



273 Weymouth Street • Rockland, MA 02370

Amphidrome[®] *

WASTEWATER TREATMENT SYSTEM MANUAL

Product Listing: Category A (residential sewage)
Product File No: 2011-004

- **Treatment Level A2** (cBOD₅ of 15 mg/L, TSS of 15 mg/L)
- **Treatment Level B2** (cBOD₅ of 25 mg/L, TSS of 30 mg/L)
- **Treatment Level C** (cBOD₅ of 125 mg/L, TSS of 60 mg/L and Oil & Grease of 25 mg/L)
- **Total Nitrogen** (TN of less than or equal to 20 mg/L)

www.amphidrome.com

Requests for information should be directed to:

F. R. Mahony & Associates, Inc.
273 Weymouth Street
Rockland, MA 02370

Phone (781) 982-9300
(800) 791-6132

*Manufactured under license from Severn Trent Services



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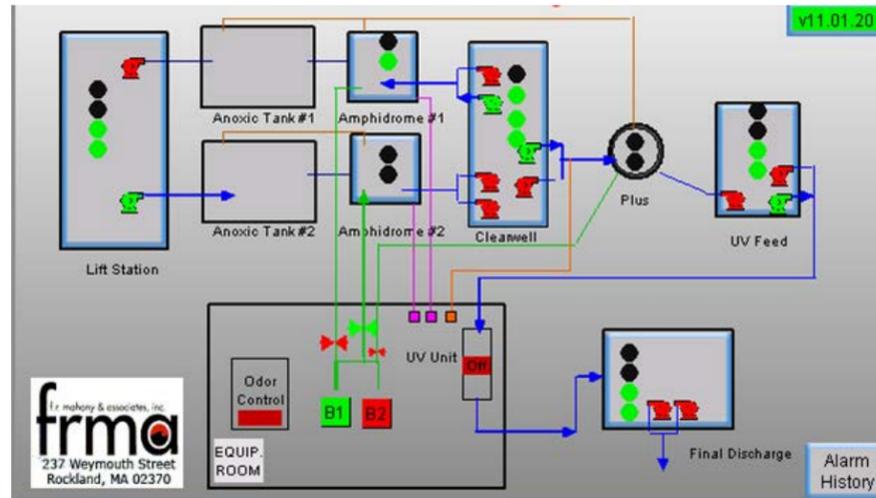
CUSTOMIZED TOUCH SCREEN CONTROLS

Amphidrome®

Licensed By
SEVERN
TRENT
SERVICES

Amphidrome®

Waste Water Treatment System



Typical Applications

- Condominiums
- Cluster System Developments
- Health Care facilities
- Resorts
- Shopping Malls
- Schools
- Office Parks
- Single Family Homes
- Lagoon Nitrification



High Level of Nitrogen Removal

Low Visual Site Impact

Your Economical Treatment Solution

f.r. mahony & associates inc.
frma
273 Weymouth Street • Rockland MA 02370

water and wastewater technologies

tel. 781-982-9300
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www.amphidrome.com

frma

Amphidrome® System



The **Amphidrome® System** is a **S**ubmerged **A**ttached **G**rowth **B**iological Reactor (**SAGB**) operating in a batch mode providing BOD reduction, superior nitrification, denitrification and filtration of suspended solids in a single reactor.

A specially selected spherical sand media provides maximum surface area for microorganisms to attach themselves. The microorganism environment is manipulated with intermittent aeration. The result is an energy efficient superior treatment system with a very small footprint.

With the addition of an **Amphidrome® Plus™** reactor, nitrogen is reduced to the lowest level biologically attainable. The **Amphidrome® ColdNite®** process nitrify at wastewater temperatures of 3.3 C.

A small building houses a control panel, air blowers, and any other ancillary equipment as may be required for a specific application such as ultraviolet (UV) disinfection or a membrane.

Benefits

Superior Treatment
High Level of Nitrogen Removal
Re-Use Quality Effluent - Turbidity & TOC
Small Footprint - Low Visual Site Impact
Energy Efficient

Amphidrome-MF™ System

Integrates a 0.1 Micron Membrane

MBR Quality Effluent

Substantially Lower Costs

Capital
Operating
Life Cycle



System Benefits

Low Visual Site Impact

- System below grade

Low Audible Site Impact

- Kaeser premium sound enclosed blowers

Easy To Operate

- Touch screen with SCADA like equipment screens, data trending and built in troubleshooting guide
- Remote access provided for BOTH control and monitoring

Energy Efficient

- Intermittent aeration - Process air runs 3-5 hours per day at 20-30 Hz
- Backwash blowers run 10 min per day
- Primary and waste solids are digested in anoxic tank – no aeration required

Low Chemical Costs

- Anoxic environment created to denitrify and reclaim alkalinity required for nitrification
- Intermittent aeration provides simultaneous nitrification-denitrification

Consistent Treatment

- Fixed film reactor with high biomass responds well to low and shock loads
- Anoxic tank equalizes mixes and dilutes incoming shock loads of chemicals dumped into the system

Filtered Effluent

- Effluent is filtered through our deep media bed filter

Upgradable

- Easily upgraded for phosphorus reduction without adding additional filtration
- Easily upgraded for UV disinfection by adding an enclosed UV and using the discharge pumps to pump through it.

SYSTEM NARRATIVE

The Amphidrome® system is a BNR process utilizing a submerged attached growth bioreactor operating in a batch mode. The deep, bed sand filter is designed for the simultaneous removal of soluble organic matter, nitrogen and suspended solids, within a single reactor.

To achieve simultaneous: oxidation of soluble material, nitrification, and denitrification in a single reactor, the process must provide aerobic and anoxic environments for the two different populations of microorganisms. The Amphidrome® system utilizes two tanks and one submerged attached growth bioreactor, subsequently called Amphidrome® reactor. The first tank, the anoxic/equalization tank, is where the raw wastewater enters the system. The tank has an equalization section, a settling zone, and a sludge storage section. It serves as a primary clarifier before the Amphidrome® reactor.

This Amphidrome® reactor consists of the following three items: underdrain, support gravel, and filter media. The underdrain, constructed of stainless steel, is located at the bottom of the reactor. It provides support for the media and even distribution of air and water into the reactor. The underdrain has a manifold and laterals to distribute the air evenly over the entire filter bottom. The design allows for both the air and water to be delivered simultaneously, or separately, via individual pathways, to the bottom of the reactor. As the air flows up through the media the bubbles are sheared by the sand; producing finer bubbles as they rise through the filter. On top of the underdrain is 18", (five layers), of four different sizes of gravel. Above the gravel is a deep bed of coarse, round, silica sand media. The media functions as a filter; significantly reducing suspended solids, and provides the surface area for which an attached growth biomass can be maintained.

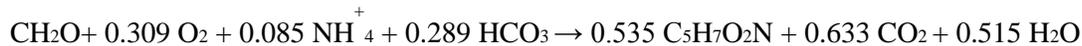
To achieve the two different environments required for the simultaneous removal of soluble organics and nitrogen, aeration of the reactor is intermittent, rather than continuous. Depending on the strength and the volume of the wastewater, a typical aeration scheme may be three to five minutes of air and ten to fifteen minutes without air. Concurrently, return cycles are scheduled every hour, regardless of the aeration sequence. During a return, water from the clear well is pumped back up through the filter and overflows into the return flow/backwash pipe. A check valve in the influent line prevents the flow from returning to the anoxic/equalization tank, via that route. The return flow/backwash is set at a fixed height above both the media and the influent line; and the flow is by gravity back to the front of the anoxic/equalization tank.

The cyclical forward and reverse flow of the waste stream, and the intermittent aeration of the filter, achieve the required hydraulic retention time and create the necessary aerobic and anoxic conditions to maintain the required level of treatment.

Biochemical Reactions

The removal of SOM is achieved by the oxidation of carbonaceous matter, which is accomplished by the aerobic growth of heterotrophic bacteria. The biochemical transformation is described by the following normalized mass based stoichiometric equation in which the carbonaceous matter is a carbohydrate (CH_2O) and the nitrogen source for the bacteria is

ammonium (NH_4^+).



The oxidation of ammonia to nitrate is accomplished by the aerobic growth of chemolithotrophic, autotrophic bacteria and is described by the following normalized mass based stoichiometric equation. The overall equation describes the two-step process in which ammonia is converted to nitrite by *Nitrosifiers*, and nitrite is converted to nitrate by *Nitrifiers*.



The final step in the removal of nitrogen from the waste stream occurs when carbonaceous matter is oxidized by the growth of heterotrophic bacteria utilizing nitrate as the terminal electron acceptor. The equation describing the biochemical transformation depends on the organic carbon source utilized. The following is the normalized mass based stoichiometric equation with the influent waste stream as the organic carbon source.



Biological removal of nitrogen has been the focus of much attention and many of today's wastewater treatment plants incorporate it. However, the difficulty in promoting these biochemical transformations in one reactor is the different environmental conditions required for each transformation.

This Amphidrome® process is designed to achieve the above reactions simultaneously within one reactor. The aerobic environment within the filter promotes the first two reactions. The return flow, to the anoxic/equalization tank, mixes the nitrates with organic carbon in the raw influent, and with organic carbon that has been released from the stored sludge. The anoxic environment within the filter promotes denitrification, the third reaction.

The Amphidrome® system is a BNR process utilizing a submerged attached growth bioreactor operating in a batch mode. The deep, bed sand filter is designed for the simultaneous removal of soluble organic matter, nitrogen and suspended solids, within a single reactor.

The system operates as a sequencing batch reactor in which the waste water is cycled back and forth through the filter. The Amphidrome® reactor is intermittently aerated to achieve both the aerobic environment required for the oxidation of organics and nitrification and the anoxic environment required for denitrification.



Figure 1. Section View of Amphidrome® System

The reactor consists of: 1) an underdrain, 2) support gravel, 3) filter media, and 4) a backwash trough. The underdrain, located at the bottom of the reactor, can be constructed of concrete blocks encased with high-density polyethylene and stainless steel piping or entirely out of stainless steel. It provides support for the media and even distribution of air and water into the reactor. The underdrain includes a manifold and laterals to distribute the air evenly over the entire filter bottom. The design allows for both the air and water to be delivered simultaneously--or separately--via individual pathways to the bottom of the reactor.



Concrete Block Underdrain



Stainless Steel Underdrain

On top of the underdrain is 1.51 ft (five layers) of four different sizes of gravel. Above the gravel is a deep bed of coarse, round silica sand media. The media functions as a filter, reducing suspended solids while providing the surface area on which an attached growth biomass can be maintained. The media specific surface area of 250 ft.²/ft.³ results in a high concentration of biomass within the reactor, which means that the hydraulic retention time (HRT) is short; therefore the reactor requires a significantly smaller volume to treat a given waste strength than would be required by some other reactors.



Reactor Quiescent Flow



Reactor During Aeration

The influent wastewater enters the system through the anoxic/equalization tank, which has an equalization zone, a settling zone, and a sludge storage zone and serves as a primary clarifier for the SAGB. The wastewater then flows by gravity into the reactor. The driving force of the forward flow is the hydrostatic pressure created by the differential liquid levels within the tanks. Operation of the SAGB alternates between down-flow (forward flow) and up-flow (reverse flow) modes. The up-flow is accomplished by pumping from the clear well back up through the filter. To achieve the required aerobic and anoxic conditions within the biofilm, process air to the reactor is supplied intermittently via the underdrain at the bottom of the reactor and is independent of the return flow cycles. During a return, water from the clear well is pumped back through the filter, following the exact same path through the reactor as it did in the forward flow cycle. However, a check valve in the influent line of the reactor prevents the flow from returning to the anoxic/equalization tank via the same route. Instead, the flow fills the reactor until it overflows into the return flow/backwash trough and flows back to the front of the anoxic/equalization tank by gravity. The recycled flow, which contains nitrates, mixes with the incoming raw influent, which contains organic carbon, and starts to flow forward again when the pump shuts off. The cyclical forward and reverse flow of the waste stream and the intermittent aeration of the filter achieve the required hydraulic retention time and create the necessary aerobic and anoxic conditions to achieve the required level of biological nitrogen removal.

Controls:

The control system is PLC based with a user friendly operator touch screen interface



Wireless Process Control Access (WPCA)

Amphidrome systems are now provided with one year of online and phone technical support. The system will be supplied with a WPCA module that will allow the operator and FRMA to log into the system. This allows real time control and observation of the system remotely via the internet. Remote access to stored system trending data, alarm history etc. provides valuable insight on system operation and any adjustments that may need to be made to optimize performance. These adjustments can be made remotely in real time.



SYSTEM DESIGN

DESIGN

- **Treatment Level A2** (cBOD₅ of 15 mg/L, TSS of 15 mg/L)
 - **Total Nitrogen** (TN of less than or equal to 20 mg/L)

It is important to note that the system is not designed or presented by "MODEL NUMBER". Systems are custom designed for both flow and waste strength. The system designs presented in Tables 1 & 2 can be used for preliminary design. Final design must be reviewed by F.R. Mahony & Associates

All Amphidrome reactors are designed on a mass loading, typically 150 lbs.-BOD₅/1,000 ft.³ of media and 40 lbs.-N/1,000 ft.³ of media. Therefore, influent waste strength (both BOD₅ and ammonia- nitrogen) both influence the size (in depth and square feet) of the reactor.

The Amphidrome Treatment System is registered for systems with a design rated capacity of less than 400 gallons per day, for single family homes, up to design flows of 10,000 gallons per day, as shown in Tables 1 & 2.

Table 1

Amphidrome System for Treatment Level A2 and for Effluent Total Nitrogen (TN) of less than 20 mg/L*

Flow (gpd)	Anoxic/EQ (gal.)	Reactor	Clearwell (gal.)
<400 - 800	2,000	2.0 ft. Diameter	1,000
700 – 1,200	2,000	2.5 ft. Diameter	1,000
900 – 1,800	2,500	3.0 ft. Diameter	1,500
1,200 – 2,500	2,000 - 3,000	3.5 ft. Diameter	1,500
1,600 – 3,250	2,500 - 4,000	4.0 ft. Diameter	1,500
2,500 – 5,200	4,000 - 6,000	5.0 ft. Diameter	2,000
3,600 -7,200	5,500 - 9,000	6.0 ft. Diameter	2,600 - 3,200
6,000 -10,000	9,000 - 13,000	8.0 ft. Diameter	4,500 - 5,200

* Third-party testing showed Amphidrome effluent achieved the Total Nitrogen [TN] level of 15 mg/L [mean TN = 15 mg/L TN with 59% removed]; CBOD₅ was 5 mg/L; TSS was 5 mg/L. Fecal coliform bacteria are expected to be greater than 10,000 cfu/100mL. Total nitrogen removal is highly dependent upon BOD and TKN loading, adequate alkalinity, temperature and toxicity; site specific alkalinity levels in the source water supply should be evaluated and homeowners should be well educated in order to achieve optimal total nitrogen reduction.

The flow range for each reactor listed is the result of the ability to vary the media depth from 4 ft. to 8ft.

Table 2
Amphidrome Plus System for Effluent Total Nitrogen (TN) of less than 10 mg/L**

Flow (gpd)	Anoxic/EQ (gal.)	Reactor	Clearwell (gal.)	Plus
<400 - 800	2,000	2.0 ft. Diameter	1,000	2.0 ft. Diameter
700 – 1,200	2,000	2.5 ft. Diameter	1,000	2.0 ft. Diameter
900 – 1,800	2,500	3.0 ft. Diameter	1,500	2.0 ft. Diameter
1,200 – 2,500	2,000 - 3,000	3.5 ft. Diameter	1,500	2.0 ft. Diameter
1,600 – 3,250	2,500 - 4,000	4.0 ft. Diameter	1,500	2.0 ft. Diameter
2,500 – 5,200	4,000 - 6,000	5.0 ft. Diameter	2,000	2.5 ft. Diameter
3,600 -7,200	5,500 - 9,000	6.0 ft. Diameter	2,600 - 3,200	2.5 ft. Diameter
6,000 -10,000	9,000 - 13,000	8.0 ft. Diameter	4,500 - 5,200	3.0 ft. Diameter

** The Amphidrome Plus system is utilized when the effluent total nitrogen must be less than 10 mg/l or when effluent phosphorus limits exist.

