

# Ecological Tanks, Inc.

Makers of

**Aqua Safe® and Aqua Aire®**

Advanced Wastewater Treatment Systems

## **Design Manual for Residential and Commercial Applications (including high strength wastes)**

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# Table of Contents

Table of Contents.....	Page 2
Introduction.....	Page 4
Design Criteria for Residential and Commercial Applications.....	Page 5
<b><u>Design Guidelines for Residential Applications</u></b> .....	<b>Page 7</b>
Pre-Treatment Chambers (residential).....	Page 8
Intermittent Use.....	Page 8
Heavy Use Applications (residential).....	Page 9
Multiple Family Dwellings.....	Page 10
<b><u>Design Guidelines for Commercial Applications, Including</u></b>	
<b><u>High Strength Waste Facilities</u></b> .....	<b>Page 14</b>
Design Considerations.....	Page 14
Characteristics and Strength of Wastewater to be Treated.....	Page 14
Pre-treatment facilities: trash tank, grease trap, pre-aeration .....	Page 15
Flow equalization.....	Page 16
Cluster Series of Aqua Safe® and Aqua Aire®.....	Page 16
<b><u>Table I: Guide for Estimating Sewage Flows from Residential and Non-</u></b>	
<b><u>residential Facilities</u></b> .....	<b>Page 5</b>
<b><u>Table II: Pre-treatment Tank: Single Family Dwellings</u></b> .....	<b>Page 9</b>
<b><u>Table III Pre-treatment Tank: Multiple Family Dwellings</u></b> .....	<b>Page 10</b>
<b><u>Table IV: Plant Sizing Guide for Aqua Safe® and Aqua Aire®</u></b>	
<b>Cluster Systems/Commercial (domestic</b>	
<b>strength waste)</b> .....	<b>Page 17</b>
<b><u>Table V: Treatment Capacity (lb BOD/day) for Each Model</u></b>	
<b>Of the Aqua Safe® and Aqua Aire®</b> .....	<b>Page 18</b>
<b><u>Table VI: Calculating the Organic Loading (lb BOD/day)</u></b> .....	<b>Page 18</b>
<b><u>Table VII: Determination of the Number and Models of Aqua Safe® and</u></b>	

Aqua Aire® plants to be Used For BOD loading exceeding  
3.75 lb BOD/day.....Page 19

Table VIII: Plant Sizing Guide for Commercial and High Strength  
Waste Applications (BOD>300 mg/l).....Page 20

Table IX: Timer Setting for Dosing Pumps for Flow Equalization.....Page 32

Table X: Aqua Aire® Cluster Series.....Page 35

Table XI: Aqua Safe® Cluster Series.....Page 36

**DIAGRAMS:**

Typical Layouts for Residential Applications.....Page 11

- Single family system without pre-treatment tank
- Single family system with pre-treatment tank
- Multiple family system with pre-treatment tank

Typical Layouts for Various Commercial Applications.....Page 21

- (Single plant) Gravity installation with pre-treatment tank
- (Single plant) Dosed system with pre-treatment tank and flow equalization tank
- (Single plant) Gravity system with pre-treatment tank and effluent pump tank
- (Multiple plants) Gravity flow with pre-treatment tank
- (Multiple plants) Dosed system, with pre-treatment tank and flow equalization
- (Multiple plants) Gravity system, with pre-treatment tank and effluent pump tank
- (Multiple plants) High strength waste design (i.e. restaurant)
- Office Building (restrooms only) / Retail shopping plaza w/out food service
- Mobile Home Park
- Multiple dosing tanks

Appendix A: Recommendation for Seasonal / Intermittent Use Facilities....Page 29

Appendix B: Flow Equalization Facilities.....Page 31

Appendix C: Operation and Maintenance of Commercial/High Strength  
Waste Facilities.....Page 33

## INTRODUCTION

The **Aqua Safe®** and **Aqua Aire®** aerobic treatment systems have been tested and certified to NSF Standard 40, for residential wastewater treatment systems. To achieve this certification, both models must demonstrate a capability to treat residential strength wastewater to a level less than 25 mg/l. of carbonaceous biochemical oxygen demand (CBOD); and 30 mg/l of total suspended solids (TSS). (Residential strength wastewater is defined as having a 30 day average strength of 100-300 mg/l CBOD and 100-300 mg/l TSS).

Although, the Standard 40 testing only addresses residential applications, both the **Aqua Safe®** and the **Aqua Aire®** plants can be used for a variety of wastewater applications, including single and multi-family residences, community systems and light commercial buildings. They can also be used on facilities that may generate high strength wastes, such as food service establishments. However, when treatment systems are designed for non-residential facilities, it is usually necessary to provide additional pre-treatment in order to overcome problems such as unusually high organic loading, as well as either organic or hydraulic “shock loads”. In some cases, it may also be advisable to provide some pre-treatment for residential systems in order to reduce unnecessary maintenance requirements.

This manual is to serve as a guide for designing both residential and commercial systems that use either the **Aqua Safe®** or the **Aqua Aire®**. While it provides tables to help you size different facilities, both residential and non-residential, always check with your State or local regulatory authority to insure you comply with their requirements.

## Design Criteria for Residential and Commercial Applications

In order to properly size an aerobic treatment system, it is necessary to provide both the hydraulic design figures (gpd), as well as the organic loading (lb BOD/day/unit). Since the **Aqua Safe®** and the **Aqua Aire®** were tested with residential strength wastewater, the rated treatment capacity of each unit indicates how many gallons/day of wastewater each can treat if you are only dealing with residential wastewater with a BOD of less than 300 mg/l. However, if you are designing for a non-residential system, it is imperative that you determine the total organic loading in lbs BOD/day in order to properly size the treatment plant. The following table includes both the hydraulic loading (gpd), as well as the organic loading (lb BOD/day/unit). Based upon these numbers, you can calculate the appropriate plant sizing required by using Tables IV and V.

**Table I: Guide for Estimating Sewage Flows  
from Residential and Non-residential Facilities**

<u>TYPE OF FACILITY</u>	<u>ESTIMATED SEWAGE FLOW (gal/unit/day)</u>	<u>BOD (mg/l)</u>	<u>BOD (lb/unit/day)</u>
Apartment	150 gal/bedroom	300	0.30 lb/bedroom
Assembly Hall (no kitchen)	5 gal/seat	300	0.01 lb/seat
Bowling Alley (no kitchen)	75 gal/lane	300	0.19 lb/lane
Church (no kitchen)	3 gal/sanctuary seat	300	0.01 lb/seat
Country Club (members)	50 gal/member	400	0.17 lb/member
Country Club (employees)	20 gal/employee	300	0.05 lb/employee
Drive-In Theater	5 gal/space	300	0.01 lb/space
Factory (no showers)	20 gal/employee	300	0.05 lb/employee
Factory (with showers)	35 gal/employee	300	0.09 lb/employee

**Food Service Facilities (Water meters should always be provided for any food service)**

Ordinary Restaurant	50 gal/seat	800	0.33 lb/seat
24-Hour Restaurant	75 gal/seat	800	0.50 lb/seat
Freeway Restaurant	100 gal/seat	800	0.67 /seat
Tavern (limited food)	30 gal/seat	400	0.10 lb/seat
Carry-out (single-service)	50 gal/seat	800	0.33 lb/seat
Fast Food Chain	100 gal/seat	800	0.67 lb/seat
Hospital (not incl. personnel)	200 gal/bed	400	0.70 lb/bed
Hospital personnel (additional)	20 gal/employee	300	0.05 lb/employee
Laundry (coin-operated)	400 gal/machine	600	2.00 lb/machine

**(NOTE: Aerobic treatment systems are not appropriate when the total flow consists of only grey water.)**

Mobile Home Park	200 gal/space	300	0.50 lb/space
Motel and Hotel (standard)	150 gal/room	300	0.38 lb/space Resort
hotel, cottage	75 gal/room	300	0.19 lb/room
Add for self-service laundry	400 gal/machine	600	2.00 lb/machine
Nursing Home (no kitchen /laundry)	100 gal/bed	400	0.30 lb/bed
Nursing Home personnel (add'l)	20 gal/employee	300	0.05 lb/employee
Office Building (per 8 hour shift)	20 gal/employee	300	0.05 lb/employee
Service Station	250 gal/urinal or toilet	300	0.63 lb/fixture
<b>Schools:</b>			
Day-type	15 gal/student	300	0.04 lb/student
Add for showers	5 gal/student	300	0.01 lb/student
Add for cafeteria	5 gal/meal	600	0.03 lb/meal
Add for employees	15 gal/employee	300	0.04 lb/employee
Boarding School	75 gal/student	300	0.19 lb/student
Shopping Center (no food service or laundry)	100 gal/1000 sq.ft. of floor space	400	0.30 lb/1000 sq.ft.
<b>Travel Trail or RV Park:</b>			
w/out water/sewer hook-ups	75 gal/space	400	0.25 lb/space
with water/sewer hook-ups	100 gal/space	400	0.30 lb/space

**NOTE: This Table is only a guide to be used when State/local sizing criteria are not available. Otherwise, follow your State and local requirements.**

# **Design Guidelines**

**For**

**Residential Applications, Including:**

- **Single-family**
- **Multiple-family**
- **Cluster Systems**

## Residential Applications

### Pre-Treatment Chambers:

Both the **Aqua Safe®** and the **Aqua Aire®** are certified to be used for residential applications either with a pre-treatment tank prior to the aeration chamber or without a pre-treatment tank. Some of the different plant models have an attached pre-treatment chamber (i.e. AS500+5DUO and the AA500-35). Other models do not have a pre-treatment chamber attached, but can incorporate a separate pre-treatment tank installed prior to the aerobic plant. When a separate pre-treatment tank is used, it should have a capacity equal to 50-100% of the design daily flow. The minimum capacity should be at least 325 gallons. **Tables II and III** give the recommended capacities for pre-treatment tanks for the different plant capacities.

