Aerobic Treatment Systems

Lauren Usilton

This presentation includes information from the NOWRA presentation titled "Aerobic Treatment Units" presented by various speakers

Objectives…

- Basic information on Aerobic Treatment systems
  - Aerobic treatment vs. others
  - Typical setup
  - Properties required for biological treatment to occur
- Design considerations
- Permitting information
- Examples of Aerobic systems approved for use in MA
- Operation and Maintenance

Aerobic Treatment Systems (ATU)

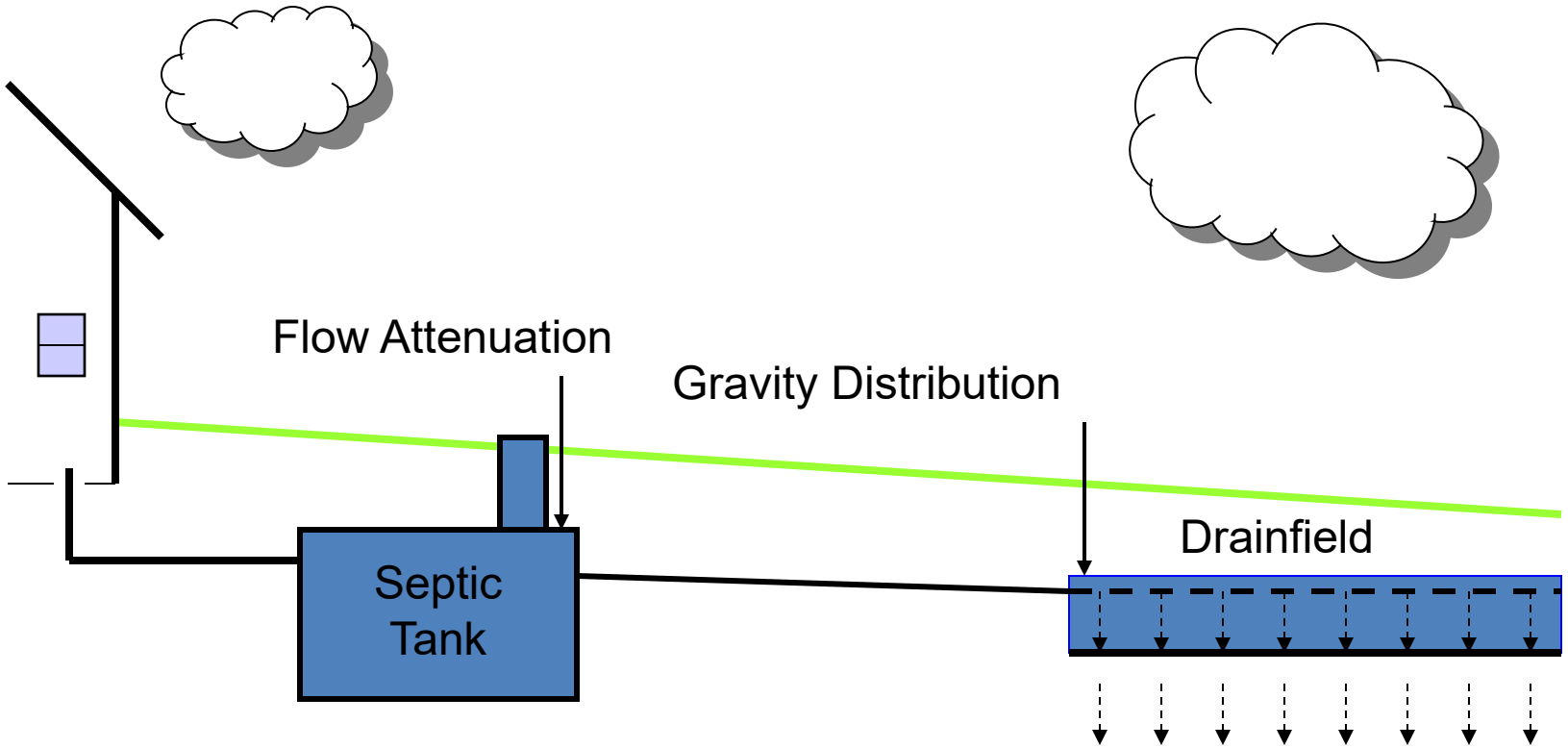
- There are many examples of this type of treatment
  - Extended Air
  - SBR
  - Fixed film
  - Integrated fixed film activated sludge (IFAS)
  - Packed Bed
  - Sand Filter
  - Others (i.e. soil based options)

Typical Onsite Treatment Trains

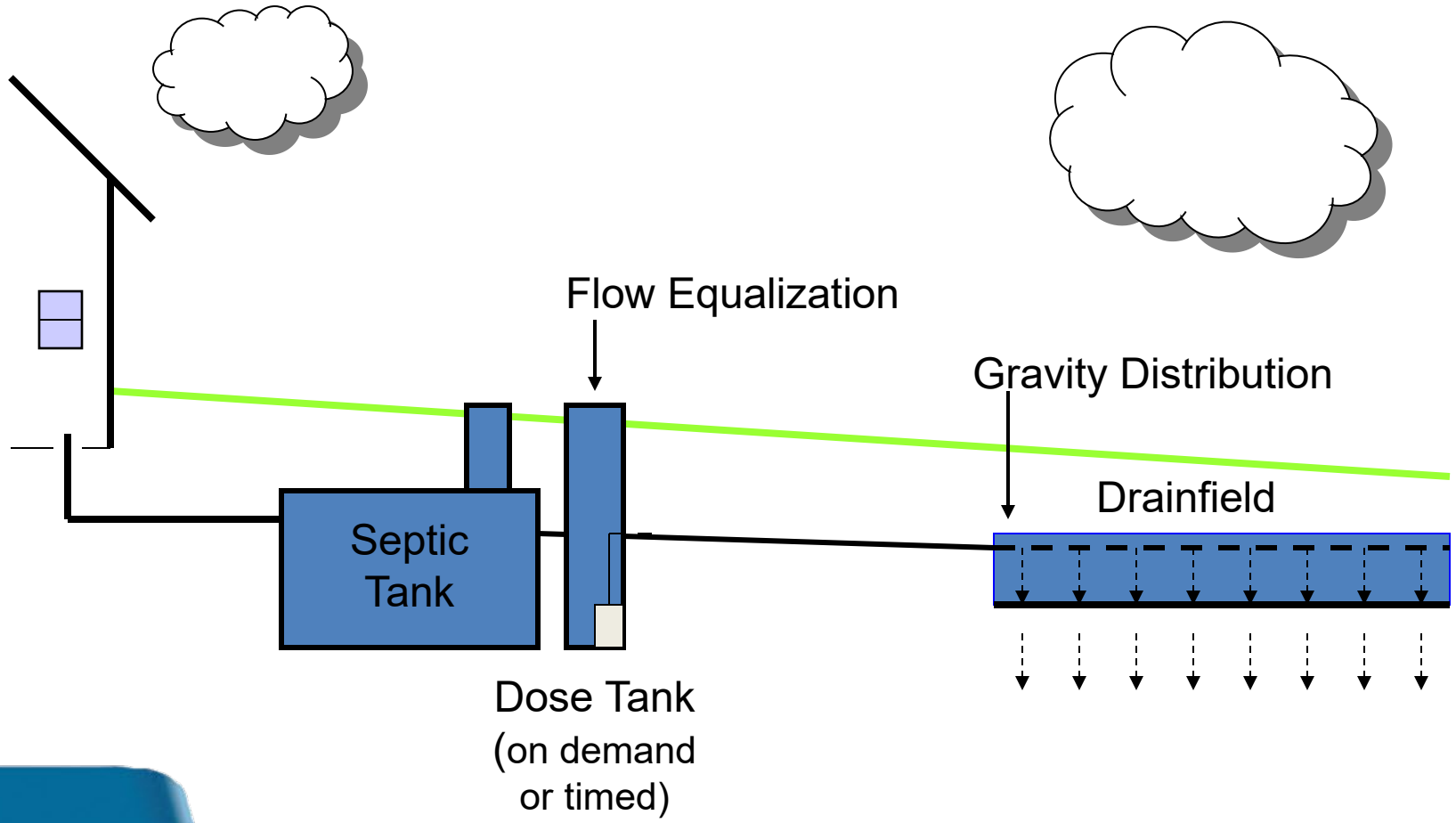
- **Treatment steps**
  - Primary (septic tank)
  - Secondary (ATU: fixed film, activated sludge)
  - Advanced (sensitive environments, nutrient reduction)
    - This can be in multiple units/tanks, or incorporated into one unit/tank

- **Commonly used treatment trains**
  - Septic tank-Soil treatment & dispersal
  - Septic tank-Aerobic treatment-Soil treatment & dispersal
  - Septic tank-Aerobic treatment-Advanced treatment-Soil treatment & dispersal