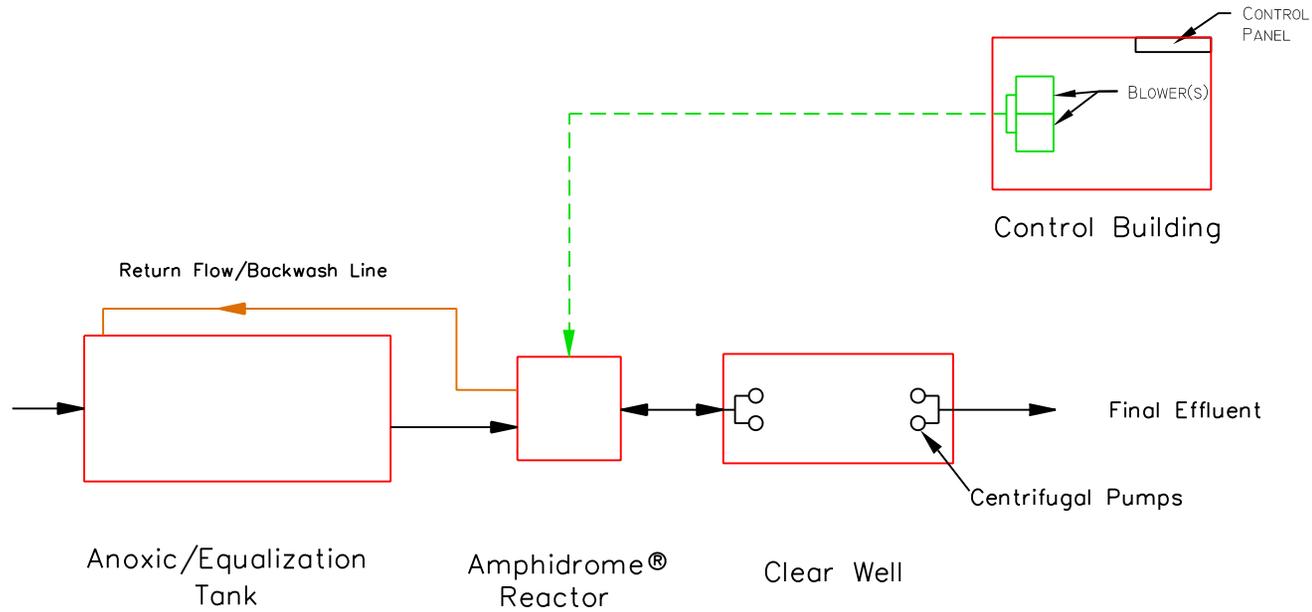
The flow range for each reactor listed is the result of the ability to vary the media depth from 4 ft. to 8ft.

1. Every Amphidrome reactor is sized by F.R. Mahony & Associates for the specific system being designed by the engineer or advanced designer. F.R. Mahony and Associates shall review and approve each design for the specific flow and required effluent limit.
2. The Anoxic Tank and Clear Well size shall meet the manufacturer's size requirements. All tanks used in the treatment process shall be approved by the manufacturer. Sewage tank(s) shall be designed to withstand the pressures to which it will be subject to. Tanks and all pipe penetrations, risers, and other connections to tanks shall be watertight.
3. F. R. Mahony and Associates, along with the Advanced Designer and Installer, are responsible to ensure that proper flow splitting devices are used to split flows when flow splitting is needed. Flow splitting devices must meet the following criteria: a) designed specifically and reliably to split wastewater flows; b) accessible for on-going operation and maintenance; c) monitored to determine flow rates; d) adjustable after construction should settlement occur; and e) have infinite or continuous adjustment features.
4. All systems shall be designed and operated with (a) suitable alarm device(s) that monitors the Amphidrome and its component, should any of the system components malfunction.
5. The treatment products are considered a Minnesota-registered product for Type IV systems. The effluent, following treatment in the Amphidrome Wastewater Treatment System, is required to be uniformly distributed to the soil for final treatment and dispersal.
6. When Amphidrome Wastewater Treatment Systems are used in systems to achieve Treatment Levels A2, B2, and C, effluent loading rates to the soil, method of distribution, and vertical

separation requirements shall meet the minimum requirements contained in Minnesota Rules Chapter 7080.2350 for flows less than 5000 GPD. For flows greater than 5000 GPD, final treatment and dispersal must also meet 7081.0270, which require a minimum three (3) feet vertical separation during operation, after accounting for groundwater mounding.

TYPICAL DRAWINGS

Amphidrome® System Process Schematic



Amphidrome® System Process Schematic

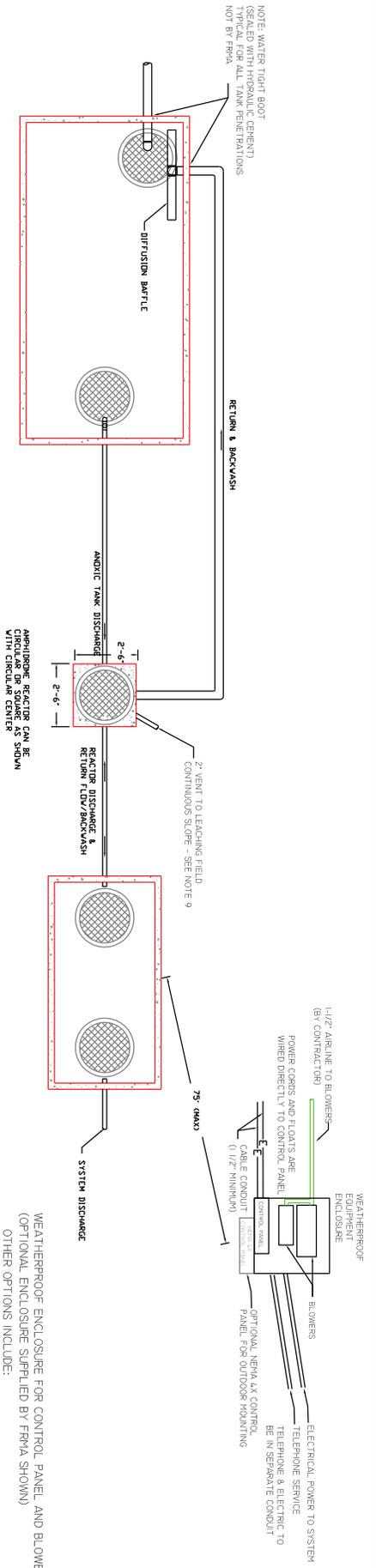
Rev: 2/23/12

Scale: NTS
Date: 4/8/10

Drawn By:
App'd By: PBP

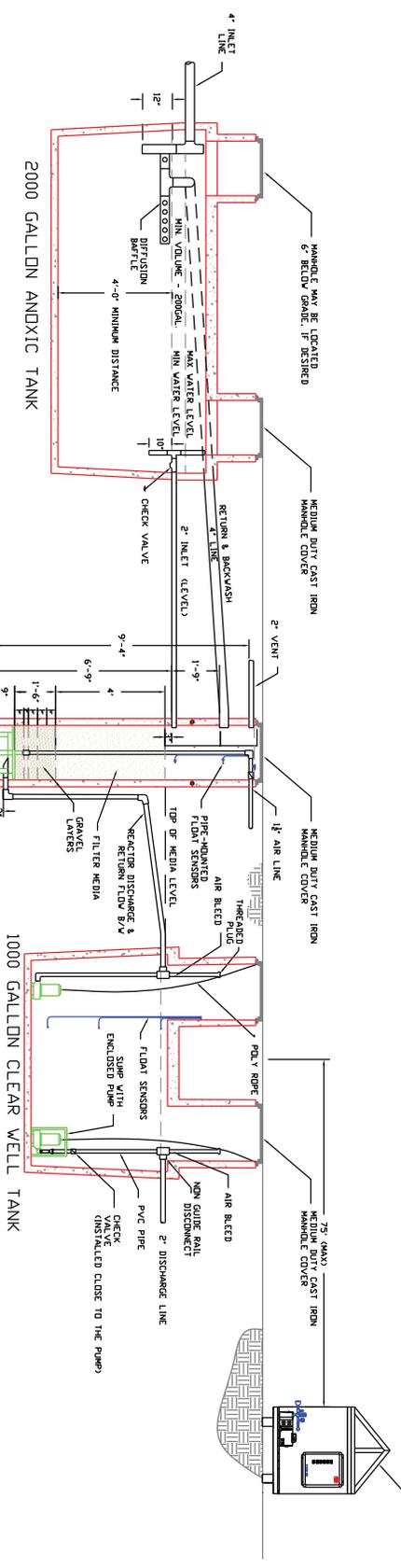
Job No.
Plan No. Basic Amphidrome

EMAHONY
& associates, inc.
Water Supply & Pollution Control Equipment
273 Weymouth Street, Rockland, Massachusetts 02370



PIPING AND CONDUIT NOTES:
 1. ALL INTERNAL PIPING SUPPLIED BY FRMA AND INSTALLED BY OTHERS
 2. ALL EXTERNAL PIPING AND CONDUIT SUPPLIED AND INSTALLED BY OTHERS.
 3. ELECTRICAL PENETRATIONS INTO TANKS MUST BE SEALED TO PREVENT CORROSIVE GASES FROM ENTERING CONTROL PANEL.

GENERAL NOTES:
 1. TANKS ARE 4000 PSI CONCRETE-STEEL REINFORCED.
 2. CONCRETE CONFORMS TO ACI 318-16-4.5.1 AND ACI 318-16-4.5.2.
 3. TANKS ARE TO BE APPROVED FOR USE IN F. R. MAHONY AMPHIDROME SYSTEMS
 4. APPROVED TANK SUPPLIERS LISTED ON THIS DRAWING.
 5. TANKS ARE NOT PROVIDED BY F. R. MAHONY (FRMA)
 6. TOP OF REACTOR IS LOCATED AT FINISHED GRADE. ANOXIC TANK DEPTH SHOULD BE COORDINATED WITH REACTOR INLET
 7. BLOWERS AND CONTROL PANEL MUST BE LOCATED IN A WEATHER-PROOF ENCLOSURE.
 8. (SEE NOTE THIS SHEET)
 9. BLOWERS MUST BE LOCATED AT AN ELEVATION HIGHER THAN THE TOP OF THE REACTOR
 10. BELOW-GRADE JUNCTION BOXES MUST BE LOCATED AT LEAST 18" ABOVE GRADE -
 11. VENT PIPING MUST HAVE CONTINUOUS SLOPE TO LEACHING FACILITY



AMPHIDROME® REACTOR

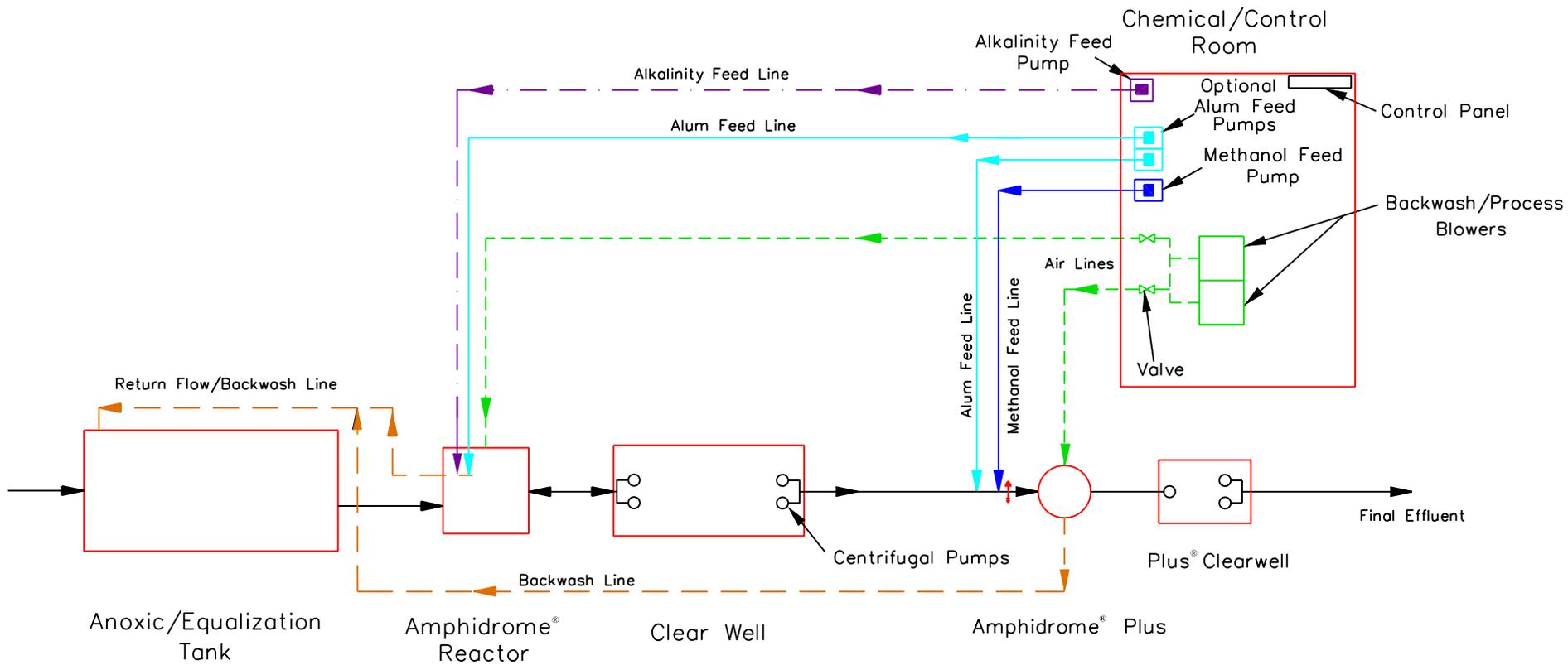
FRMA APPROVED TANK SUPPLIERS:
 1. MERSHON CONCRETE, BORDENTOWN, NJ
 2. SCITUATE RAY PRECAST, MARSHFIELD, MA

Rev.	Date:	By:	Description:
6	02/28/11	ARM	Renumber parts and revise

Dwg:	Drawing 1	AMPHIDROME® SINGLE FAMILY LAYOUT	
Rev:	6 (02-28-2011)		
Drawn By:	ADW / ARM	APP'd by:	
Scale:	NTS	Date:	01/23/08

Water Supply & Pollution Control Equipment / 02320
 223 Magnolia Street, Andover, Massachusetts 01820
F. R. MAHONY & ASSOCIATES, INC.
 PG.

Process Schematic of Amphidrome® Plus System

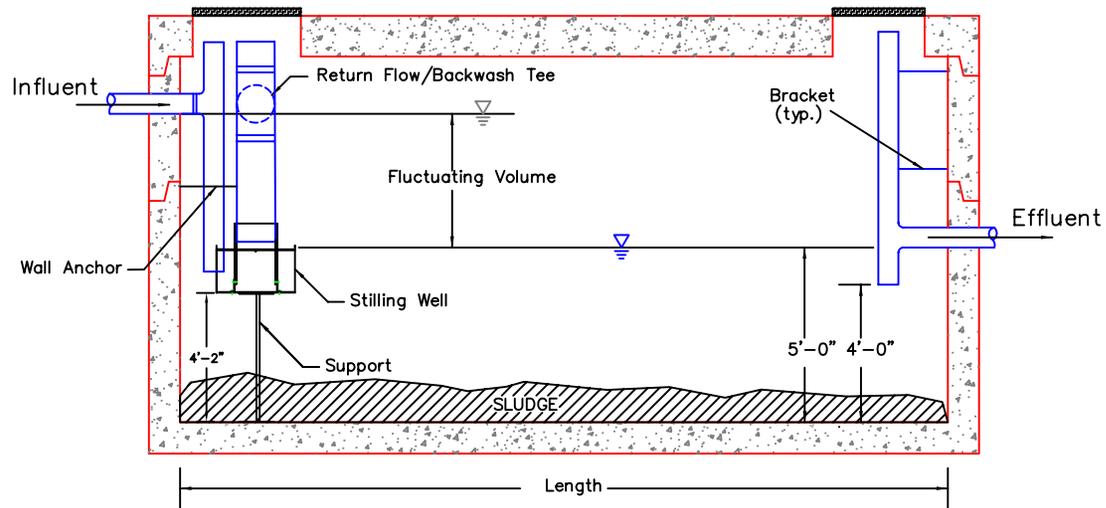


← Inline Static Mixer

Amphidrome Plus® System Process Schematic

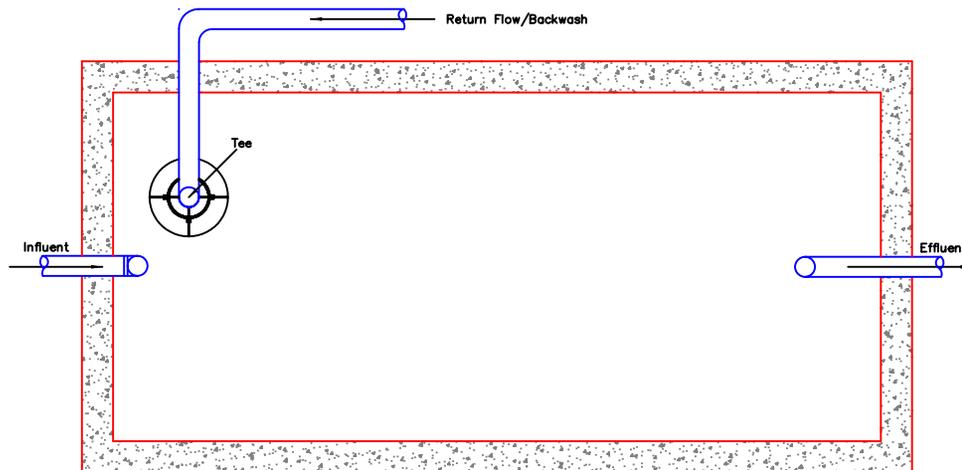
Scale: NTS	Drawn By:	Job No.
Date: 2/10/10	App'd By: PBP	Plan: # 36

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& associates, Inc.
Water Supply & Pollution Control Equipment
273 Weymouth Street, Rockland, Massachusetts 02370

