wastewater generation that is topographically isolated from collection/ treatment facilities can benefit from this technology; provided the cost of pumping required to overcome the topography is cost-effective. Additional applications might include state parks, recreational/second home developments, or business parks. Low gradient areas (e.g., beach communities) might also benefit by using this system.

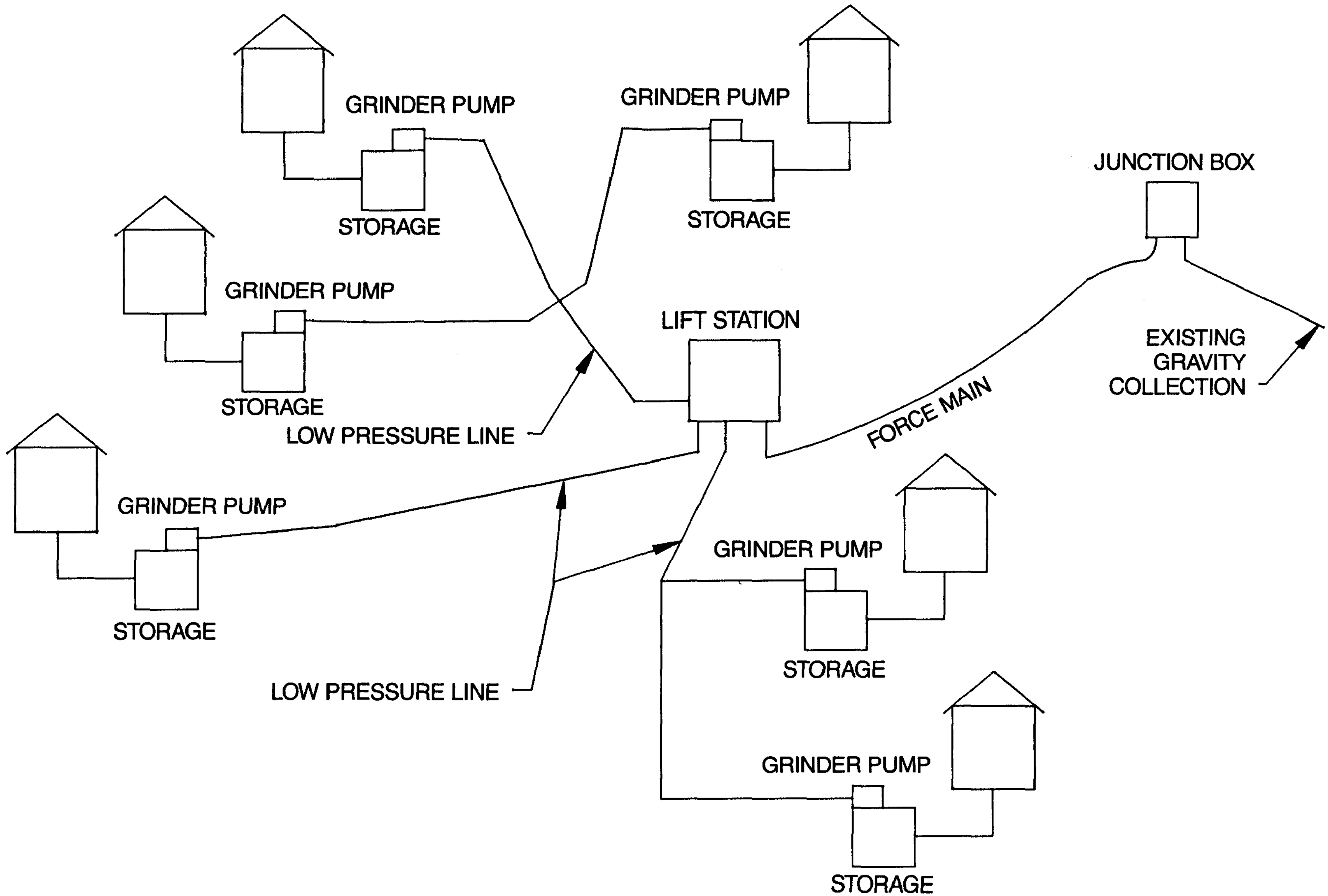


FIGURE 7. GRINDER PUMP FLOW SCHEMATIC;
GREENE CO., VA.

SMALL DIAMETER EFFLUENT SEWERS
MT. ANDREW, ALABAMA

Description: The Mt. Andrew, AL small diameter effluent sewer (SDES) system was installed in 1975 and serves a subdivision community of 31 houses. The system consists of modified septic tanks, small-diameter transport lines, and a lagoon for final treatment. The system uses 2-inch and 3-inch PVC gravity lines and a 3-inch pressure/gravity line. Eight of the houses are situated below the 3-inch pressure/gravity line grade, and the effluent from these houses is pumped to the collection line. Collection lines were installed along the existing grades, independent of the elevation and without manholes or cleanouts. The collection line grades go uphill at several points.

Benefits: The benefits to Mt. Andrew are: 1) lower installation costs due to the use of small diameter pipe and pipe installation following existing contours, which eliminated costly deep cuts and lift stations; 2) a reduced number of manholes, cleanouts, and associated infiltration/inflow; and 3) negligible maintenance costs due to smaller pipe sizes and an essentially closed system.

Status: The small diameter effluent sewer system at Mt. Andrew has been operating satisfactorily since 1975. The transport lines have proven to be very reliable with only minimal maintenance requirements. The modified septic tanks have functioned as designed, although rapid solids buildup in the primary section of the tanks occurred due to their initial undersizing which caused more frequent pumping than anticipated.

Applications: Small diameter effluent sewers are best suited to reasonably small user groups which will not be experiencing large amounts of growth.

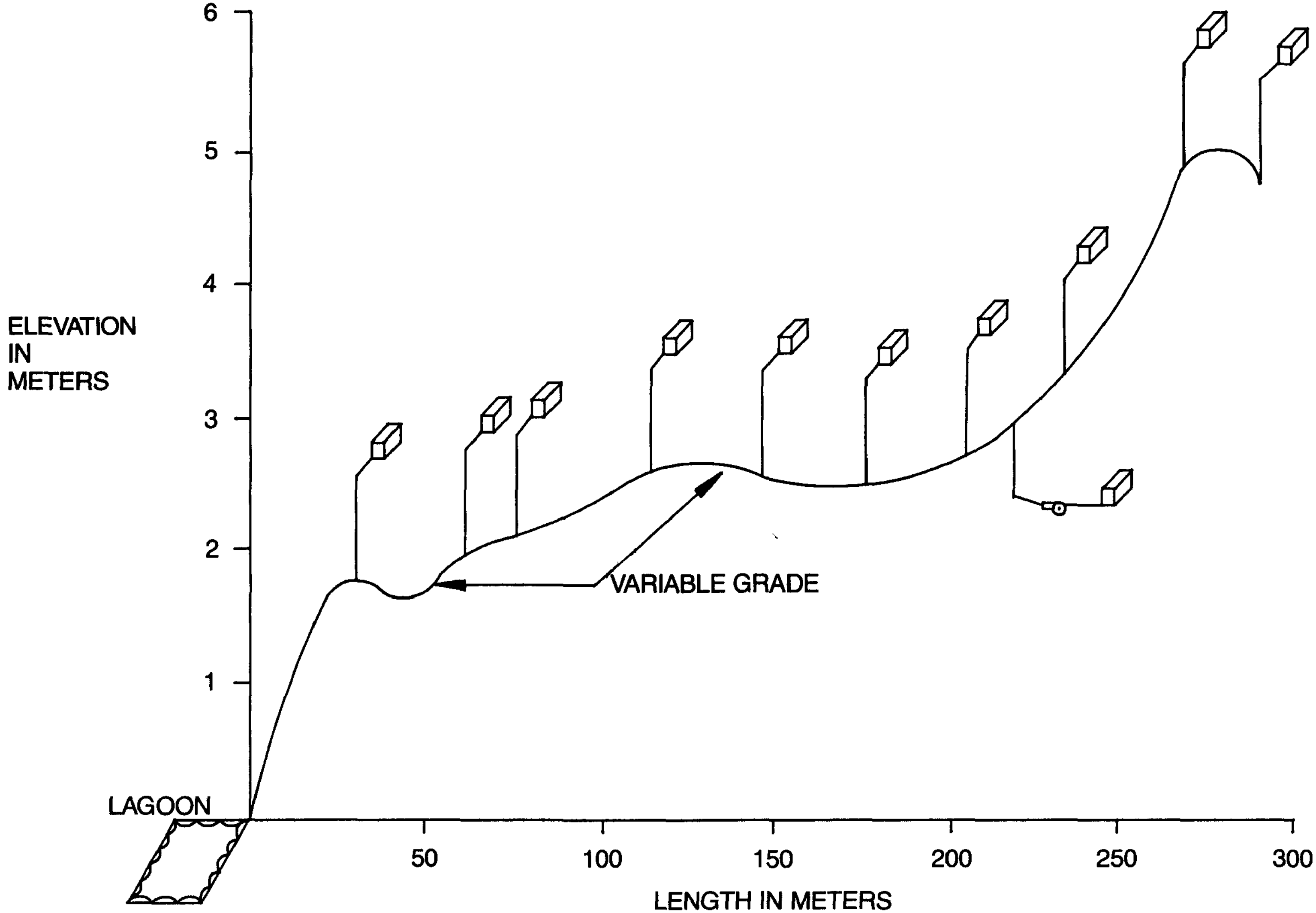


FIGURE 8. SMALL DIAMETER EFFLUENT SEWERS;
MT. ANDREW, AL.

COMMUNAL TREATMENT SYSTEM
MAYO PENINSULA, MD

Description: The decentralized wastewater treatment project developed for the 8-square-mile Mayo Peninsula, MD includes three treatment approaches. One approach is on-site septic systems in areas with suitable soils. The second approach is cluster soil absorption systems where septic tank effluent is collected from several homes and conveyed to an area with soils suitable for a communal infiltration field. The final approach is a 0.9 mgd communal treatment system for the majority of the peninsula. The communal system starts with collection and discharge of septic tank effluent into seven acres of recirculating sand filters. Following this sequentially are a 7-acre constructed bulrush/cattail wetland, with intermediate ultraviolet disinfection, an 8-acre constructed peat wetland with final ultraviolet disinfection, and final discharge into a constructed, offshore, submerged wetland.

Benefits: Following a history of failed septic tank systems with the accompanying flooding and adversely affected well water quality, local residents encouraged development of a system which would treat the residential wastes, but would not contribute to rapid development of the area. The decentralized system will achieve the community goals while reducing initial costs by $12 million when compared to conventional systems.

Status: Only the cluster absorption system is currently under construction. It is scheduled to be completed by August 1987. Initial construction of the communal treatment system is scheduled for fall, 1987. Existing septic tanks are being evaluated and necessary rehabilitation should begin during the spring of 1988.