The use of a pre-treatment chamber will usually improve the long-term operation and maintenance of the aerobic system by trapping grease, oils and other non-biodegradable materials. These materials do not readily break down and therefore can continue to accumulate in the aeration chamber, requiring more frequent pumping. A pre-treatment chamber can also help to buffer “shock” loading caused by heavy laundry use, garbage disposals or the possible occurrence of cleaning agents or disinfectants. A pre-treatment chamber may also help to minimize the effects of some medications. However, it is never advisable to dispose of medications and disinfectants into your treatment system if it can be avoided.

### Intermittent Use (i.e. weekend or seasonal use):

Both the **Aqua Safe®** and the **Aqua Aire®** can be used for residences that are not occupied on a year round basis. These include weekend get-aways, winter or summer cottages and other residential properties with limited use. For these applications, it is usually not advisable to install a pre-treatment tank. If a pre-treatment chamber is used, it should not exceed 50% of design capacity of the

treatment plant, with a minimum capacity of 325 gallons. Intermittent use installations normally maintain a fairly low level of aeration chamber solids. In this regard, the plant typically operates like a new installation and may be affected by “shock” loads. Refer to Appendix A for recommendations on the operation and maintenance, including start-up/shut-down procedures, for seasonal facilities.

**Heavy Use Applications (i.e. rental condominiums)**

Frequently, rental property (especially houses and condos located near the seacoasts) have a much higher occupancy than would be expected for the same property if it were owner-occupied. A three bedroom condo may be rented to as many as 8-10 people, for extended periods of time. Such rental properties are characterized by heavy water usage from showers and laundry. For these types of applications, it may be necessary to install a larger plant than would normally be required for the same building if it was owner-occupied. In all cases, it is advisable to install a pre-treatment tank prior to the **Aqua Safe®** or **Aqua Aire®** plant.

**Table II: Pre-treatment Tank: Single Family Dwellings**

<u># of Bedrooms</u>	<u>Pre-treatment tank*</u>	<u>Min. capacity of Aqua Safe®/Aqua Aire®**</u>
1-2	None recommended	500 gpd
3	325-500	500 gpd
4	450-600	600 gpd
5	750	750 gpd

\* A pre-treatment tank should always be used on any residence with a garbage disposal.

\*\* These capacities are based upon 150 gal/bedroom. You need to contact your State or local regulatory authority to determine if your local sizing requirements are different.

NOTE: The design capacity of the treatment plant indicates the **maximum** daily or hourly sewage flow that the plant can treat. **In most cases, the design average flow (D.A.F.) should be no more than 2/3 of the anticipated peak flow.** Due to intermittent heavy hydraulic loading, it may be necessary to provide flow equalization. Refer to Appendix B, or contact the factory for recommendations

**Multiple Family Dwellings**

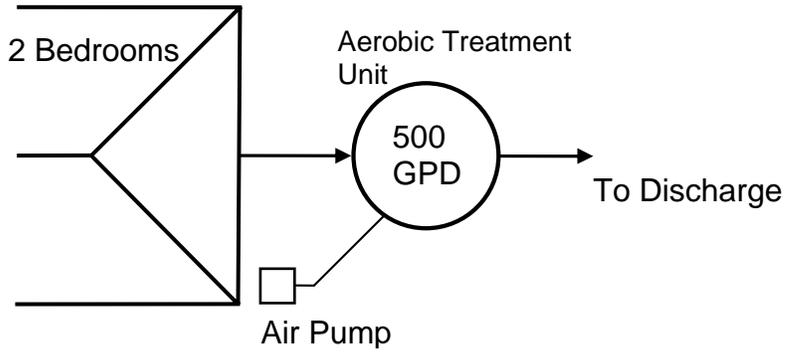
Frequently, it is more economical to cluster several dwellings together and then provide treatment in a single larger treatment plant. This is especially applicable when dealing with apartments, condos and rental cabins that have a common owner. Table III provides recommended plant sizing for different configurations of dwellings. Please note that these sizing recommendations assume 150 gal/bedroom. You will need to check with your local regulatory authority for your local sizing requirements.

**Table III: Pre-Treatment Tank: Multiple Family Dwellings  
(i.e. apartments and condos that are designed in clusters)**

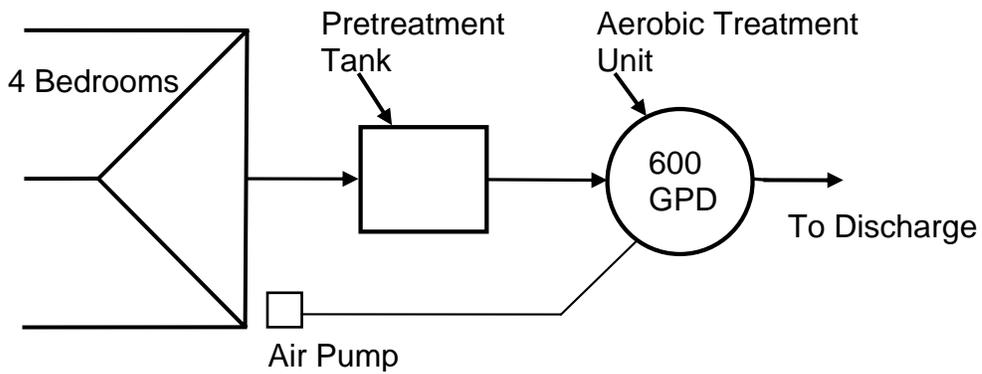
<u>Number of Units Per Cluster</u>	<u>Recommended Size of Pre-treatment Tank</u>	<u>Minimum Treatment Capacity of Aqua Safe®/Aqua Aire®</u>
<u>(2 bedroom units)</u>		
2 units (600 gpd*)	500 gallon	600 GPD (AS600/AA600)
3 units (900 gpd*)	750 gallon	1000 GPD (AS1000/AA1000)
4 units (1200 gpd*)	1000 gallon	1200 GPD (AS 1200/AA1200)
5 units (1500 gpd*)	1000 gallon	1500 GPD (AS 1500/AA1500)
<u>(3 bedroom units)</u>		
2 units (900 gpd*)	750 gallon	1000 GPD (AS1000/AA1000)
3 units (1350 gpd*)	1000 gallon	1500 GPD (AS1500/AA1500)

\*Total flow/cluster = #Bedrooms/unit x 150 gal/bedroom x #Units/cluster

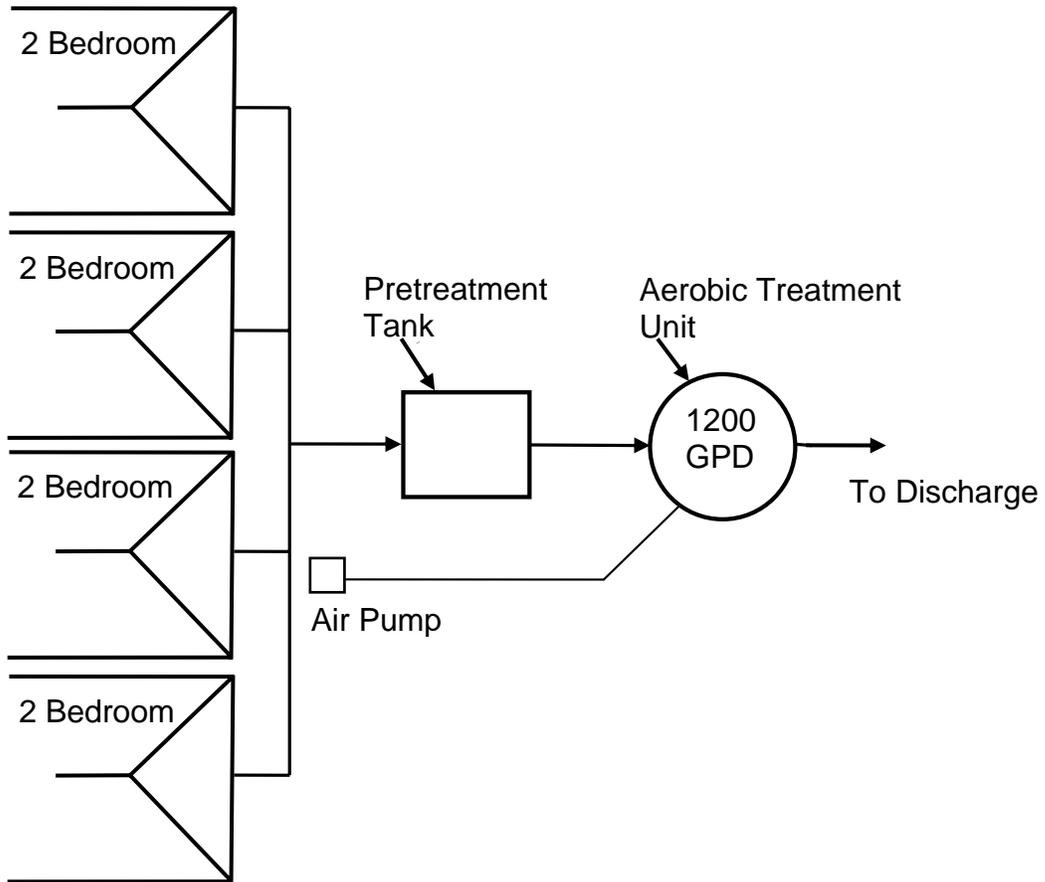
**Diagram A: Typical layout of Single family system w/out pre-treatment tank**