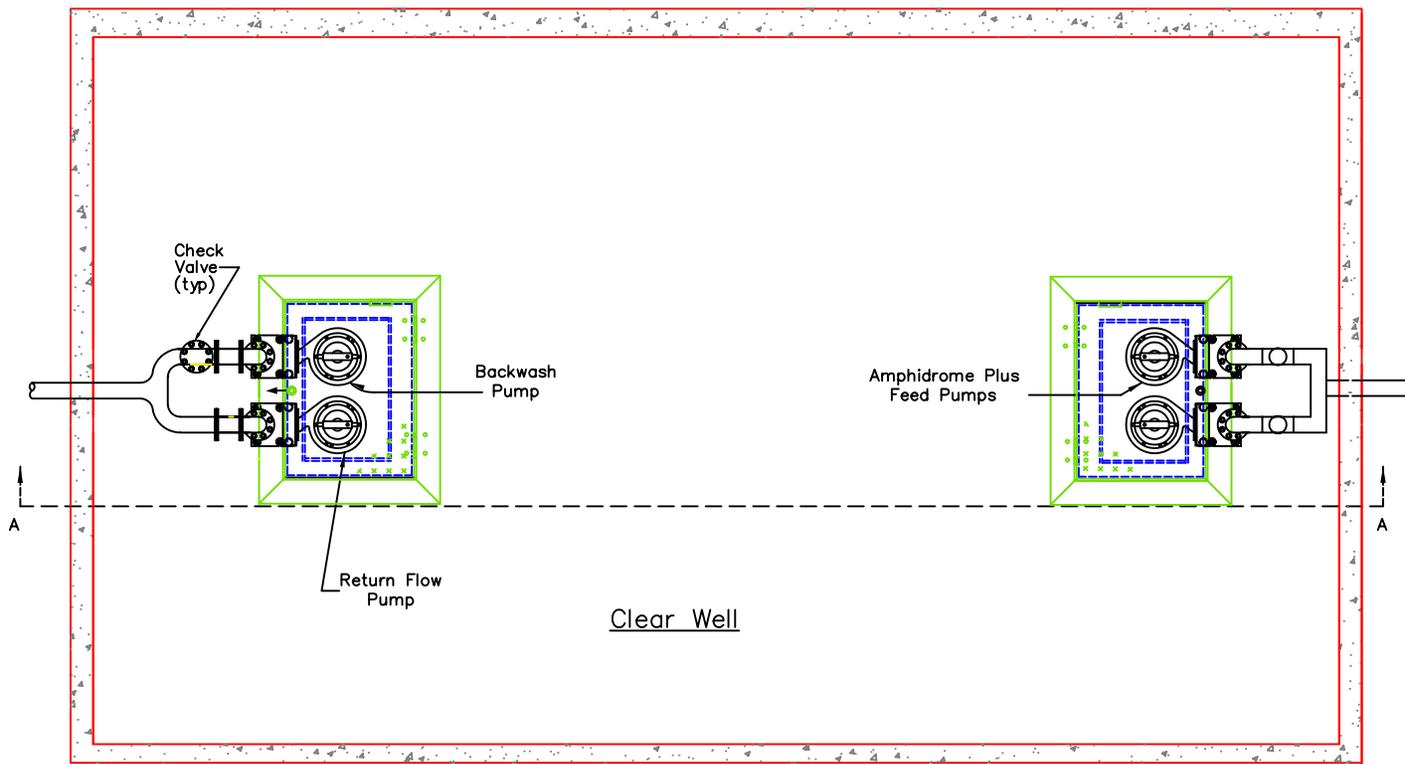


Notes:

Effluent Tee should extend into riser.
 Effluent line invert should be at an absolute minimum of 5 ft. from the bottom.



Drawing No.	Amphidrome® System
Drawn By: ADW	Anoxic Tank with stilling well
Rev:	App'd by: PBP
Scale: NTS	Date: 4/22/04
EMAHONY <small>& Associates, Inc.</small> <small>Water Supply & Pollution Control Equipment</small> <small>273 Weymouth Street, Rockland, Massachusetts 02370</small>	



GENERAL ARRANGEMENT

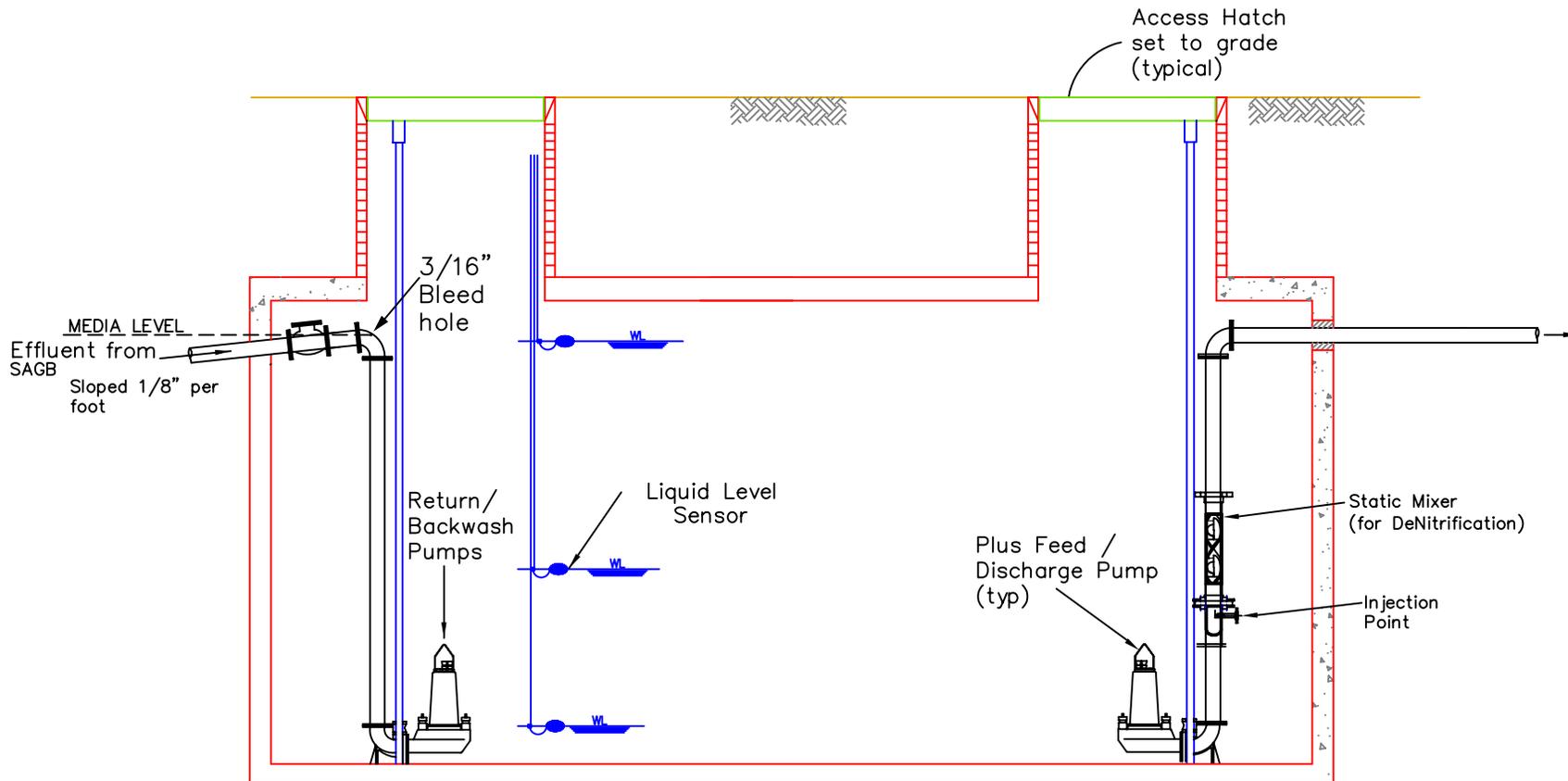
Amphidrome® System
Clear Well with Static Mixer

Scale: NTS
Date: 01/20/08

Drawn By: JTB / ARM
App'd By: PBP

Job No.
Plan No. Clearwell Plan

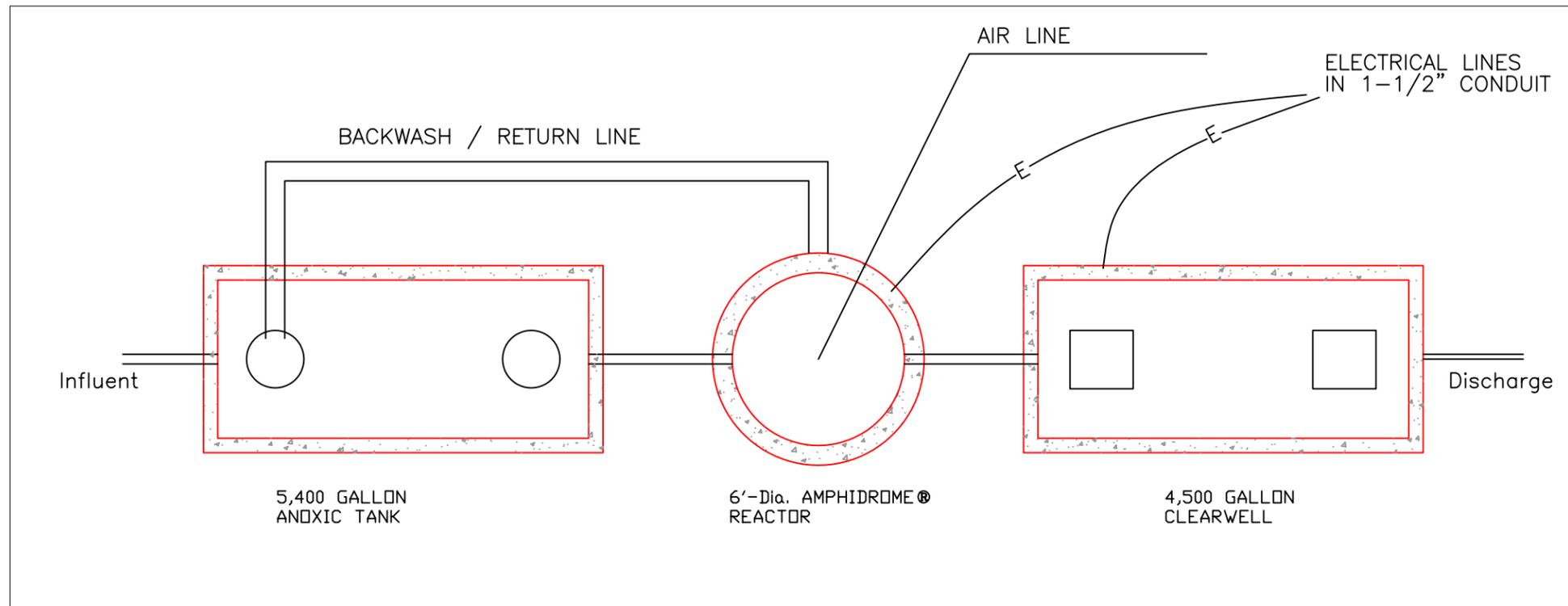
EMAHONY
& associates, Inc.
Water Supply & Pollution Control Equipment
273 Weymouth Street, Rockland, Massachusetts 02370



Notes

1. Low float should be set for minimum submergence of return pump.
2. Middle float should be set to one backwash volume.
3. High float should be set at the elevation of the bleed hole.

Drawing No. Clear Well	Amfidrome® Clear Well
Drawn By: T. Morrison	App'd by:
Rev:	Date: Nov. 15, 2005
Scale: NTS	
EMAHONY <small>& associates, Inc.</small> <small>Water Supply & Pollution Control Equipment</small> <small>273 Weymouth Street, Rockland, Massachusetts 02370</small>	



GENERAL NOTES:

1. SEE OTHER PLANS FOR APPLICABLE NOTES.
2. SEE APPLICABLE SHEETS FOR MORE DETAIL
3. SEE PROFILE FOR INVERTS
4. POWER SUPPLY TO BE DETERMINED VIA CONSULT WITH OWNER AND CONTRACTOR, BASED ON POWER AVAILABILITY
5. EXISTING TANKS THAT CALL FOR NEW INVERTS SHALL BE SAW-CUT AS NEEDED AND ALL PENETRATIONS SEALED WITH HYDRAULIC CEMENT.
6. REACTORS SHALL BE TESTED FOR WATER-TIGHTNESS
7. DISTURBED AREAS TO BE REPLACED IN KIND OR AS DIRECTED BY THE OWNER.
8. EXISTING INVERTS TO BE VERIFIED PRIOR TO CONSTRUCTION
9. THE DESIGN FLOW FOR THIS SYSTEM IS 35,000 GALLONS PER DAY
10. THE ENGINEER SHALL INSPECT AND CERTIFY THE INSTALLATION AS FOLLOWS:
11. A PLS SHALL SUBMIT AN AS-BUILT PLAN OF THE COMPLETED SYSTEM. THE ENGINEER SHALL CERTIFY ON THE AS-BUILT PLAN THAT THE SYSTEM IS INSTALLED AS DESIGNED AND APPROVED BY THE BOARD OF HEALTH.
12. A QUALIFIED F. R. MAHONY REPRESENTATIVE SHALL BE PRESENT AT THE CLEARWATER TEST AND SHAL CERTIFY THAT THE SYSTEMS ARE OPERATING AS DESIGNED
13. ELECTRICAL PERMITS AND INSPECTIONS AS REQUIRED BY THE TOWN SHALL BE OBTAINED BY THE CONRACTOR.
14. ALL VENTS SHALL MAINTAIN CONSTANT INCREASING SLOPE FROM TANK TO THE ODOR CONTROL UNIT, WITHOUT ANY PIPE SAGS. CONTRACTOR UST ENSURE SUFFICIENT COMPACTION TO ENGINEER'S SATISFACTION TO PREVENT FUTURE PIPE SAGGING.

NOTES TO INSTALLER

1. ALL TREATMENT PLANT BUILDING CONSTRUCTION SHALL BE COORDINATED WITH STRUCTURAL, ARCHITECTURAL AND RELATED PLANS.
2. THE CONTRACTOR SHALL COMPLY WITH ALL TOWN OF WELLFLEET AND BOARD OF HEALTH RULES AND REGULATIONS AND THE MASSACHUSETTS STATE ENVIRONMENTAL "GUIDELINES FOR THE DESIGN OF SMALL WASTEWATER SEWAGE TREATMENT FACILITIES."
3. ALL CONSTRUCTION IS SUBJECT TO THE INSPECTION OF THE ENGINEER, THE TOWN OF WELLFLEET, AND THE MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTIONS (DEP). THE CONTRACTOR SHALL NOTIFY THE ENGINEER A MINIMUM OF 48 HOURS IN ADVANCE WHEN FIELD INSPECTION IS REQUIRED. THE ENGINEER MUST OBSERVE AND CERTIFY THE CONSTRUCTION OF THE PROPOSED DISPOSAL SYSTEM IN ACCORDANCE WITH DEP REGULATIONS.
4. THE CONTRACTOR SHALL SPECIFICALLY REQUEST, IN WRITING, ANY PROPSD CHANGES OR SUBSTITUTIONS IN THE WORK AS SHOWN ON THE PLANS AND SPECIFIED PRIOR TO ORDERING MATERIALS OR EXECUTION OF THE WORK INVOLVED. THE CONTRACTOR MUST RECORD ANY CHANGES OR ALTERATIONS IN THE PROPOSED DESIGN ON AS-BUILT DRAWINGS AND PROVIDE A MINIMUM OF 3 COPIES TO THE ENGINEER FOR SUBMITTAL TO THE TOWN AND DEP PRIOR TO FINAL INSPECTION AND ACCEPTANCE OF THE WORK.
5. THE CONTRACTOR SHALL ASSIST IN CONDUCTION THE CLEAR WATER HYDRAULIC TESTING OF THE TREATMENT PLANT EQUIPMENT IN THE PRESENCE OF THE ENGINEER, THE TOWN, DEP AND MANUFACTURER'S REPRESENTATIVE AND MAKE ANY ADJUSTMENTS AND/OR ALTERATIONS AS MAY BE REQUIRED INITIALLY IN THE PLANT START-UP FOR PROPER OPERATION.
6. UTILITY INFORMATION SHOWN IS BASED ON BOTH A FIELD SURVEY AND PLANS OF RECORD. THE LOCATIONS OF UNDERGROUND PIPES AND CONDUITS HAVE BEEN DETERMINED FROM THE AFOREMENTIONED RECORD PLANS, AND ARE APPROXIMATE ONLY. BEFORE PLANNING FUTURE CONNECTIONS, THE PROPER UTILITY ENGINEERING DEPARTMENT SHOULD BE CONSULTED AND THE ACUTAL LOCATION OF SUBSURFACE STRUCTURES SHOULD BE DETERMINED IN THE FIELD. CALL THE TOLL-FREE DIG SAFE CALL CENTER AT 800-322-4844 72 HOURS PRIOR TO EXCAVATION.

LOCUS MAP

ANDREW R. McBREARTY P.E.