Applications: Decentralized systems are feasible for rural areas with widespread clusters of population. Systems similar to the Mayo Peninsula project enhance the current lifestyle, while not contributing to unplanned growth. Areas striving to maintain a simplified infrastructure could benefit from a decentralized waste treatment plan.

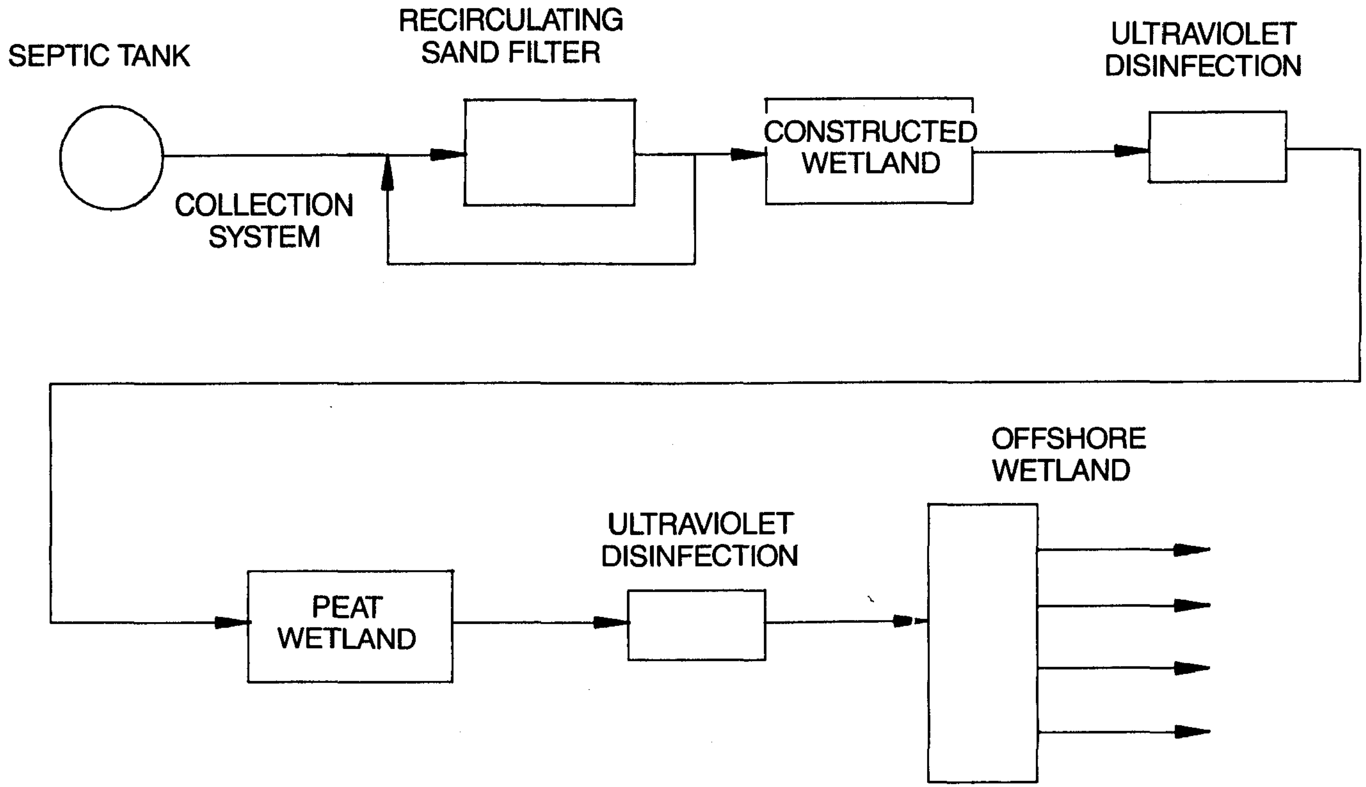


FIGURE 9. COMMUNAL SYSTEM FLOW DIAGRAM;
MAYO PENINSULA, MD.

CONSTRUCTED WETLANDS SYSTEMS TECHNOLOGY

Description: A constructed wetlands (CW) system is essentially a lateral, subsurface flow trickling filter. Primary or secondary treated wastewater flows into a long, shallow trough filled with a stone base and topped with a layer of pea gravel supporting rooted aquatic plants. The biological treatment of the wastewater is restricted to the aerobic root zone below the pea gravel surface. Open surface and root/rhizone-produced aeration provide the necessary oxygen. Degradation of organic material by bacteria in the root zone produces substances (e.g., metabolites) which are assimilated by plants. In turn, microorganisms utilize plant metabolites and dead plant material as a food source.

Application: CW systems have a wide range of applications for small to medium size residential, commercial, and industrial waste streams. Following primary treatment to prevent gravel clogging, the CW system can serve as a secondary or tertiary level of treatment. The most promising application may be the replacement of septic tank drain fields. CW systems are also being used to treat river water contaminated with organic pollutants, acid mine drainage, and agricultural runoff.

Benefits: The CW concept has the potential to lower capital and O&M costs compared to conventional mechanical treatment alternatives. The process is flexible and can be designed to meet specific treatment needs, including the removal of toxics and nutrients. Reeds used in CW systems have a wide range of tolerance for temperature, salinity, and toxicity, which greatly expands its applicability. Compared to a floating marsh treatment system, the CW system requires less land area. The CW system has a nice appearance and the biomass produced may also have an economic value.

Status: The National Space Technology Laboratories Station in Mississippi is operating three CW systems. Several systems are currently being designed or constructed in Alabama, Louisiana, and Mississippi. The Public Health Service is designing a system at their hospital facility in Corvallis, MS.

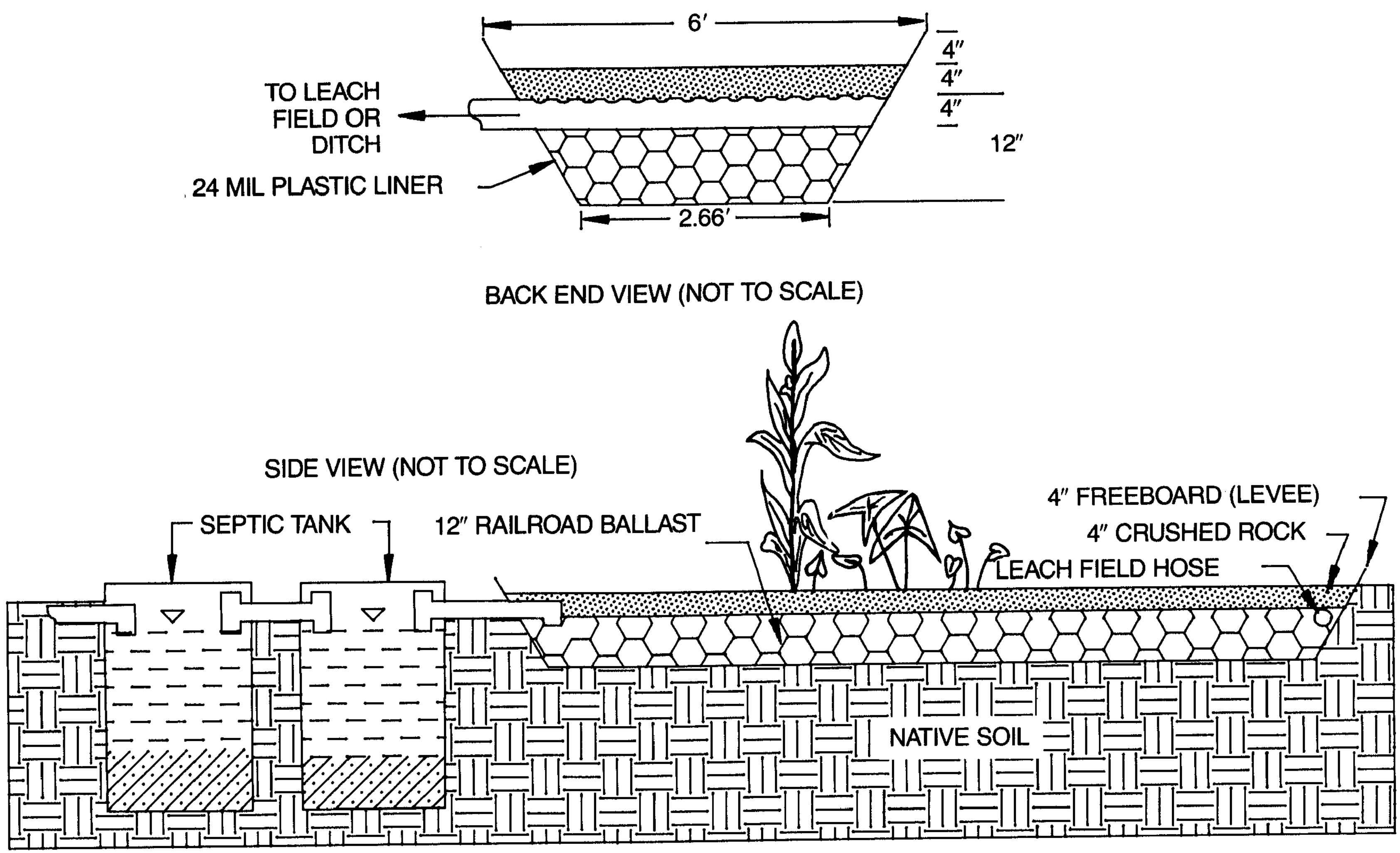


FIGURE 10. CONSTRUCTED WETLANDS.

FIELD TESTS

A special category for field testing innovative technology projects was created by the 1981 Clean Water Act Amendments. Field testing provides a mechanism to verify the basis of design for promising advances in treatment technology prior to committing funds for full scale facilities. The intent is to reduce the risk of failure before funding construction of many similar projects. Field testing grants offer an excellent opportunity to evaluate emerging, higher risk technologies which have the greatest potential to advance municipal wastewater treatment practices in this country. Table 4 lists the field test projects funded to date, including a brief indication of the results achieved where available.

PULSED BED FILTRATION
CLEAR LAKE, WI

Description: The primary purpose of this field test was to evaluate the ability of PBF to reduce organic loading to secondary biological treatment systems and, thereby, increase the operational performance. The filter selected was the Hydro Clear Pulsed Bed Filter developed and marketed by Zimpro, Inc. It uses a shallow bed of fine sand with an air diffuser just above the bed's surface to keep solids in suspension. Periodically, an air pulse is generated through the backwash/underdrain system that re-suspends trapped solids and/or distributes them throughout the bed. After a set number of pulses, the filter is backwashed through the underdrain system. A semi-automatic grease cleaning system restores the sand to its original greaseless condition. The PBF was tested in the primary effluent filtration mode utilizing primary clarifier and/or roughing filter effluent.

