

APPENDIX D

TABLE 1
WASTEWATER TREATMENT COMPARISON
 Weston & Sampson Engineers, Inc.

Treatment Process	Example Vendor	Comments	Sludge Pump Out	Basic System Effluent Quality (no mods.)	Denitrification System Required (to reach TN of <5mg/L)	Life (years)	Buildings
Fixed Media (Conventional)	Bioclere	Good option achieves high degree of treatment. Less complicated than other options.	yes	BOD 30mg/L; TSS 30mg/L; TN +10mg/L	yes	10yr+ for blower, pumps, mixers; tankage for much longer	Small control building is required. Self contained system (filter, tank, distributor, and pump) majority of which is below grade in a glass-reinforced plastic container.
Suspended Growth Process - Batch (Conventional)	Sequencing Batch Reactors (SBR)	Good option because allows for flexibility in flows. Loading to SAS is batched.	yes	BOD 5-10mg/L; TSS 10-20mg/L; TN 80%-90% Removal	no	10yr+ for blower, pumps, mixers; tankage for much longer	Small control building is required. Steel or fiberglass treatment tanks are exposed to atmosphere.
Submerged Media (Conventional)	FAST	Limited operator flexibility.	yes	BOD 30mg/L; TSS 30mg/L; TN +10mg/L	yes	10yr+ for blower, remaining system is concrete	Small control building that contains blowers. Filter media located in above or below ground concrete tank.
Extended Aeration (Conventional)	SINGULAR	Limited operator flexibility.	yes	BOD 30mg/L; TSS 30mg/L; TN +10mg/L	no	10yr for aeration equipment	Small control building that contains blowers. Filter media located in above or below ground concrete tank.
Membrane Filtration (Alternative)	Zenon	This is the "top of the line" option. The system is expensive. This technology offers a water re-use option.	yes	BOD < 3mg/L; TSS < 3mg/L; TN < 3mg/L	yes	10 for membranes, 25+ for the rest	Complete system is enclosed in one large building. Treatment takes place in large steel tank located within the building. Tank requires confined space procedures.



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Narrative Description

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The Amphidrome® process is an advanced biological wastewater treatment system that utilizes a fixed film, sequencing batch biofilter. The system consists of a deep bed filter that alternates between aerobic and anoxic treatment. The unique design allows for the nitrification and denitrification of the waste stream to be carried out in a single reactor. The cyclical action of the system is created by allowing a batch of wastewater to pass from the anoxic/equalization tank through the granular biological filter into the clear well, and then reversing the flow through the use of a pump. The reverse flow passes from the clear well up through the filter, where it overflows into a trough that carries it back to the anoxic/ equalization tank. These cycles are repeated multiple times, while the treatment is allowed to progress from aerobic to anoxic conditions within the filter. Once sufficient cycles have been repeated to insure the degree of treatment required, a batch of effluent is discharged.

In the aerobic portion of the cycle, air is supplied to the reactor by process air blowers. The air is distributed at the bottom of the media by the underdrain. As it flows up through the media the air bubbles are sheared by the sand, thus producing a fine even pattern throughout the bed. During the aerobic phase of operation carbonaceous BOD, ammonia, and organic nitrogen-based compounds are oxidized. As the batch of wastewater is cycled back and forth the mode of operation progresses from aerobic to anoxic. While operating in

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the anoxic mode the nitrates are reduced to nitrogen gas, thus completing the removal of nitrogen from the waste stream.

Periodically, the deep bed filter in the reactor has to be backwashed. This is accomplished by simultaneously pumping water, back from the clearwell, and blowing air, at a high volume, into the **Amphidrome®** Reactor.

Application rates (i.e., loading rates) to the soil absorption are as follows, for the given percolation rates:

	Application Rates (gpd/ft ²)		
Perc Rate (min/inch)	<5	5-10	10-20
Leaching Pits	3.0	2.5	1.5
Leaching Chambers	3.0	2.5	1.5
Leaching Trenches	2.5	1.5	1.0

The major benefits of this system are that it allows a sewage treatment installation in nitrogen sensitive areas, where a conventional system may not be allowed. It also allows for a significant reduction in leaching area, which may significantly lower the cost for a system that may require mounding.