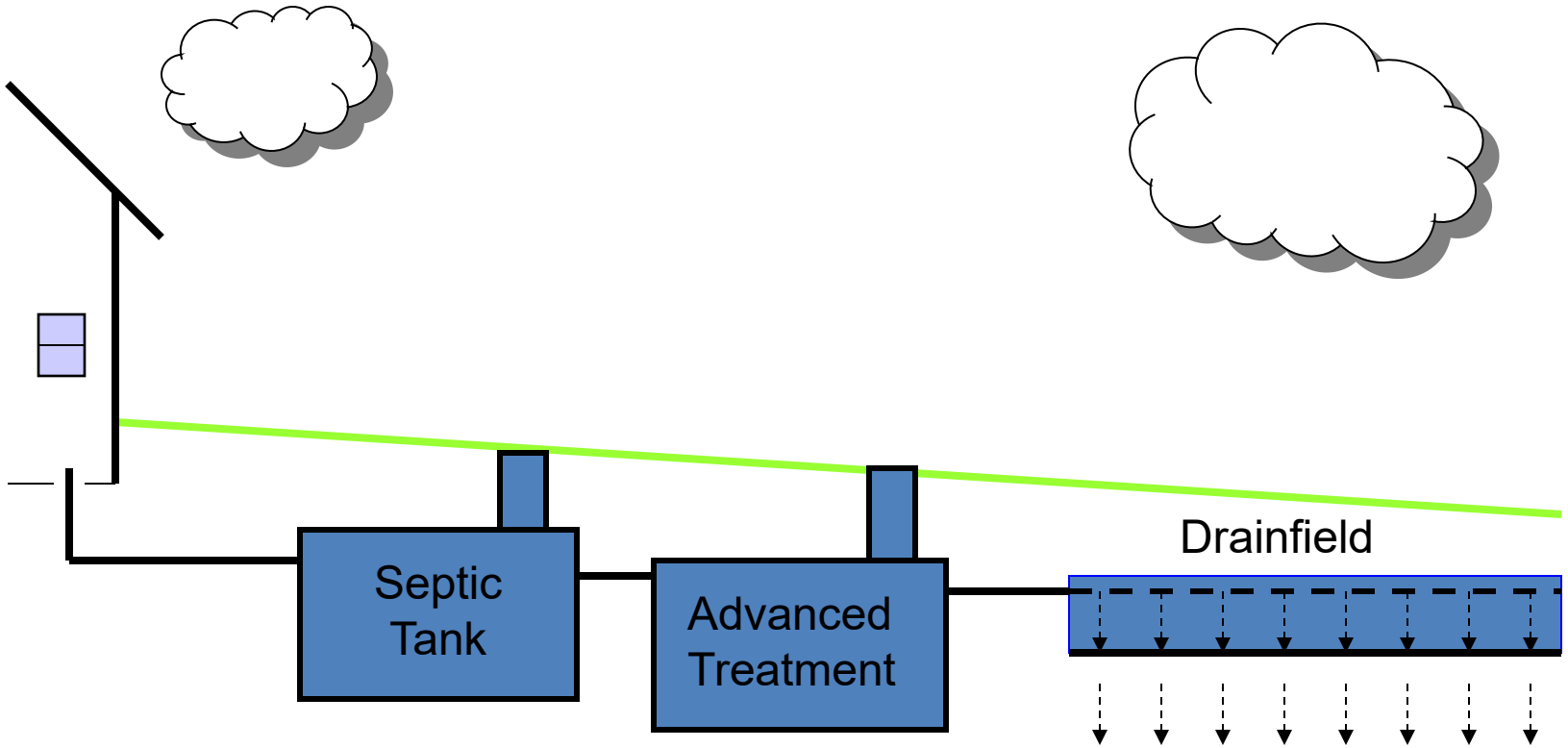
Treatment level 1
Septic tank → Soil treatment



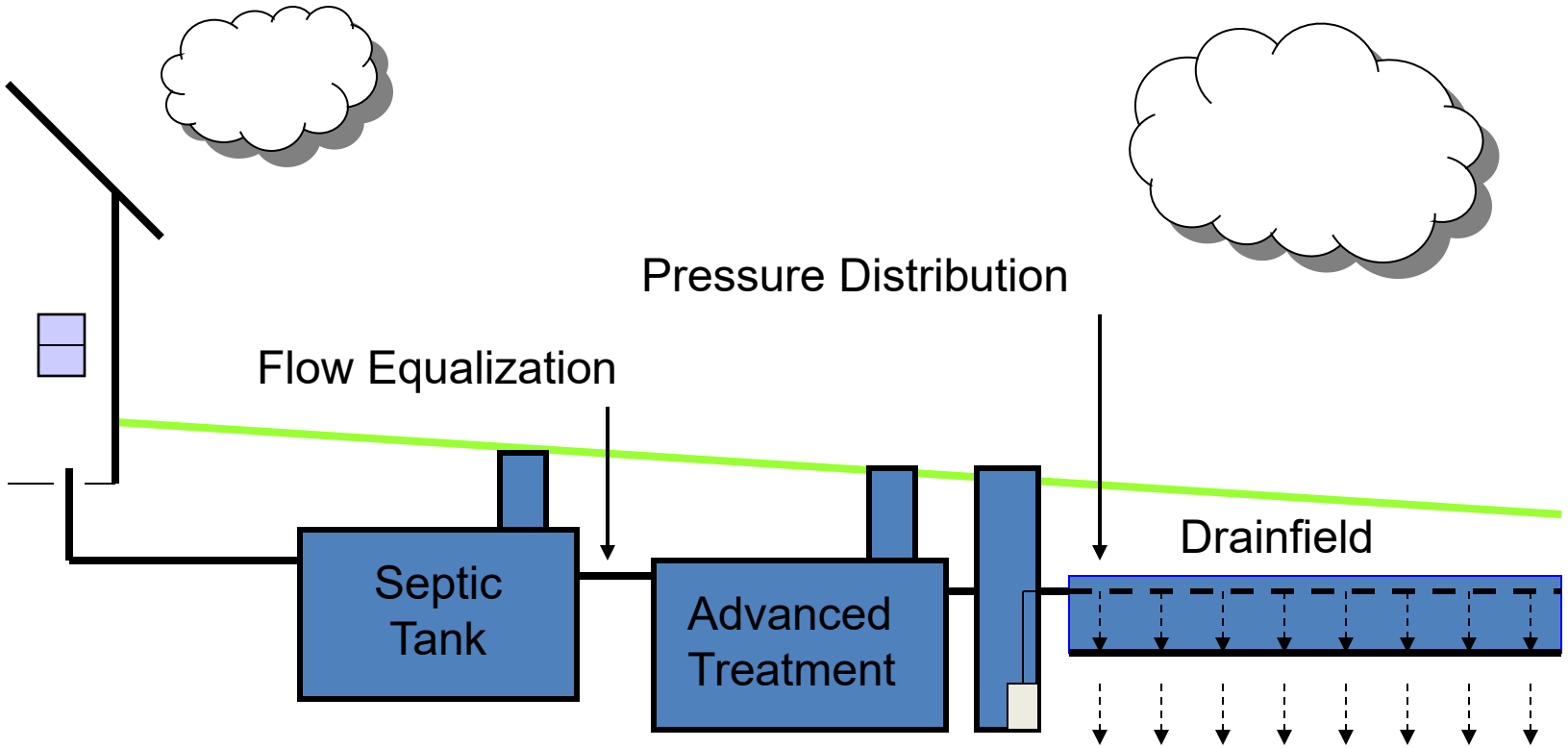
Treatment Level 1
Septic tank → Soil treatment



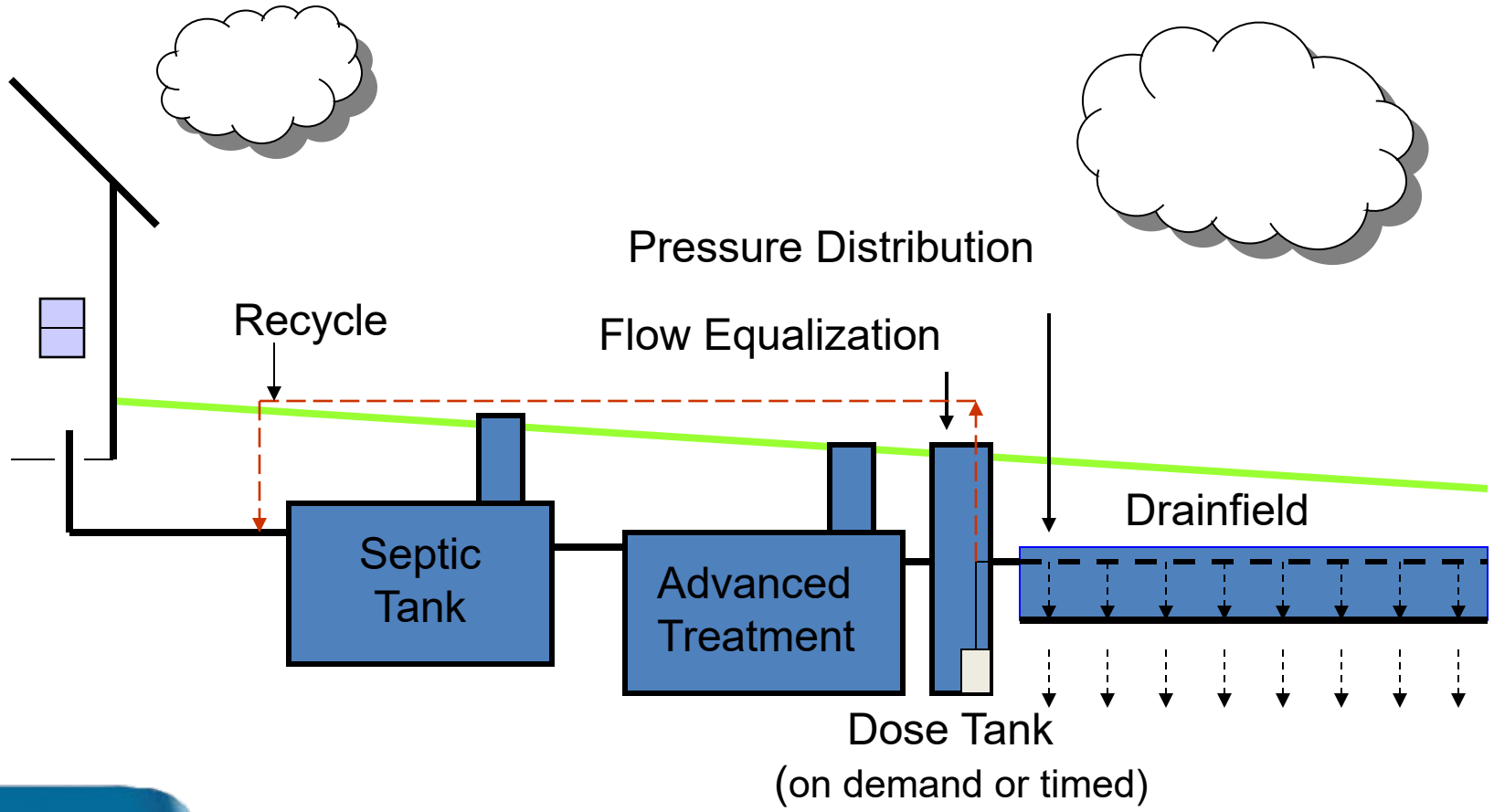
Treatment Level 2
Aerobic treatment → Soil treatment