Findings: Throughout the two month field test, the PBF reduced suspended solids by an average of approximately 52 percent, with a corresponding average reduction of approximately 24 percent in total BOD at the trickling filter effluent. The best results were achieved during the third of five test periods when the discharge to the PBF was changed from the combined primary/roughing filter effluent to roughing filter effluent only. The additional biological activity in the roughing filter produced a higher proportion of larger particle sizes which were more amenable to filtration.

Benefits: The benefits of primary effluent filtration include the removal of large quantities of solids, increased capacity of existing secondary biological treatment facilities, and reduction of biological treatment sludge.

Applications: In addition to primary effluent filtration, PBF has proven effective in the filtration of raw water supplies, process waters, wastewater roughing streams, cooling tower water, and boiler feed water.

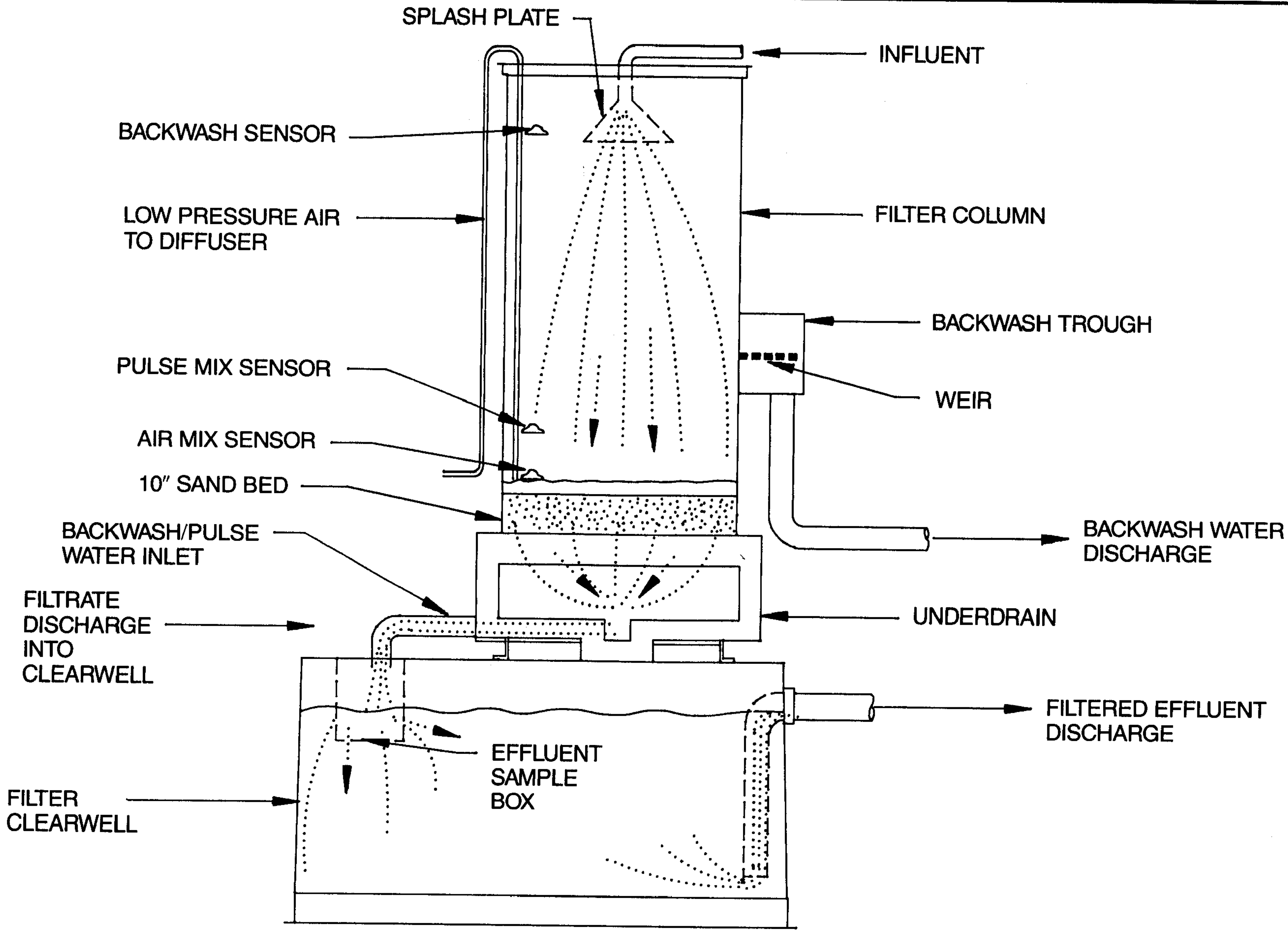


FIGURE 11. ZIMPRO® PULSE BED FILTRATION;
CLEAR LAKE, WI.

ANAEROBIC/OXIC BIOLOGICAL NUTRIENT REMOVAL
FAYETTEVILLE, AR

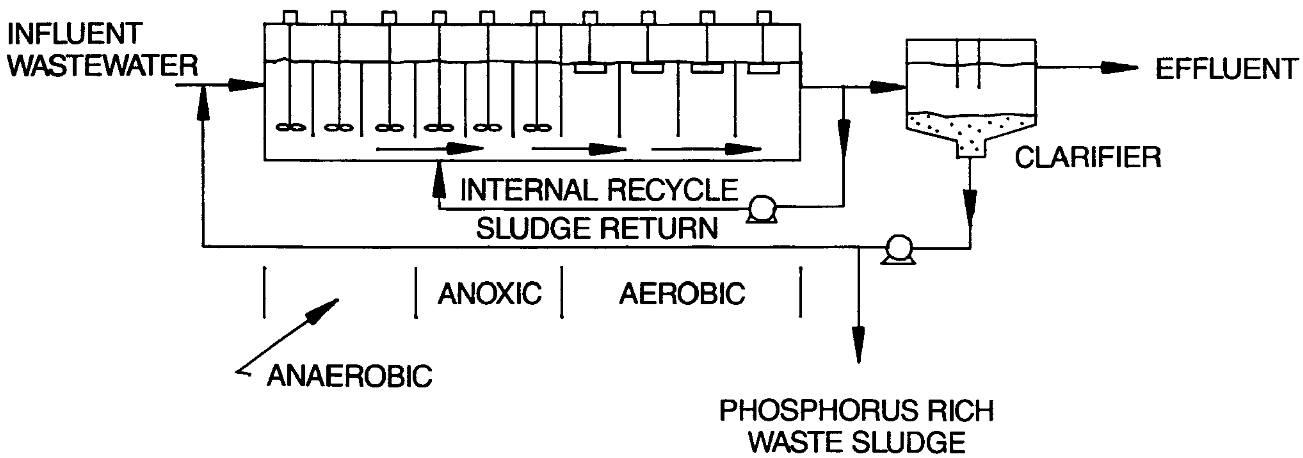
Description: A pilot-scale test study was operated at Fayetteville, AR to determine if the A/O process could achieve desired operational performance under design conditions. The pilot test was a one gpm pilot plant sized to allow the same retention time as the full-scale plant, thereby simulating the full-scale process. In the A/O process, microorganisms solubilize phosphorus in the absence of oxygen in the anaerobic cells. In the oxic cells, soluble phosphorus uptake occurs; organic matter is converted to cell matter, carbon dioxide, and water; and ammonia is oxidized to nitrite and nitrate.

Findings: The pilot plant generally achieved excellent BOD, suspended solids, ammonia, and phosphorus removal. Effluent concentrations of BOD, ammonia, and suspended solids were consistently at or below permit limits. Alum had to be added to the oxic basin effluent during low flows to reach the 1 mg/L phosphorus effluent limit. Without alum addition, effluent phosphorus ranged from 0.5 to 3.1 mg/L. The field test demonstrated that the full-scale facility will be capable of meeting effluent limits.

Benefits: The A/O process can save capital costs because oversized clarifiers are not required for phosphorus removal, separate nitrification and denitrification basins are not required for ammonia removal, and chemical storage/handling facilities are not required. Since the only chemicals required are relatively small amounts of alum, operating and maintenance costs are reduced. Stringent effluent limits for BOD, suspended solids, ammonia, and phosphorus reduction can be met with relatively simple operating controls. The A/O process substantially reduces sludge volumes when compared to conventional systems.

Applications: The A/O process is applicable to wastewater systems that have a phosphorus and/or nitrogen discharge limit.