**Diagram B: Typical layout of Single tank family system with pre-treatment**



**Diagram C: Typical layout of Multiple family system**



**Design Guidelines**

**For**

**Commercial Applications,**

**Including High Strength Waste Facilities**

## Commercial Applications (including high strength waste)

### Design Considerations:

Both the **Aqua Safe®** and **Aqua Aire®** treatment plants can be used effectively to treat wastewater from commercial or non-residential facilities. However, it is important to understand that there are several differences between residential and non-residential (commercial) applications. These differences must be addressed in the design and maintenance of the treatment systems in order to avoid unnecessary operational problems. The following sections address these issues and describe how to design different non-residential systems.

### Characteristics and Strength of Wastewater to be Treated:

Typically, non-residential wastewater can have a higher organic strength than domestic wastewater due to reduced dilution from a lack of grey water (i.e. showers and laundry), high strength commercial cleaning agents, stripping compounds, as well as the presence of some type of food service. At the extreme end, almost all restaurants will generate wastewater that will be several times the strength of domestic sewage. Refer to **Table I** for the estimated organic strength of wastewater from different types of non-residential facilities.

In the design of systems that will treat high strength waste, it is necessary to calculate the total pounds of BOD that will be generated from the installation. By using **Table IV**, you can calculate the total lb. BOD/day to be treated and, in turn, determine the appropriate size of plant (**Aqua Safe®** or **Aqua Aire®**) that will be required. The rated hydraulic capacities that are indicated for each model assume residential strength waste, which has a BOD of less than 300 mg/l. As the BOD increases above 300 mg/l, you will not be able to treat the rated daily flow of the plant. For example, if you

are treating wastewater with a BOD of 600 mg/l, a 1000 gpd plant (AS1000 or AA1000) will only be able to treat 500 gallons of the high strength waste. This is because the higher strength wastewater requires more oxygen or longer retention time to treat or stabilize the waste.

### Pre-treatment Facilities:

In addition to increasing treatment plant capacity as a means to address high strength wastes, it is also advisable to provide some type of pre-treatment prior to the aerobic system. This can be accomplished in one or more ways:

- **Pre-treatment (trash) tank:** Commercial facilities typically are subject to greater user-abuse than residential systems. In this regard, a pre-treatment or trash tank can benefit plant performance by removing non-biodegradable materials, greases, oils and other materials detrimental to plant performance. The pre-treatment tank also liquefies the waste, making it more readily treated in the aerobic plant. Finally, if there are several waste streams (i.e. kitchen and restrooms) the pre-treatment tank allows mixing of these wastes to occur, reducing the “shock” effect to the treatment plant. For larger flows, it is preferable to use 2 tanks in series or a multiple compartment tank.
- **Grease Trap:** All food services require some type of grease removal. Generally, State or local requirements will establish specific criteria for sizing the grease traps. However, due to frequent use of emulsifying agents such as degreasers, conventional grease traps do not always remove significant amounts of the soluble grease. In these instances, it may be beneficial to aerate the grease trap in order to enhance the grease removal by air flotation. It is also advisable to pipe both the discharge from the grease trap and from the restrooms into the trash trap, which is installed prior to the aerobic tank.
- **Pre-aeration Tank:** For extremely high strength waste (> 600 mg/l), it is advisable to provide additional aeration ahead of the aerobic plant. This can be accomplished by installing a compressor and air line in the pre-treatment tank.

This will begin the aerobic process, as well as helping to remove some of the chemical cleansers and disinfectants.

- **Flow Equalization:** Many commercial facilities are characterized by extreme peak loading periods. Restaurants frequently discharge the majority of their design flow during 2, or possibly, 3 meal periods. During these peak periods, the plant may become anoxic due to the demand for oxygen exceeding the volume of oxygen supplied by the compressor.

Some facilities, such as churches, may generate the majority of their weekly flow during a few hours of a single day. Even office buildings, especially larger ones, discharge the majority of their daily flow during two or three peak periods (lunch and break periods) within an 8 hour operating day. Schools and daycare centers also have several peak periods during a short daily operating time. They also must accommodate lunch periods and showers. Hospitals and nursing homes are also subject to extreme peak loading periods, in addition to the use of medications and sanitizing agents.

To allow the aerobic plant to operate at its most optimum level, it is advisable to provide flow equalization prior to the plant. This requires the installation of a surge tank equal to at least 100% of the design peak flow. The sewage pumps installed in the surge tank are set to operate on a timed basis. Typically, the pump will dose 15-20 gallons/dose, at a frequency of 20-30 minute intervals.

- **Cluster Series of Aerobic Treatment Units:** For design flows that exceed 1500 gpd (domestic strength waste), multiple aerobic treatment plants can be installed in parallel. This will allow for the design of treatment systems to handle daily flows up to 9000 gpd. Refer to **Tables X and XI** for specifications on the **Aqua Safe®** and **Aqua Aire® Cluster Series**.

**TABLE IV: Plant Sizing Guide for Aqua Safe® and Aqua Aire®  
Cluster Systems/Commercial (domestic strength waste)**

The following chart provides the minimum hydraulic capacities of the Aqua Safe®/Aqua Aire® plants, as well as the recommended size of the pre-treatment tank for light commercial applications (without foodservice or laundry), and cluster systems (residential). These recommendations only apply to facilities with a waste strength < 300 mg/l BOD.

<u>Flow</u>	<u>Recommended Size of Pre-treatment Tank*</u>	<u>Minimum Capacity of Daily Aqua Safe®/Aqua Aire®</u>
0 – 500 gpd	350 gallon	500 gpd (AS500/AA500)
501 – 600 gpd	450 gallon	600 gpd (AS600/AA600)
601 – 750 gpd	750 gallon	750 gpd (AS750/AA750)
751 – 800 gpd	750 gallon	800 gpd (AS800/AA800)
801 – 1000 gpd	1000 gallon	1000 gpd (AS1000/AA1000)
1001 – 1200 gpd	1000 gallon	1200 gpd (AS1200/AA1200)
1201 – 1500 gpd	1000 gallon	1500 gpd (AS1500/AA1500)
1501 – 2000 gpd **	1500 gallon	(2) 1000 gpd (AS1000/AA1000)
2001 – 2400 gpd **	1500 gallon	(2) 1200 gpd (AS1200/AA1200)
2401 – 3000 gpd **	1750 gallon	(2) 1500 gpd (AS1500/AA1500)
3001 – 3600 gpd **	2000 gallon	(3) 1200 gpd (AS1200/AA1200)
3601 – 4500 gpd **	2500 gallon	(3) 1500 gpd (AS1500/AA1500)
4501 – 6000 gpd **	3000 gallon	(4) 1500 gpd (AS1500/AA1500)

\*For the larger flows, it is recommended that two (2) pre-treatment tanks in series be used. For example: 2, 1500 gallon pre-treatment tanks = 3000 gallons.

\*\*Refer to Tables IX and X for specifications on the Aqua Safe® and Aqua Aire® Cluster Series.

**Table V, Treatment Capacity (lb/BOD/day) for each model of the  
Aqua Safe® and Aqua Aire®**

<u>Aqua Safe®</u>	<u>Aqua Aire®</u>
Model AS 500 = 1.25 lb BOD/day	Model AA 500 = 1.25 lb BOD/day
Model AS 600 = 1.50 lb BOD/day	Model AA 600 = 1.50 lb BOD/day
Model AS 750 = 1.85 lb BOD/day	Model AA 750 = 1.85 lb BOD/day
Model AS 800 = 2.00 lb BOD/day	Model AA 800 = 2.00 lb BOD/day
Model AS 1000 = 2.50 lb BOD/day	Model AA 1000 = 2.50 lb BOD/day
Model AS 1200 = 3.00 lb BOD/day	Model AA 1200 = 3.00 lb BOD/day
Model AS 1500 = 3.75 lb BOD/day	Model AA 1500 = 3.75 lb BOD/day

**Table VI, Calculating the Organic Loading (lbs/BOD/day)**

$$\text{Total lbs of BOD} = \frac{(\text{a}) \text{ GPD} \times (\text{b}) \text{ mg/l BOD} \times 8.34 \text{ lb/gal.}}{1,000,000}$$

(a) = Daily Average Flow (D.A.F.) in gallons/day (refer to State/local Code)

(b) = Concentration of BOD in mg/l (refer to Table I)

Example: 20 seat restaurant = 20 seats x 50 gal/seat (from Table I) = 1000gpd

$$\text{BOD loading} = \frac{1000 \text{ gpd} \times 800 \text{ mg/l (from Table I)} \times 8.34 \text{ lb/gal}}{1,000,000}$$

$$= 6.7 \text{ lb BOD/day}$$

Note: Another way to calculate the daily BOD loading is to multiply the number of seats (20) by 0.35 lb BOD/seat (from Table I): 20 seats x 0.35 lb BOD/day = 7 lb/day.)