Treatment Level 3
Advanced treatment → Soil treatment



Treatment Level 3
Advanced treatment → Soil treatment



ATU Treatment

- Remove substantial amounts of BOD and TSS
- Nitrification of ammonia
- Reduction of pathogenic organisms
  - Not Sterilized
- May have denitrification as a component

Biological Treatment Process

- A biological treatment process where acclimated bacteria comes in contact with biological waste in the water with oxygen to remove the BOD from the stream.
  - Suspended Growth; The activated sludge process may be in the form of waste and water mixed in a tank with air.
  - Fixed Film; The process may be in the form of the acclimated bacteria being attached to a media.
  - Modified systems; too numerous to count

Microbes

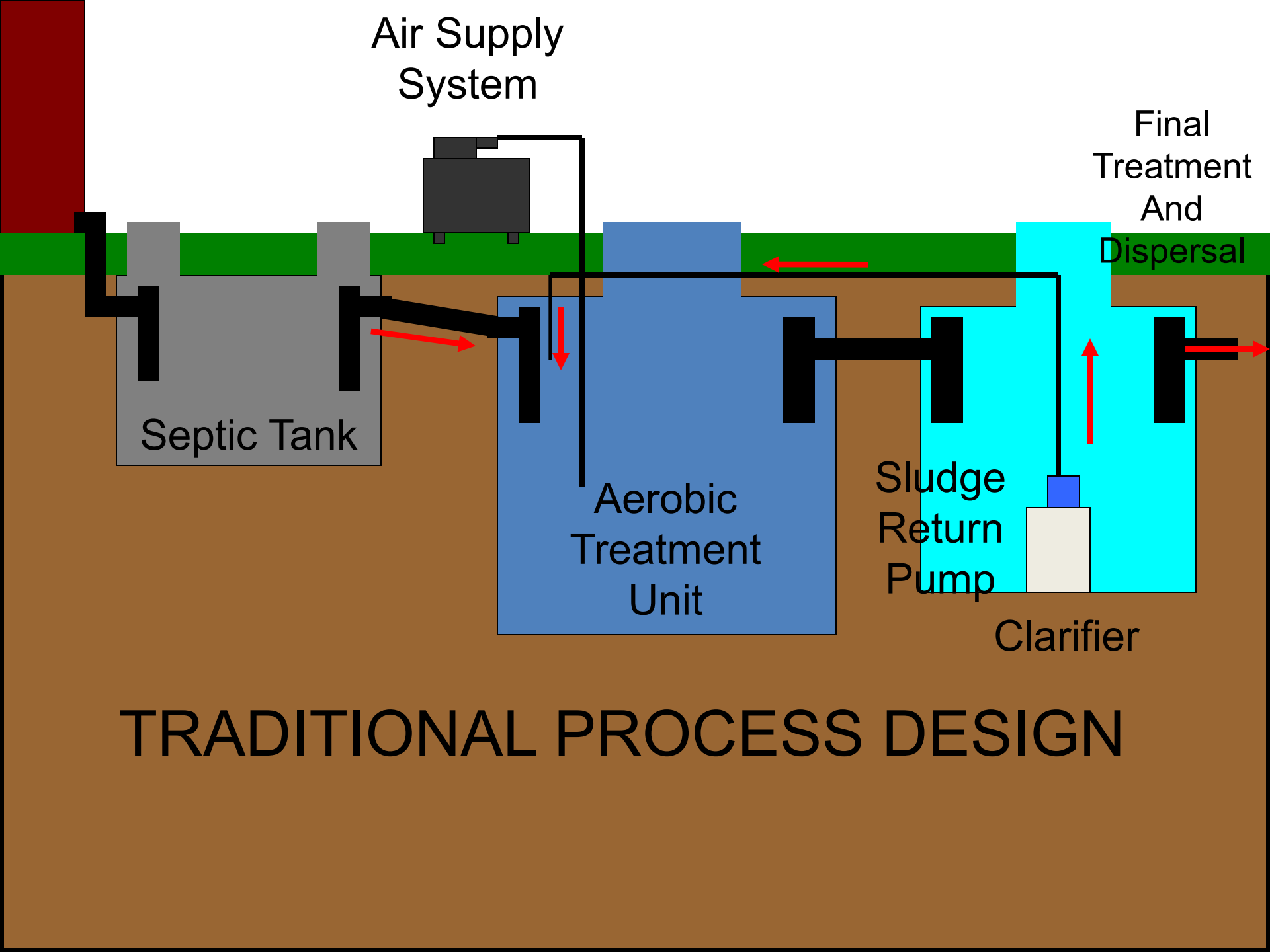
- Microbes
  - Provide treatment
  - Must keep them healthy
    - Food
    - pH
    - Oxygen - DO
    - Temperature
- Dead Microbes
  - Stink
  - Are Black
  - Don’t move

Residuals Management

- Biological treatment processes generate residual solids that must be managed.
- The solids must be stored and then removed
- Sludge may be treated as part of the process to reduce the volume.
- Excess sludge must NOT be delivered to the drainfield.

Components

- Septic/Settling compartment/tank
  - Large solids – settling – scum
  - Can be used as part of the treatment (i.e. dentrification)
- Aerobic Treatment
  - Mixing of the Food & Bacteria
  - F/M ratio (food to microbe ratio)
- Air Supply
- Clarification
- Sludge return/storage


Air Supply System
Final Treatment And Dispersal
Septic Tank
Aerobic Treatment Unit
Sludge Return Pump
Clarifier
TRADITIONAL PROCESS DESIGN

Aerobic Treatment – Nitrogen Reduction

- Aerobic treatment systems can also provide nitrogen reduction
- The system would include an anaerobic zone, recycle to septic tank, or other considerations to allow for the proper environment for denitrification
- Aerobic treatment systems are very good at nitrification, which is the first step in the nitrogen process
- Some manufacturers have a different model for nitrogen, so be sure to specify if nitrogen removal is needed
- Septic Tank Effluent vs. Treated Effluent
  - Septic Tank effluent – typically 60 mg/L TN
  - Treated Effluent after ATU - should be less than 19 mg/L in residential applications to meet NSF and MA DEP requirements

NITRIFICATION

Conversion of
Ammonia–Nitrogen to
Nitrate–Nitrogen

Optimal Design Criteria for Nitrification

- Dissolved Oxygen > 2.0 mg/L

$$\frac{\text{Oxygen for Nitrification}}{4.6 \text{ lb. } O_2+/NH_3\text{-N}}$$

- pH 7.0 would be optimum but will occur within the range of 6.5-8
- Temperature > 20°C (68°F) 25°C is optimum – Nitrification rates will increase as temperature rises
- No Inhibitory Chemicals
- Alkalinity

Toxic Chemicals
(for wastewater treatment)

- Homes: liquid fabric softeners, pine oil, and drain cleaners
- Commercial Facilities: Strong sanitizers or Quats, floor stripping waste
- Pesticides
- Acid and Caustic Materials

Alkalinity in Wastewater Treatment

Total Alkalinity Requirement = 7.14 lbs as $CaCO_3$ / lb N oxidized

or

For every 1mg/l of Ammonia that is converted to Nitrate Nitrogen 7mg/ of Alkalinity will be used

3.57 mg/l of Alkalinity is produced during the Denitrification process

DENITIRIFICATION

Denitrification is the conversion of Nitrate–Nitrogen to Nitrogen gas through a biological process.

Principles of Denitrification

1. Nitrification must precede denitrification
2. Anoxic conditions must exist
3. A carbon source must be available to facilitate the reaction
4. pH 6.5 to 7.5
5. Anoxic zone must be completely mixed

Total Nitrogen =

Organic-N+
Ammonia-N+ } TKN
Nitrite-N+
Nitrate-N

Designing an Aerobic Treatment System

Designing an ATU Considerations

- Source of the Wastewater
- Facility Practices
- Flow Patterns (e.g. churches)
- Effluent Requirements
- Operational/Management Resources

Designing an ATU

- Sizing the unit
  - For residential systems with requirements for BOD and TSS removal only, system can usually be sized based on gpd
  - For commercial systems or any system required to meet Nitrogen requirements, system should be sized not only on flow but on BOD loading as well (lbs/BOD/day)
  - Whenever possible an effluent sample is preferred to size the system
- Location of the unit
  - Be aware of water runoff, low spots
  - Locate above grade components away from buildings or in a remote location
- Manufacturer's requirements
  - Check with system's vendor on requirements for design review, onsite support, system startup, etc.