DATE

F. R. MAHONY & ASSOCIATES, INC.
275 WEYMOUTH STREET
ROCKLAND, MASSACHUSETTS
781-982-9300

SITE LAYOUT
AMPHIDROME WASTEWATER
TREATMENT SYSTEM

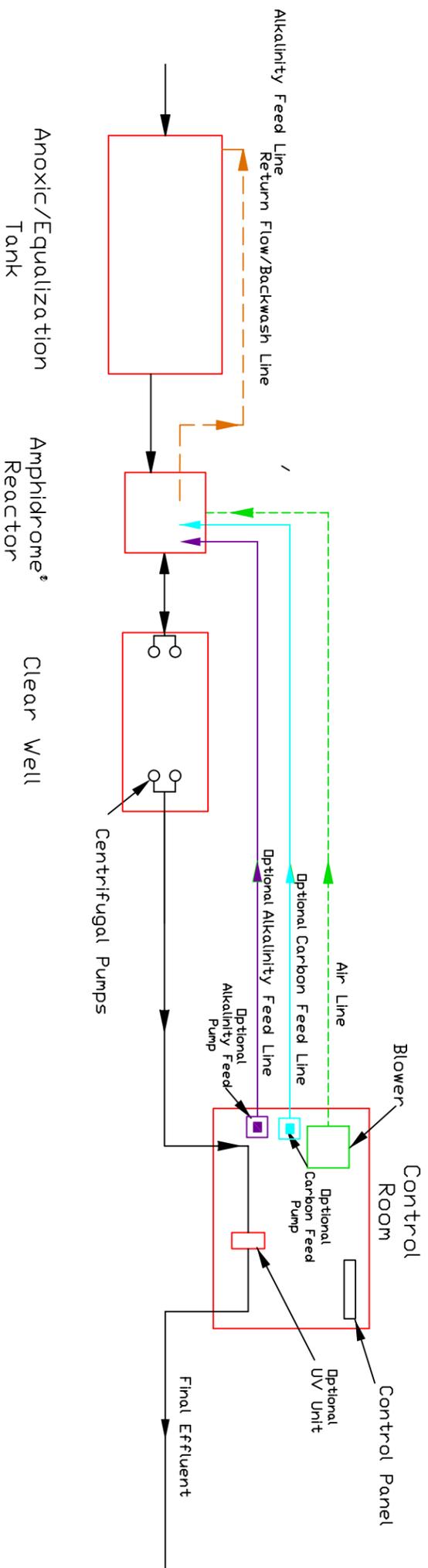
LOCATION:
Asheville, NC

REFERENCE:
LOT
BLOCK

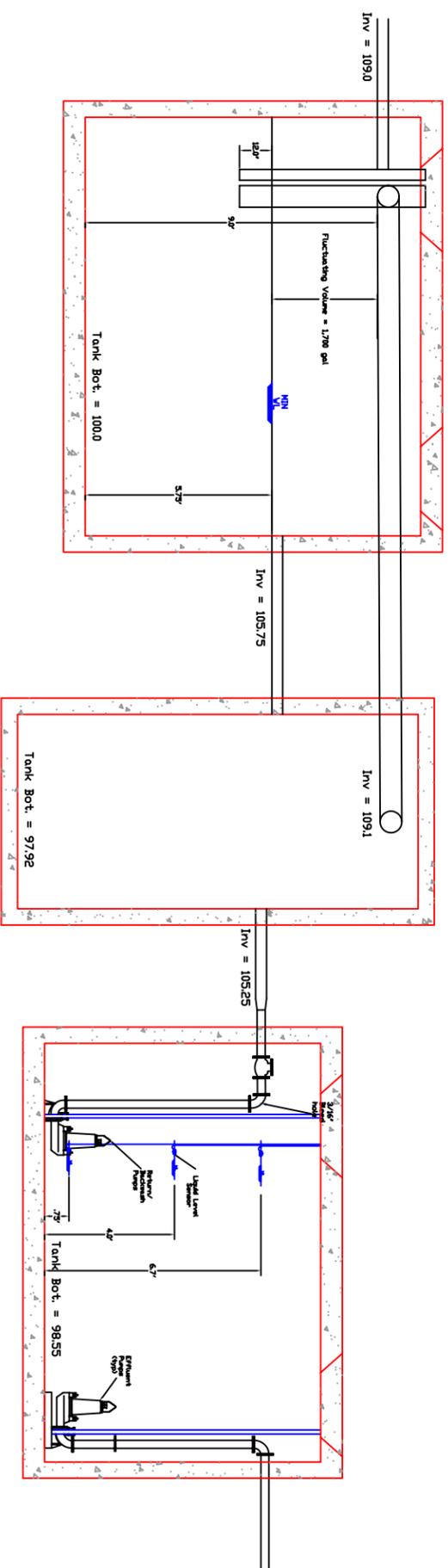
PREPARED FOR:
SUMMIT CHARTER SCHOOL

1		
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No.	Revision/Issue	Date

Project JOB# 02-201	Sheet
Date 02/08/08	WW 1
Scale 1" = 20'	



PROCESS SCHEMATIC



HYDRAULIC PROFILE

LOCUS MAP

ANDREW R. MCBREARTY P.E.

DATE

F. R. MAHONY & ASSOCIATES, INC.
275 WENWOOD STREET
ROCKLAND, MASSACHUSETTS
781-982-9500

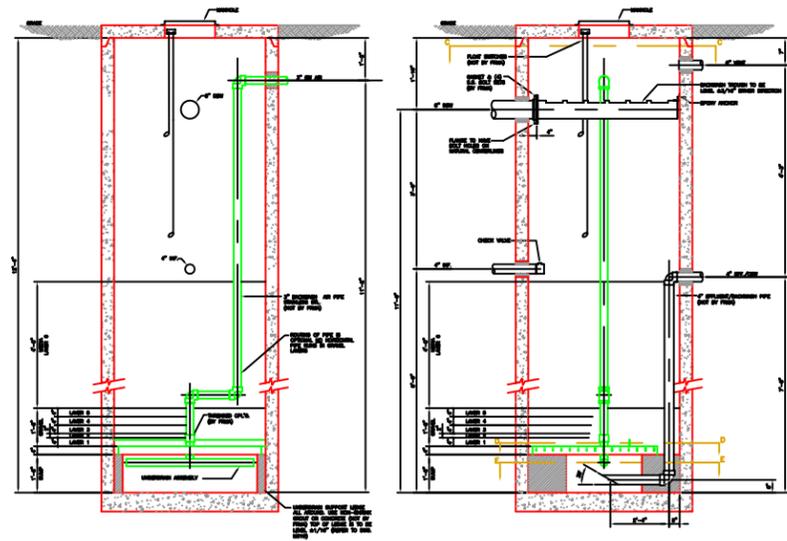
DETAILS PLAN
AMPHIDROME® WASTEWATER
TREATMENT SYSTEM
HYDRAULIC PROFILE

LOCATION:
Asheville, NC

REFERENCE:
LOT
BLOCK
PREPARED FOR:
SUMMIT CHARTER SCHOOL

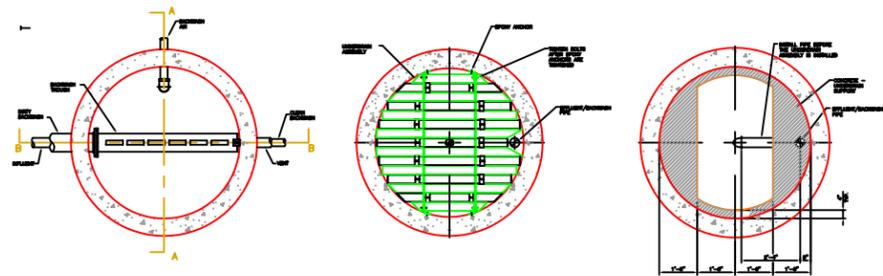
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No.	Revision/Issue	Date

Project	JOB# 02-201	Sheet
Date	02/08/08	WW 2
Scale	AS NOTED	



SECTION A-A

SECTION B-B



SECTION C-C

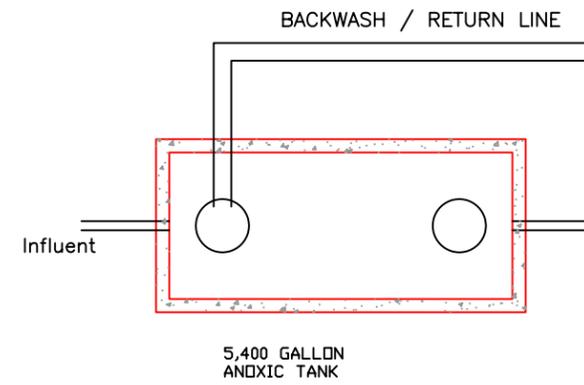
SECTION D-D

SECTION E-E

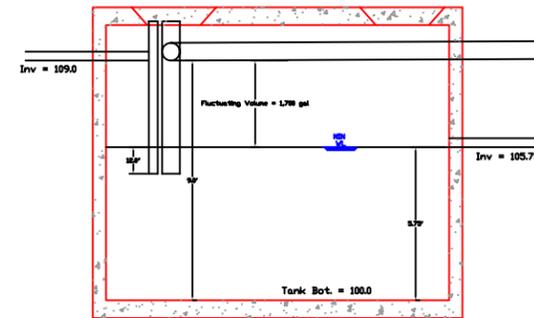
6'-DIAMETER' AMPHIDROME® REACTOR

NOTES:

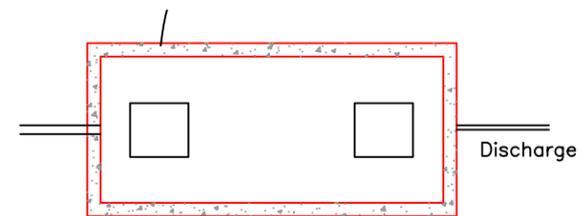
1. ALL CONSTRUCTION TO BE WATERTIGHT
2. ALL TANKS TO BE ABLE TO WITHSTAND H-20 LOADING.
3. CONDUIT AND CABLES SHALL CONFORM TO ALL ELECTRICAL CODES
4. ALL VENT PIPING IS TO BE PLACED ON A FIRM, COMPACT, LEVEL BASE WITH A CONTINUOUS SLOPE AWAY FROM THE REACTOR.
5. CONTRACTOR IS RESPONSIBLE FOR INSTALLING REACTOR INTERNALS ACCORDING TO THE DETAILED INSTALLATION INSTRUCTIONS.
6. PUMP AND ALARM SYSTEMS TO BE PROVIDED WITH PROVISION TO CONNECT TO A STANDBY POWER SUPPLY.
7. CONTRACTOR IS RESPONSIBLE FOR INSTALLING CONDUIT TO THE CONTROL SHED AND INSTALLING CONTROLS.



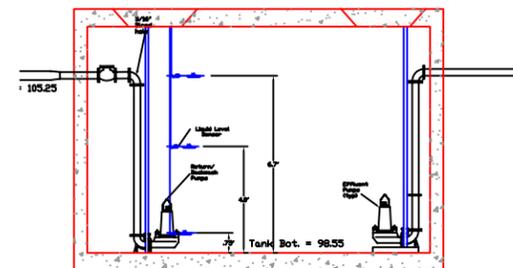
5,400 GALLON ANOXIC TANK



5,400 GALLON ANOXIC TANK



4,500 GALLON CLEARWELL



4,500 GALLON CLEARWELL

LOCUS MAP

ANDREW R. McBREARTY P.E.