The following is an equipment list for a typical three-bedroom home at 440 gallons per day:

- 2 ft diameter stainless steel underdrain
- 4.7 ft³ of various size gravel.
- 15.7 ft³ of filter media
- Process air blower
- Backwash
- Return flow/backwash pump
- Effluent discharge pump
- 4 Float switches
- 2 Float brackets
- Amphidrome®** Control panel
- Sample collector

The **Amphidrome®** reactor consists of the following four items: underdrain, support gravel, and the filter media. The underdrain, constructed of stainless steel, is located at the bottom of the **Amphidrome®** reactor and provides support for the media and distribution liquid into the reactor. It is also designed

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as a manifold to distribute air evenly over the entire filter bottom during the aerobic portion of the cycle. Air is fed from a common pipe at the center of the underdrain. The air is pumped down into the reactor from above and enters the underdrain via a lateral distribution header. The air flows from the header into channels that distribute the air evenly throughout the bottom of the **Amphidrome®** reactor. On top of the underdrain is approximately 18" of gravel. Several layers of different size gravel are used. Above the gravel is a deep bed of coarse, round silica sand. The deep bed filter design, employed in this manner is multi-functional. First, it functions as filter, significantly reducing suspended solids. Secondly, it serves as a fixed film reactor.

Septic tank, clear well tank, **Amphidrome®** Reactor tanks, and interconnecting and internal piping are by others. Installation and piping of reactor is by contractor. The **Amphidrome®** system is typically installed underground. The control panel and blowers may be installed in a garage, shed, basement, or a small separate building. The entire operation of the system is controlled by PLC. Typically the programmed cycle is design for 12, or 24 hours. In the event of a problem (i.e., either excess flow, or insufficient flow), float switches will override the programmed mode of operation for the pumps.

Inspection/Maintenance

In Massachusetts, the system must be operated by a Massachusetts Class 2 operator. The operator must maintain the system monthly for the first year, quarterly thereafter, and any time there is an alarm condition.

Costs

The equipment cost for a single-family home **Amphidrome®** System, (330 to 440 gallons per day) is \$7,500.00. The total installed cost is between \$12,000.00 and \$14,000.00. The average electrical cost for operation of the system is 70 cents per day.

Cluster/Multiple Residence Potential

This system could be used for multiple residences. Currently, there are fourteen large systems operating with design flows ranging from 5,000 to 36,000 gallons per day. The systems are located in Massachusetts and Connecticut.

Delivery Time

Single family systems are in stock. The delivery time for large systems is approximately eight to ten weeks.

Manufacturer

Company: Tetra Technologies
Address: 503 Martindale Avenue
Pittsburgh, PA 15212
Telephone: (412) 321-7400

Local Designers/Engineers

Company: FR Mahony & Associates
Address: 273 Weymouth Street
Rockland, MA 02370
Telephone: (781) 982-9300
Fax: (781) 982-1056
eMail: FRMA@CompuServ.com
Contact: Keith Dobie

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Last updated on Wednesday, June 14th, 2006

URL: <http://www.epa.gov/ne/assistance/ceitts/wastewater/techs/amphidrome.html>



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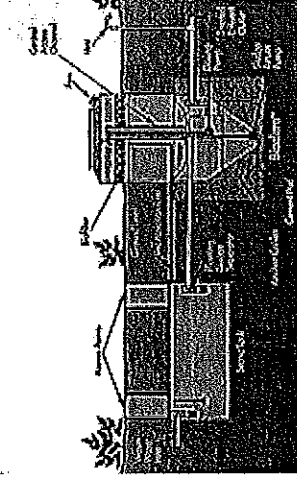
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Wastewater Virtual Trade Show Bioclere

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Narrative Description

The Bioclere is a modified trickling filter over a clarifier designed to provide secondary treatment and nitrification for waste streams with intermittent flows and varying strengths of waste in climates with seasonal temperature variations. The combination of its natural fixed film process and its capacity for internal and external recirculation makes the Bioclere a resilient, versatile and competitive treatment system. The ability of the biological film to self-regulate variations in hydraulic and organic loading as well as environmental variations such as temperature, pH, and process inhibitors is widely acknowledged.