ATU Selection Considerations

1. Wastewater loading conditions
2. Process Robustness for loading
3. Siting conditions with room and access for required tanks
4. Availability of Local Service support
5. Customer preference
6. Economics – initial costs and long term costs
7. Manufacturers Support

ATU System Design Considerations

1. Flow Equalization
2. Settling/storage requirements
3. Site Access
4. Component Access
5. Service & Monitoring requirements
6. Regulatory requirements
7. Manufacturers Support

Permitting Requirements

MA DEP Requirements

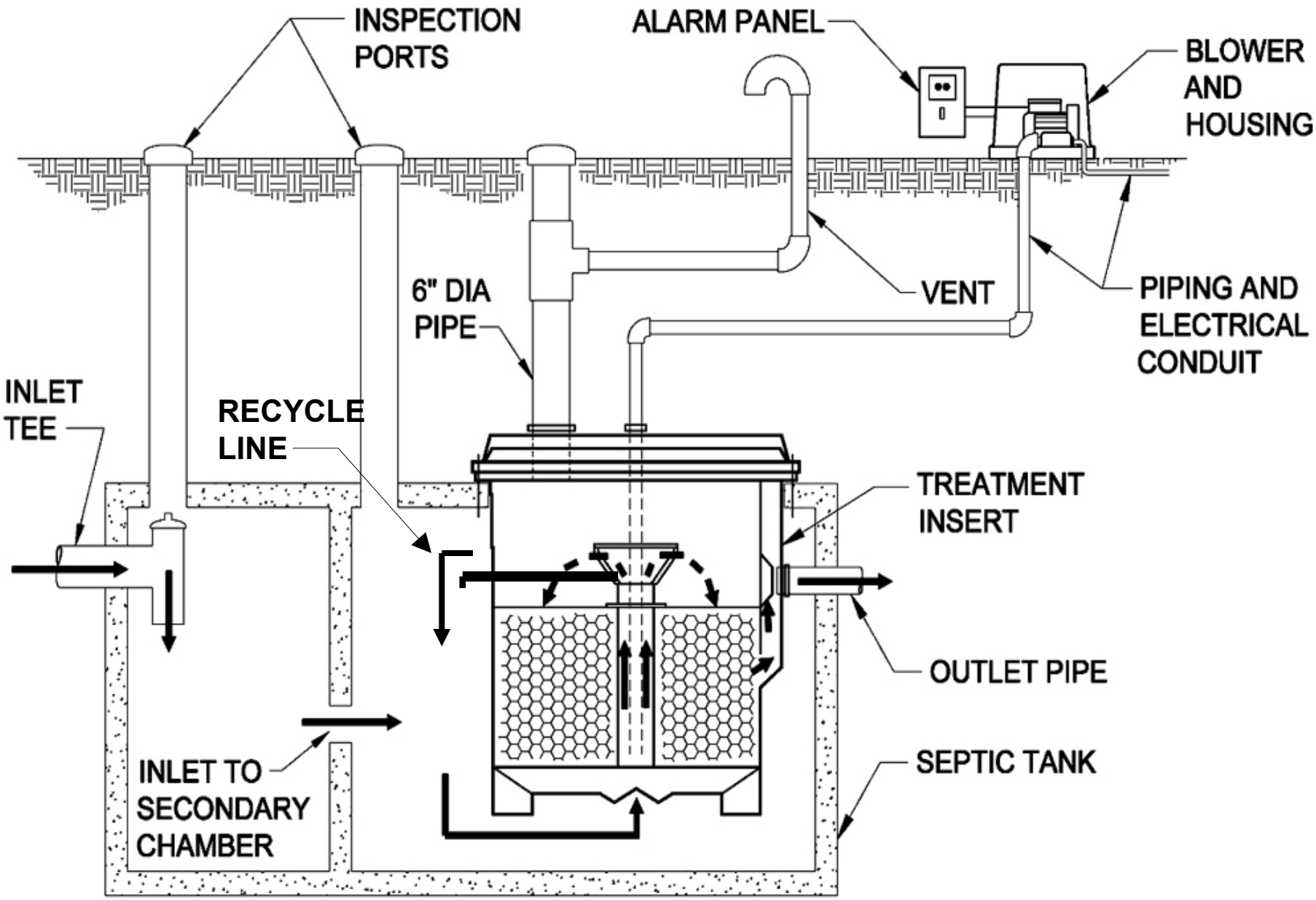
- Flows up to 10,000 gpd under MA DEP
- Remedial allows for reduction to groundwater or ledge; or a 50% field size reduction
- General allows for a 50% field size reduction
- General Denite and Provisional allow for increased TN loading per acre in a DEP Zone 2
  - General Denite is used for residential applications, less than 2,000 gpd; allows for 660 gpd/acre with a TN of <19 mg/L
  - Provisional is used for commercial applications, or flows greater than 2,000 gpd; allows for 550 gpd/acre with a TN of <25 mg/L
- Piloting

Aerobic Treatment Systems in MA

- Traditional ATUs
  - BioMicrobics FAST
  - Hoot Systems
  - Jet
  - Norweco Singulair

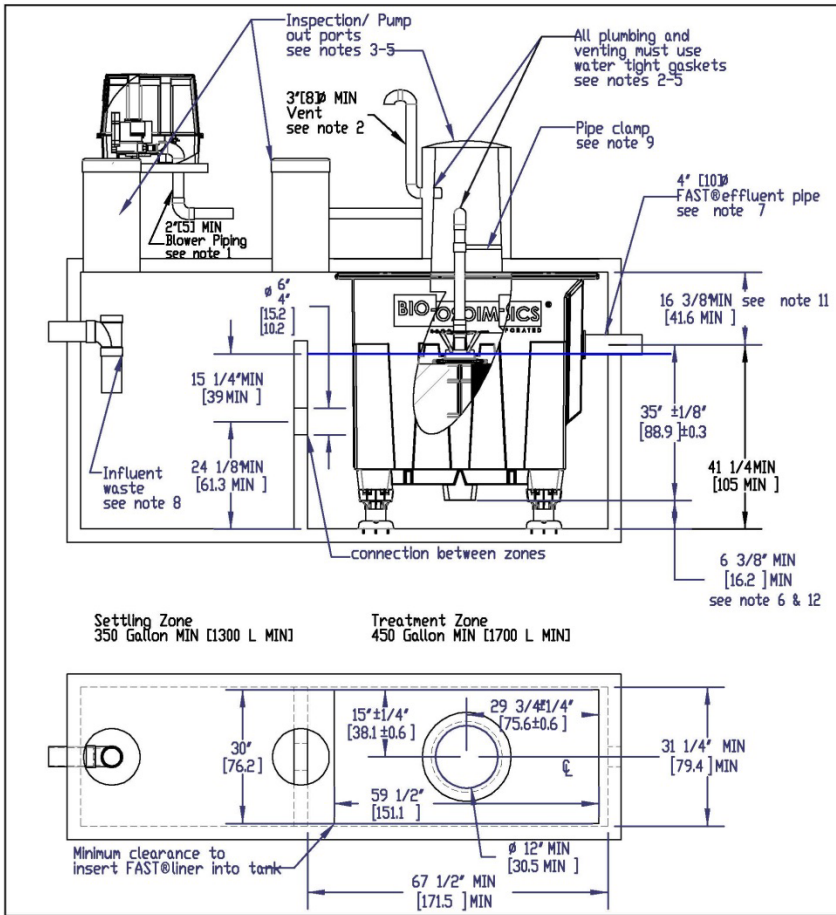
- Many other systems utilize Aerobic environments as part of the treatment process

FAST® Wastewater Treatment System Flow Diagram



Robust Aeration

AVERAGE BIOLOGICAL GROWTH



NOTES

1. Airline piping to FAST® may not exceed 100 FT [30m] total length ar have a maximum of 4 elbows in the piping system. For distances greater than 100 FT [30m] consult factory. Blower must be locate above flood levels on a concrete base 26" X 20" X 2" [65 X 50 X 5cm] min.
2. Vent to desired location and cover opening with a vent grate wit least 7 sq in.[45 sq. cm] open surface area. Secure with stainless screws. Vent piping must not allow condensate build up or create back pressure. Vent must be above finished grade or higher (see sheet 4 of 4).
3. All appurtenances to FAST® (e.g. tanks, access ports, electrical, must conform to all applicable country, state, province, and local plumbing and electrical codes. Pump out access shall be adequate to thoroughly clean out both zones.
4. All inspection, viewing and pump out ports must be secured to prevent accidental or unauthorized access.
5. Tank, piping, conduit, etc. are provided by others. Blower control system by Bio-Microbics, Inc. See Installation Manual.
6. If less than the specified minimums are considered necessary, con factory for guidance.
7. All piping and ancillary equipment installed after FAST must not impede or restrict free flow of effluent.
8. The tank(s) shall be designed to prevent air passage between t settling zone/tank and the treatment zone and preventing an air Examples include a baffle wall sealed to the lid or treatment zon inlet line with a pipe cap. Consult factory for guidance.
9. The air supply line into the FAST® unit must be secured to preve vibration induced damage. The air supply line should be secured wi a non-corrosive clamp every 2' min [60 cm]. See alternate air sup option on sheet 4 of 4.
10. Specialized treatment levels may require specific features to be incorporated into the design. Consult factory for guidance.
11. Min. height may be reduced, consult factor and reference "Low Profile Module Procedure.pdf"
12. Refer to sheet 4 of 4 for leg extensions requirements.

DO NOT SCALE

UNLESS NOTED DIMENSIONS ARE IN INCHES [CENTIMETERS] TOLERANCES ± 0.02 IN/IN [± 0.05 CM/CM]

BIO MICROBICS
BETTER WATER. BETTER WORLD.