DATE

F. R. MAHONY & ASSOCIATES, INC.
273 WEYMOUTH STREET
ROCKLAND, MASSACHUSETTS
781-982-9300

DETAILS PLAN

AMPHIDROME WASTEWATER
TREATMENT SYSTEM
REACTOR DETAILS

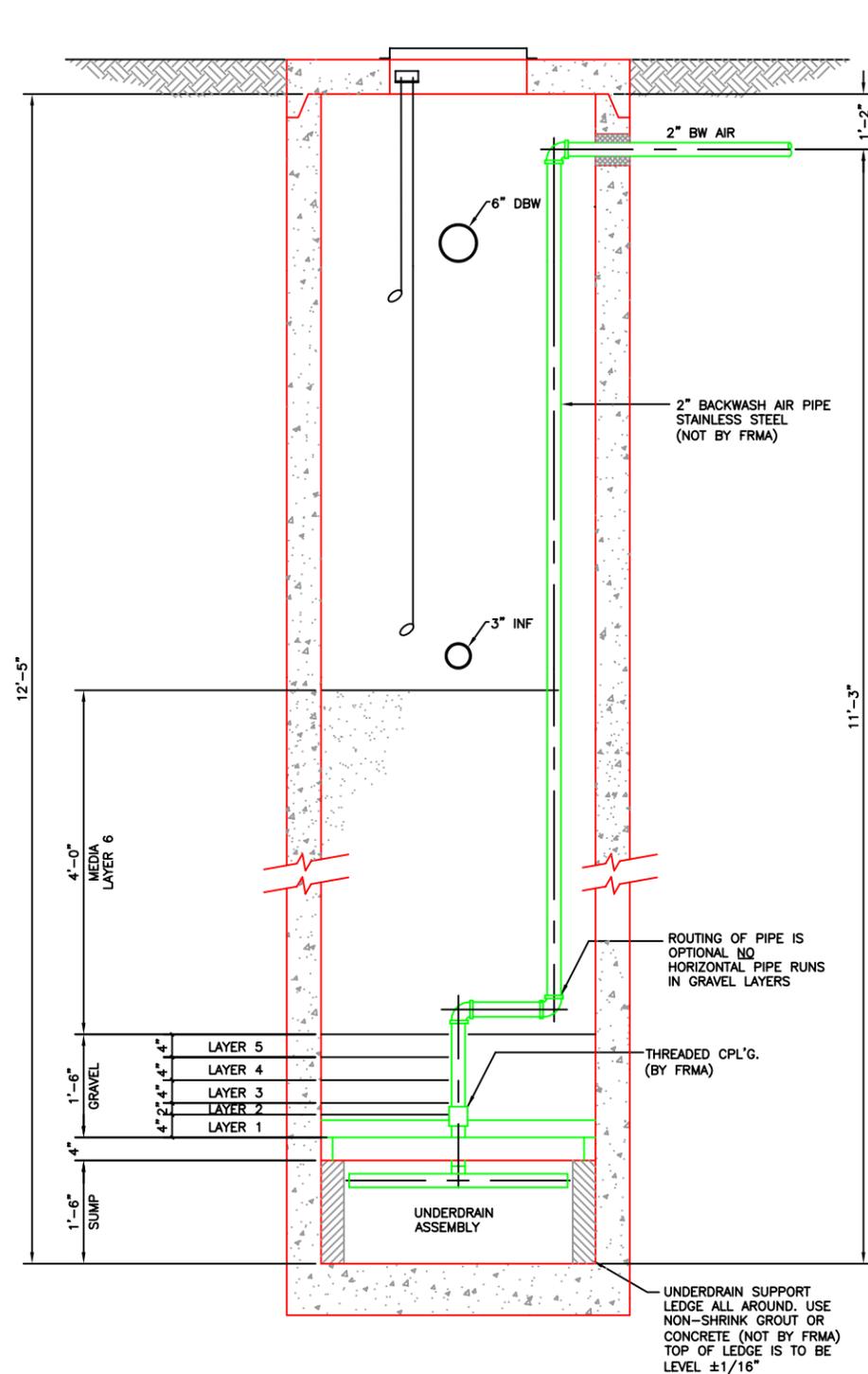
LOCATION:
Asheville, NC

REFERENCE:
LOT
BLOCK

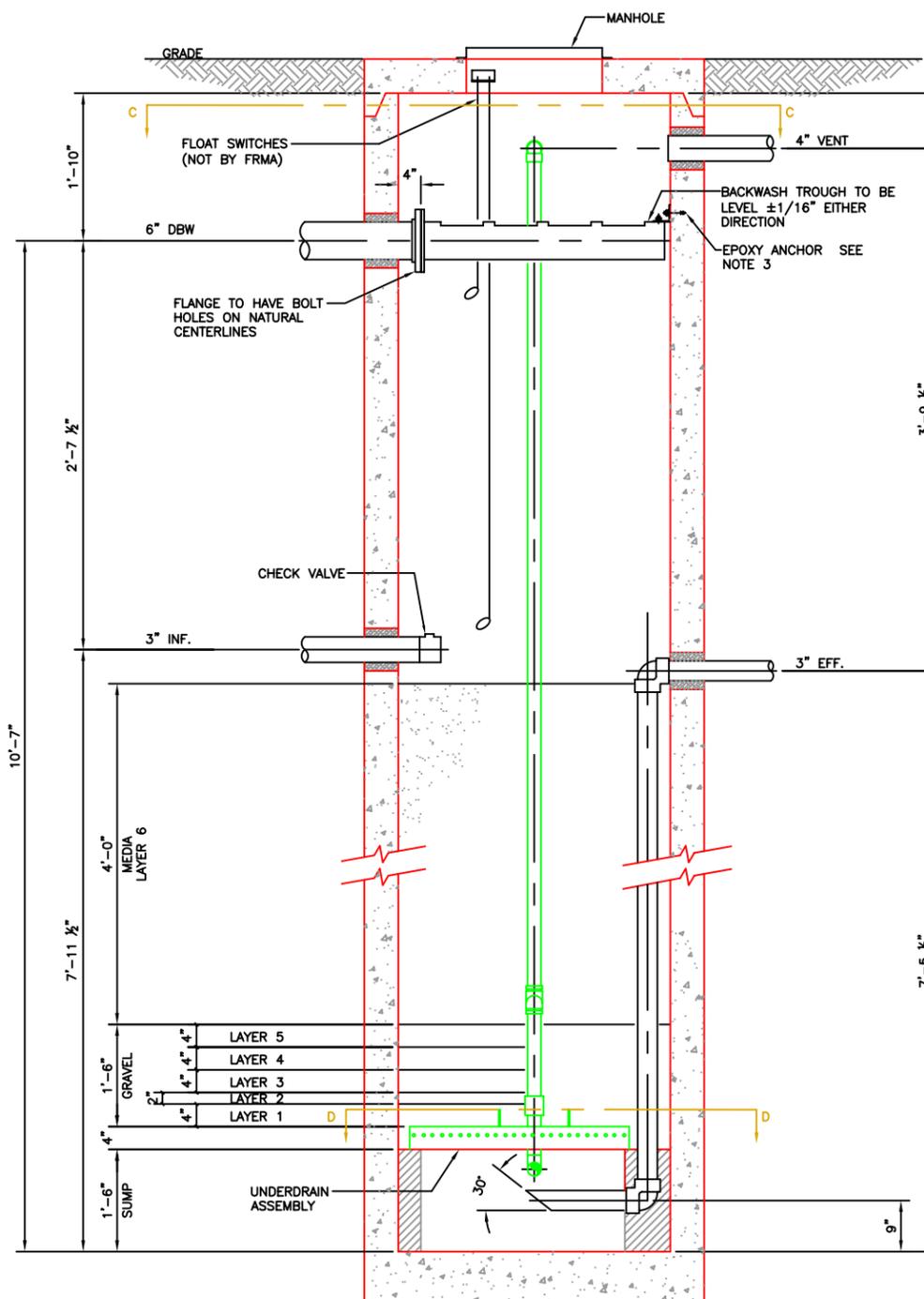
PREPARED FOR:
SUMMIT CHARTER SCHOOL

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No.	Revision/Issue	Date

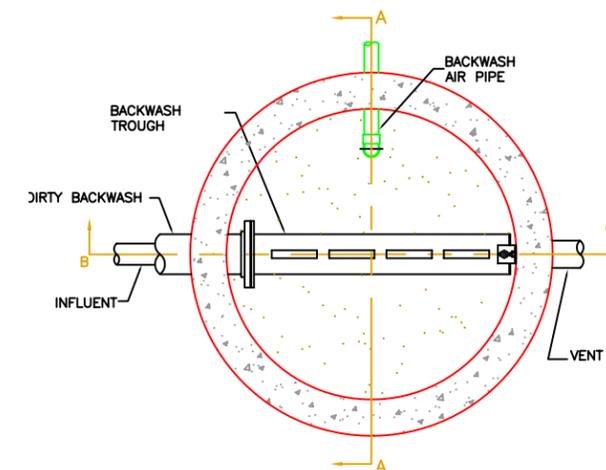
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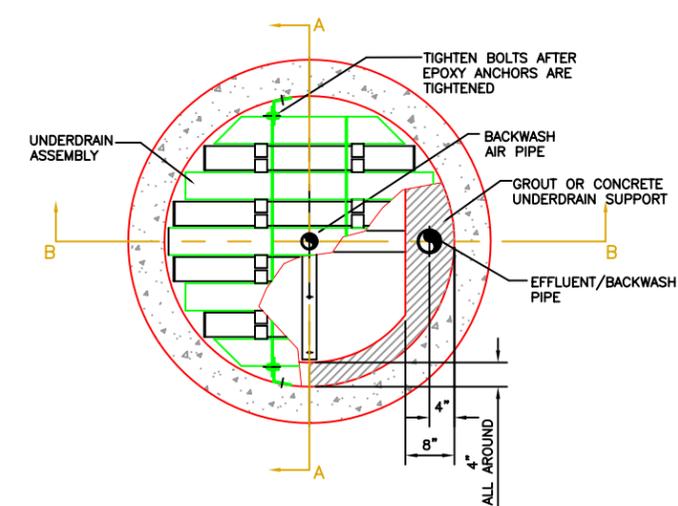
SECTION A-A



SECTION B-B



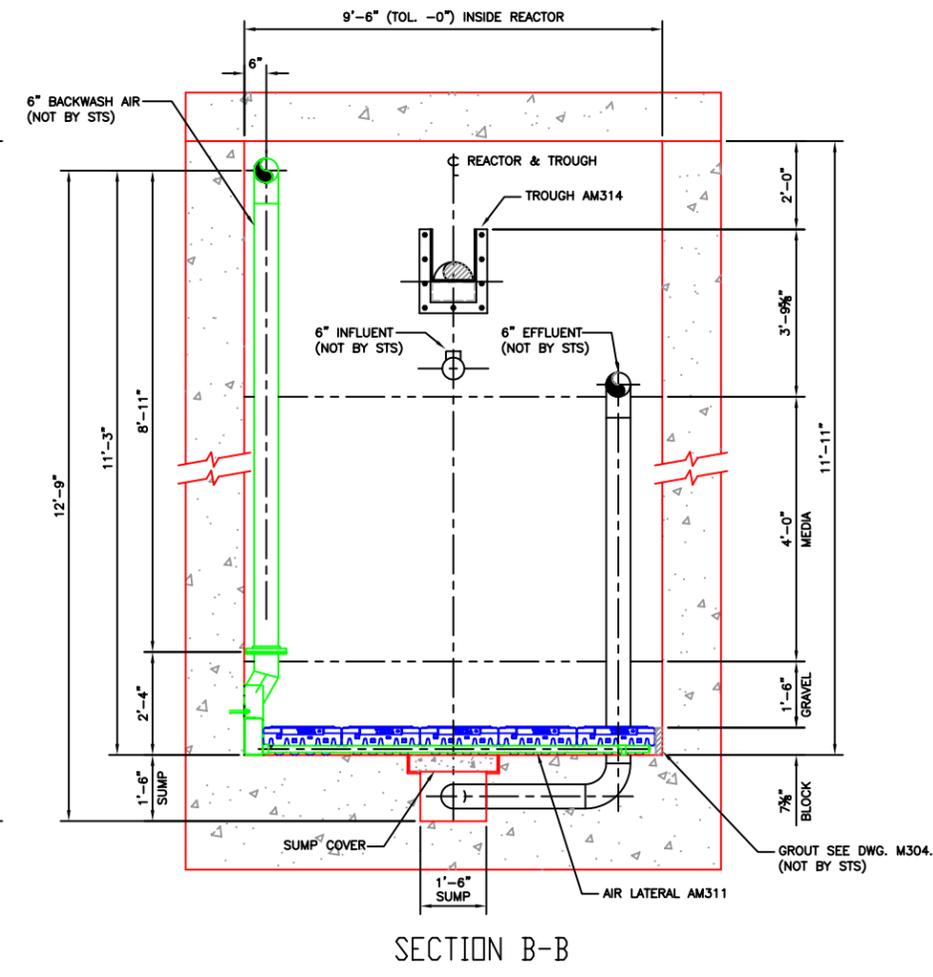
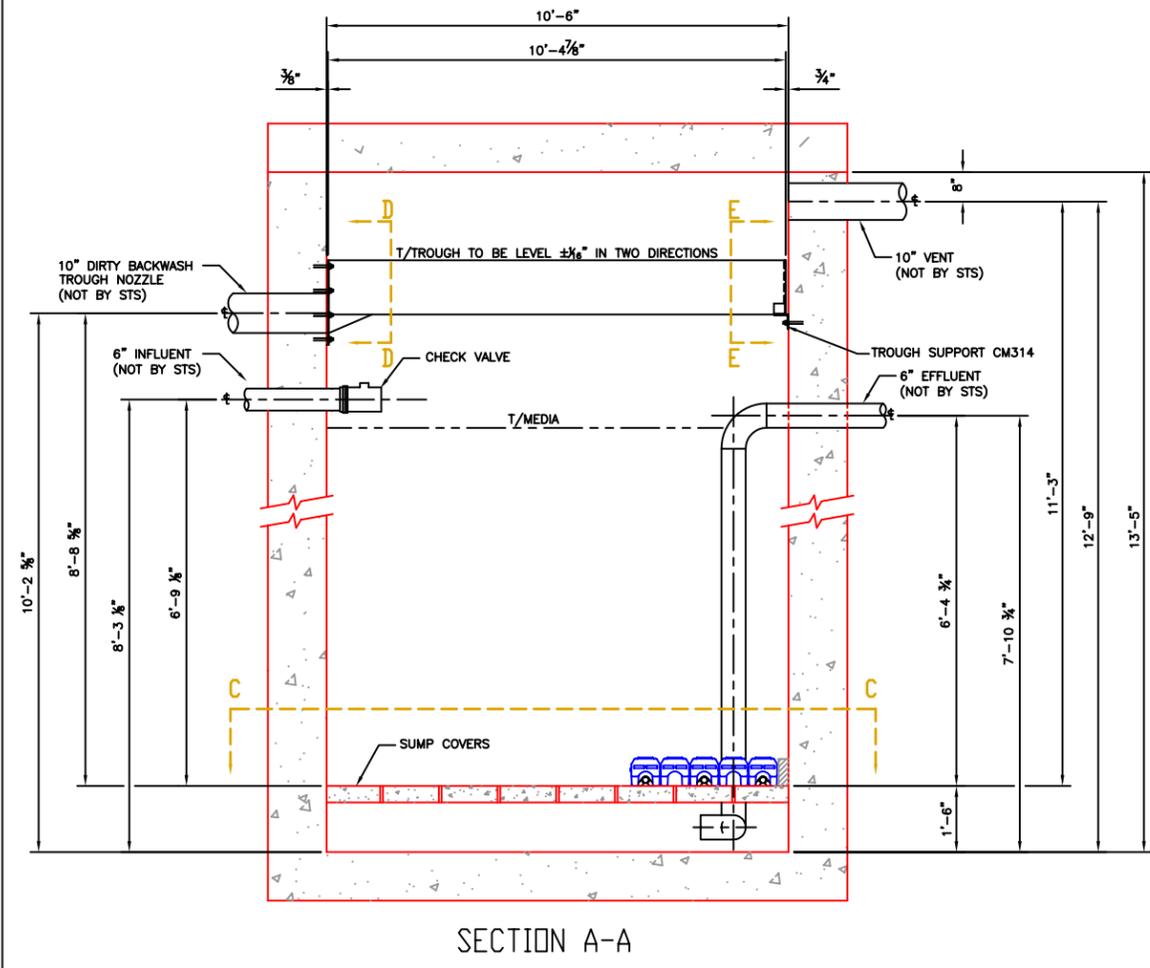
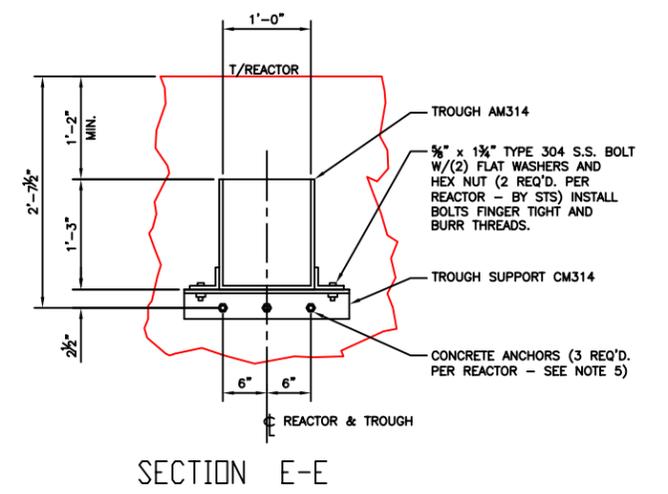
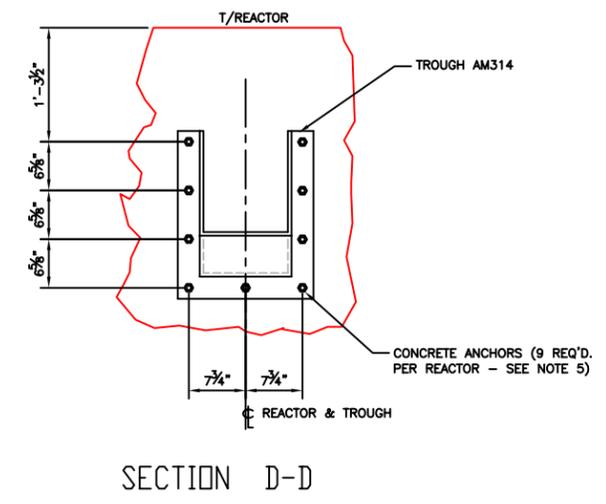
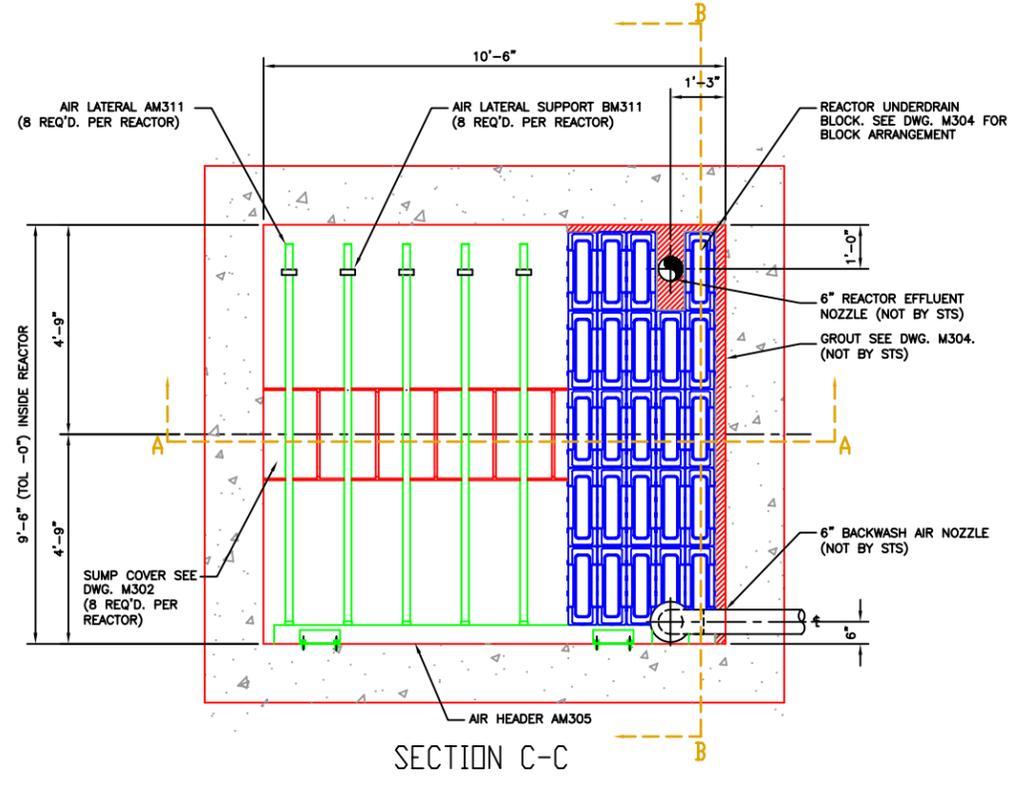
SECTION C-C



SECTION D-D

Drawing No. 4d-4m	Round Amphidrome® Reactor
Drawn By: ADW	App'd by: PBP
Rev:	Date: 5/4/04
Scale: NTS	

EMAHONY
 & associates, inc.
 Water Supply & Pollution Control Equipment
 273 Weymouth Street, Rockland, Massachusetts 02370



REFERENCE DRAWINGS	
DWG. No.	DESCRIPTION
M300	FIELD INSTALLATION PROCEDURE NOTES
M302	AIR HEADER & SUMP COVER FIELD INSTALLATION
M303	TYPICAL SECTIONS & DETAILS
M304	UNDERDRAIN BLOCK & GROUT INSTALLATION

NOTES:

1. BOTTOM OF ALL REACTORS MUST BE SMOOTH AND LEVEL IN TWO DIRECTIONS $\pm \frac{1}{8}$ "
2. ALL ITEMS WITH PIECE MARKS OR OTHERWISE NOTED TO BE SUPPLIED BY STS.
3. INSTALLATION NOT BY STS.
4. ALL QUANTITIES SHOWN ARE FOR ONE REACTOR ONLY. CONCRETE ANCHORS (TAG JM801 & KM800) TO BE 5/8" X 6" TYPE 304 S. STL.
5. EPOXY ANCHOR WITH FLAT WASHER AND HEX NUT (BY STS). INSTALL IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. USE 11/16" DRILL BIT TO MAKE A 4" DEEP HOLE.