The Bioclere is modular, and may be installed in parallel to accommodate larger flows, or in series to achieve higher levels of treatment. Typical installations range from 300 to 100,000 gallons per day.

The Bioclere has been —

- National Sanitation Foundation (NSF) Certified under Standard 40,

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Innovative Technology Inventory

- Formally reviewed under an Advisory Letter from the New England Interstate Water Pollution Control Commission (NEIWPCC),
- Permitted under the Ten State Standards for trickling filters,
- Accepted under a Memorandum of Understanding for technology transfers agreed to by California, Illinois, Massachusetts, New Jersey, New York and Pennsylvania.

imply endorsement or recommendation by the EPA.

The **Bioclere** has been installed or approved in twenty US states and in Canada. Many states allow variances in design requirements for soil disposal fields based on a level of treatment equivalent to recirculating sand filters.

General Description: The trickling filter is a well-known treatment process in which microorganisms attach themselves to a highly permeable media, creating a biological filter or slime layer. Loading rates for the **Bioclere** for both BOD removal and nitrification conform to well-known standards for trickling filters.

In the **Bioclere** the biofilter is enclosed and insulated. Hydraulic dosing and sludge return pumps are set at pre-determined rates, minimizing maintenance and enhancing treatment. Oxygen is introduced to the system through a fan in the **Bioclere** housing and is exhausted through a vent that is usually located in the discharge line.

The **Bioclere** is a passive gravity flow treatment system installed in line between the primary tank and distribution box. The **Bioclere** neither intrudes on nor adversely affects the flow of a conventional on-site system. Electrical outages do not inhibit flow, and dilution factors within the system minimize the impact of a short-term power failure on effluent quality.

The **Bioclere's** fixed film process and hydraulic capacity minimize the impact of organic and hydraulic fluctuations on the treatment process and effluent quality. Generally, **Bioclere** installations do not require flow equalization prior to treatment.

Process Flow: Wastewater flows from the primary settling tank (septic tank), into a baffled chamber in the clarifier of the **Bioclere**. Dosing pumps located in this baffled chamber distribute the wastewater over the filter media. In the trickling filter, the organic material in the wastewater is reduced by a population of microorganisms, which attach to the filter media and form a biological slime layer. In the outer portion of the slime layer, treatment is accomplished by aerobic microorganisms. As the microorganisms multiply, the

biological film thickens and diffused oxygen and organic substrate are consumed before penetrating the full depth of the slime layer. Consequently, the biological film develops aerobic, anoxic, and anaerobic zones.

Periodically, the microorganisms in the anaerobic zone near the media surface lose their ability to cling to the media due to the lack of sufficient oxygen and food. The wastewater flowing over the media washes the slime layer from the media bed and a new slime layer begins to form. This process of losing the slime layer is called "sloughing" and is primarily a function of the organic and hydraulic loading on the filter. This natural process allows the media bed to be self-purging and maintenance-free.

The sloughed biomass settles to the bottom of the sump as sludge. These secondary sludges are periodically pumped back to the primary tank for storage, and eventually removed.

Nitrification: Consistent nitrification is accomplished by cultivating a healthy microorganism population and an environment where pH, temperature, organic loading, and supply of oxygen are stable. In a **Bioclere** system, the pH is buffered by the carbonate system associated with the wastewater; the temperature remains constant because of the insulated environment and the exothermic biological activity.

Denitrification: Denitrification utilizing septic tank carbon is widely considered to be the most economical and efficient method for nitrogen removal. Utilizing prescribed recirculation rates, nitrified wastewater from the **Bioclere** is returned to the anoxic zone of the primary tank where influent wastewater provides a suitable carbon source for the denitrification reaction. In this process, bacteria convert the nitrate to nitrogen gas, which is then released to the atmosphere. This method has achieved reductions of nitrogen between 65% and 75%.

Site Constraints/Limitations

The single-family **Bioclere** will accommodate up to 1000 gallons per day. The **Bioclere** has a five-foot diameter footprint; it poses no additional problems in terms of site constraints. Other model sizes and configurations are available to accommodate larger flows as well as commercial, light industrial and shared residential systems.