THE A/O SYSTEM FOR BOD AND PHOSPHORUS REMOVAL
WITH NITRIFICATION AND DENITRIFICATION



THE A/O SYSTEM FOR BOD AND PHOSPHORUS REMOVAL
WITHOUT NITRIFICATION

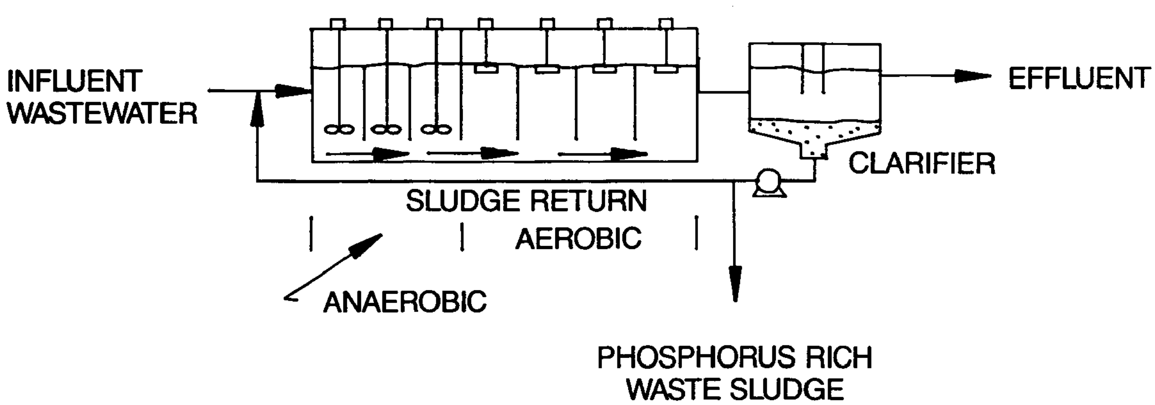


FIGURE 12. ANAEROBIC/OXIC BIOLOGICAL NUTRIENT REMOVAL;
FAYETTEVILLE, AR

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
AERATION/MIXING				
AERATED MIXING CHAMBER AND BLOWERS				
TULSA	OK	20.60	CH2M HILL TULSA, OK	ENV. RELIABILITY
AERO-MOD SYSTEM				
EDGAR SPRINGS	MO	0.04	HEAGLER AND MARSHALL ROLLA, MO	ENV.BEN.
LINDSEY	OH	0.10	POGGEMEYER DESIGN BOWLING GREEN, OH	COST
NORWOOD	MO	0.30	SCOTT CONSULTING ENGINEERS SPRINGFIELD, MO	ENERGY
SALUDA	NC	0.70	APPALACHIAN ENGINEERS CHARLESTON, WV	COST
ASPIRATING PROPELLER PUMP				
WELCH	WV	0.40	L. ROBERT KIMBALL ASSOC. HUNTINGTON, WV	COST
EDI AERATION SYSTEM				
GUILFORD-SANGERVILLE	ME	1.01	WRIGHT-PIERCE TOPSHAM, ME	COST & ENERGY
INTERMITTENT CYCLE EXTENDED AERATION				
CLEVELAND	TN	9.0	RESOURCE CONSULTANTS BRENTWOOD, TN	COST
CORNERSVILLE	TN	0.11	JOHN COLEMAN HAYES NASHVILLE, TN	COST
TULLAHOMA	TN	3.00	BARGE WAGGONER SUMNER CANNON INC. NASHVILLE, TN	COST & ENERGY
UNION CITY	TN	4.03	J.R. WAUFORD CONSULTING ENGINEERS NASHVILLE, TN	COST
SUBMERGED MIXING OF EQUALIZATION TANKS				
EAST WALKER	AL	0.25	ALMON AND ASSOCIATES TUSCALOOSA, AL	COST & ENERGY
NORTH MANKATO	MN	10.00	ZENK ENGINEERS INC. ALBERT LEA, MN	TOXICS MGMT.
SUBMERGED PROPELLER MIXER				
MARQUETTE COUNTY	MI	2.64	FOTH AND VAN DYKE ASSOC. GREEN BAY, WI	ENERGY
STORM LAKE	IA	3.34	KUEHL AND PAYER LTD. STORM LAKE, IA	COST & ENERGY
TROUP	TX	0.31	THE BRANNON CORP. TYLER, TX	COST
SUBMERGED TURBINE DRAFT TUBE				
ANDALUSIA	AL	2.84	CARTER DARNELL GRUBBS ENGINEERS ANDALUSIA, AL	REG.DISCR.
CRANSTON	RI	23.00	UNIVERSAL ENGINEERING CORP. WARWICK, RI	ENERGY
CLARIFIERS				
AERATED CLARIFIER				
CHOCTAW	OK	0.50	REA ENGINEERING OKLAHOMA CITY, OK	REG.DISCR.

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
CANTILEVERED CLARIFIER BAFFLING				
TRI-CITY	OR	13.50	CH2M HILL PORTLAND, OR	COST, ENERGY & ENV.BEN.
COMBINED SECONDARY SEDIMENTATION/CHLORINATION				
FLAGSTAFF	AZ	6.00	BROWN AND CALDWELL TUSCON, AZ	COST
FIXED-MEDIA CLARIFIER				
WAYNESBURG	OH	0.40	HAMMONTREE AND ASSOC. LTD. NORTH CANTON, OH	COST & ENERGY
PLATE SETTLERS				
SANFORD	ME	3.60	ENVIRONMENTAL ENGINEERS CONCORD, NH	REG.DISCR.
DISINFECTION				
COMBINED SECONDARY SEDIMENTATION/CHLORINATION				
FLAGSTAFF	AZ	6.0	BROWN AND CALDWELL TUCSON, AZ	COST & ENERGY
FLOW-PACED SULFUR DIOXIDE AND CHLORINE ADDITIONS				
SOUTHHAMPTON COUNTY	VA	0.3	HENRY P. SADLER AND ASSOC. INC. RICHMOND, VA	COST & ENERGY
OZONATION				
MOORHEAD	MN	6.00	WATERMATION ST. PAUL, MN	REG.DISCR.
PRE-OZONATION				
CLEVELAND	OH	50.00	ENGINEERING-SCIENCE INC. CLEVELAND, OH	COST
DISPOSAL OF EFFLUENT				
DEEP WELL INJECTION				
ST. PETERSBURG	FL	20.00	CH2M HILL CHARLESTON, SC	COST & ENV.BEN.
SUBSURFACE FILTER/SURFACE DISCHARGE				
NEWPORT	VT	0.04	PHILLIP AND EMBERLEY SHELBURNE, VT	COST & ENV.BEN.
WATER SUPPLY/AQUIFER RECHARGE				
EL PASO	TX	10.00	PARKHILL SMITH AND COOPER INC. EL PASO, TX	REG.DISCR.
ENERGY CONSERVATION AND RECOVERY				
BLOWER HEAT RECOVERY SYSTEM				
TRI-CITY	OR	13.50	CH2M HILL PORTLAND, OR	COST, ENERGY & ENV. RELIABILITY
DIGESTORS HEATED BY GEOTHERMAL HEAT				
ELKO	NV	2.50	KENNEDY JENKS CHILTON TWIN FALLS, ID	ENERGY
EARTH SHELTERING AND PASSIVE SOLAR DESIGN				
KASSON	MN	0.35	MCGHEE AND BETTS ROCHESTER, MN	ENERGY
LAKE CRYSTAL	MN	0.59	BOLTON AND MENK INC. MANKATO, MN	ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
ENERGY RECOVERY FROM SLUDGE TREATMENT FACILITY				
TULSA	OK	11.00	BLACK AND VEATCH TULSA, OK	ENERGY
ENERGY RECOVERY/HEAT PUMPS				
NEW YORK CITY	NY	100.00	MALCOLM PIRNIE/ MICHAEL BAKER ALBANY, NY	REG.DISCR.
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND RALPH PARSONS PASADENA, CA	ENERGY
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/BABCOCK WILCOX LIVINGSTON, NJ	ENERGY
INCINERATION WITH HEAT RECOVERY				
MACON-BIBB COUNTY	GA	28.00	JORDAN JONES GOULDING INC. ATLANTA, GA	MUN./IND. TREATMENT
SLUDGE HEAT EXCHANGERS				
ROCHESTER	MN	12.50	HOLLAND KASTLER SCHMITZ ROCHESTER, MN	ENERGY
SLUDGE USED TO GENERATE ELECTRICITY				
INDEPENDENCE	MO	40.00	E.T. ARCHER AND CO. KANSAS CITY, MO	ENERGY
SOLAR POWER SYSTEM				
WAYNESBURG	OH	0.40	HAMMONTREE AND ASSOC. LTD. NORTH CANTON, OH	COST & ENERGY
WASTE HEAT USED TO POWER STEAM GENERATORS				
WAUKESHA	WI	11.60	ALVORD BURDICK HOWSON CHICAGO, IL	ENERGY
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND RALPH PARSONS PASADENA, CA	ENERGY
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/BABCOCK WILCOX LIVINGSTON, NJ	ENERGY
FILTRATION				
ACTIVATED BIO-FILTER				
MEMPHIS	TN	80.00	BLACK AND VEATCH KANSAS CITY, MO	COST
AUTOMATIC LOW HEAD FILTER SYSTEM				
LEESBURG	VA	2.5	BETZ CONVERSE MURDOCK INC. VIENNA, VA	COST & ENERGY
BIOLOGICAL AERATED FILTER				
ONEONTA	AL	2.20	CARR AND ASSOC. BIRMINGHAM, AL	COST
ST. GEORGE	SC	0.25	B.P. BARBER AND ASSOCIATES COLUMBIA, SC	COST
WALLACE	NC	0.18	HENRY VON OESEN ASSOC. WILMINGTON, NC	ENV.BEN.
CONTINUOUS CLEANING SAND FILTERS				
EVELETH	MN	0.70	ROBERT WALLACE AND ASSOC. HIBBING, MN	COST, ENERGY & ENV.BEN.

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
JOHNSTOWN	OH	0.75	EVANS MECHWART HAMBLETON AND TILTON GAHANNA, OH	COST
FLOATING DREDGE SAND FILTER				
GREEN RIVER	WY	1.50	CULP WESNER CULP CAMERON PARK, CA	REG.DISCR.
INNOVATIVE SAND FILTER				
SABATTUS	ME	0.12	WOODARD AND CURRAN ASSOCIATES PORTLAND, ME	COST & ENV.BEN.
PRIMARY EFFLUENT FILTRATION				
CORRY	PA	4.00	LAKE ENGINEERS EDINBORO, PA	COST
DEKALB	IL	7.25	BELING ENGINEERS JOLIET, IL	COST
WHEATON	IL	10.00	BAXTER AND WOODMAN CRYSTAL LAKE, IL	COST
RECIRCULATING SAND FILTER				
CONTRA COSTA	CA	0.03	HARRIS ASSOC. LAFAYETTE, CA	ENERGY
IXONIA	WI	0.01	DONAHUE AND ASSOCIATES SHEBOYGAN, WI	COST
MIRANDA	CA	0.05	WINZLER AND KELLY CONSULTING ENGINEERS EUREKA, CA	ENERGY
SADIEVILLE	KY	0.03	PROCTOR DAVIS RAY CONSULTING ENGINEERS HUNTSVILLE, AL	COST
UPFLOW SAND FILTER				
EMINENCE	MO	0.01	MISSOURI ENGINEERING CORP. ROLLA, MO	ENV.BEN.
LAGOONS				
AQUACULTURE				
AUSTIN	TX	26.00	PARKHILL SMITH COOPER INC. LUBBOCK, TX	COST & ENERGY
CRAIG-NEW CASTLE	VA	0.18	ANDERSON AND ASSOC. BLACKSBURG, VA	COST & ENERGY
SAN BENITO	TX	2.17	NEPTUNE WILKINSON ASSOC. AUSTIN, TX	COST
BAFFLE SYSTEM IN LAGOON WITH DUCKWEED COVER				
PARAGOULD	AR	2.20	BLACK AND VEATCH DALLAS, TX	REG.DISCR. & ENV. RELIABILITY
COMPLETE MIX LAGOON				
DOUGLAS	WY	1.50	BLACK AND VEATCH DENVER, CO	COST
CONTROLLED DISCHARGE STABILIZATION POND				
JACKMAN	ME	0.10	WOODARD AND CURRAN INC. PORTLAND, ME	COST
DEEP CELL LAGOON				
DODGE CITY	KS	4.15	ENGINEERING ENTERPRISES NORMAN, OK	REG.DISCR.
ST. PAUL	KS	0.11	SHETLAR GRIFFITH SHETLAR IOLA, KS	ENV.BEN.