**Table VII: Determination of the number and models of Aqua Safe® or Aqua Aire® plants to be used for BOD loadings exceeding 3.75 lb BOD/Day**

- (1) Calculate the total lbs. of BOD to be treated.
- (2) Divide the total lbs/day of BOD to be treated, by the lbs/BOD/treatment plant for the Aqua Safe® or Aqua Aire® model that will allow you to use the fewest plants in order to equal or slightly exceed the minimum required lbs of BOD/day.

**Example:**

To determine the number of plants (and the model), divide the total lb BOD/day to be treated (i.e. 6.7 lb BOD) by the total lb BOD/day that can be treated by a Model AS 1500 (i.e. 3.75 lb BOD/day). Whenever this results in a fraction, always go to the next higher whole number.

$$\frac{6.7 \text{ lb BOD/day}}{3.75 \text{ lb BOD/day (Model AS 1500)}} = 1.8 \text{ (therefore, it will require 2, AS 1500 plants)}$$

(Refer to Tables IX and X: Aqua Safe® and Aqua Aire® Cluster Series)

Occasionally, a designer may wish to use smaller plants to provide the required treatment capacity. Although, this will require more individual plants, it will allow for future expansion of the treatment system to be accomplished more gradual increments. Regardless of the size and number of the individual plants that comprise the total treatment system, the total treatment capacity must equal or exceed the total BOD requirements of the facility during peak operating periods.

## TABLE VIII: Plant Sizing Guide for Commercial and High Strength Waste Applications (BOD>300 mg/l)

Note: The following Table is to be used to size system components of facilities that generate high strength waste discharges that exceed 300 mg/l. Typically, this will apply to food service facilities.

(Column 1) <u>Avg. Daily Loading</u> <u>lb BOD/Day</u>	(Column 2) <u>Peak Loading</u> <u>lb BOD/Day</u>	(Column 3) <u>Grease Trap</u> <u>(if required)</u>	(Column 4) <u>Pre-aeration</u> <u>Tank</u>	(Column 5) <u>Surge Tank</u> <u>Capacity</u>	(Column 6) <u>Treatment Plant</u> <u>Models</u>
0.85 lb BOD	1.25 lb BOD	750 gal.	750 gal.	1000 gal	(1) AS/AA 500
1.00 lb BOD	1.50 lb BOD	750 gal.	750 gal.	1000 gal.	(1) AS/AA 600
1.25 lb BOD	1.85 lb BOD	750 gal.	750 gal.	1000 gal.	(1) AS/AA 750
1.35 lb BOD	2.00 lb BOD	750 gal.	750 gal.	1000 gal.	(1) AS/AA 800
1.65 lb BOD	2.50 lb BOD	1000 gal.	1000 gal.	1000 gal.	(1) AS/AA 1000
2.00 lb BOD	3.00 lb BOD	1200 gal.	1200 gal.	1200 gal.	(1) AS/AA 1200
2.50 lb BOD	3.75 lb BOD	1500 gal.	1500 gal.	1500 gal.	(1) AS/AA 1500
3.35 lb BOD	5.00 lb BOD	(2) 1000 gal.	2000 gal.	2000 gal.	(2) AS/AA 1000
4.20 lb BOD	6.25 lb BOD	(2) 1250 gal.	2500 gal.	2500 gal.	(2) AS/AA 1500
5.00 lb BOD	7.50 lb BOD	(2) 1500 gal.	3000 gal.	3000 gal.	(3) AS/AA 1000
6.00 lb BOD	8.75 lb BOD	(2) 1750 gal.	3500 gal.	3500 gal.	(3) AS/AA 1200
6.50 lb BOD	10.00 lb BOD	(2) 2000 gal.	4000 gal.	4000 gal.	(3) AS/AA 1500
7.50 lb BOD	11.25 lb BOD	(2) 2250 gal.	4500 gal.	4500 gal.	(3) AS/AA 1500

Column 1: (For existing facilities) These numbers are based upon the highest 30 day average gal/day values.

Column 2: (For existing facilities) These numbers represent 150% of the avg. daily flow.

(For new facilities) These numbers represent the maximum daily flow as determined by State or local codes; or Table I, applicable.

Column 3: These are recommendations for sizing grease traps on facilities that include a food service as a major part of the daily flow. Always comply with State or local requirements when applicable.

Column 4: Minimum of 750 gallons or 100% of peak daily flow, assuming domestic strength sewage.

Column 5: 100 % of peak daily flow, assuming domestic strength sewage.

Column 6: AS refers to Aqua Safe® model. AA refers to Aqua Aire® model.

# Typical Layouts for Various Commercial Applications

## Single Tank Designs:

Diagram D: Gravity installation with pre-treatment tank (side and top views).

Diagram E: Dosed system, with pre-treatment tank and flow equalization tank (side and top views).

Diagram F: Gravity system, with pre-treatment and pump tanks (side and top views).

## Modular tank design (showing multiple aerobic treatment plant for higher flows):

Diagram G: Gravity flow with pre-treatment tank and multiple treatment plants (top view).

Diagram H: Dosed system, pre-treatment tank, flow equalization tank and multiple treatment plants (top view).

Diagram I: Multiple treatment plants, with pre-treatment tank and effluent pump tank (top view).

## Typical Commercial Applications:

Diagram J: High strength waste design (food service), with grease trap, pre-treatment tank (optional pre-aeration), flow equalization tank and multiple treatment plants (top view).

Diagram K: Office building (restrooms only) / Retail shopping plaza w/out food

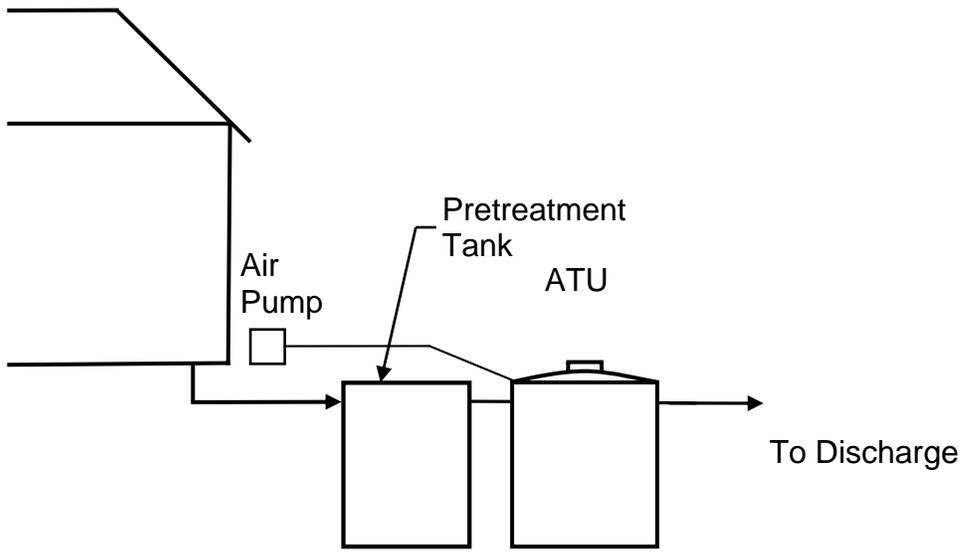
Diagram L: Mobile Home Park

## Dosing Tanks:

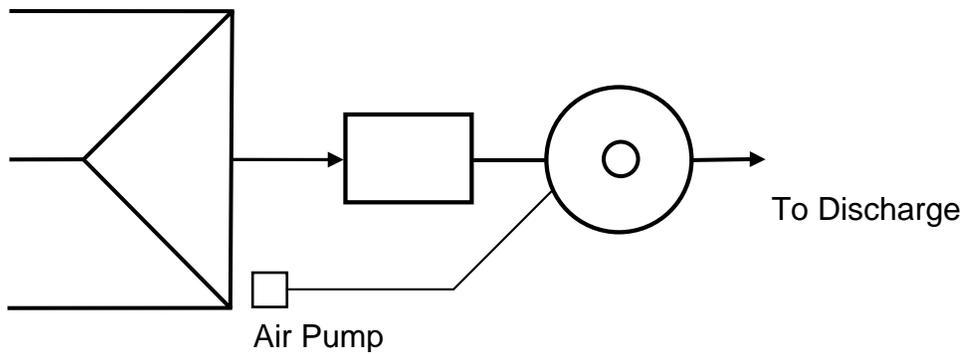
Diagram M: Multiple dosing tanks in series