MATERIALS OF CONSTRUCTION:

- AIR HEADERS----- $\frac{3}{8}$ " TYPE 304 S.STL. PLATE
- AIR LATERALS-----SCH. 40S TYPE 304 S.STL. PIPE
- AIR LATERAL SUPPORTS-----TYPE 304 S.STL.
- SUMP COVERS----- $\frac{1}{2}$ " THK. CONCRETE
- UNDERDRAIN BLOCK-----HDPE JACKETED 5000 PSI CONCRETE
- TROUGH-----TYPE 304 S.STL. PLATE
- TROUGH SUPPORT-----304 S.STL.

FRMA Drawing No. 100-4m	9'-6" x 10'-6" Amphidrome Reactor
STS Drawing No. M301	
Rev: 9/27/06 - 10" vent	App'd by:
Scale: NTS	Date: 1/22/04
FRMAHONY & associates, inc. Water Supply & Pollution Control Equipment 273 Weymouth Street, Rockland, Massachusetts 02370	
pg.	

This Management Plan identifies some basic requirements for proper operation and maintenance of the Amphidrome and Amphidrome Plus biological nutrient removal (BNR) system operated in batch mode for residential use. Refer to the manufacturer's Operation and Maintenance Manual for the Amphidrome wastewater treatment products for detailed instructions on proper system operation and maintenance.

SYSTEM COMPONENT	TASK	FREQUENCY	RESPONSIBLE PARTY
Amphidrome and Amphidrome Plus	Monitor control center alarms.	On-going	User & Service Provider
	Keep vented lid free from obstruction.	On-going	User & Service Provider
	Record equipment run times.	Bi-Annually <1,500 gpd Quarterly >1,500 gpd <5,000 gpd Monthly >5,000 gpd <10,000 gpd	Service Provider & Maintainer
	Check mechanical and electrical components to ensure proper operation.		
	Monitor flow and perform operational field tests on influent/effluent quality including odor, color, turbidity, temperature, dissolved oxygen ammonia and nitrate and pH as appropriate.		
	Check sludge level in all sewage tanks; follow manufacturer's recommendations for solids removal and sludge wasting.		
	Sample effluent as required in the local Operating Permit.	See Operating Permit and Table on following page	
For seasonal use, follow manufacturer's guidelines.	As required based on seasonal usage	Service Provider	

At the time of each service visit, Form 7-2: Aerobic Treatment Unit should be completed. See <http://www.onsiteconsortium.org/omspchecklists.html>

Items not permitted in the Amphidrome wastewater systems are specified in the Amphidrome Manual for Minnesota. The protocol for collection of wastewater samples is specified in the Amphidrome Manual for Minnesota.

Minimum sampling frequencies*

Amphidrome

Treatment Goal	Design Flow (gpd)	Parameter	Minimum Sampling Requirement*
A2	< 1,500	BOD and TSS	Bi-annually

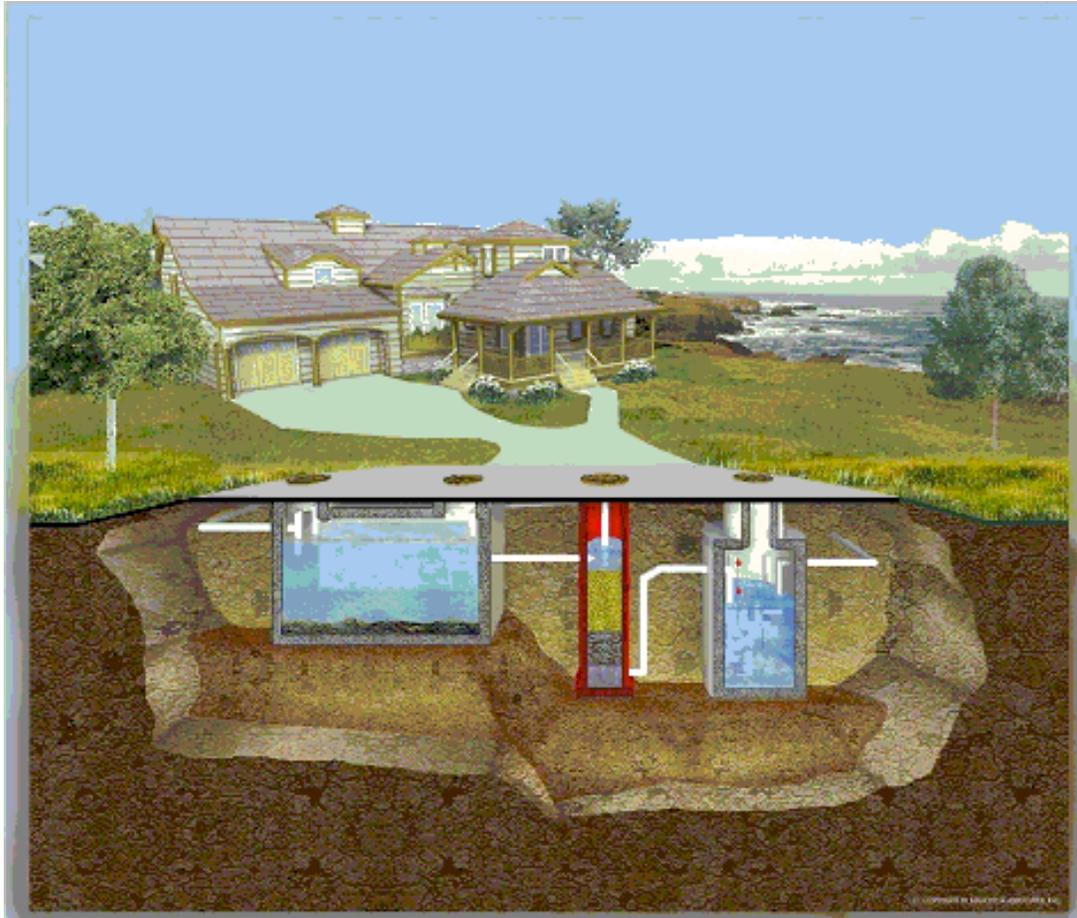
A2	> 1,500 – <5,000	BOD and TSS	Quarterly
A2	>5,000 – < 10,000	BOD and TSS	Monthly

Amphidrome Plus

Treatment Goal	Design Flow (gpd)	Parameter	Minimum Sampling Requirement*
TN	< 1,500	BOD and TSS Total Nitrogen = TKN + NO ₃ ⁻ + NO ₂ ⁻	Bi-annually
TN	> 1,500 – <5,000	BOD and TSS Total Nitrogen = TKN + NO ₃ ⁻ + NO ₂ ⁻	Quarterly
TN	>5,000 – < 10,000	BOD and TSS Total Nitrogen = TKN + NO ₃ ⁻ + NO ₂ ⁻	Monthly

*These minimum sampling requirements assume a system that is operated year round. These values may be reduced if the system is not used year round.

Amphidrome®



Operation & Maintenance Manual Amphidrome® System & Amphidrome Plus® System

frma / advanced treatment solutions

273 Weymouth Street • Rockland, MA 02370

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Forward

This manual has been prepared to help meet the objectives of long equipment life, minimal equipment maintenance, and cost-effective performance. This manual must be read and understood by those responsible for the operation and maintenance of an Amphidrome® Wastewater Treatment System. Non-recommended or unauthorized operating or maintenance procedures may result in: damage to the equipment, down time, substandard treatment, and voidance of any warranties. Included in this manual is a brief summary of biological nutrient removal, a description of the Amphidrome® process, and a detailed description of the control programming. Operation and maintenance procedures for all of the equipment used in an Amphidrome® system are also included. The specific manufacturer's literature should always be referenced when performing any maintenance or troubleshooting. This manual should be used in conjunction with the design or the "As-built" plans, when provided. All standard safety procedures must be observed.

If any special information, regarding the care and operation of the Amphidrome® Wastewater Treatment System, is desired, F.R. Mahony will furnish it upon request.

Requests for information should be directed to:

F. R. Mahony & Associates, Inc.
273 Weymouth Street
Rockland, MA 02370

Phone (781) 982-9300
(800) 791-6132

Introduction

The removal of soluble organic matter (SOM) from wastewater streams has been the major application of biochemical operations for many years. For typical domestic waste streams, which have a biodegradable chemical oxygen demand (COD) range between 50 - 4,000 mg/l, aerobic cultures of microorganisms are especially suitable. Removal occurs as microorganisms use a portion of the carbon in the waste stream as a food source, converting it to new biomass and converting the remaining into carbon dioxide (CO₂). The (CO₂) is released as a gas and the biomass is removed by sedimentation. To accomplish the removal of soluble organics, a culture of heterotrophic bacteria must be maintained in suitable environmental conditions. The microorganisms are classified as heterotrophic because they derive their carbon from an organic source, such as the incoming waste stream, or from supplemental methanol or ethanol.

Since the effect of eutrophication have been shown to be detrimental to receiving waters, the removal of inorganic nutrients from wastewater has become a consideration in the design of wastewater treatment plants. The prime causes of eutrophication are the inorganic nutrients, nitrogen and phosphorus. In sea water and in tidal estuaries, nitrogen is typically the limiting nutrient. Therefore, nitrogen discharge limits in coastal areas have been made especially stringent in recent years. Biological removal of nitrogen to very low levels is easily accomplished. Biological removal of phosphorus is also possible; however, it is more difficult and has a limit, after which, chemical removal is required.

In domestic wastewater, nitrogen is present as ammonia (NH₃) and as organic nitrogen (NH₂) in the form of amino groups. The organic nitrogen is released as ammonia, in the process of ammonification, as the organic matter containing it undergoes biodegradation. Two groups of bacteria are responsible for converting ammonia nitrogen to the innocuous form, nitrogen gas (N₂). The completion of this process occurs in two steps, by completely different bacteria, in very different environments. In the first step, nitrifying bacteria oxidize ammonia to nitrate (NO₃⁻) in a process called nitrification. The bacteria responsible for nitrification are chemolithotrophic autotrophs that are also obligate aerobes, therefore, requiring an aerobic environment. Chemolithotrophic bacteria obtain energy from the oxidation of inorganic compounds, which in the nitrogen cycle are ammonia (NH₃) and nitrate (NO₃⁻). Autotrophic bacteria obtain their carbon source from inorganic carbon, such as carbon dioxide. In the second step, denitrification, facultative heterotrophic bacteria convert nitrate to nitrogen gas, which is released to the atmosphere. This is accomplished only in an anoxic environment in which the bacteria use NO₃⁻ as the final electron acceptor. The ultimate electron acceptor being nitrogen as it undergoes a stepwise conversion from an oxidation state of +5 in NO₃⁻ to 0 in N₂. This process may be carried on by some of the same facultative, heterotrophic bacteria that oxidize the soluble organic matter under aerobic conditions. However, the presence of any dissolved oxygen will inhibit denitrification, since the preferential path for electron transfer is to oxygen instead of to nitrate.

Since biological removal of nitrogen is both possible and economically viable, many of today's wastewater treatment plants require the removal of both soluble organic matter and nitrogen. To achieve this requires: a heterotrophic population of bacteria operating in an aerobic environment to remove the SOM, a chemolithotrophic autotrophic population of bacteria also operating in an aerobic environment to convert the ammonia to nitrate and finally, a facultative heterotrophic population of bacteria to convert nitrate to nitrogen gas in an anoxic environment. Therefore, typical treatment plant designs approach the removal of organics and nutrients in one of three ways. The first method is to combine the aerobic steps, (i.e. SOM removal and nitrification), into one operation and design the anoxic denitrification process as a separate unit operation. The second method is to design three separate unit operations for each step. The third method is to design a sequencing batch reactor (SBR), which has both aerobic zones and anoxic zones. The type of technology utilized greatly influences the number of unit operations to reach the desired effluent treatment level.

Biochemical operations have been classified according to the bioreactor type because the completeness of the biochemical transformation is influenced by the physical configuration of the reactor. Bioreactors fall into two categories, depending on how the biological culture is maintained within, suspended growth or attached growth, also called fixed film. In a suspended growth reactor, the biomass is suspended in the liquid being treated. Examples of suspended growth reactors include activated sludge and lagoon. In a fixed film reactor the biomass attaches itself to a fixed media in the reactor and the wastewater flows over it. Examples of attached growth reactors include rotating biological contactor (RBC), trickling filter, and submerged attached growth bioreactor (SAGB), also called biological aerated filter (BAF). Extensive research has been conducted on both the activated sludge process and the RBC process but to a lesser degree on the other types of treatment.

During the last twenty years, different configurations of SAGBs have been conceived and modest advances in the understanding of the systems have been made. The advantages of biological aerated filters are that they may operate without a solids separation unit process after biological treatment and with high concentrations of viable biomass. Removal of sludge is usually achieved by backwashing the filter. In such bioreactors, the hydraulic retention time (HRT) is less than the minimum solids retention time (SRT) required for microbial growth on the substrates provided. This means that the growth of suspended microorganisms is minimized and the growth of attached microorganisms is maximized. The low hydraulic retention time results in a significantly smaller required volume, to treat a given waste stream, than would be achieved with either a different fixed film reactor or a suspended growth reactor for the same waste stream.

The Amphidrome® Process

The Amphidrome® system is a submerged attached growth bioreactor process operating in a batch mode. It is a deep-bed sand filter designed for the simultaneous removal of soluble organic matter, nitrogen and suspended solids within a single reactor. However,

if stringent total nitrogen limits, (i.e. less than 10 mg/l), are required, a second smaller polishing reactor is required. Since it removes nitrogen, it is also a biological nutrient removal (BNR) process.

To achieve simultaneous oxidation of soluble material, nitrification and denitrification in a single reactor, the process must provide aerobic and anoxic environments for the two different populations of microorganisms. The Amphidrome® system utilizes two tanks and one submerged attached growth bioreactor, subsequently called Amphidrome® reactor. The first tank, the anoxic/equalization tank, is where the raw wastewater enters the system. The tank has an equalization section, a settling zone, and a sludge storage section. It serves as a primary clarifier before the Amphidrome® reactor.

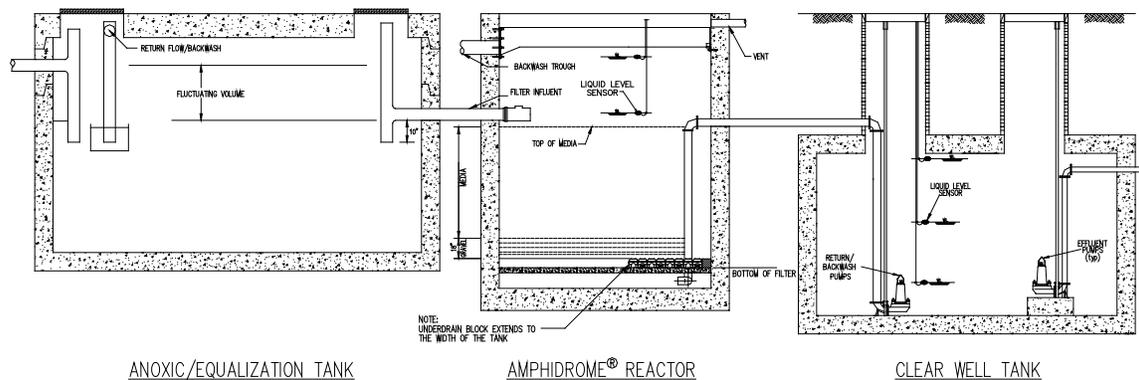


Figure 1. Cross Section View Of Amphidrome™ Reactor and Tanks

This Amphidrome® reactor consists of the following four items: underdrain, support gravel, filter media, and backwash trough. The underdrain, constructed of stainless steel, or HDPE encased concrete block, is located at the bottom of the reactor. It provides support for the media and even distribution of air and water into the reactor. The underdrain has a manifold and laterals to distribute the air evenly over the entire filter bottom. The design allows for both the air and water to be delivered simultaneously, or separately, via individual pathways to the bottom of the reactor. As the air flows up through the media, the bubbles are sheared by the sand--producing finer bubbles as they rise through the filter. On top of the underdrain is 18", (five layers), of four different sizes of gravel. Above the gravel is a deep bed of coarse, round, silica sand media. The media functions as a filter, significantly reducing suspended solids, and provides the surface area for which an attached growth biomass can be maintained.

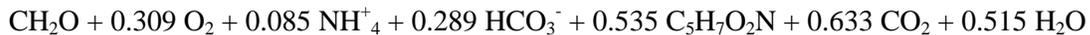
To achieve the two different environments required for the simultaneous removal of soluble organics and nitrogen, aeration of the reactor is intermittent, rather than continuous. Depending on the strength and the volume of the wastewater, a typical aeration scheme may be three to five minutes of air and ten to fifteen minutes without air.

Concurrently, return cycles are scheduled every hour, regardless of the aeration sequence. During a return, water from the clear well is pumped back up through the filter and overflows into the trough. A check valve in the influent line prevents the flow from returning to the anoxic/equalization tank, via that route. The trough is set at a fixed height above both the media and the influent line; and the flow is by gravity back to the front of the anoxic/equalization tank.

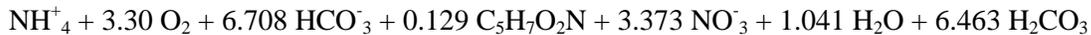
The cyclical forward and reverse flow of the waste stream and the intermittent aeration of the filter achieve the required hydraulic retention time and create the necessary aerobic and anoxic conditions to maintain the required level of treatment.