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
DUCKWEED COVER IN LAGOON				
WILTON	AR	0.09	MCCLELLAND CONSULTING ENGINEERS FAYETTEVILLE, AR	TOXICS MGMT. & ENV.BEN.
EARTHEN POND SYSTEM				
QUINCY	CA	0.72	JOHN CAROLLO ENGINEERING WALNUT CREEK, CA	COST & ENERGY
FACULTATIVE LAGOON				
HOLBROOK	AZ	1.30	JOHN COROLLO ENGINEERS PHOENIX, AZ	ENERGY
FACULTATIVE LAGOON WITH ROCK REED FILTER SYSTEM				
BENTON	LA	0.31	TERRY D. DENMON AND ASSOC. MONROE, LA	COST, ENERGY & TOXICS MGMT.
HYDROGRAPH CONTROLLED DISCHARGE LAGOON IN LIEU OF CHLORINATION				
CANTON	ME	0.04	WOODARD AND CURRAN INC. PORTLAND, ME	REG.DISCR. & ENV.BEN.
PERMAFROST CONSTRUCTION				
BRISTOL BAY	AK	0.15	TRYCK NYMAN AND HAYES ANCHORAGE, AK	COST
NITRIFICATION				
FIXED GROWTH BIOLOGICAL NITRIFICATION				
REDWOOD FALLS	MN	0.60	KBM INC. GRAND FORKS, ND	COST
NITRIFICATION ENHANCED BY AERATED POLISHING POND				
BOYDTON	VA	0.15	R. STUART ROYER AND ASSOC. RICHMOND, VA	COST
PURE OXYGEN/SINGLE STAGE NITRIFICATION				
INDIANAPOLIS	IN	125.00	REID QUEBE ALLISON WILCOX ASSOC. INDIANAPOLIS, IN	REG.DISCR.
ROTATING BIOLOGICAL CONTACTORS FOR NITRIFICATION				
BRIDGEWATER	MA	1.1	DUFRESNE-HENRY WESTFORD, MA	COST & ENERGY
MILFORD	MA	1.12	HALEY AND WARD ENGINEERING WALTHAM, MA	COST
OAK VIEW	CA	3.00	JAMES MONTGOMERY CONSULTING ENGINEERS PASADENA, CA	COST
SPECIALIZED BACTERIA				
HORNELL	NY	3.25	LABELLA ASSOC. ROCHESTER, NY	COST
UPFLOW PACKED BED NITRIFICATION				
UPPER EAGLE VALLEY	CO	3.20	M AND I ENGINEERS FORT COLLINS, CO	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
NUTRIENT REMOVAL				
ALLIED PROCESS FOR PHOSPHORUS REMOVAL				
BIGFORK	MT	0.50	ALLIED ENGINEERS INC INC. SAN RAMON, CA	ENERGY & ENV. RELIABILITY
BARDENPHO				
FORT MYERS	FL	6.00	POST BUCKLEY SHUH AND JERNIGAN MIAMI, FLA	ENERGY
PAYSON	AZ	2.40	MOORE KNICKERBOCKER ASSOC. PHOENIX, AZ	COST
BIOMEDIA FILTER TREATMENT PROCESS FOR TKN REDUCTION				
OAKLAND	MD	0.90	FRANKLIN ASSOC. INC. MOUNTAIN LAKE PARK, MD	COST
BREAKPOINT CHLORINATION FOR AMMONIA REMOVAL				
LONGMONT	CO	11.55	MCCALL ELLINGSON MORRILL INC. DENVER, CO	COST
CHEMICAL ADDITION TO LAGOON				
ALBANY	MN	0.30	RIEKE CARROLL MULLER ASSOC. HOPKINS, MN	COST
ALBERTVILLE	MN	0.05	MEYER-ROHLING INC. BUFFALO, MN	COST
SLUDGE DIGESTOR SUPERNATANT TREATMENT FOR AMMONIA NITROGEN REDUCTION				
MOKENA	IL	1.10	DONAHUE AND ASSOC. SHEYBOYGAN, WI	COST
USE OF WASTE PICKLE LIQUOR/PHOSPHORUS REMOVAL				
BALTIMORE	MD	180.00	WHITMAN REQUARDT AND ASSOC. BALTIMORE, MD	COST
OXIDATION DITCHES				
ANOXIC OXIDATION DITCH				
CHATHAM	VA	0.45	OLVER INC. BLACKSBURG, VA	COST
BENTHAL STABILIZATION OXIDATION DITCH				
WELLSBORO	PA	0.01	TATMAN AND LEE ASSOC. WILMINGTON, DE	COST
CARROUSEL OXIDATION DITCH				
MT. HOLLY SPRINGS	PA	0.60	TRACY ENGINEERS INC. CAMP HILL, PA	COST
MCALESTER	OK	1.3	POE AND ASSOCIATES MCALESTER, OK	ENV. RELIABILITY
OXIDATION DITCH WITH CENTRALLY LOCATED CLARIFIERS				
KING GEORGE COUNTY	VA	0.05	GILBERT CLIFFORD ASSOC. FREDERICKSBURG, VA	ENERGY
ROTATING BIOLOGICAL CONTACTORS				
AIR DRIVEN ROTATING BIOLOGICAL CONTACTOR				
OAK VIEW	CA	3.00	JAMES MONTGOMERY CONSULTING ENGINEERS PASADENA, CA	COST & ENERGY
UNDERFLOW CLARIFIER/ROTATING BIOLOGICAL CONTACTOR				
ASBURY PARK	NJ	4.40	CLINTON BOGERT ASSOC. FORT LEE, NJ	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
SLUDGE TECHNOLOGY				
BELT FILTER PRESS				
CAPE MAY COUNTY	NJ	6.30	PANDULLO QUIRK ASSOC. LYNDHURST, NJ	REG.DISCR.
LOUISVILLE	KY	105.00	CAMP DRESSER MCKEE DALLAS, TX	COST
NEWBERG	OR	4.0	KRAMER, CHIN AND MAYO, INC. PORTLAND, OR	COST
BELT FILTER PRESS WITH LIME FEED				
EWING-LAWRENCE	NJ	16.00	BUCK SIEFERT JOST INC. ENGLEWOOD CLIFF, NJ	COST & ENERGY
CARVER-GREENFIELD				
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND RALPH PARSONS PASADENA, CA	COST & ENERGY
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/BABCOCK WILCOX LIVINGSTON, NJ	COST & ENERGY
MERCER COUNTY	NJ	20.00	CLINTON BOGERT ASSOC. FORT LEE, NJ	COST & ENERGY
FACULTATIVE SLUDGE BASIN				
FLAGSTAFF	AZ	6.00	BROWN AND CALDWELL TUCSON, AZ	COST & ENERGY
FREEZE/THAW SLUDGE DRYING/DEWATERING				
FAIRBANKS	AK	8.00	ROEN DESIGN ASSOC. FAIRBANKS, AK	COST
LATERAL FLOW SLUDGE THICKENERS				
HUTCHINSON	KS	12.00	WILSON AND CO. SALINA, KS	COST
BONNER SPRINGS	KS	1.40	A.C. KIRKWOOD ASSOC. KANSAS CITY, KS	ENERGY
SLUDGE CAKE CONVEYANCE SYSTEM				
OMAHA	NE	70.0	HENNINGSON, DURHAM AND RICHARDSON OMAHA, NE	ENV.BEN.& ENV. RELIABILITY
TRAVELLING GUNS FOR LAND APPLICATION OF SLUDGE				
GRAND STRAND	SC	6.00	CH2M HILL CHARLESTON, SC	COST
VACUUM/BELT SERIES				
OKLAHOMA CITY	OK	40.00	BENHAM BLAIR AFFILIATES OKLAHOMA CITY, OK	ENERGY
VACUUM DE-ODORIZATION OF DIGESTED SLUDGE				
SACRAMENTO	CA	115.0	SACRAMENTO AREA CONSULTANTS SACRAMENTO, CA	COST & ENERGY
WEDGEWIRE SLUDGE FILTER BEDS				
CULLMAN	AL	4.75	J.E. O'TOOLE ENGINEERS BIRMINGHAM, AL	REG.DISCR.
NEW BRAUNFELS	TX	3.1	HUNTER ASSOCIATES INC. AUSTIN, TX	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
INCINERATION				
CO-INCINERATION				
SITKA	AK	1.80	TRYCK NYMAN HAYES ANCHORAGE, AK	COST
GLEN COVE	NY	8.00	WILLIAM F. COSULICH ASSOC. WOODBURY, NY	REG.DISCR.
STARVED AIR COMBUSTION OF SLUDGE				
ST. LOUIS	MO	125.00	SVERDRUP AND PARCEL ASSOC. ST. LOUIS, MO	ENERGY
GREENSBORO	NC	20.00	HAZEN SAWYER NEW YORK, NY	ENERGY
THERMAL PROCESS WITH PRODUCTION OF CONSTRUCTION AGGREGATE				
PHILADELPHIA	PA	210.00	FRANKLIN RESEARCH INST. PHILADELPHIA, PA	REG.DISCR.
SLUDGE COMPOSTING				
AERATED STATIC PILE COMPOSTING				
LEXINGTON-FAYETTE	KY	0.16	PROCTOR DAVIS RAY CONSULTING ENGINEERS HUNTSVILLE, AL	ENV. RELIABILITY
MYRTLE BEACH	SC	12.50	PLANNING RESEARCH GROUP MYRTLE BEACH, SC	ENV. RELIABILITY
ENCLOSED MECHANICAL SLUDGE COMPOSTING				
AKRON	OH	73.00	BURGESS AND NIPLE LTD. COLUMBUS, OH	ENV. RELIABILITY
DOTHAN	AL	12.00	WAINWRIGHT ENGINEERING DOTHAN, AL	COST
IN-VESSEL COMPOSTING				
CLINTON COUNTY	NY	16.0	METCALF AND EDDY NEW YORK, NY	COST
EAST RICHLAND	SC	7.0	POST BUCKLEY SCHUH AND JERNIGAN COLUMBIA, SC	ENERGY
NEWBERG	OR	4.0	KRAMER, CHIN AND MAYO, INC. PORTLAND, OR	COST
MODIFIED WINDROW COMPOSTING				
TAMPA	FL	60.00	GREELEY AND HANSEN TAMPA, FL	COST
SLUDGE DIGESTION				
AEROBIC DIGESTION				
CHINOOK	MT	0.50	ROBERT PECCIA ASSOC. HELENA, MT	COST
WEISER	ID	2.30	CH2M HILL BOISE, ID	ENV.BEN.
ANAEROBIC DIGESTION				
FERGUS FALLS	MN	3.81	BONESTROO ROSENE ANDERLIK ST. PAUL, MN	ENV.BEN.
KASSON	MN	0.35	MCGHEE AND BETTS ROCHESTER, MN	ENERGY
SACRAMENTO	CA	115.0	SACRAMENTO AREA CONSULTANTS SACRAMENTO, CA	COST & ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
DUAL ANAEROBIC/AEROBIC DIGESTION				
CHARLESTON	WV	14.0	DUNN ENGINEERS INC. CHARLESTON, WV	COST
HAGERSTOWN	MD	8.0	BUCHART-HORN BALTIMORE, MD	COST & ENERGY
HENDERSON	NC	4.14	L.E. WOOTEN AND CO. RALEIGH, NC	
EGG-SHAPED ANAEROBIC DIGESTOR WITH GAS UTILIZATION				
JUNEAU	AK	4.00	ARCTIC ENGINEERS ANCHORAGE, AK	COST & ENERGY
MISCELLANEOUS				
CAPTOR BIOLOGICAL TREATMENT PLANT				
MOUNDSVILLE	WV	2.35	CERRONE AND VAUGHN WHEELING, WV	COST
COMBINED SEWER OVERFLOW				
WORCESTER	MA	120.0	FAY, SPOFFORD AND THORNDIKE BOSTON, MA	COST
CONSTRUCTED WETLANDS FOR LAGOON EFFLUENT				
COLLINS	MS	0.30	ENGINEERING ASSOCIATES JACKSON, MS	ENV.BEN.
DISSOLVED AIR FLOTATION THICKENER				
WEISER	ID	2.30	CH2M HILL DENVER, CO	ENV.BEN.
EDUCTOR-INDUCED VACUUM CHEMICAL FEED SYSTEM				
DISTRICT OF COLUMBIA	DC	309.00	METCALF AND EDDY BOSTON, MA	COST
ENCLOSED IMPELLOR SCREW PUMP				
REPUBLIC	MO	0.93	HOOD RICH SPRINGFIELD, MO	ENERGY
SPRINGFIELD	MO	6.40	BURNS MCDONNELL KANSAS CITY, KS	ENERGY
WESTBOROUGH	MA	7.68	SEA CONSULTANTS BOSTON, MA	REG.DISCR.
HUTCHINSON	KS	12.00	WILSON AND CO. SALINA, KS	COST
FLUIDIZED BED TREATMENT OF DIGESTOR SUPERNATANT				
LANSING	MI	27.00	MCNAMEE PORTER SEELEY ASSOC. ANN ARBOR, MI	COST
LAND APPLICATION THROUGH PEAT FILTER CELLS				
BEAVER BAY	MN	0.05	MATEFFY ENGINEERING NEW BRIGHTON, MN	COST
MARSH/POND/MEADOW				
UPPER AUGUSTA TOWNSHIP	PA	0.01	JOHN R. BAKOWICZ, PE SUNBURY, PA	ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW (MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
POWDERED ACTIVATED CARBON/REGENERATION				
KALAMAZOO	MI	53.30	JONES AND HENRY TOLEDO, OH	COST
BEDFORD HEIGHTS	OH	3.00	URS DALTON-DALTON CLEVELAND, OH	REG.DISCR.
NORTH OLMSTED	OH	9.00	URS DALTON-DALTON CLEVELAND, OH	COST
SAUGET	IL	27.00	RUSSELL AND AXON ASSOC. ST. LOUIS, MO	COST
PRIMARY TREATMENT FACILITY				
EAST MILLINOCKET	ME	0.49	CAMP DRESSER AND MCKEE BOSTON, MA	COST & REG.DISCR.
PURE OXYGEN FLUIDIZED BED REACTOR				
HAYWARD	CA	13.10	KENNEDY JENKS ENGINEERS SAN FRANCISCO, CA	REG.DISCR.
NASSAU COUNTY	NY	10.00	CONSOER TOWNSEND ASSOC. CHICAGO, IL	REG.DISCR.
SANILOGICAL SYSTEM				
BERRYSBURG	PA	0.04	GLACE ASSOCIATES HARRISBURG, PA	COST & ENERGY
SEQUENCING BATCH REACTOR RECEIVING SEPTIC TANK EFFLUENT				
ELMHURST	PA	0.11	PENN-EAST ENGINEERING, INC SCRANTON, PA	ENERGY
SHALLOW-BED PLASTIC MEDIA BIOFILTER				
DELMONT	PA	1.74	DUNCAN LAGNESE ASSOC. PITTSBURGH, PA	COST
SOIL TREATMENT SYSTEM				
KAPEHU	HI	0.02	PHILIP YOSHIMURA INC. HILO, HI	COST & ENERGY
SLOW RATE-DUAL WATER SYSTEM FOR URBAN IRRIGATION				
ST. PETERSBURG	FL	20.00	CH2M HILL CHARLESTON, SC	COST
SPIRAGRIT GYRO-TYPE GRIT SEPARATOR				
SOUTHHAMPTON COUNTY	VA	0.3	HENRY P. SADLER AND ASSOC. INC. RICHMOND, VA	COST & ENERGY
TEACUP GRIT REMOVAL				
JUNEAU	AK	4.00	ARCTIC ENGINEERING ANCHORAGE, AK	COST & ENERGY
CALERA	AL	0.75	CARR AND ASSOC. BIRMINGHAM, AL	COST & ENERGY
TOTAL RESOURCES RECOVERY PROJECT				
SAN DIEGO	CA	1.0	BLACK AND VEATCH SAN DIEGO, CA	REG.DISCR.
TUBULAR SCREW PUMPS				
GARDINER	ME	1.60	SEA CONSULTANTS BOSTON, MA	REG.DISCR.
UNIQUE CIRCULAR PUMP STATION				
HOUSTON	TX	531.00	LOCKWOOD ANDREWS NEWMAN INC. HOUSTON, TX	COST