**Diagram D: Gravity installation, with pre-treatment tank**

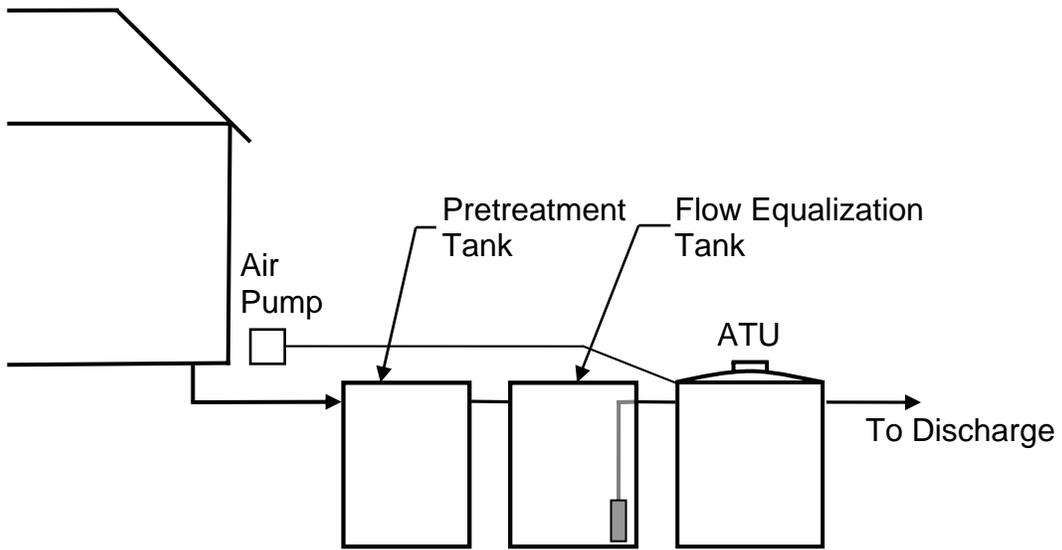
**(Side View)**



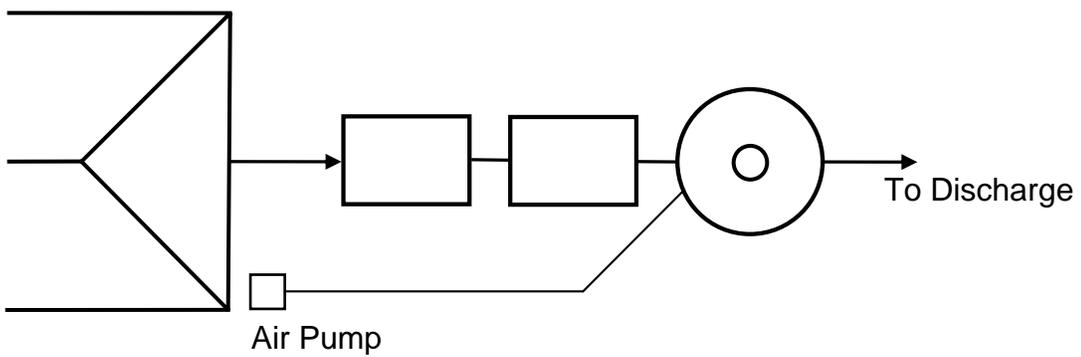
**(Top View)**



**Diagram E: Dosed system, with pre-treatment tank and flow equalization tank (Side View)**

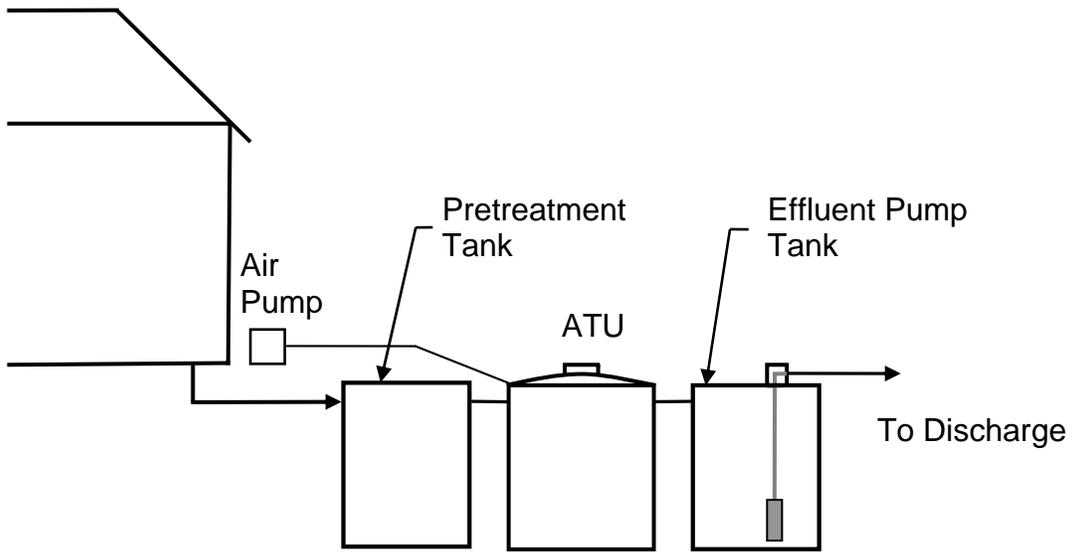


**(Top View)**

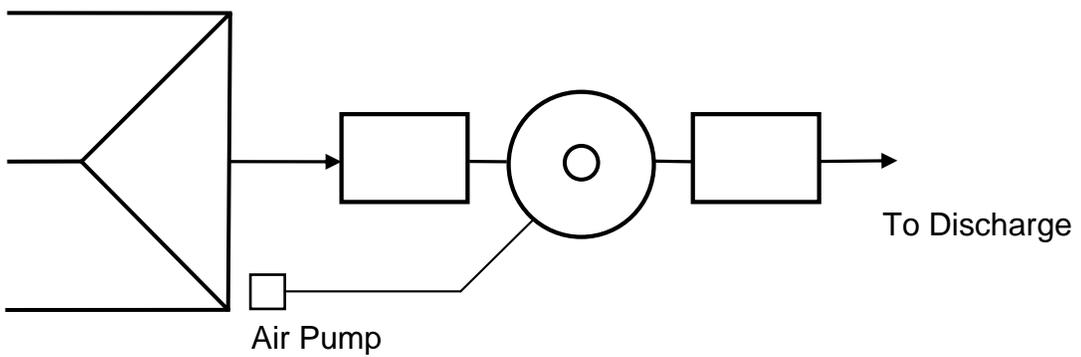


**Diagram F: Gravity installation, with pre-treatment tank and effluent pump tank**

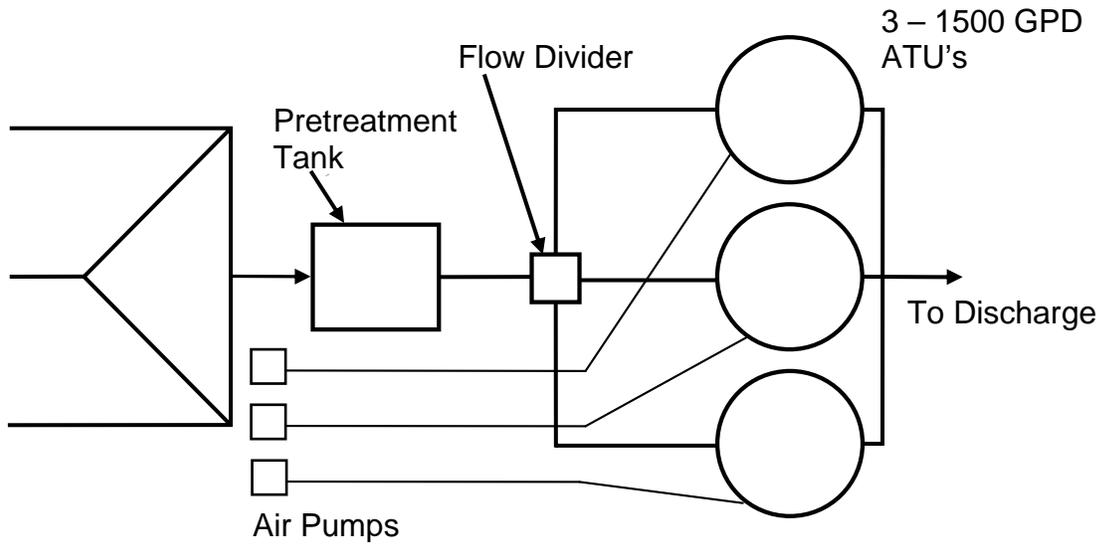