Biochemical Reactions

The removal of SOM is achieved by the oxidation of carbonaceous matter, which is accomplished by the aerobic growth of heterotrophic bacteria. The biochemical transformation is described by the following normalized mass based stoichiometric equation in which the carbonaceous matter is a carbohydrate (CH₂O) and the nitrogen source for the bacteria is ammonium (NH₄⁺).



The oxidation of ammonia to nitrate is accomplished by the aerobic growth of chemolithotrophic, autotrophic bacteria and is described by the following normalized mass based stoichiometric equation. The overall equation describes the two-step process in which ammonia is converted to nitrite by Nitrosifiers and nitrite is converted to nitrate by Nitrifiers.



The final step in the removal of nitrogen from the waste stream occurs when carbonaceous matter is oxidized by the growth of heterotrophic bacteria utilizing nitrate as the terminal electron acceptor. The equation describing the biochemical transformation depends on the organic carbon source utilized. The following is the normalized mass based stoichiometric equation with the influent waste stream as the organic carbon source.



Biological removal of nitrogen has been the focus of much attention and many of today's wastewater treatment plants incorporate it. However, the difficulty in promoting these biochemical transformations in one reactor is the different environmental conditions required for each transformation.

This Amphidrome® process is designed to achieve the above reactions simultaneously within one reactor. The aerobic environment within the filter promotes the first two reactions. The return flow, to the anoxic/equalization tank, mixes the nitrates with organic carbon in the raw influent and with organic carbon that has been released from the stored sludge. The anoxic environment within the filter promotes denitrification, the third reaction.

Wastewater Characteristics

The Amphidrome® process, like all wastewater processes, is designed to operate within design parameters for flow and wastewater characteristics. The first step to successful operation of any treatment facility is to characterize the wastewater through various analyses, which include: BOD₅, total suspended solids, settleable solids, COD, pH, alkalinity, DO, temperature, total solids, dissolved solids, nitrogen and phosphorus. Some of these parameters may not be specified by any imposed discharge limits; however, occasional sampling may prove prudent should any problems arise. Maintaining a history of these analyses will prove helpful in following trends or anticipating changes in the treatment efficiency. Samples should be taken in the same locations and testing should follow “Standard Methods” or other approved regulatory testing procedures. Consistent techniques will provide more useful and valid information.

Wastewater Flow

Large fluctuations in wastewater flow may effect the treatment process; however, daily flows will fluctuate and should be expected. Major changes should be limited to the design capabilities of the treatment process. Wastewater flows may be monitored through water meter or pump run time. However, effluent flow metering is the most common and will provide an accurate measure of the flow actually processed at the facility.

Treatment plants are often designed based on expected flow rates from established literature or from regulatory standards. These standards usually result in design flows that are greater than the actual flows. Once the facility is constructed, operating parameters must be set to treat actual flows; therefore, some adjustment may be required. Flows should not exceed the design permit flow.

pH, Alkalinity and Temperature

Typical domestic wastewater has a pH between 6.5 and 8.0. Biological microorganisms are affected by extreme variations in pH and in temperature. It has been shown experimentally that the reactions, of both nitrification and denitrification, are optimized at pH values in the range of 8. Therefore, it is recommended that supplemental alkalinity be used to maintain such a pH, as long as this does not put the plant in violation of any effluent limits. Maintaining such a pH will also insure that sufficient alkalinity is present for nitrification. The bacteria responsible for nitrification consume the inorganic carbon

supplied by the bicarbonate dissolved in the wastewater. Therefore, bicarbonate alkalinity is an important parameter in the treatment process and should, therefore, be monitored in an Amphidrome® system. Two general rules may be used as operational guidelines: first, 7.4 mg/l of alkalinity is needed for each mg of ammonia to be nitrified, and second, a residual alkalinity value of 100 mg/l should be left after complete nitrification. Typically, both these conditions will be met if supplemental alkalinity is used to maintain the pH level at approximately 8.

Temperature fluctuations from weather conditions should not effect the Amphidrome® process since the process tanks are all underground. The anoxic/equalization tank provides buffering of influent temperature prior to the reactor. This should serve to permit reasonable temperature fluctuations in the waste stream.

BOD, COD and Suspended Solids

Organic and solids loading are fundamental characteristics governing the size of treatment processes. BOD and COD are measures of the strength of the wastewater.

BOD (biochemical oxygen demand) measures the rate of oxygen uptake from the wastewater by microorganisms in biological reactions. These microorganisms are converting the waste materials to carbon dioxide, water and inorganic nitrogen compounds. The oxygen demand is related to the rate of increase in microorganism activity resulting from the presence of food, organic waste, and nutrients.

COD (chemical oxygen demand) measures the presence of carbon and hydrogen but not amino nitrogen in organic materials. COD does not differentiate between biologically stable and unstable compounds. COD tests can be inhibited by chloride. Thus, wastewater containing high salt concentrations, such as brine, cannot be readily analyzed without modification.

Suspended solids measure the solids in wastewater that floats or suspends in the liquid stream. This does not measure the total solids loading to the facility that includes settleable and dissolved solids. The settleable solids are normally removed in the anoxic/equalization tank while suspended and dissolved solids are to be treated in the filtering and biological processes in the Amphidrome® reactor. As solids breakdown and are backwashed from the reactor, they settle and form a layer of sludge at the bottom of the anoxic/equalization tank. Periodic removal of the sludge is required.

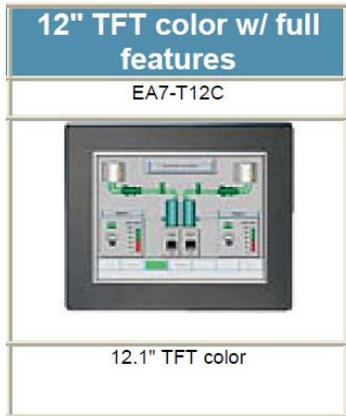
Nitrogen

In domestic wastewater, nitrogen is present as ammonia (NH_3) and as organic nitrogen (NH_2^-) in the form of amino groups. The organic nitrogen is released as ammonia, in the process of ammonification, as the organic matter containing it undergoes biodegradation. To achieve biological nitrogen removal, bacteria must convert ammonia to the innocuous form, nitrogen (N_2) gas. However the stepwise process produces nitrate (NO_3^-) as an intermediate compound. Nitrate in drinking water is of concern to infants because it has

been widely stated in literature to be linked to “methemaoglobinemia,” which may result in death for infants. Monitoring of both ammonia and nitrate is extremely useful for process control and should be done once or twice weekly after the plant is in compliance.

Controls Description

Touch Screen



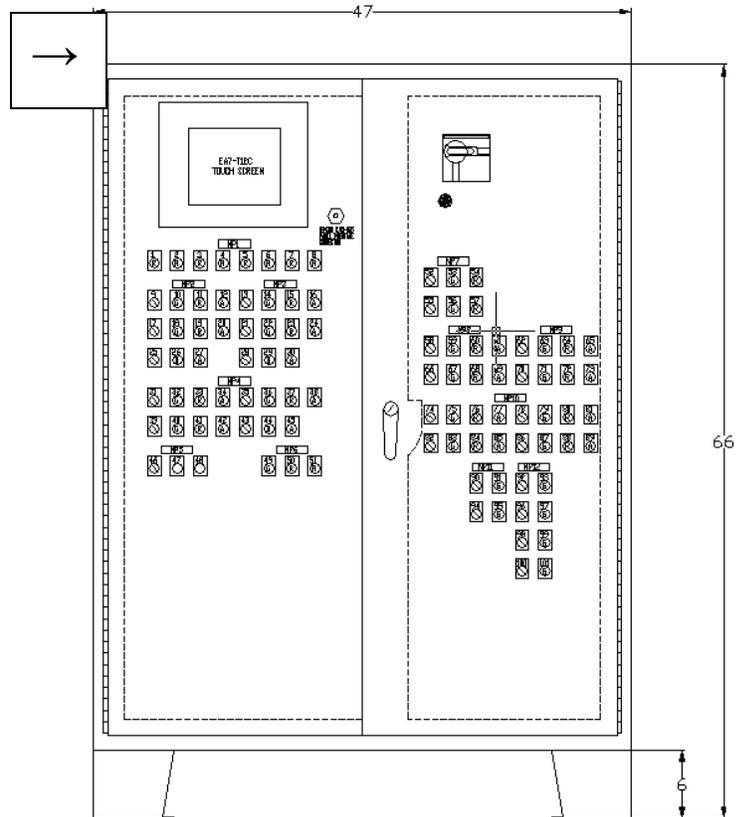
Touch Screen Operation

The Amphidrome™ process control utilizes an analog positive 12-bit resolution touch screen HMI (human/machine interface). Several sizes of touch screen panels are available with the Amphidrome control panel. This screen is generally mounted on the front face of the control panel and provides access to system operating readouts and allows the operator to access and modify operation settings. The touch screen panel has a battery back up to store calendar-month/day/year. *The replaceable battery –ADC Part #D2-BAT-1 (Manufacturer Part # CR2354)*

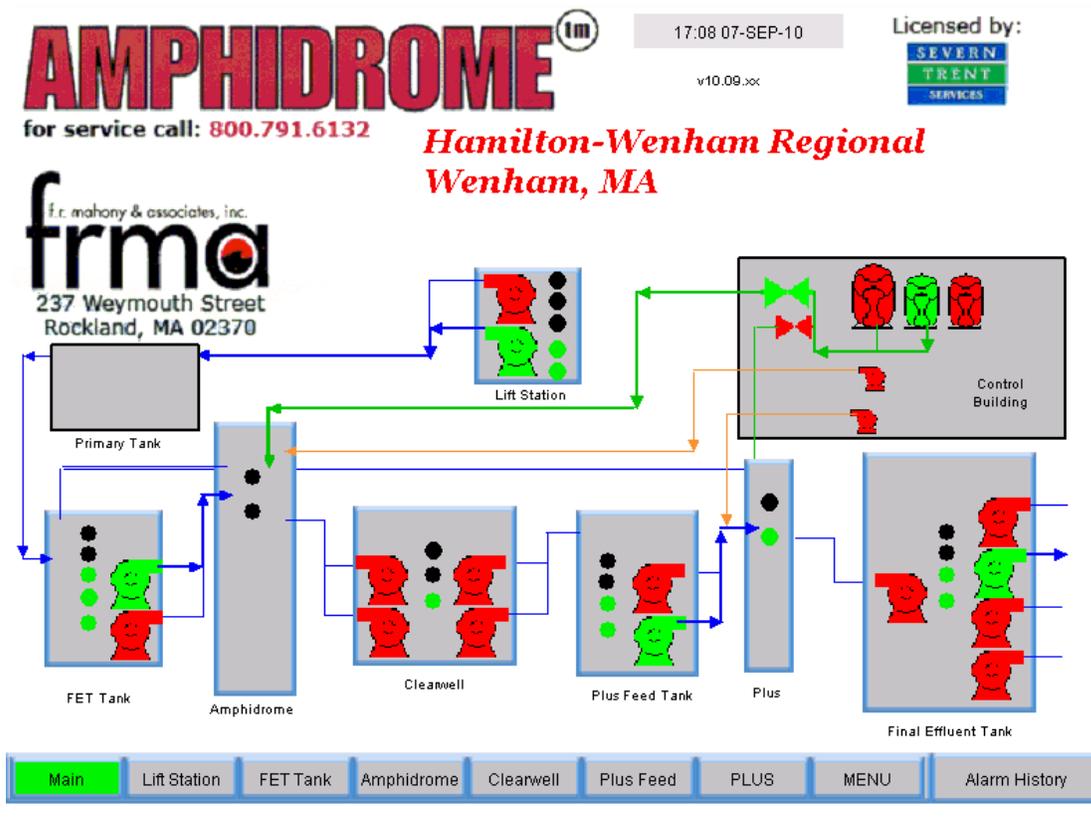
Operator settings are based on a real time clock built into the panel.

The touch screen panel will display current operation status and provides access to additional screens which display system component status and settings. The pathways to each screen are menu driven with common menu buttons such as “Main”, “Back”, “Home”, and “Menu”.

This manual is intended to demonstrate pathways to the menu screens and will show values such as 0 (zero) or some entered values based on general system operating parameters. Specific settings for each system should be taken from the program settings and operator adjustments as may be required for the specific treatment plant operation. References to operator settings in this manual are therefore used as an example.



Main Screen



The “Main Screen” provides access to each system component. Access to component screens may be obtained through the menu buttons at the bottom of the Main Screen, or by touching on a component with a blue outline.

Status indicators on the Main Screen will display if a float is raised or if a particular piece of equipment is in operation. Floats in each of the system tanks appear as a black dot when down, and will light as green when raised (made).

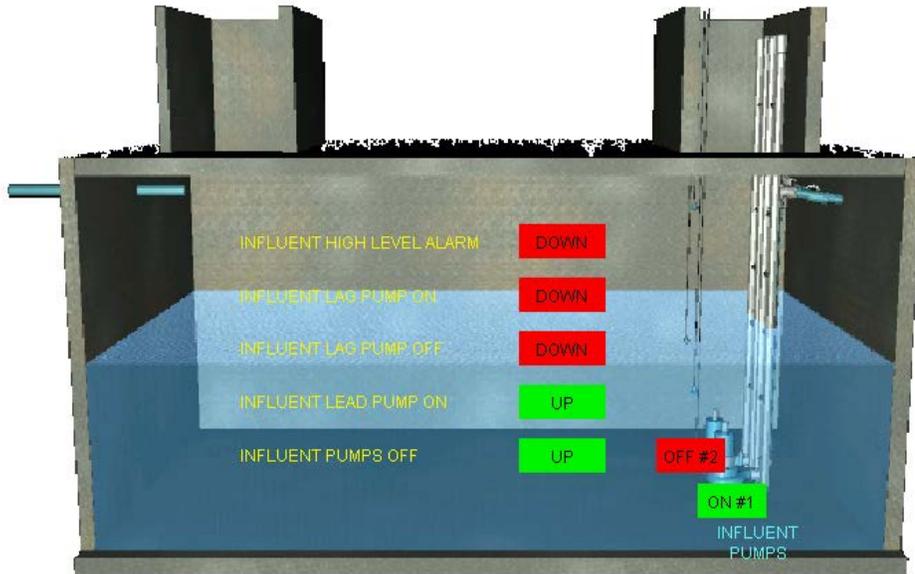
Example: The system display above demonstrates the float and pump status with running pumps in “green” and idle pumps “red”.

The real time clock display in the top center right displays the current time and date as HH:MM:SS Military Time. The time shown in this image is **17:08** which would be 5:08 PM. The date is shown as **07-SEP-10** or September 7, 2010. Adjusting the clock settings will be discussed later in this manual. Below the time and date is the version number of this touch screen program (currently v10.09.xx). Touching the version number will display a pop-up with details on the current version (e.g. modifications and enhancements.)

Lift Station Screen

Touching on the Lift Station will open the Lift Station Screen. The Lift Station pumps raw wastewater to the Anoxic Tank.

19:53:09 07-SEP-10



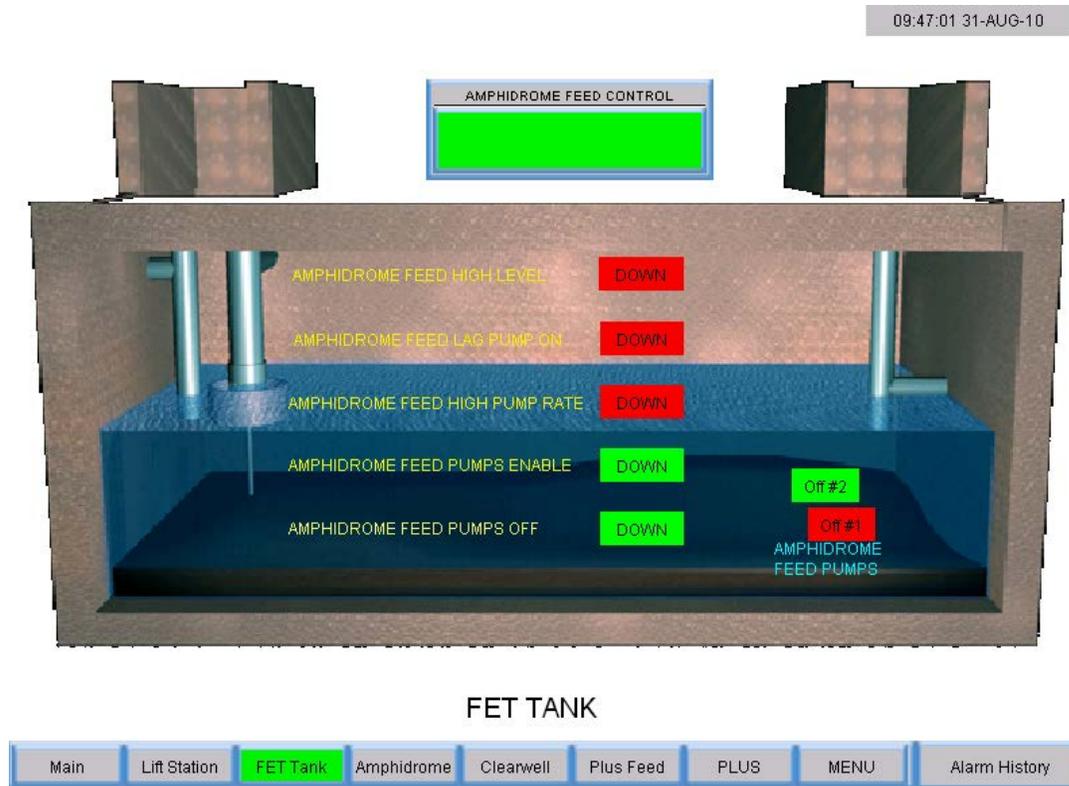
Lift Station (Feed to Primary Tank)



The pumps are demand-driven and controlled by the floats in the Lift Station Tank. The current status of the floats and pumps are shown on the screen. Notice that the menu bar at the bottom of the screen highlights the current screen being displayed.