Performance

The **Bioclere** has been certified by the National Sanitation Foundation (NSF) for the secondary treatment of wastewater. NSF test results indicate:

- 91-97% removal of CBOD
- 86-93% removal of TSS
- 75% reduction in fecal coliform.

Inspection/Maintenance

Semi-annual maintenance is required; however, many states require quarterly service as part of their codes.

Costs

Single Family Residential **Bioclere** units are not sold except to qualified management districts. In our judgement the cost of properly managing, maintaining and monitoring residential systems is significant regardless of the technology.

Cluster/Multiple Residence Potential

Bioclere systems for clustered residential applications may be cost as little as \$800.00 per home.

Potential Problems & Solutions

Problems tend to relate to the biology of the wastewater and the habits of the homeowner. The **Bioclere** is vented through the septic tank to the home roof vent. Typical systems do not experience odor problems.

Delivery Time

Delivery time is approximately 4 to 6 weeks.

Manufacturer

Company: AWT / Aquapoint
Address: 241 Duchaine Boulevard, PO Box 50120
New Bedford, MA 02745

Telephone: (508) 998-7577
Fax: (508) 998-7177
eMail: awt@aquapoint.com
Website: www.aquapoint.com EXTERDISCLAIMER

Contact: Sales office, New Bedford, MA 508 998-7577 ext.18

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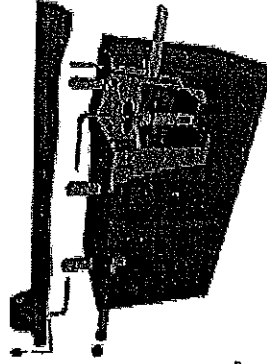
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Narrative Description

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The FAST® wastewater treatment system is a pre-engineered modular wastewater treatment system/device designed to treat wastewater from residential, commercial, high strength and small community applications. The FAST, or Fixed Activated Sludge Treatment, system is a fixed film, aerated system utilizing a combination of attached and suspended growth, capable of performing nitrification/denitrification in a single tank. This innovative combination of the stability of fixed film media and the effectiveness of proven activated sludge treatment is reliable and environmentally sound.



The FAST system cultivates large volumes of microorganisms in the inner aerated media chamber to digest the wastewater coming from a residence and turn it into a clear, odorless, high-quality effluent. The attached growth system assures that more microorganisms remain inside the system rather than being flushed out, even during times of peak hydraulic flows. During times of low usage, the large volumes of thriving microorganisms prevent a dying-off of the system, making FAST equally suited for intermittent use applications.

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FAST technology is well suited for high strength waste, residential development, renovation of failing systems, and light commercial applications on marginal or severely limited sites. Multiple units may be used, in parallel or in series, to meet larger flow and waste strength needs.

Installation of the FAST system is straightforward, consisting simply of mounting the unit into a locally obtained septic tank. The first compartment of the two-compartment septic tank will act as the primary settling and anaerobic zone. Inside the FAST treatment insert is the aerobic zone. The area of the second compartment immediately surrounding the FAST insert is anoxic.

Once installed, the FAST system is virtually maintenance free. The clean, odorless FAST wastewater treatment system is located below ground level and the system's only moving part, the quiet-running aerating blower, is placed above ground in an unobtrusive blower housing that can be located up to 100 feet away. The FAST system needs no other filters or pumps.

FAST has been tested and certified by the National Sanitation Foundation (NSF) International. In addition to ANSI/NSF Standard 40, Class 1, FAST has obtained certification from Canadian Great Lakes (the most stringent marine standard in the world). FAST also carries certification from the US Coast Guard and the International Maritime Organization (IMO) rules by the UK Department of Trade. FAST is listed with the Commonwealth of Massachusetts Department of Environmental Protection as an approved Title V system Certified for General Use, Provisional Use and Remedial Use. FAST is listed as an approved system with the State of Rhode Island and can be found on the Rhode Island Department of Environmental Management's Innovative or Alternative Technology List.

Specifications

FAST wastewater treatment systems are ideally suited for use in single family dwellings, clustered subdivisions, restaurants and other commercial applications as well as renovation of biologically failed septic systems.