**(Side View)**



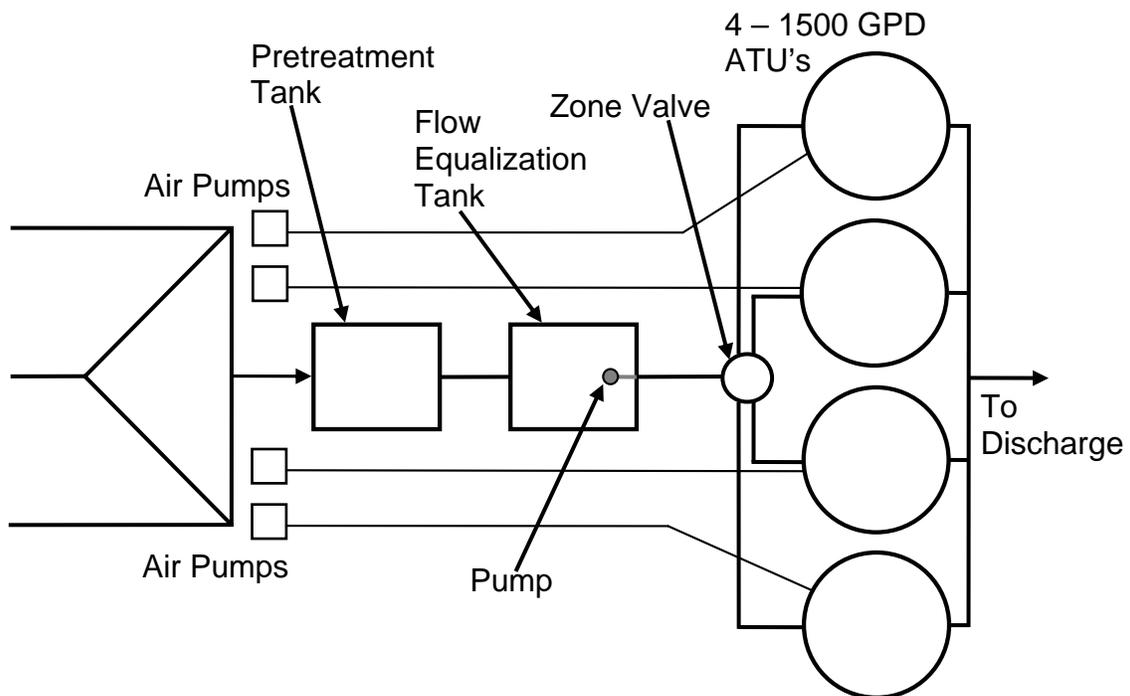
**(Top View)**



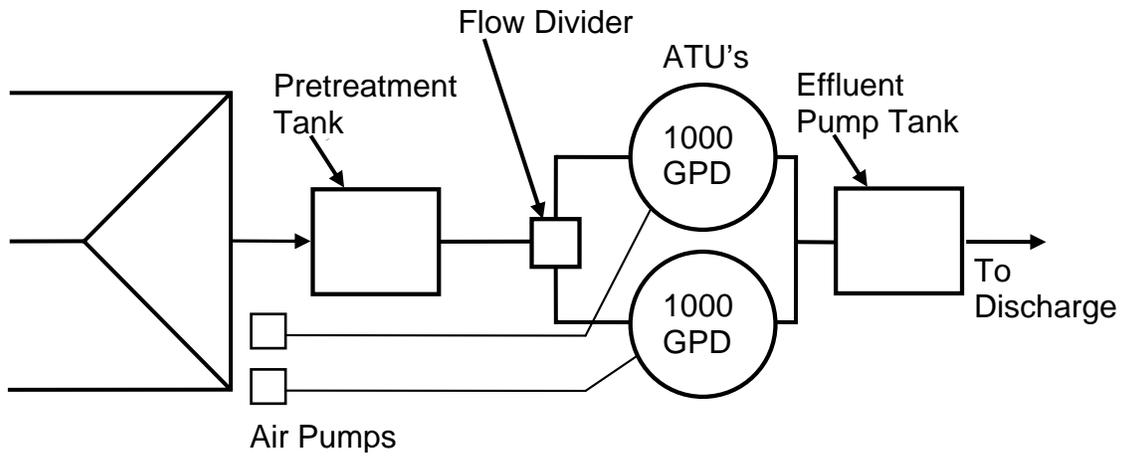
**Diagram G: Gravity flow with pre-treatment tank and multiple treatment plants**



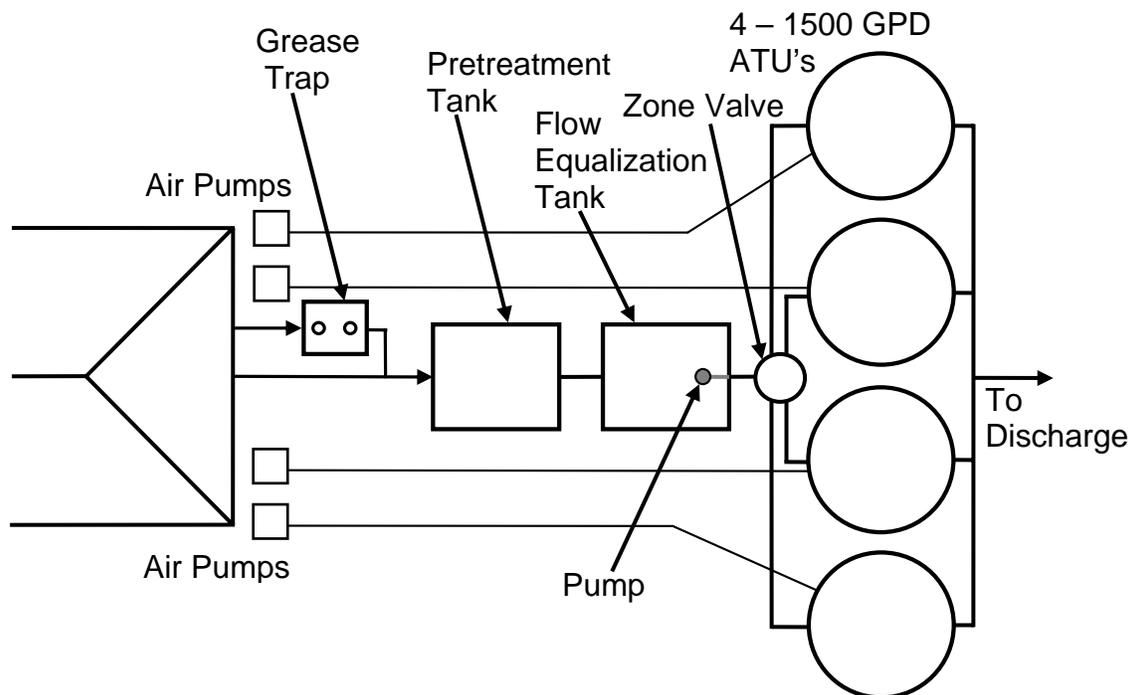
**Diagram H: Dosed system, with pre-treatment tank, flow equalization tank and multiple treatment plants**



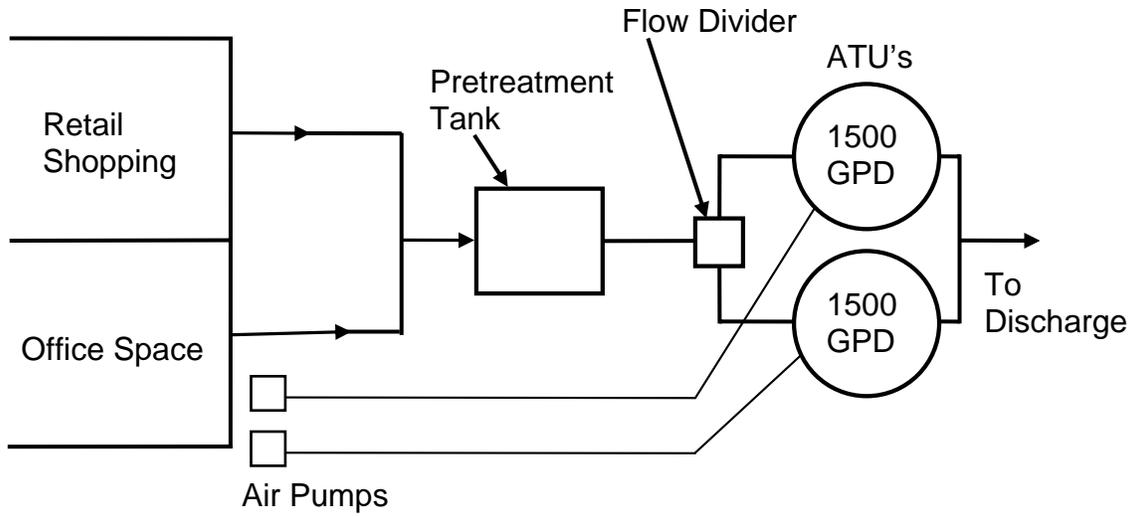
**Diagram I: Multiple treatment plants, with pre-treatment tank and effluent pump tank**