MicroFAST 0.50 FAST Unit

WEIGHT	lb	SIZE	DRAWING NUMBER	SHEET
	NAME / DATE	A	MicroFAST®0.50 with feet	2 OF 4
DRAWN	CTC 12/18/2006			
CHECKED	PF 9/18/2013		REVISED 9/18/2013 REV. INI-05-V	

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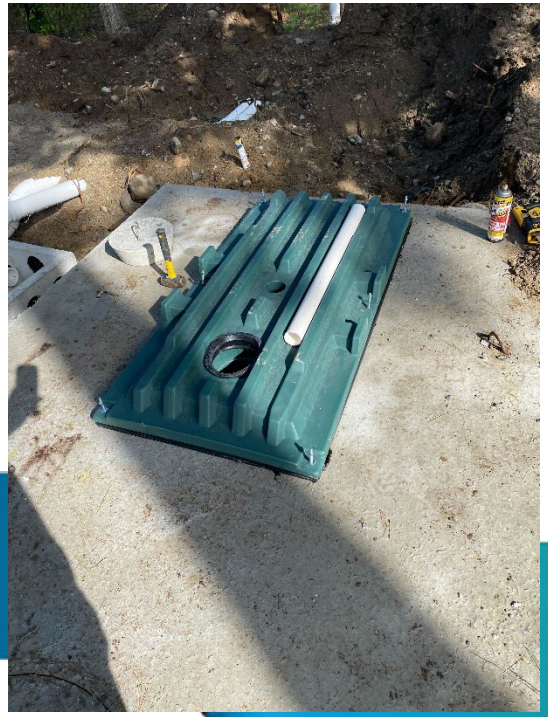
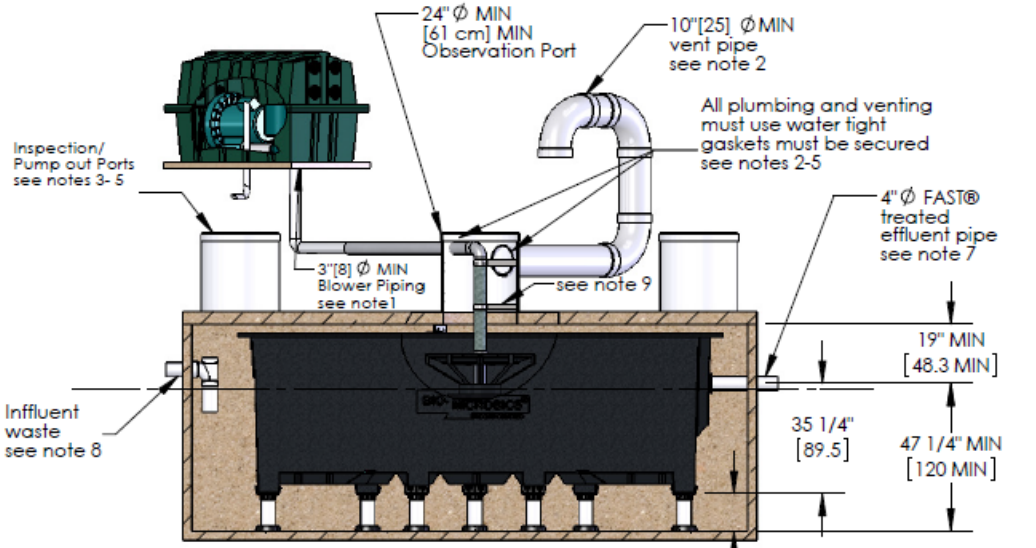
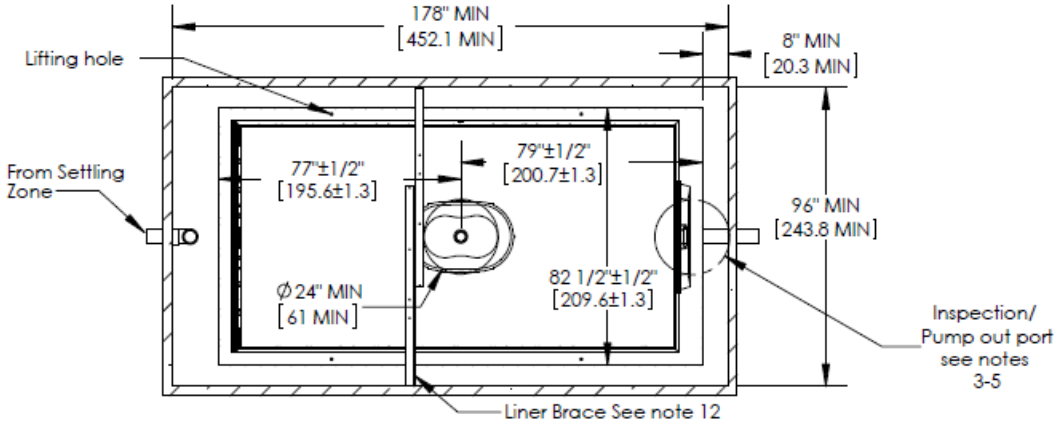
DO NOT STACK

Residential Use







NOTES

1. Airline piping to FAST® may not exceed 100 FT [30m] total length and have a maximum of 4 elbows in the piping system. For distances greater than 100 FT [30m] consult factory. Blower must be located above flood levels on a concrete base 56.8" X 35.8" X 2.5" [144 X 91 X 6.35cm] minimum.
2. Vent to desired location and cover opening with a vent grate with at least 20 sq in.[125 sq. cm] open surface area. Secure with stainless steel screws. Vent piping must not allow condensate build up or create back pressure. Vent must be above finished grade or higher (see sheet 4 of 4).
3. All appurtenances to FAST® (e.g. tanks, access ports, electrical, etc.) must conform to all applicable country, state, province, and local plumbing and electrical codes. Pump out access shall be adequate to thoroughly clean out both zones.
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7. All piping and ancillary equipment installed after FAST must not impede or restrict free flow of effluent.
8. The tank(s) shall be designed to prevent air passage between the settling zone/tank and the treatment zone and preventing an air lock. Examples include a baffle wall sealed to the lid or treatment zone inlet line with a pipe cap. Consult factory for guidance.
9. The air supply line into the FAST® unit must be secured to prevent vibration induced damage. The air supply line should be secured with a non-corrosive clamp every 2' min [60 cm]. See alternate air supply option on sheet 3 of 3.
10. Specialized treatment levels may require specific features to be incorporated into the design. Consult factory for guidance.
11. Refer to sheet 3 of 3 for leg extensions requirements.
12. Secure provided support braces to prevent movement.

DO NOT SCALE

UNLESS NOTED DIMENSIONS ARE IN INCHES [CENTIMETERS] TOLERANCES ± 0.02 IN/IN [± 0.05 CM/CM]

BIO MICROBICS
BETTER WATER. BETTER WORLD.

MicroFAST 4.5 FAST Unit

WEIGHT	lb	SIZE	DRAWING NUMBER		SHEET
NAME	DATE	A	MicroFAST 4.5 with feet		1 OF 3
DRAWN CTC	5/10/2006				
CHECKED PF	4/16/2014	REVISED 4/16/2014		REV. INI-07-C	

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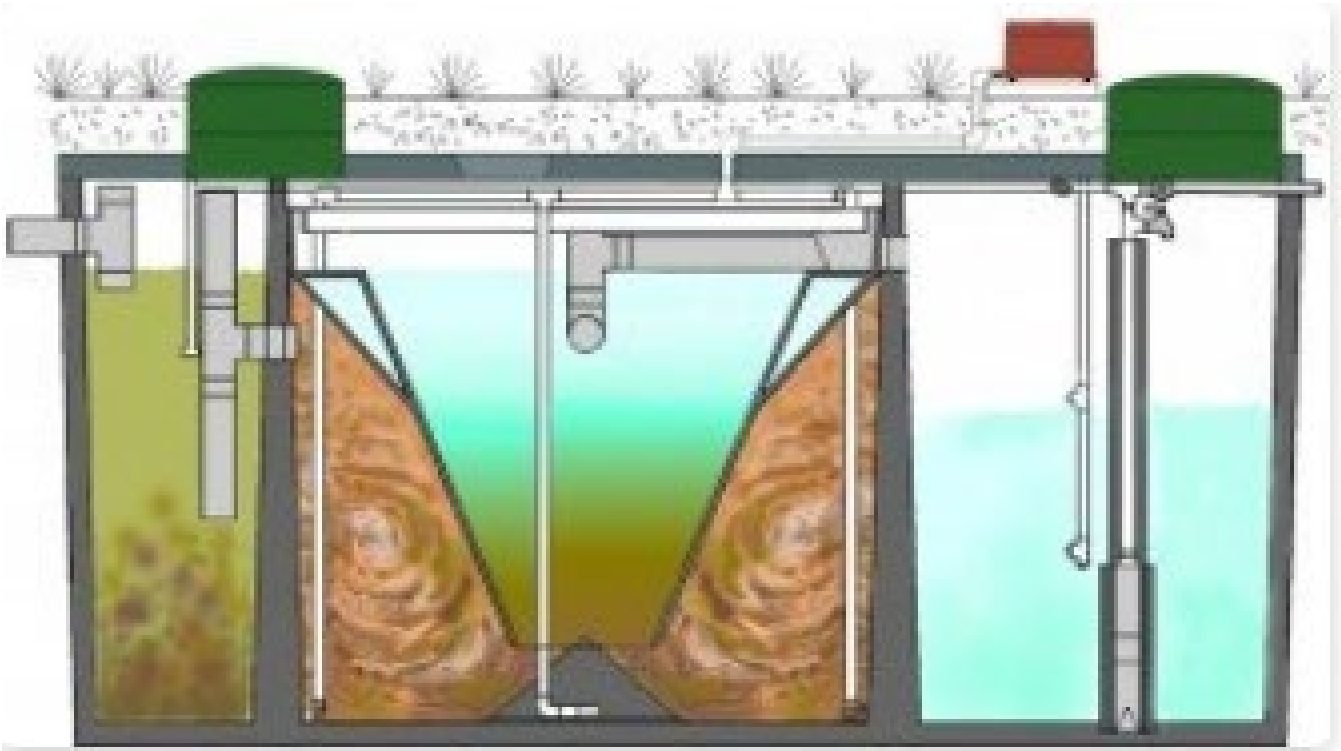
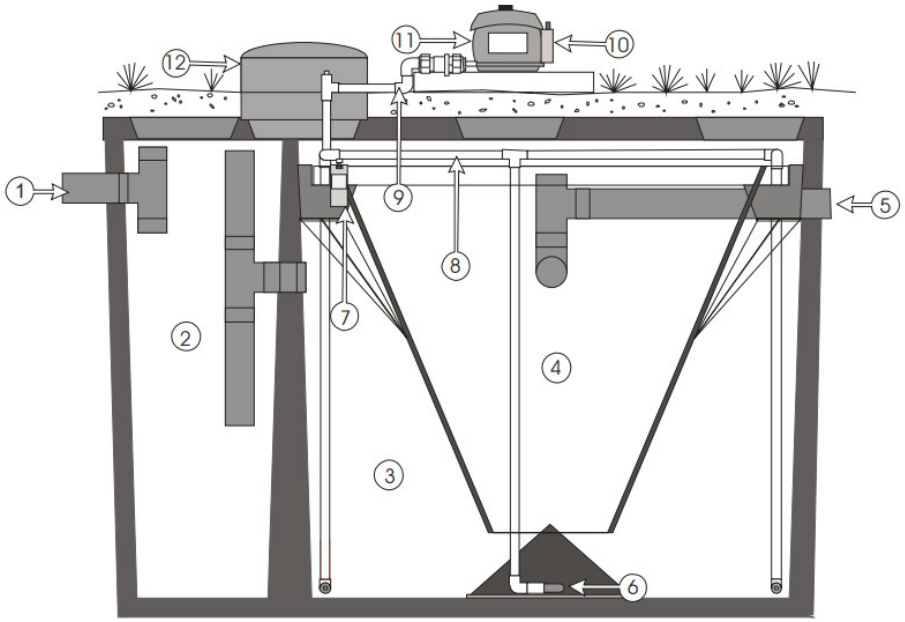
Commercial use