TABLE 2. SUMMARY OF INNOVATIVE TECHNOLOGIES FUNDED FIVE OR MORE TIMES

Note: Detailed information for these projects can be obtained from EPA's I/A Database. *Contact the State I/A Coordinator for access to the data.*

EPA REGION	STATE	Anoxic/oxic systems (A/O)	Counter-current aeration	Draft tube aeration	Fine bubble diffusers	Flocculating clarifiers	Hydrograph controlled release lagoons	Integral clarifiers	Intrachannel clarifiers	Land treatment	Microscreens	Oxidation ditches
I	Connecticut				1							
	Maine			1			1			1		
	Massachusetts				1							
	New Hampshire											
	Rhode Island			1								
	Vermont											
II	New Jersey											1
	New York			6				2				5
	Puerto Rico											
	Virgin Islands											
III	Delaware			1					1			1
	Washington, D.C.											
	Maryland	1							1			
	Pennsylvania	1		2								
	Virginia		1	1				1	1	1	1	4
	West Virginia			2				2	2			1
IV	Alabama		5	2	2		5		3			5
	Florida	1	1									
	Georgia		1						1	1		
	Kentucky						1		6			
	Mississippi						8		1	1	1	
	North Carolina		5	2								2
	South Carolina		1				1		1	1		1
	Tennessee		7				2		2	1		3
V	Illinois				1				2	2		1
	Indiana				2	1						
	Michigan											
	Minnesota								1			1
	Ohio				2				3			1
	Wisconsin				1	1						
VI	Arkansas	1							1	1		
	Louisiana						1		4	1		4
	New Mexico			1								
	Oklahoma								1	1		1
	Texas								1	3		1
VII	Iowa								1			1
	Kansas			1					1			1
	Missouri								4			
	Nebraska										1	
VIII	Colorado										1	
	Montana					2				1		
	North Dakota											
	South Dakota								2	1		1
	Utah					1						
	Wyoming											
IX	Arizona											
	California											
	Guam											
	Trust Territories											
	Hawaii											
	Nevada										1	
	N. Marianas Islands											
X	Alaska											
	Idaho			1							1	1
	Oregon	1								1		
	Washington											
TOTAL		5	21	21	10	5	19	5	40	17	6	36

TABLE 2. SUMMARY OF INNOVATIVE TECHNOLOGIES FUNDED FIVE OR MORE TIMES (cont'd)

Note: Detailed information for these projects can be obtained from EPA's I/A Database. Contact the State I/A Coordinator for access to the data.

EPA REGION	STATE	Phostrip	Sequencing batch reactors (SBR)	Single cell lagoons with sand filter	Small diameter gravity sewers	Solar heating	Swirl concentrators	Trickling filter/solids contact	Ultraviolet disinfection	Vacuum assisted sludge drying beds	Other
I	Connecticut								2		
	Maine					1	1		3		
	Massachusetts	1				1			2		1
	New Hampshire								1		
	Rhode Island					1					
	Vermont					1			1		
II	New Jersey										7
	New York	2			2			1	4		1
	Puerto Rico										
	Virgin Islands										
III	Delaware										
	Washington, D.C.						1				
	Maryland		1						3		
	Pennsylvania		2		1						
	Virginia				1				1	1	1
	West Virginia										
IV	Alabama								1		2
	Florida										1
	Georgia					1					
	Kentucky										1
	Mississippi										
	North Carolina									1	2
	South Carolina		2			1					1
	Tennessee		1				1				1
V	Illinois			10			1	1	1	1	3
	Indiana						3			1	
	Michigan										4
	Minnesota	1				1			4	1	4
	Ohio				5	2	1	2	2	1	3
	Wisconsin										4
VI	Arkansas							2			3
	Louisiana										
	New Mexico							1			1
	Oklahoma		4					1	2	1	2
	Texas									1	1
VII	Iowa		3			1			1		
	Kansas								3		
	Missouri								2		2
	Nebraska										2
VIII	Colorado		1						1	1	
	Montana				1				2	1	1
	North Dakota										
	South Dakota		1								
	Utah								1		
	Wyoming					1		1	4		
IX	Arizona					1			1		1
	California									1	
	Guam										
	Trust Territories										
	Hawaii										
	Nevada	1									
	N. Marianas Islands										
X	Alaska		1								
	Idaho							1			
	Oregon										1
	Washington										1
TOTAL		**5**	**16**	**10**	**10**	**12**	**8**	**10**	**42**	**11**	**51**

TABLE 3. SUMMARY OF ALTERNATIVE TECHNOLOGY PROJECTS

Note: Detailed information for these projects can be obtained from EPA's I/A Database. Contact the State I/A Coordinator for access to the data.