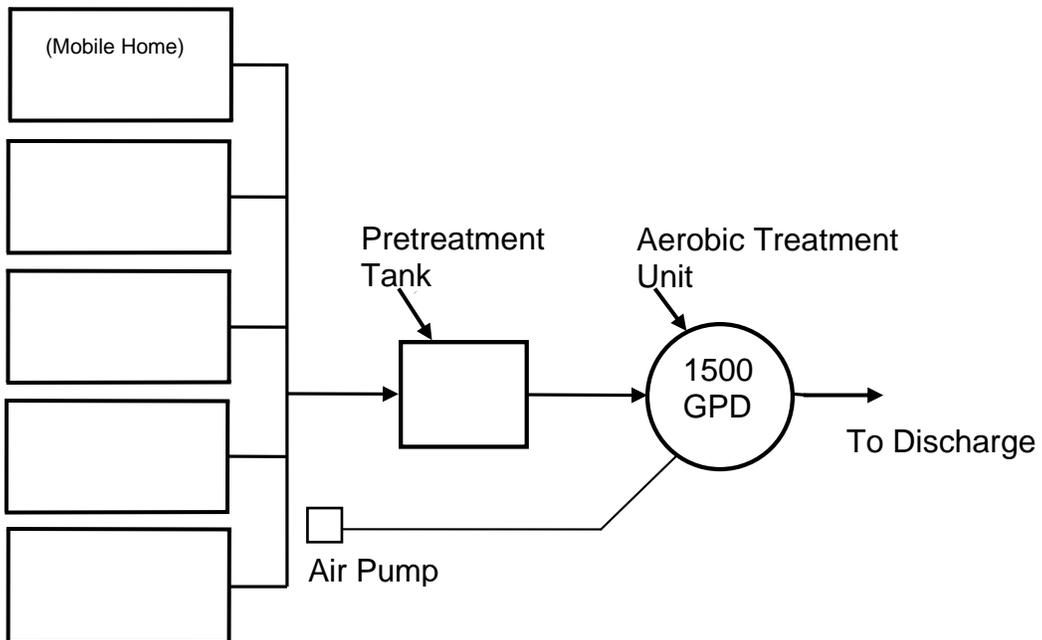
**Diagram J: High strength waste design (food service), with grease trap, pre-treatment tank (optional pre-aeration), flow equalization tank and multiple treatment plants**



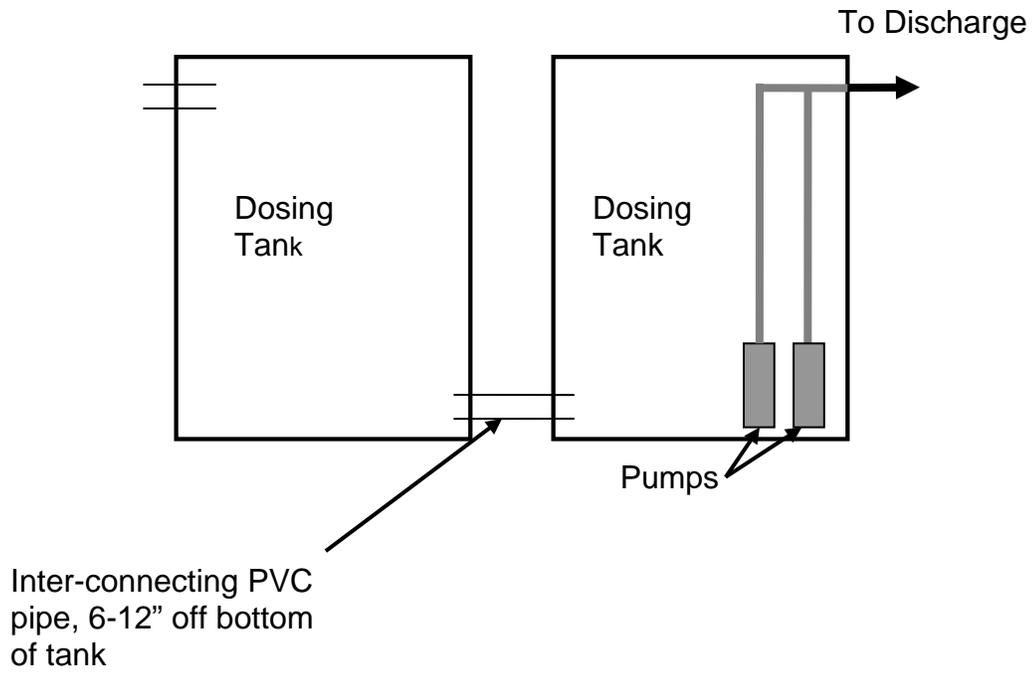
**Diagram K: Retail shopping plaza / Offices (no food service/laundry)**



**Diagram L: Mobile Home Park**



**Diagram M: Multiple Dosing Tanks, Connected at the Bottom**



## Appendix A

### Recommendations for the Use of the Aqua Safe® or Aqua Aire® Treatment Plants for Seasonal/Intermittent Use Facilities

Both the Aqua Safe® and Aqua Aire® wastewater treatment systems can be used on seasonal and intermittent use residences and certain types of commercial facilities such as summer camps and campgrounds. These types of installations are characterized by low volume usage and intermittent flows, which require some modification in the operation and maintenance procedures.

Seasonal Facilities: This type of facility is characterized by several months of normal operation, followed by several months of inactivity. If the periods of inactivity exceed 2-3 months, a “start-up/shut-down” maintenance schedule should be established. To shut down or winterize the system, the authorized Aqua Safe® or Aqua Aire® service representative should do the following:

1. Disconnect power to the compressor and alarm.
2. Remove the compressor and store in a dry location.
3. Pump out the solids from the plant(s) and fill with clear water. In some cases, it may be possible to allow the plant to continue to run after the occupants have left. Generally, in a week or two, the volatile organic solids are converted to inert material that is no longer susceptible to anaerobic decomposition. At this point, the plant can be shut down in accordance with items 1 and 2.
4. In freezing climates, the liquid level should be pumped down to a level below the inlet and outlet structures. Food grade anti-freeze should be added and thoroughly mixed, in order to prevent freezing.

Intermittent Use Facilities: Weekend cabins and vacation homes frequently are used on a year-round basis, but not continuously. They may be used for 2-3 days or 2-3 weeks, followed by several days or weeks of non-use. Because of the light and intermittent usage, treatment plants serving these facilities are characterized by light organic loading and subsequent low solids build-up.

1. Weekend Use: Normally, the waste treatment system that serves weekend cabins can be allowed to run continuously. However, in order to conserve electricity, the owner may wish to install a timer on the compressor that is set to run for 2-4 hours each day. During the weekend, the occupant will want to by-pass the timer to allow for continuous aeration.

Important: Always contact the factory before installing a timer.

2. Vacation Homes: Depending on the length of inactivity, vacation homes can either be shut down (refer to procedures under “seasonal facilities”), or, be allowed to run (possibly with a timer). If the residence is unoccupied for longer than 2-3 months, it should be shut down, but the compressor doesn’t need to be removed if the period of non-use does not exceed 2 months.

Use of a pre-treatment tank: Because of the light loadings that seasonal and intermittent systems receive, it is usually not advisable to install pre-treatment tanks in front of the Aqua Safe® plant.

## Appendix B:

### Flow Equalization Facilities

Various types of commercial establishments and occasionally, some large residential applications, are characterized by large, short-term hydraulic loading peaks. Such peak flows can reduce the settling characteristics of the clarifier, increasing the quantity of suspended solids in the effluent. These peak flows can also increase the short-term organic loading to the treatment plant to a point where the oxygen requirements temporarily exceed the volume of oxygen provided by the compressor. This can create anoxic conditions in the treatment plant, allowing undesirable organisms to get established, resulting in poor treatment, odors and other deleterious conditions to occur. Such facilities include restaurants, schools, nursing homes, hospitals, vet clinics and even large office buildings. Other types of facilities, such as churches and meeting halls, typically generate a large percentage of their weekly flow in one or two days, with very little flow occurring during the rest of the week.

The use of flow equalization facilities will minimize the effect of short term peak loading periods by dosing small quantities of wastewater into the plant throughout a 24 hour period. Such facilities can also be used to store one day flows from churches and meeting halls, and dose the plant over 3-4 days, thereby reducing the required capacity of the treatment plant (and disposal field), as well as providing food for the plant organisms during periods of inactivity. Flow equalization facilities may also be advisable on some large residential applications, if their social agenda results in periodic large hydraulic flows during the owner's entertaining.

#### Components of a flow equalization system:

- Surge Tank: The surge tank's purpose is to hold the majority of a day's flow and allow it to be dosed in small, pre-determined quantities into the treatment plant. For this reason, the minimum capacity of the surge tank should be at

least equal to 100% of the peak daily flow. For larger flows, it is possible to use multiple tanks of smaller capacities, that are connected together at the bottom of the tanks (refer to Diagram M).

- Pumps: Duplex pumps should always be used for commercial applications. A pre-treatment tank should be installed prior to the surge tanks to prevent large solids from entering the pump tank. This will allow the use of smaller, sewage handling (2" solids) pumps, rather than grinder pumps. The pumps should be activated by a timer that will allow for short operating periods of no more than 1-2 minutes, followed by 30-60 minute rest periods. It is not advisable for the dosing pumps to run continuously, since this will reduce the settling efficiency of the clarifier. (Contact Ecological Tanks, Inc. for assistance in choosing the appropriate pump and timer control.)