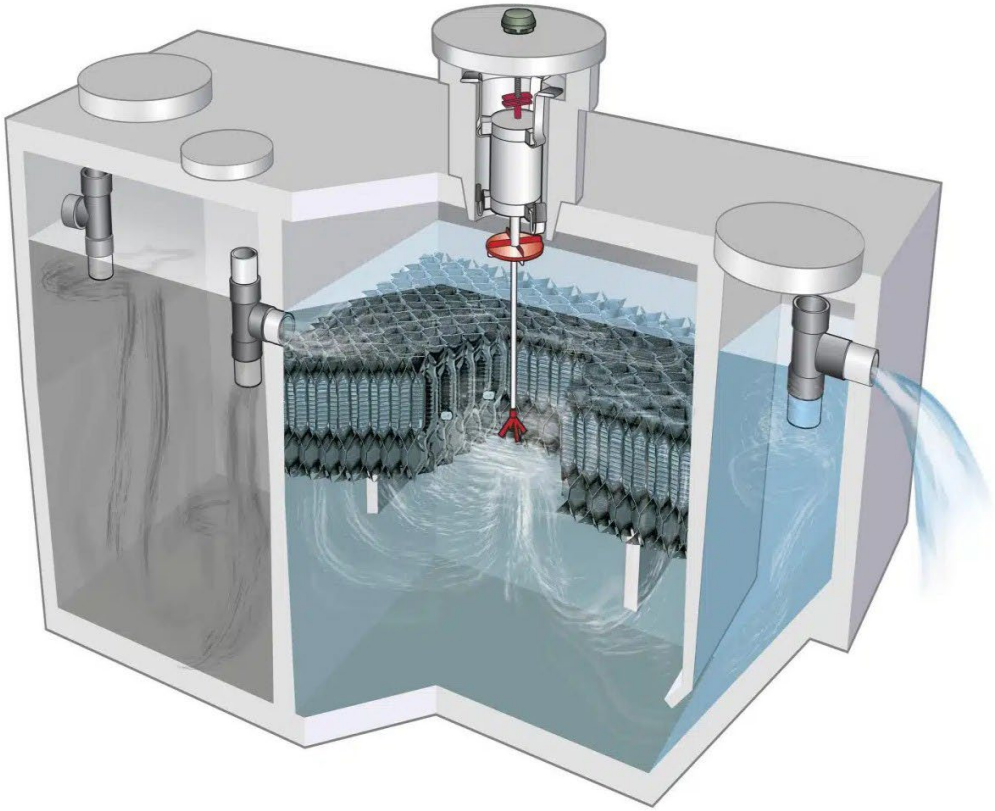
Hoot Systems



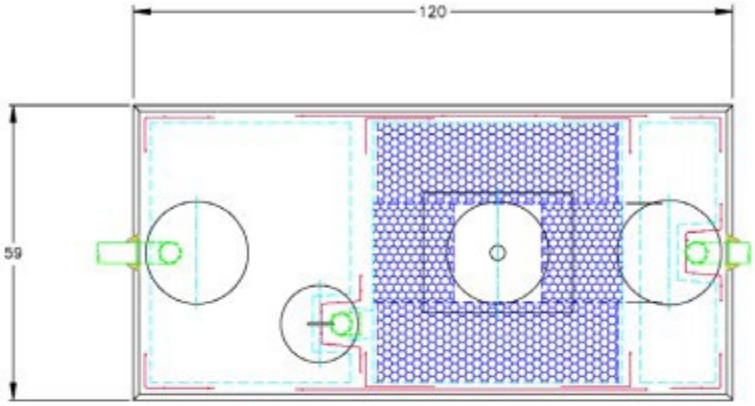


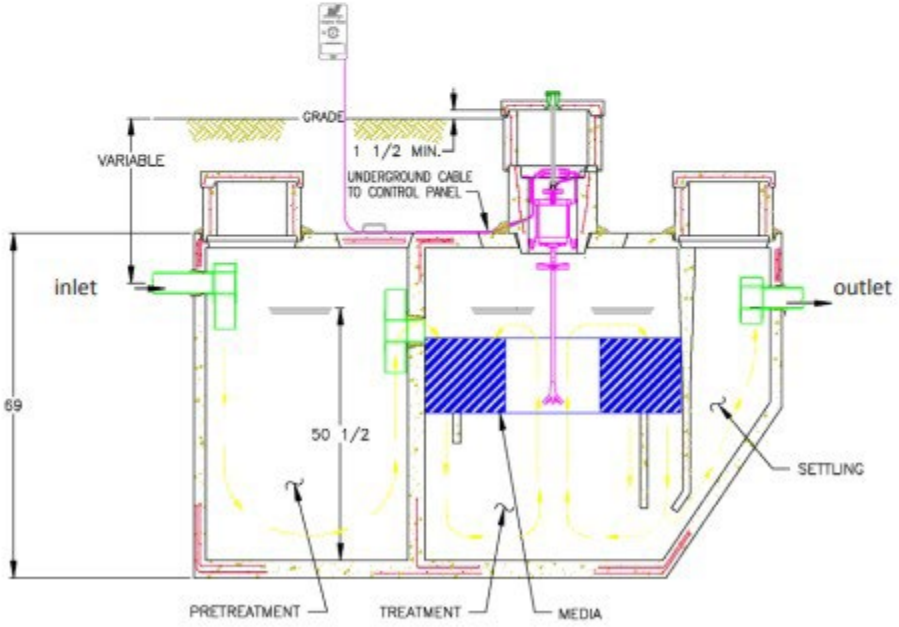
1. **Inlet:** Where sewage enters the system
2. **Pretreatment Tank**: Or Trash Trap, for Settling and Floating of non liquid waste.
3. **Aeration Chamber:** Where air is introduced to digest organic waste.
4. **Clarifier:** a still chamber where a clear, odorless, effluent rises.
5. **Outlet:** Where the treated effluent leaves the system.
6. **Diffuser:** How dissolved oxygen is added to the system.
7. **High Water Alarm:** Float that activates the high water alarm.
8. **Aeration Manifold:** How compressed air is delivered to the Diffusers.
9. **Air Line:** Delivers air to the aeration manifold and eventually the diffusers.
10. **Intergraded Alarm Panel**: Provides both High water and compressor failure alarms.
11. **Linear Air Compressor:** Provides the compressed air to operate the system.
12. **At Grade Access Riser:** Provides access to the Pre-Treatment, Aeration and Clarifier chambers for servicing and pump out.