MicroFAST is used in primarily domestic wastewater applications and is engineered to be sized based on population equivalents and/or flow.

MicroFAST is currently available in module sizes of 250, 500, 900, 1500, 3000, 4500, and 9000 US gallons per day.

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High-StrengthFAST is utilized in commercial applications or anywhere the strength of the waste introduces special challenges. **High-StrengthFAST** is currently available with hydraulic capacities of 1000, 1500, 3000, 4500, and 9000 US gallons per day. (Biological treatment capacities will vary with waste strength - consult factory for assistance in design of these unique, non-domestic applications.)

Multiple modules may be used in parallel and/or in series to meet larger flow or waste strength needs. Each treatment vessel or tank containing **FAST** treatment systems is capable of housing a single system or multiple systems, depending on size and design, giving engineers and project managers maximum flexibility.

In addition to the traditional tank-housed system, specially designed buoyant modules allow any of the **FAST** treatment systems to become floating treatment systems. These cleverly designed systems, called **LagoonFAST**, are ideally suited to retrofit and upgrade the treatment levels in underperforming lagoons, as well as to provide treatment in ponds, fish farms, etc.

Every **FAST** system has similar functionality and operation, keeping O & M simple and straightforward. Dependable, regenerative blowers are utilized, introducing high volumes of oxygen into the robust system. Blowers range from 0.25 to 7.5 HP with output levels of 15 to 325 cfm. Blowers and control panels are available in 110/115V, 208/220/230V, or 460V (single phase and three phase). Each **FAST** system is equipped with an inlet filter assembly and near-permanent, washable filter element (replacement value approximately \$20.00 for the most common sizes).

FAST systems come equipped with a simple and effective control panel. Common malfunctions (including blower interruption/failure and high water conditions) would trigger both visual and audible alarms. Expanded panels are available with additional features for a variety of applications. Control panels are equipped with built-in timers to allow sequencing of the systems blower to assist in optimizing operation. Remote monitoring is also possible should the application call for such assurances. Disinfection devices such as ultraviolet, ozone or chlorination can offer very reliable treatment when site conditions and disposal options dictate their use.

All system specifications and schematics are available for download as AutoCAD files on Bio-Microbics' website, www.biomicrobics.com
EXTENDED, listed under technical specs.

Performance

Sufficient conditions are present to allow nitrification and denitrification to occur in the same tank without any system modifications. Special patented technology allows FAST to consistently reduce nitrogen levels, including nitrates and all other nitrogen species, by over 70%. A properly designed FAST system can be expected to reliably produce an effluent of:

BOD	≤ 10 mg/L
TSS	≤ 10 mg/L
Total Nitrogen	≤ 10 mg/L
Nitrate	≤ 5 mg/L

Inspection/Maintenance

Annual maintenance involves a system check of the aboveground components, easily cleanable, to assure continuous problem-free operation. The air filter element located at the remote blower should be checked for washing or possible replacement (a replacement cost of approximately \$20.00). The septic tank should be inspected annually to determine if pumpout is necessary.

Costs

The cost for FAST wastewater treatment systems starts at \$2,000.00.

Cluster/Multiple Residence Potential

FAST systems are ideally suited to cluster applications of several homes.

Delivery

FAST wastewater treatment systems are pre-engineered and factory assembled, and field installation involves very simple connections. **FAST** systems are lightweight, each system is shipped complete via regular ground transportation

Manufacturer

Company: Bio-Microbics, Inc.
Address: 8450 Cole Parkway
Shawnee, KS 66227

Telephone: (800) 753-FAST (3278) or (913) 422-0707
Fax: (913) 422-0808
eMail: sales@biomicrobics.com
Website: www.biomicrobics.com [Extra-Disclaimer](#)

Contacts: Raymond Peat, Vice President, Marketing
Brody Dorland, Sales and Marketing Coordinator

Local Supplier

Company: J & R Sales and Service, Inc.
Address: 44 Commercial Street
Raynham, MA 02767

Telephone: (508) 823-9566

Contacts: Jim Dunlap
John Rowland

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