**Table IX : Timer Settings for Dosing Pumps (flow equalization).**

<u>Maximum Daily Flow (gpd)</u>	<u>Number of Doses/Day</u>	<u>Gallons/Dose</u>
500	24	21
600	28	21
750	36	21
800	36	22
1000	48	21
1200	48	25
1500	60	25

## Appendix C

### Operation and Maintenance of Commercial/High Strength Waste Facilities

Restaurants and other facilities that generate high strength waste discharges, are characterized by the presence of detergents, emulsifiers and sanitizers in their waste stream, in addition to greases, oils and other food products. Not only do these chemicals create a high oxygen demand, but they are also toxic in nature and either inhibit or prevent bacterial growth. This can impact on the treatment plant's ability to achieve normal start-up. Depending on the type and concentration of the chemical additives, it may be difficult for the plant to develop sufficient numbers of viable organisms necessary to buffer the plant against shock loads. As a result, treatment plants that serve facilities that generate high strength wastes typically require more frequent maintenance than a normal residential system. Pre-treatment facilities, as described earlier, will help minimize operation and maintenance problems.

Plant Start-up: It may be necessary to "seed" the treatment plant with a sufficient volume of activated sludge from an existing treatment plant. This is especially true with facilities that have excessive quantities of cleaners and sanitizers in their discharge. These materials prevent the initial growth and development of viable organisms. Typically, a quantity of seed sludge equal to 10-20% of the plant capacity is recommended. Make sure that the seed material is taken from a well operating treatment plant. Never use solids taken from a septic tank.

Maintenance Schedule: Monthly inspections should be conducted at least until the plant has achieved normal start-up. These inspections should monitor settleable solids in the treatment plant, as well as grease and scum accumulation in the grease trap. It is important that the odors and color of the aeration chamber and of the effluent be monitored closely, since this is the best indicator of plant performance. It is

also necessary to monitor the daily water usage to insure that the plant is not hydraulically overloaded. This is a common problem where public restrooms in restaurants have faucets that are left running; and, toilets and urinals can stick and run continuously. All commercial treatment systems should have some means of flow measurement.

Pumping Schedules: Because of the higher organic loading on the plant, it is common for the treatment plant to require more frequent pumping that would be anticipated on a residential system. Also, grease traps are frequently pumped at monthly intervals.

Plant Upsets: Food spillage and periodic facility cleaning can result in an unusually large volume of either toxic or high strength wastewater being discharged to the plant. This can result in odor problems, foaming, temporary deterioration of effluent quality, or in extreme cases, a complete die off of the plant . In many cases, the effects are temporary and will clear up as the shock load is assimilated by the treatment plant. Pumping the grease traps and pre-treatment tanks will facilitate recovery. In extreme case where a complete plant die off occurs, it may be necessary to pump out the treatment plant and initiate start-up procedures, including seeding the plant. Since it may require several months for the treatment plant to develop a good, biological community, pumping of the treatment plant should only be done when recovery from the shock loading is unlikely. Usually, after a treatment plant has been operation for a continuous period of time, it will develop sufficient numbers of bacteria and other organisms that will be able to buffer the effects of periodic shock loads.

**Table X: Aqua Aire® Cluster Series**

<u>Model Number</u>	<u>AA-C2000</u>	<u>AA-C3000</u>	<u>AA-C4500</u>	<u>AA-C6000</u>	<u>AA-C7500</u>	<u>AA-C9000</u>
Design Flow (GPD)	2,000	3,000	4,500	6,000	7,500	9,000
BOD Loading (lb/day)	5.00	7.50	11.25	15.00	18.75	22.50
Aeration Volume (Gal.)	2,126	3,398	5,097	6,796	8,495	10,194
Clarifier Volume (Gal.)	714	1,034	1,551	2,068	2,585	3,102
Air Required (CFM)	12.60	16.40	24.60	32.80	41.00	49.20
Pre-treatment Volume(Gal.)	1,500	1,750	2,500	3,000	3500	4500

**AA-C2000:** 2-AA1000 gpd units

**AA-C3000:** 2-AA1500 gpd units; or, 3-AA1000 gpd units

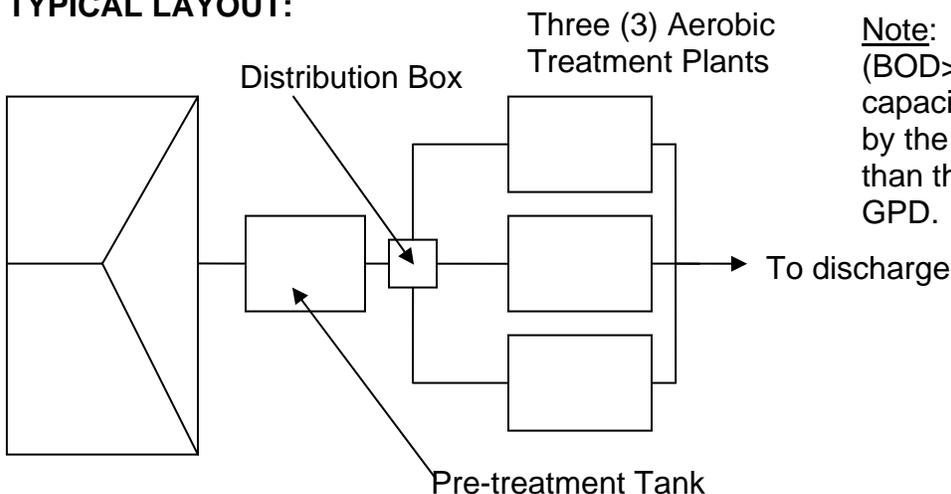
**AA-C4500:** 3-AA1500 gpd units

**AA-C6000:** 4-AA1500 gpd units; or, 6-AA1000 gpd units

**AA-C7500:** 5-AA1500 gpd units

**AA-C9000:** 6-AA1500 gpd units; or, 9-AA1000 gpd units

**TYPICAL LAYOUT:**



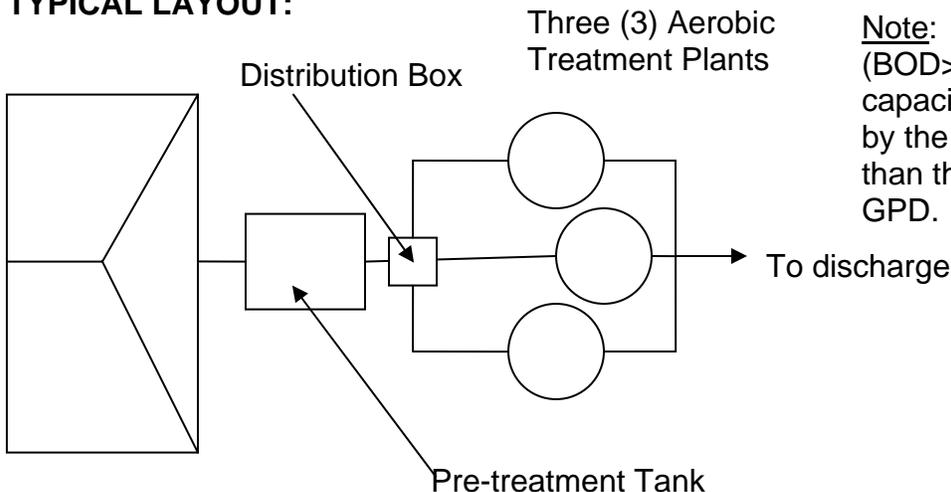
Note: For high strength waste (BOD>300 mg/l), the plant capacity should be determined by the total lb BOD/day, rather than the design hydraulic flow in GPD.

**Table XI: Aqua Safe® Cluster Series**

<u>Model Number</u>	<u>AS-C2000</u>	<u>AS-C3000</u>	<u>AS-C4500</u>	<u>AS-C6000</u>	<u>AS-C7500</u>	<u>AS-C9000</u>
Design Flow (GPD)	2,000	3,000	4,500	6,000	7,500	9,000
BOD Loading (lb/day)	5.00	7.50	11.25	15.00	18.75	22.50
Aeration Volume (Gal.)	3,412	4,698	7,047	9,396	11,745	14,094
Clarifier Volume (Gal.)	604	1,138	1,707	2,276	2,845	3,414
Air Required (CFM)	12.60	16.40	24.60	32.80	41.00	49.20
Pre-treatment Volume(Gal.)	1,500	1,750	2,500	3,000	3500	4500

- AS-C2000:** 2-AS1000 gpd units
- AS-C3000:** 2-AS1500 gpd units; or, 3-AS1000 gpd units
- AS-C4500:** 3-AS1500 gpd units
- AS-C6000:** 4-AS1500 gpd units; or, 6-AS1000 gpd units
- AS-C7500:** 5-AS1500 gpd units
- AS-C9000:** 6-AS1500 gpd units; or, 9-AS1000 gpd units

**TYPICAL LAYOUT:**



**Note:** For high strength waste (BOD>300 mg/l), the plant capacity should be determined by the total lb BOD/day, rather than the design hydraulic flow in GPD.