Jet

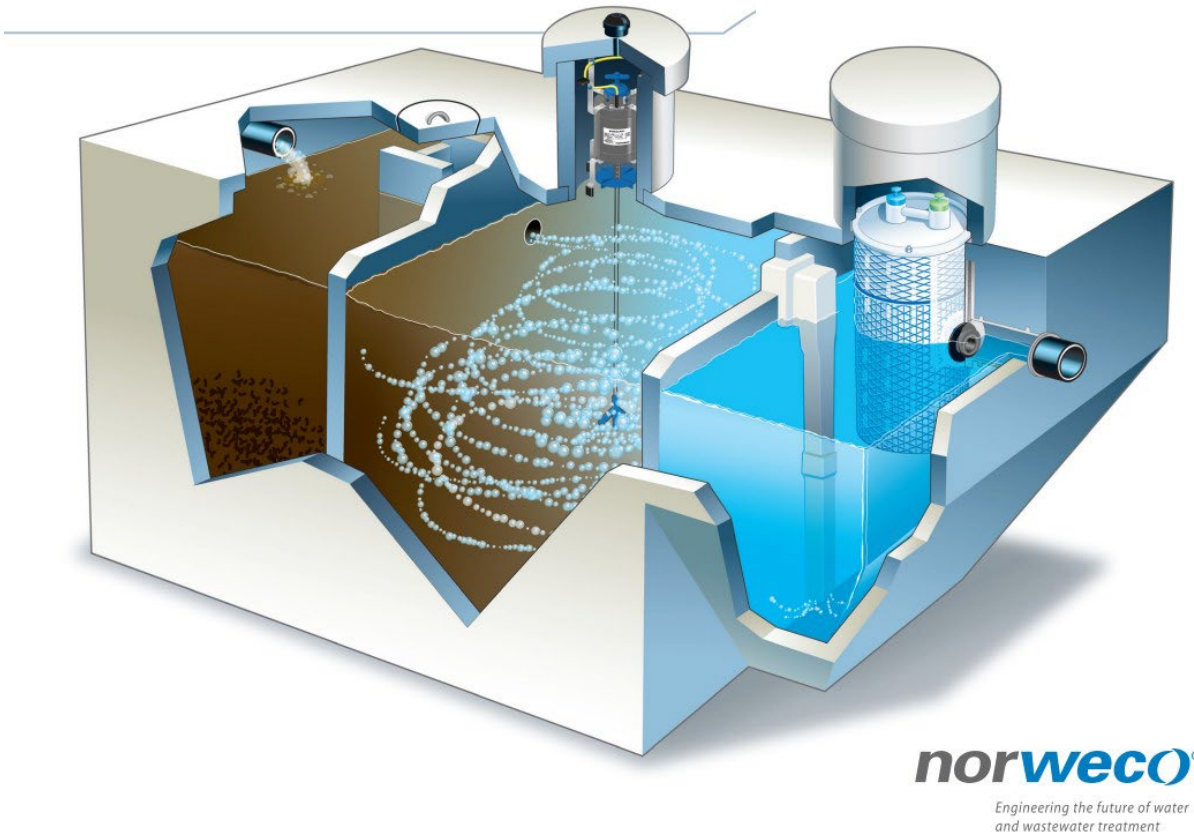


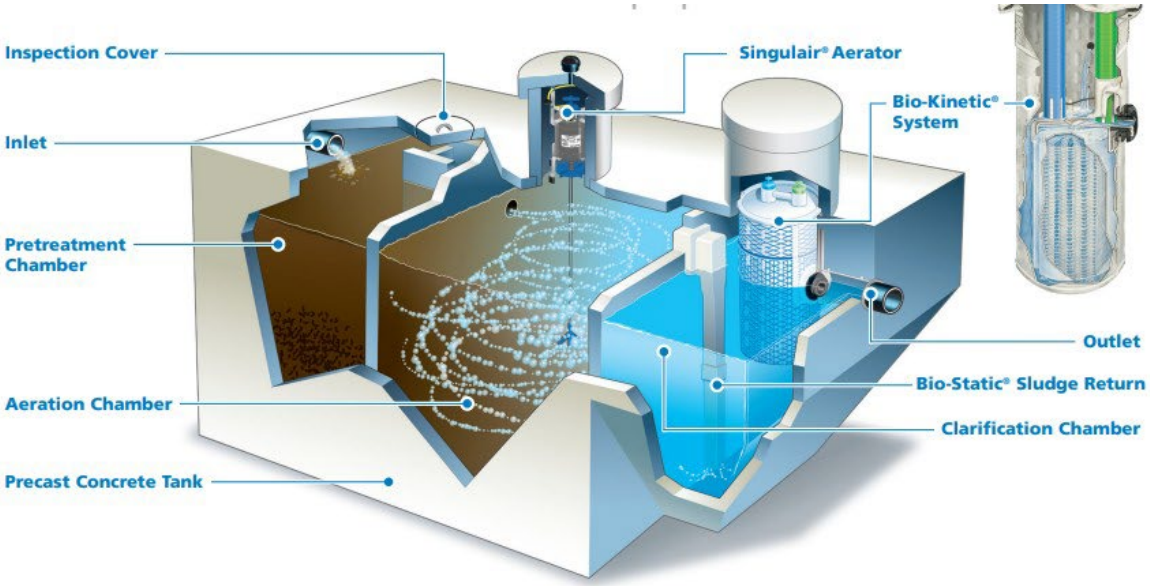
JET MODEL 500 THROUGH 800 GPD PLANTS





Norweco Singulair





Inlet
Untreated wastewater enters the system here.

Pretreatment Chamber
Wastewater enters at the Singulair inlet and is equalized here as anaerobic bacteria and gravity precondition it.

Aeration Chamber
Here, safe, living aerobic bacteria convert the wastewater into stable substances. Flow equalization maximizes this biological oxidation and assures 24-hour retention and treatment.

Aerator provides complete treatment
Our exclusive aerator infuses the fresh air that safe, living micro-organisms require to fully digest and treat wastewater inside the Aeration Chamber. Powered by our 1725 RPM, 115 volt, fractional horsepower motor, our quiet, reliable aerator is inexpensive to operate, reduces heat build up and dramatically increases bearing life. Each aerator is precision engineered, tested and certified to operate only 30-minutes per hour. Only the stainless steel aspirator shaft and reinforced nylon aspirator come in contact with liquid in the Aeration Chamber.

Clarification Chamber
Flow equalization enhances the settling of biologically active substances inside the Clarification Chamber. Wastewater has now been converted into clarified liquids in this chamber.

Flow Equalization Ports
They control the flow through all upstream and downstream processes and they regulate the amount of treated effluent that can enter the Bio-Kinetic System.

Bio-Kinetic® System
Constructed entirely of plastic and rubber components that are impervious to this environment, our Bio-Kinetic System combines filtration, settling, non-mechanical flow equalization, optional disinfection, adjustable outlet weir and optional dechlorination features into a single, revolutionary package.

Precast Concrete Tank
Every Singulair System is constructed of high quality, non-corrosive materials under our rigid quality control standards. The tank, access risers and cover are reinforced precast concrete manufactured locally by your factory-trained, licensed Norweco distributor.

Inspection Cover
Access is safe and easy.

Outlet
Only a clear, safe and odorless liquid exits the system here for return to your environment.

SERVICE PRO® Control Center

EVERY SINGULAIR AERATOR IS INSTALLED WITH A SOLID STATE ELECTRICAL CONTROL CENTER. EACH IS EQUIPPED WITH RESETTABLE CURRENT SENSOR, ON/OFF SELECTOR SWITCH, RED WARNING LIGHT, TIME CLOCK, AUDIBLE ALARM, AUXILIARY INPUTS AND FCC LICENSED AUTODIALER FOR REMOTE

Operation and Maintenance Considerations

System Access

- All above grade components should be accessible for maintenance
- Below grade components should be accessible with covers to grade
- Considerations should be made for sludge removal
  - Vertical sludge storage
  - Horizontal sludge storage
  - Pump back of sludge

ATU Access

a. Locate at grade

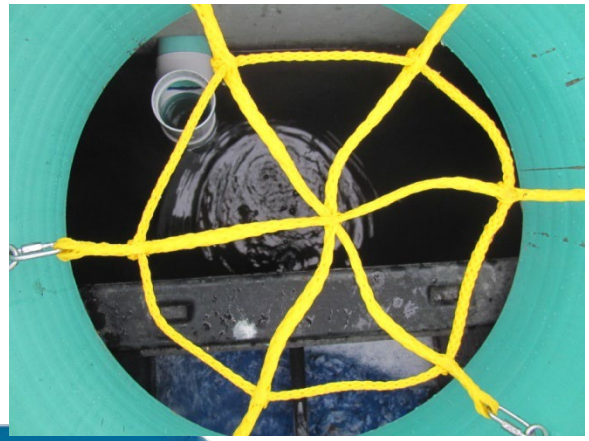
b. If not it should be

Conditions at the ATU

At grade access is important

ATU Access

- Provide Risers on tanks
- Prevent infiltration in the risers
- Lids should be securely fastened



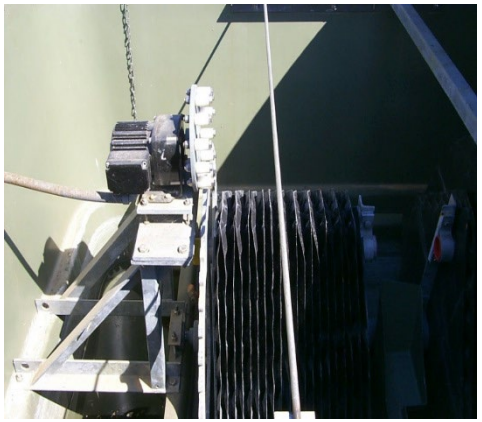
FAST system under driveway or parking lot

- At many installations, homeowners will place a mulch or flower bed over the FAST covers.

Air Supply

Air supply methods:

- ☐ Aspirator
- ☐ Aerator
- ☐ Compressor
- ☐ Blower
- ☐ Free Air

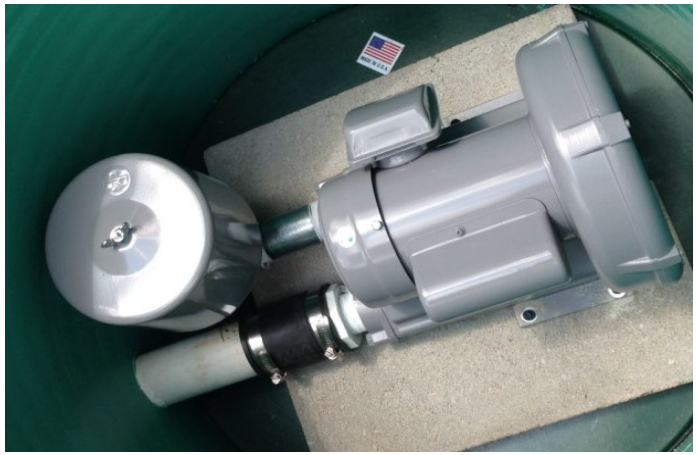


Aspirator/Aerator Access

- Vacuum pulls air into the water
- Spinning shaft or impeller causes the vacuum
- Check air flow
- Remove aerator
- Clean shaft

Blowers

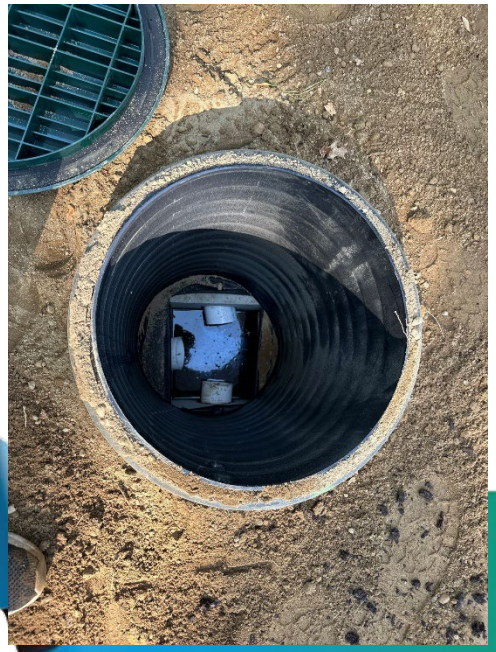
- Check Air flow
- Check inlet screens/filters