EPA REGION	STATE	ONSITE TREATMENT								LAND TREATMENT					
		Septic Tank/Soil Absorption (Single Family)	Mounds	Evapotranspiration Beds	Aerobic Units	Sand Filters	Septic Tank/Soil Absorption (Multiple Families)	Septage Treatment and Disposal	Other Onsite Treatment	Aquaculture/Wetlands Marsh	Overland Flow	Rapid Infiltration	Slow Rate	Preapplication Treatment or Storage	Other Land Treatment
I	Connecticut					1	2	7				1			
	Maine	3				5	5						1		
	Massachusetts					1		19				2	1		
	New Hampshire					4	3	7			2				
	Rhode Island							2							
	Vermont					2	1						1		
II	New Jersey						1	11						1	
	New York	1	2			12	2	4	1		2	3			
	Puerto Rico														
	Virgin Islands														
III	Delaware						2					1			
	Washington, D.C.														
	Maryland	3	2			2		2	1	1	2	1	4	3	2
	Pennsylvania	3	1		1	1	2			2		1	5	2	1
	Virginia							3			3	1	1		
	West Virginia	1							1						
IV	Alabama												2		
	Florida										1	2	20		
	Georgia										2		20		
	Kentucky	1					2				1		2		
	Mississippi										11		2		
	North Carolina												21		
	South Carolina											1	9		
	Tennessee	2									2		6	4	
V	Illinois	5	1			13					3	1	3		3
	Indiana		2				2								1
	Michigan	2					6			1	1	3	13		
	Minnesota	8	8			2	5		1			1	14	11	
	Ohio	2			1			3					1		1
	Wisconsin		2									8		5	9
VI	Arkansas	1											3	2	1
	Louisiana				1						6		2	2	
	New Mexico												6	5	
	Oklahoma								1				30	16	
	Texas	2									1	1	11	10	1
VII	Iowa					1				3			2	3	
	Kansas									1		1	16	9	
	Missouri		1			1					9		12		
	Nebraska									1		2	5		
VIII	Colorado												2	1	
	Montana											3	8		
	North Dakota		4								1		6		
	South Dakota									1		7	1	3	
	Utah												2	1	
	Wyoming											3	2		
IX	Arizona									3		1	12	1	
	California		1				7	3		3	2	14	20	24	
	Guam											2			
	Trust Territories						6		1						
	Hawaii												2		
	Nevada											5	6	5	
	N. Marianas Islands														
X	Alaska						2							1	
	Idaho					2	1		1	1		3	5	8	1
	Oregon			2		3				2		1	6	9	1
	Washington		1				2			1			3	4	1
TOTAL		**34**	**25**	**2**	**3**	**50**	**51**	**61**	**7**	**20**	**49**	**69**	**288**	**130**	**22**

TABLE 3. SUMMARY OF ALTERNATIVE TECHNOLOGY PROJECTS (cont'd)

Note: Detailed information for these projects can be obtained from EPA's I/A Database. Contact the State I/A Coordinator for access to the data.

EPA REGION	STATE	COLLECTION SYSTEMS				ENERGY RECOVERY/ SLUDGE		SLUDGE TREATMENT				OTHER		
		Pressure Sewers/ Effluent Pump	Pressure Sewers/ Grinder Pump	Small Diameter Gravity Sewers	Vacuum Sewers	90% Methane Recovery /Anaerobic Digestion	Self-Sustaining Incineration	Land Spreading of POTW Sludge	Preapplication Treatment	Composting	Other Sludge Treatment or Disposal	Aquifer Recharge	Direct Reuse	Total Containment Ponds
I	Connecticut					4	1			1				
	Maine	1	1							6				
	Massachusetts			1		2	2	1		4				
	New Hampshire		1							1				
	Rhode Island						1			1				
	Vermont		3	1				12						
II	New Jersey		2		2			1	3	5	1			
	New York	3	16	16	2	16	1	2		2	1			
	Puerto Rico													
	Virgin Islands													
III	Delaware		2	1				2	1	2				
	Washington, D.C.									1				
	Maryland	1	19	2	2	2		3		5				
	Pennsylvania	6	15	11		3		5		3	2			
	Virginia	3	2	2		5	2	9	1	3	3		5	
	West Virginia	6	10	5	8	2								
IV	Alabama	1	2	3		3		2		2				
	Florida					3			1	2		1	3	
	Georgia	2		1		3	1	5						
	Kentucky	2	3	4	2	2		12						
	Mississippi	1	3	1				3			1			
	North Carolina		2	1		6		4			1			
	South Carolina			2		1		5						
	Tennessee	5	6	10	1			5		1	1			
V	Illinois	5	2	18		6		47	7		5		4	
	Indiana	2	4	13		3		19						
	Michigan	1		1		1		10						
	Minnesota	8	2	6		5		24	1	2				
	Ohio	2	5	2		6		34	3	3				
	Wisconsin	1	3	3		1		15			1			
VI	Arkansas		9	2		1		2						
	Louisiana	1		1				1						
	New Mexico					1					1			
	Oklahoma						1	5	2	1				29
	Texas	2	4	1		6		18	8	1	1		4	1
VII	Iowa	2	3	1		6		24	2					
	Kansas					5	2	20		1	2			27
	Missouri	6	14	13		1		25			8			
	Nebraska					3		5	3	2	2			32
VIII	Colorado		1			1		2				1		
	Montana					2		9			1			5
	North Dakota	3	2	14										17
	South Dakota		1			4		11	1				1	7
	Utah					1		1		1				
	Wyoming					1		2						3
IX	Arizona					3		1			1		1	1
	California	8		4	1	5	1	2	2	1	2		2	1
	Guam													
	Trust Territories			1										
	Hawaii													1
	Nevada					3								4
	N. Marianas Islands			1										
X	Alaska	1		1		1	1	1		1	1			
	Idaho	2		3		2		6						2
	Oregon	5		4		5		4	3	1	2			1
	Washington	2	1	1		2		1	1					2
TOTAL		**82**	**138**	**151**	**18**	**127**	**13**	**360**	**39**	**53**	**37**	**2**	**20**	**133**

TABLE 4. INNOVATIVE/ALTERNATIVE FIELD TEST PROJECTS

FACILITY	TECHNOLOGY	STATUS	COMMENTS
Fayetteville, AR	*A/O Process Biological Nutrient Removal	Completed	Demonstrated good Biological and Phosphorous removal during winter months
Paragould, AR	Baffle System/ serpentine flow with duckweed	Ongoing	
Phoenix, AZ	Digester gas scrubbing	Completed	Field test report under review by state agency and EPA
Hayward, CA	*Oxytron pure-oxygen fluid bed reactor	Completed	Demonstrated energy savings approximately 23-35% compared to conventional activated sludge
City of Gustine, CA	Aquaculture/marsh polyculture	Completed	Demonstrated BOD and suspended solids removal could be achieved; and refined the design criteria
Monterey, CA	Advanced secondary crop irrigation	Completed	Demonstrated advanced secondary treatment adequate for food crop production
San Diego, CA	Aquaculture/pulsed and fixed bed anaerobic hybrid rock-reed filters	Ongoing	
Idaho City, ID	Rapid infiltration/ wetlands	Completed	Field test report under review by state agency and EPA
Wauconda, IL	Trickling filter/ solids contact	Ongoing	
Denham Springs, LA	Rock-reed filter system	Planned	
Homer, LA	Intra-channel boat clarifier	Planned	
Jackman, ME	Phosphorous removal/ stabilization pond	Ongoing	
Yarmouth, MA	Septage treatment	Ongoing	
Deer Island, MA	Sludge Composting	Ongoing	
Rising Sun, MD	*Photozone activated ozone disinfection	Completed	Demonstrated not cost effective compared to UV disinfection

TABLE 4. INNOVATIVE/ALTERNATIVE FIELD TEST PROJECTS (cont'd)

FACILITY	TECHNOLOGY	STATUS	COMMENTS
Kimberling City, MO	Flow reduction for on-site systems	Planned	
Roswell, NM	*Brown bear sludge drying	Ongoing	
Chemung County, NY	Trickling filter/ solids contact	Completed	Demonstrated capability of single stage filter for BOD reduction/ nitrification
Hornell, NY	Seeded bacterial nitrification	Completed	Demonstrated cheaper methods for nitrification
Toledo, OH	Swirl concentrator	Completed	Demonstrated less than 20% solids and BOD removal
Grand Strand, SC	Advanced waste treatment/wetlands	Ongoing	
Craig-New Castle, VA	Aquaculture/finfish	Ongoing	
Proctor, VT	UV disinfection	Ongoing	
Moundsville, WV	*Captor porous biomass activated sludge in series with conventional activated sludge	Completed	Demonstrated consistent secondary sludge concentration of 3.6% without sludge thickening
Clear Lake, WI	*Zimpro filtration primary effluent using pulsed bed filter	Completed	Demonstrated 56% solids and 28% BOD removal

*MENTION OF TRADE NAMES OR COMMERCIAL PRODUCTS DOES NOT CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

TABLE 5. 100% MODIFICATION/REPLACEMENT GRANTS

FACILITY	TECHNOLOGY	STATUS
Atmore, AL	Draft Tube Aerators	Award Pending
Opelika, AL	Draft Tube Aerators	Award Pending
Paragould, AR	Baffle System/Serpentine Flow with Duckweed	Under Review
Fallen Leaf Lake, CA	Vacuum Collection System/ Air Ejection System	Awarded 9/83
Gilroy-Morgan Hill, CA	Percolation Ponds/Diffused Aeration	Denied 2/85
Manila, CA	Septic Tank Effluent Pump Collection System/Sonic Level Detectors	Awarded 8/83
Nevada City, CA	Vacuum Assisted Sludge Drying Beds	Award Pending
City of Reedley, CA	Innovative Pond Underdrains	Under Review
Ventura, CA Nyeland Acres	Septic Tank Effluent Pump Collection System Controllers and Pumps	Under Review
Ventura, CA North Coast	Septic Tank Effluent Pump Collection System Controllers and Pumps	Under Review
Sterling, CO	Microscreens-Ponds	Under Review
Fairfield, IA	Draft Tube Aerators	Under Review
Hanover, IL	Sand Filter	Under Review
Waynesville, IL	Community Mound System	Under Review
Auburn, IN	Swirl Concentrators	Under Review
Portage, IN	Vacuum Assisted Sludge Drying Beds	Awarded 4/86
Sabattus, ME	UV Disinfection	Under Review
South Portland, ME	Composting	Under Review
Rising Sun, MD	Activated Ozone Disinfection	Award Pending
Fall River, MA	Self Sustaining Incineration	Under Review
Morehead, MN	Ozone Disinfection	Under Review

TABLE 5. 100% MODIFICATION/REPLACEMENT GRANTS (cont'd)

FACILITY	TECHNOLOGY	STATUS
Northfield, MN	UV Disinfection	Funded Out of Original Step 3
Rochester, MN	Biological Phosphorous Removal	Under Review
Gallatine, MO	Intrachannel Clarifier	Under Review
Scotts Bluff, NE	Microscreens	Under Review
Stafford, NJ	Vacuum Collection System Controllers	In Litigation
Sante Fe, NM	Draft Tube Aerators	Under Review
Lawrence, NY	Community Mound System	Awarded 9/85
Burlington, NC	Powdered Activated Carbon	Under Review
Greensboro, NC	Starved Air Incineration	Under Review
Greenville, NC	Schreiber Counter Current Aeration	Under Review
Pilot Mountain, NC	Jet Aeration Oxidation Ditch	Under Review
Churchs Ferry, ND	Community Mound System	Under Review
Clifford, ND	Community Mound System	Award Pending
Bedford Heights, OH	Powdered Activated Carbon	Under Review
Cranston, RI	Draft Tube Aerators	Awarded 9/86
Black Diamond, WA	Wetlands	Award Pending
Elbe, WA	Community Mound System	Award Pending
Crab Orchard-MacArthur, WV	Draft Tube Aerators	In Litigation
Cambellsport, WI	Rapid Infiltration	Awarded 9/85
Hayward, WI	Rapid Infiltration	Under Review
Wittenberg, WI	Seepage Cells	Under Review

TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 6. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont'd)

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TABLE 7. LIST OF INNOVATIVE ALTERNATIVE TECHNOLOGY PUBLICATIONS

Title	Ordering Code
CURRENT I/A TECHNOLOGY FOLDOUTS	
Alternative Wastewater Collection Systems: Practical Approaches	1,2,3,4
Aquaculture: An Alternative Wastewater Treatment Approach	1,2,3,4
The Biological Aerated Filter: A Promising Biological Process	1,2,3,4
Biological Phosphorous Removal	1,2,3,4
Composting: A Viable Method of Resource Recovery	1,2,3,4
Counter-Current Aeration: A Promising Process Modification	1,2,3,4
Disinfection with Ultraviolet Light	1,2,3,4
Hydrograph Controlled Release Lagoons: A Promising Modification	1,2,3,4
Innovative and Alternative (I/A) Technology: Wastewater Treatment to Improve Water Quality and Reduce Cost	1,2,3,4
Intermittent Sand Filtration	1,2,3,4
Intrachannel Clarification: A Project Assessment	1,2,3,4
Land Application of Sludge: A Viable Alternative	1,2,3,4
Land Treatment Silviculture: A Practical Approach	1,2,3,4
Less Costly Wastewater Treatment For Your Town	1,2,3,4
Large Soil Absorption Systems: Design Suggestions for Success	1,2,3,4
Methane Recovery: An Energy Resource	1,2,3,4
Operation of Conventional WWTP in Cold Weather	1,2,3,4
Overland Flow An Update: New Information Improves Reliability	1,2,3,4
Rapid Infiltration: A Viable Land Treatment Alternative	1,2,3,4
Rapid Infiltration: Plan, Design, and Construct for Success	1,2,3,4
Rotating Biological Contactors	1,2,3,4
Sequencing Batch Reactors: A Project Assessment	1,2,3,4
Side-Streams in Advance Waste Treament Plants: Problems and Remedies	1,2,3,4
Small Wastewater Systems: Alternative Systems for Communities and Rural Areas	1,2,3,4
Total Containment Ponds: Plan, Design, and Construct for Success	1,2,3,4
Vacuum-Assisted Sludge Dewatering Beds: An Alternative Approach	1,2,3,4
Vacuum-Assisted Sludge Drying (Update)	1,2,3,4
Wastewater Stabilization Ponds: An Update on Pathogen Removal	1,2,3,4
Water Reuse Via Dual Distribution Systems	1,2,3,4
Wetlands Treatment: A Practical Approach	1,2,3,4

TABLE 7. LIST OF INNOVATIVE ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont'd)

Title	Ordering Code
AVAILABLE IN LATE 1987	
Hydrograph Controlled Release Lagoons	1,2,3,4
Cold Weather Operation of Natural Systems	1,2,3,4
In-Vessel Composting	1,2,3,4
Autothermal Thermophilic Aerobic Digestion	1,2,3,4
Counter-Current Aeration	1,2,3,4
Sludge Dewatering for Small Communities	1,2,3,4
Self-Sustaining Incineration	1,2,3,4
Powdered Activated Carbon Treatment	1,2,3,4
Upgrading Small Community Wastewater Treatment	1,2,3,4
Small Diameter Effluent Sewers	1,2,3,4
Planning Wastewater Facilities for Small Communities	1,2,3,4
I/A RESEARCH REPORTS	
Large Soil Absorption Systems for Wastewaters from Multiple Home Developments	1,5
The Lubbock Land Treatment System Research and Demonstration Project: Volume IV Lubbock Infection Surveillance Study	1,5
Status of Porous Biomass Support Systems for Wastewater Treatment	1,5
Small Diameter Gravity Sewers: An Alternative Wastewater Collection Method for Unsewered Communities	1,5
Survival of Parasite Eggs in Stored Sludge	1,5
Toxic and Priority Organics in Municipal Sludge Land Treatment Systems	1,5
Process Design Manual for Land Treatment of Municipal Wastewater; EPA/625/1-81-013 and Supplement; EPA/625/1-81-013a	1,5
Process Design Manual Land Application of Municipal Sludge; EPA/625/1-83-016	1,5
Design Manual Municipal Wastewater Stabilization Ponds; EPA/625/1-83-015	1,5
Handbook Septage Treatment and Disposal; EPA 625/6-84-009	1,5
Emerging Technology Assessment of Phostrip, A/O and Bardenpho Process for Biological Phosphorus Removal; EPA/600/2-85/008; PB85-165744/AS	1,5,8
Implementation of Sequencing Batch Reactors for Municipal Treatment; EPA/600/D-84/022; PB84-130400/AS	1,5,8

TABLE 7. LIST OF INNOVATIVE ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont'd)

Title	Ordering Code
I/A RESEARCH REPORTS (cont'd)	
Technology Assessment of Aquaculture Systems for Municipal Wastewater Treatment; EPA/600/2-84/145; PB84-246347/AS	1,5,8
Technology Assessment for Sequencing Batch Reactors; EPA/600/2-85/007; PB85-167245/AS	1,5,8
Technology Assessment of Wetlands for Municipal Wastewater Treatment; EPA/600/2-84/154; PB85-106896/AS	1,5,8
Summary Report: Fine Pore (Fine Bubble) Aeration Systems; EPA/625/8-85/010	1,5
Evaluation of Color Infrared Aerial Surveys of Wastewater Soil Absorption Systems; EPA/600/2-85/039; PB85-189074/AS	1,5,8
Alternative On-Site Wastewater Treatment and Disposal Systems on Severly Limited Sites; EPA/600/2-86/116; PB87-140992/AS	1,5,8
Evaluation of Anaerobic, Expanded-Bed Contactors for Municipal Wastewater Treatment; EPA/600/D-86/120; PB86-210648/AS	1,5,8
Autothermal Thermophilic Aerobic Digestion in the Federal Republic of Germany; EPA/600/D-85/194; PB85-245322/AS	1,5,8
Biological Phosphorus Removal – Technology Evaluation; EPA/600/J-86/198; PB87-152559	1,5,8
Full-Scale Studies of the Trickling Filter/Solids Contact Process; EPA/600/J-86/271; PB87-168134/AS	1,5,8
Technology Evaluation of Sequencing Batch Reactors; EPA/600/J-85/166	1,5
Trickling Filter/Solids Contact Process: Full-Scale Studies; EPA/600/2-86/046; PB86-183100/AS	1,5,8
Alternative Sewer Studies; EPA/600/2-85/133; PB86-131224/AS	1,5,8
Alternative Sewer Systems in the United States; EPA/600/D-84/095; PB84-177815/AS	1,5,8
Biological Phosphorus Removal: A Technology Evaluation; EPA/600/J-86/198; PB87-152559/AS	1,5,8
Forecasting On-Site Soil Absorption System Failure Rates; EPA/600/2-86/060; PB86-216744/AS	1,5,8
Handbook Estimating Sludge Management Costs; EPA/625/6-85/010; PB86-124542/AS	1,5,8
Municipal Sludge Composting Technology Evaluation; EPA/600/J-86/139; PB87-103560/AS	1,5,8

TABLE 7. LIST OF INNOVATIVE ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont'd)

Title	Ordering Code
I/A RESEARCH REPORTS (cont'd)	
Land Application of Municipal Sludge; EPA/625/1-83/016	1,5
Characterization of Soil Disposal System Leachates; EPA/600/2-84/101; PB84-196229/AS	1,5,8
Technology Evaluation of the Dual Digestion System; EPA/600/J-86/150; PB87-116802/AS	1,5,8
Costs of Air Pollution Abatement Systems for Sewage Sludge Incinerators; EPA/600/2-86/102; PB87-117743/AS	1,5,8
Determination of Toxic Chemicals in Effluent from Household Septic Tanks; EPA/600/2-85/050; PB85-196798	1,5,8
Wastewater Treatment Plant Instrumentation Handbook; EPA/600/8-85/026; PB86-108636/AS	1,5,8
OTHER I/A PUBLICATIONS	
Is Your Proposed Wastewater Project Too Costly?: Options for Small Communities	1,2,3
Management of On-Site and Small Community Wastewater Systems; EPA/600/8-82-009	1,2,3,5
Planning Wastewater Management Facilities for Small Communities; EPA/600/8-80-030	1,2,3,5
Design Manual: On-Site Wastewater Treatment and Disposal Systems; EPA/625/1-80-012	1,3,5
A Reference Handbook on Small-Scale Wastewater Technology	6
Guidance Manual for Sewerless Sanitary Devices and Recycling Methods; HUD-PD&R-738	6
Alternative Small Scale Treatment Systems; MIS Report VOL 17, Number 4	7
It's Your Choice – A Wastewater Treatment Handbook for the Local Official	1,2,3
I/A TECHNOLOGY VIDEO TAPES	
Small Diameter Effluent Sewers (11 minutes)	2,3
Sand Filters (9 minutes)	2,3
Upgrading Small Community Wastewater Treatment (20 minutes)	2,3
Planning Wastewater Facilities for Small Communities (15 minutes)	2,3

TABLE 7. LIST OF INNOVATIVE/ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont'd.)

ORDERING CODES

The Documents listed in this table can be ordered from the following addresses, as designated by document.

1. Environmental Quality Instructional Resources Center (IRC)
   The Ohio State University
   1200 Chambers Road Room 310
   Columbus, Ohio 43212
2. National Small Flows Clearinghouse
   258 Stewart Street
   Morgantown, WV 26506
3. EPA-OMPC-MFD (WH-595)
   401 M Street SW
   Washington, D.C. 20460
4. EPA Regional Offices
   For mailing address see Table 6
5. EPA-Center for Environmental Research Information
   26 W. St. Clair Street
   Cincinnati, OH 45268
6. HUD User
   P.O. Box 280
   Germantown, MD 20874
7. International City Management Association
   1120 G Street NW
   Washington, D.C. 20005
8. National Technical Information Service (NTIS)
   5285 Port Royal Road
   Springfield, VA 22161

GLOSSARY

Term	Meaning
A/O	anaerobic/oxic
BAF*	Biological Aerated Filters*
BOD	biochemical oxygen demand
CW System	constructed wetlands system
CWA	Clean Water Act of 1977
EPA	Environmental Protection Agency
GP	grinder pump
gpd	gallons per day
gpm	gallons per minute
I/A	innovative/alternative
I/I	infiltration/inflow
mgd	million gallons per day
mg/L	milligrams per liter
MLSS	mixed liquor suspended solids
M/R Grants	100 percent Modification/Replacement Grants
O&M	operation and maintenance
OMPC	Office of Municipal Pollution Control
PBF	pulsed bed filter
PVC	polyvinyl chloride
SDES	small diameter effluent sewers
STEP	septic tank effluent pump