Option for blower placement near the home…

Underground Blower Vault

Residential Use
Mashpee, MA



What not to do…

What not to do…

What not to do…

Venting

Venting operation

- Air entering system
- Air must exit somewhere
  - Unit
  - Remote vent
  - Biofilter

Biofilter (Underground Vent)

FAST Underground Vent – Bed of stone, then perforated PVC is laid out – length is determined by the FAST unit size

Infiltrator/Cultec (any brand can be used) style leaching chamber is cut in half and placed over perforated PVC

Stone is placed on top of chamber; then hardwood woodchips to grade

Finished

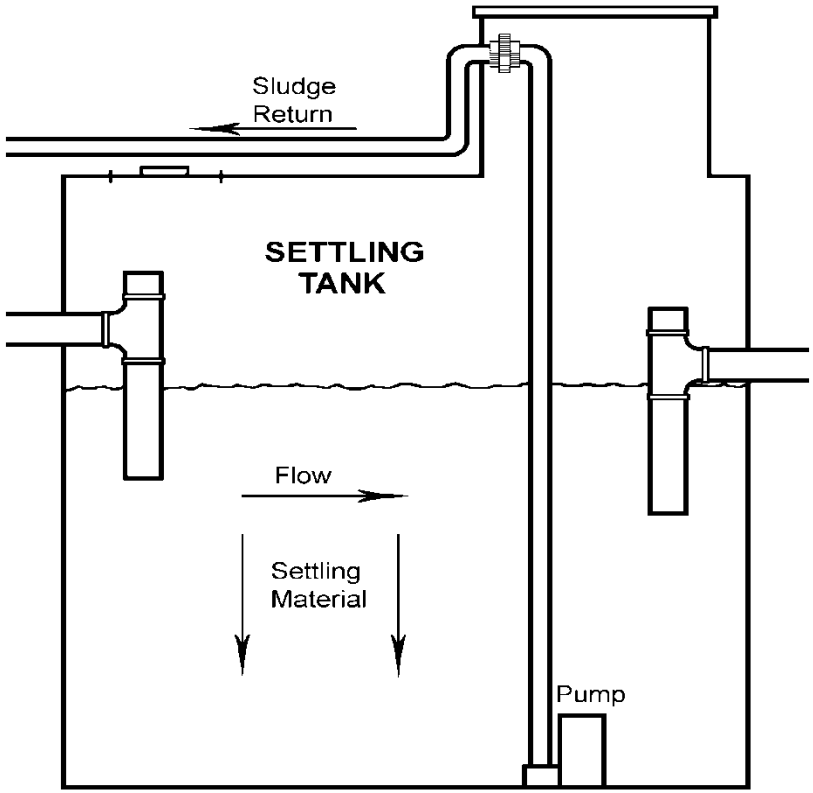
Sludge Return Operation

Note method for sludge return

Passive - Active

a. If active, pump was checked manually

b. Pump operating properly



Sludge Measurement

I/A System pumping

Control Panel and Alarm Options

a. Alarm(s) present

Types:

- High water
- Air pressure
- Remote

b. Alarm operation (auto reset)

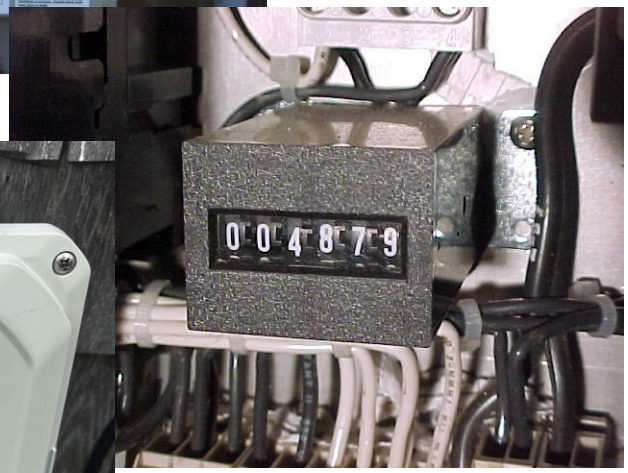
c. Other items

i. Elapsed time meter

ii. Cycle counter

d. Battery backup charged

e. Telemetry operational



Operating & Monitoring Manual

- An O & M manual should be provided.
- The O&M Manual should detail typical operation, troubleshooting and guidance for pumping
- The manual should also detail operational adjustments for effluent quality (i.e. testing practices, sample handling, etc.)
- Provide manuals for each component of the treatment train, if multiple manufactures products are used.
- MA also requires an Owners Manual to be available or provided

Operating & Monitoring Manual Considerations

Many manufacturers provide O & M procedures that are very practical

Checklist for Service Visit

a. Evaluate the presence of odor within 10 feet of perimeter of system:
    - None
    - Mild
    - Strong
    - Chemical
    - Sour

b. Source of odor?

Main Points to Remember
(maintenance should be simple)

KEEP THE SYSTEM RUNNING

(clean what is required)

MAKE SURE AEROATION IS OCCURING

(no air leaks/restrictions)

CHECK AMOUNT OF GROWTH & WATER LEVEL

LOOK AT THE EFFLUENT

(looks clear and clean)

PUMP THE SLUDGE

(monitor sludge in both compartments)

Lab Samples Collected for Monitoring

- Constituent monitoring
  - Regulatory requirements
  - Manufacturer requirements
  - Designer O&M requirements
- Collect, transport and store samples using standard procedures.
- Utilize approved laboratory for sample analysis
- Report information to proper entities

Reporting Requirements

- Copies of your report to:
  - Owner
  - Health Department
  - Your files
  - Others ?
- System failures must be reported ASAP
- Check regulations for requirements

Owner Education is Key to System Performance

- Service provider should encourage owners to learn about the system installed at their property
- Offer onsite meetings to go over their specific system in person
- Have available a list of items that should not be introduced to the system
- Owner education is imperative to maintain a positive and beneficial relationship
- Allows the owner to understand their system and share in the responsibility to keep it functioning as it should
- Any I/A systems ability to affectively treat wastewater is determined by the influent quality and characteristics of the wastewater coming in

NOTICE TO OCCUPANT

The wastewater that is produced by your residence or business is treated by FAST®, an advanced wastewater treatment system. The FAST® treatment unit is located on your property and is an on-site treatment system. Any on-site treatment and disposal system will work properly provided the occupants of the premises do not place harmful substances in the system. Therefore, certain standards must be followed in order to receive optimal performance from your FAST® system. You may be interested to know that most of these same standards are also important to follow even for those who are connected to a municipal or city sewer treatment system or conventional septic systems. Please refer to the list below for important information on how to help keep your treatment system performing as it should. In addition to these standards, all required maintenance must be completed in a timely manner.

DO NOT SHUT THE BLOWER OFF (Notify your maintenance provider if it appears to be functioning improperly or if you will be leaving the property for an extended period of time.)

DISINFECTANTS OR BLEACHES
Use in accordance with manufacturers recommendations and sparingly. Quaternary ammonia sanitizers (found primarily in commercial settings) or pine oil cleaners should not be used.

MEDICATIONS
Normal use of over the counter medications should not affect the system. However, strong antibiotics or chemotherapy drugs have been known to severely disrupt the treatment process. Please notify your service provider of this kind of issue so they may be aware of the reason for the system upset.

DETERGENTS
Should be low-suds, biodegradable, and low phosphate. (Some examples are: Arm & Hammer, ALL, and Ecolab® Products (commercial use))

PAPER PRODUCTS
Use white toilet paper products. Some natural bacteria do not eat color dyes in paper and therefore do not breakdown colored paper. Non-bleached paper (brown in color) takes a long time to breakdown due to the increased level of wood pulp.

NO TOILET BOWL TABLETS SHOULD BE USED.

NO DISCHARGE FROM WATER SOFTENERS SHOULD GO INTO THE SYSTEM.

NO ANIMAL FATS, SUCH AS BACON GREASE, LARD, OR ANY OTHER OILS SHOULD GO INTO THE SYSTEM. (Normal cleaning of pots and pans is acceptable).

NO DRAIN CLEANERS SHOULD BE USED. (Vinegar and baking soda mixed in the drain is a good substitute. As a last resort, chemical drain cleaners can be used, but use sparingly because they are toxic to the bacteria in the system.)

NO LIQUID FABRIC SOFTENERS SHOULD BE USED. (These products typically contain quaternary ammonia which is toxic to the bacteria. Please use dryer sheets.)

NO HARSH CHEMICALS OR TOXINS SHOULD BE PUT INTO THE SYSTEM
(i.e. Floor stripping waste / household paints / solvents / thinners / caustic cleaners / pesticides / herbicides etc.)

OBJECTS NOT TO BE PUT INTO THE SYSTEM

DISPOSABLE DIAPERS	CAT LITTER	SANITARY NAPKINS
BANDAGES	CIGARETTE BUTTS	AUTOMOTIVE FLUIDS
RAGS	STRING	STICKS
MUD	CONDOMS	PLASTICS
METAL OBJECTS	PAPER TOWELS	CORN COBS
ANIMAL BONES	MELON RINDS	COFFEE GROUNDS
HOME BREWERY WASTE	EGG SHELLS	OLD MEDICATIONS

Laundry Wash Loading
It is recommended that wash loads be spread throughout the week.

Septic Tank Additives, Enzymes, and Bacteria
Under normal circumstances these would be unnecessary with advanced treatment systems and not recommended for traditional septic systems.

Clean Effluent is the Goal!

Any Questions?

Thank you for your time!