Flow Equalization Tank (FET) Screens

Touching on the FET Tank will open the FET Screen.



The Flow Equalization Tank receives raw waste from the Lift Station as well as the return and backwash water from the Amphidrome® and Amphidrome® Plus. Two Amphidrome Feed Pumps are located in this tank. The pumps are controlled by a combination of the floats and an operator-defined on and off time.

Selecting the “Amphidrome Feed Control” button on this screen will pop-up the feed control dialog.

AMPHIDROME REACTOR FEED (FET) CONTROLS

ENABLE FET CYCLE (HH.MM)

Start Cycle #1	End Cycle #1
00.00	00.00
Start Cycle #2	End Cycle #2
00.00	00.00

PUMP control if FET tank level is Normal

ON	OFF
0 min	0 min

PUMP control if FET tank level is HIGH

ON	OFF
0 min	0 min

DONE

08:35:43 08-SEP-10

Using this dialog, you may define two separate start and end times during which the feed pumps will run. You will also define the two on-off cycles at which the pumps operate.

The pumps will operate at the “Normal” cycle any time the water level is above the “Off” float (the lowest float in the tank) and below the “High Rate” float (the 3rd float in the tank). The feed pumps will begin to ‘cycle’ on-and-off at the “Normal” rate when the “Enable” float (2nd float) is raised. It will continue operations at this rate until: 1) the “Off” float drops out and the pumps stop, or 2) the “High Rate” float is raised and the pump cycle at the “High” feed rate.

Optimal settings for the “Normal” cycle would be to set the “ON” time to displace one half (½) of the volume of water in the reactor and have the “OFF” time at least as long as the time it takes for one complete ON/OFF cycle.

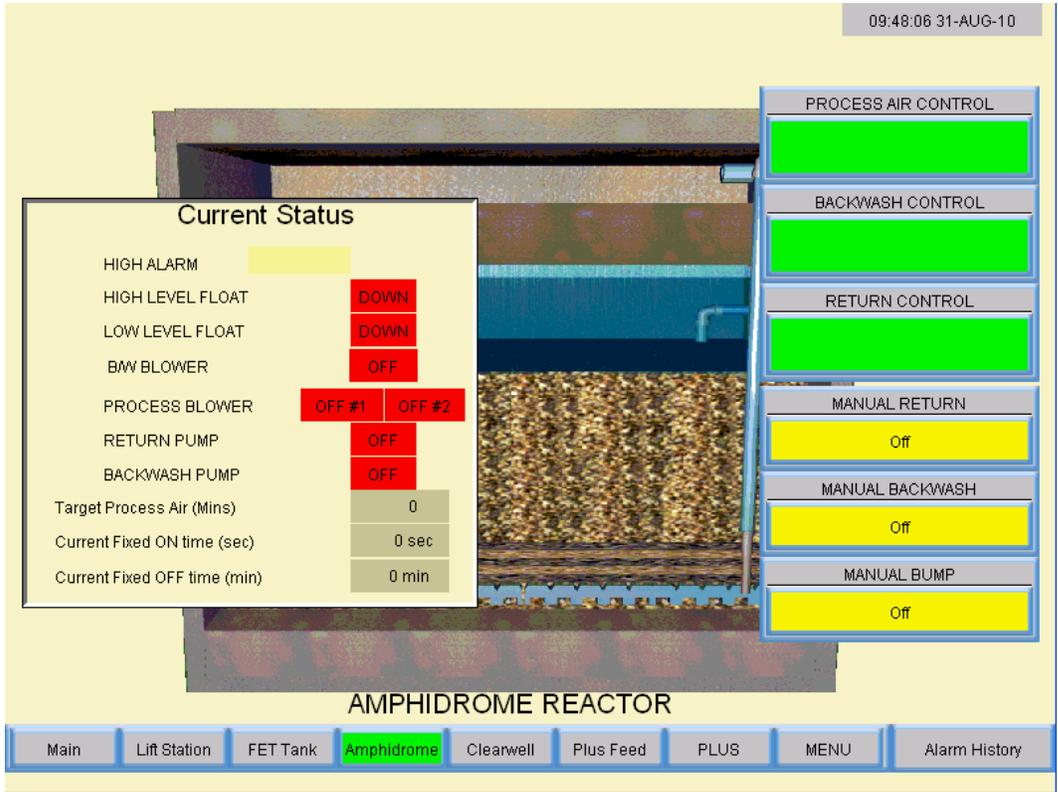
For example: if the reactor is 9.5’x10.5’ with 6 feet of media, the volume to displace would be: 9.5’ x 10.5’ x 3’ x 7.48 gallons/cuft x 0.4 = 895 gallons per dose.

If pumps run at 200 gpm, then the pump ON time would be 4-5 minutes. If the process air is setup to run around 3-mins ON/ 8 mins OFF (11 minutes per cycle), then the OFF time for the pumps would be would be

Select “DONE” to exit this dialog.

Reactor Screens

Touching on the Amphidrome will open the Amphidrome Reactor Screen.



The Current Status box shows the status of key components such as floats and pump operations associated with the Amphidrome Reactor.

Operator adjustable process controls are “Process Air Control”, “Backwash Control” and “Return Control” (green buttons upper right).

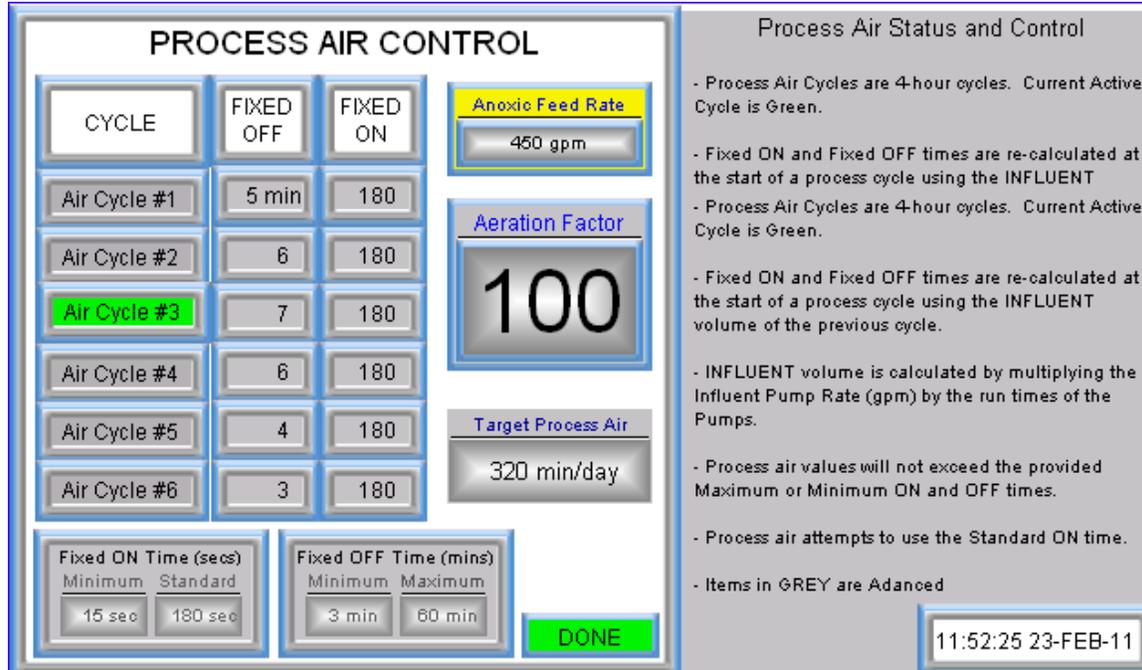
Manual startup buttons for “Return”, “Backwash”, and “Bump” cycles are provided on this screen as well. Once the “cycle” is initiated, it must be permitted to complete the full cycle and can not be stopped from this screen. Therefore this button is colored yellow as a caution to be used sparingly.

The current time and date are displayed at the top right of the Amphidrome Reactor Screen.

By pressing the “Main” button you will be returned to the Main Screen. You may also jump to any component along the flow train by pressing on the appropriate button or “Menu” button at the bottom of the screen

Process Air Control Screen

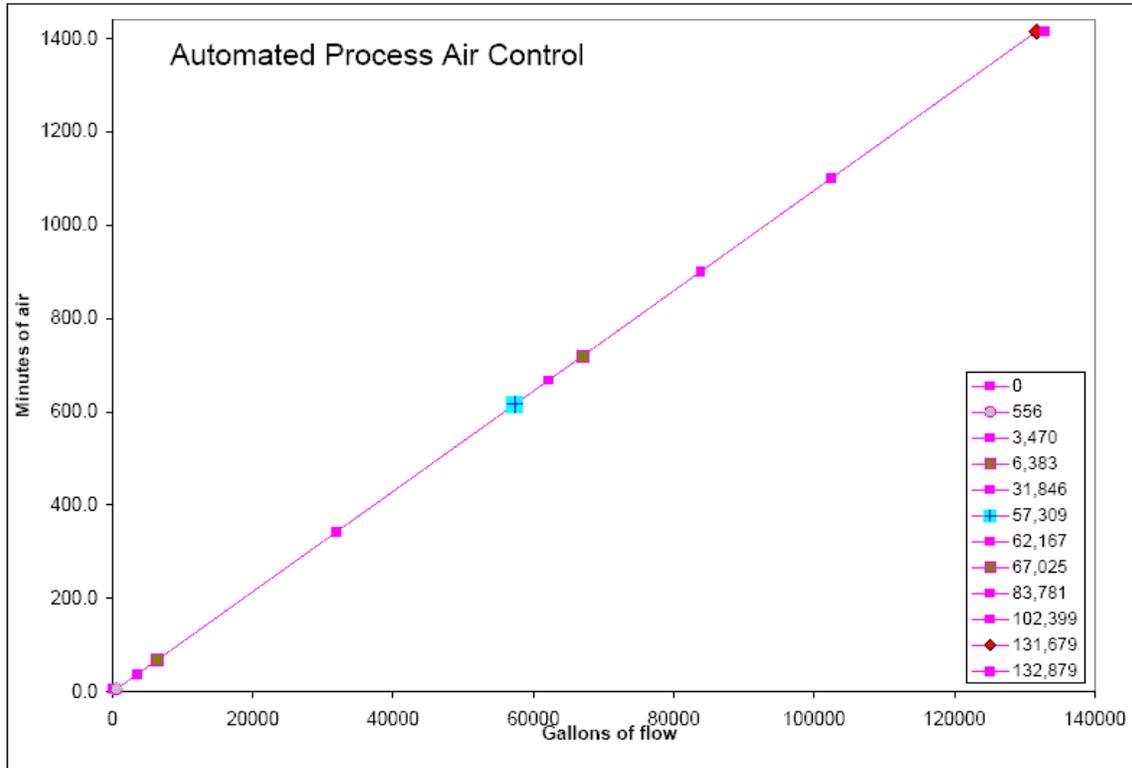
The process control screen, like all pop-up dialog screens in this system provides some operator notes and guides. These help guides describe the controls found on the screen and their application.



Process air settings (fixed off and fixed on times) are automatically recomputed every four hours using the flow to the treatment system.

The Aeration Factor at startup is set to a value of 100. This value may be viewed as a percentage of the calculated “design process air” that is required to treat the waste stream. If the wastewater strength is lower or higher than the design parameters, this number will need to be decreased or increased, as necessary to provide adequate process air. The Aeration factor may be in the range of (1 – 999), however, if it rises above 300, or drops below 40, FRMA should be consulted in order to verify the program operations and possibly re-calibrate the system an Aeration Factor of 100.

Figure 1 presents a plot demonstrating how the total minutes of process air varies based on volume of wastewater. The slope of the line is calculated based on the design influent constituent and flow volume. On this graph, 615 minutes of process air (in 24 hours) is required to treat 57,000 gallons of wastewater. The required “minutes of process air” is then used to calculate the fixed ON and fixed OFF time for the process air blowers. The fixed off and fixed on times for each process air cycle are shown on the Process Air Control dialog. The current (active) process air cycle is shown in green.



Until a colony is fully established in the reactor, the Aeration Factor should be set to around 150. This setting would provide excess air to the system and should promote the rapid growth of nitrifying bacteria. As the bacteria colony becomes established, the ammonia level in the clearwell will drop to (near) zero.

Once the ammonia level is fractional, the operator will need to reduce the Aeration Factor (trim back air) until the ammonia level just start to rise (remaining below 1.0 mg/L). Since the results of reducing or increasing the process air is typically seen within a few days, initial changes of the aeration factor may be large.

Example:

Initial aeration factor = 150, Ammonia is fractional; nitrates are > 10 mg/L.

Reduce Aeration factor to 90. Test for ammonia & nitrates 24 and 48hrs later.

Ammonia is now 1.8mg/L, nitrates are 4.

Increase Aeration factor to 95, test again for ammonia & nitrates 24 and 48hrs later.

Repeat process until ammonia is fractional, and nitrates are low.

Backwash and Return Control

The Backwash / Return Screen is shown below.

AMPHIDROME RETURN and BACKWASH CONTROL

Return	AR #1	Return Time	AR #2	AR #3	AR #4	Time Over Trough
1	00:00	00:15	00:30	00:45	1	
2	01:00	01:15	01:30	01:45	1	
3	02:00	02:15	NONE	02:45	2	
4	03:00	03:15	03:30	03:45	1	
5	04:00	04:15	04:30	04:45	1	
6	05:00	05:15	05:30	05:45	1	
7	06:00	06:15	06:30	06:45	1	
8	07:00	07:15	07:30	07:45	2	
9	08:00	08:15	08:30	08:45	1	
10	09:00	09:15	09:30	09:45	1	
11	10:00	10:15	10:30	10:45	1	
12	11:00	11:15	11:30	11:45	2	

Return #	AR #1	Return Time	AR #2	AR #3	AR #4	Time Over Trough
13	12:00	12:15	12:30	12:45	1	
14	13:00	13:15	13:30	13:45	1	
15	14:00	14:15	14:30	14:45	1	
16	15:00	15:15	15:30	15:45	2	
17	16:00	16:15	16:30	16:45	1	
18	17:00	17:15	17:30	17:45	1	
19	18:00	18:15	18:30	18:45	0	
20	19:00	19:15	19:30	19:45	1	
21	20:00	20:15	20:30	20:45	2	
22	21:00	21:15	21:30	21:45	1	
23	22:00	22:15	22:30	22:45	1	
24	23:00	23:15	23:30	23:45	1	

BACKWASH CONTROL

Both return volumes and reactor backwash times may be adjusted from this screen.

You schedule a backwash by simply touching on the time under the desired reactor. The selected time will be shown as a green box around the time. For example, on the above screen, Amphidrome #2 has a backwash scheduled for 12:15 AM (00:15). Selecting the time again, will remove the backwash time.

If a backwash is not scheduled, a return will occur at the time shown. You may define the time over the trough for each return. As seen on the screen, a return will occur every hour. Set "Time Over Trough" to '0' to disable that return. Note that disabling a return 'time over trough' will disable returns for all reactors in that row.

To change the return times in this screen, touch the "Time Over Trough" entry to modify to open the keypad entry screen. This screen will appear much like a calculator screen and allows entry of the new value. You may then accept the change by pressing "Enter" or stop the change by pressing "Cancel". When you are completed making these changes, press "Done" to return to the reactor screen. NOTE that the time values are clock times in military time. To set a backwash for 4:00PM, you would enter 1600 on the keypad.

Backwash Control Screen

BACKWASH CONTROL

BLOWER CONTROLS*

START BLOWER STOP BLOWER

0 0

PUMP CONTROLS*

START PUMP MINs OVER

0 0

SELECT DAYS TO BACKWASH

Su Mo Tu W Th Fr Sa

START MANUAL BACKWASH REACTOR #1 START MANUAL BACKWASH REACTOR #2

START MANUAL BACKWASH REACTOR #3 START MANUAL BACKWASH REACTOR #4

DONE

This screen is used to setup the Backwash Control for the Amphidrome Reactors.

- Time to backwash is selected on main Backwash/Return screen.
- The value placed into "Time Over Trough" is the time (in minutes) for the pumps to continue to run AFTER the high float in the reactor is hit.
- The Blower Start and End times as well as the Pump start times are relative to the time that the backwash starts.
- A typical system has one (1) backwash each day.

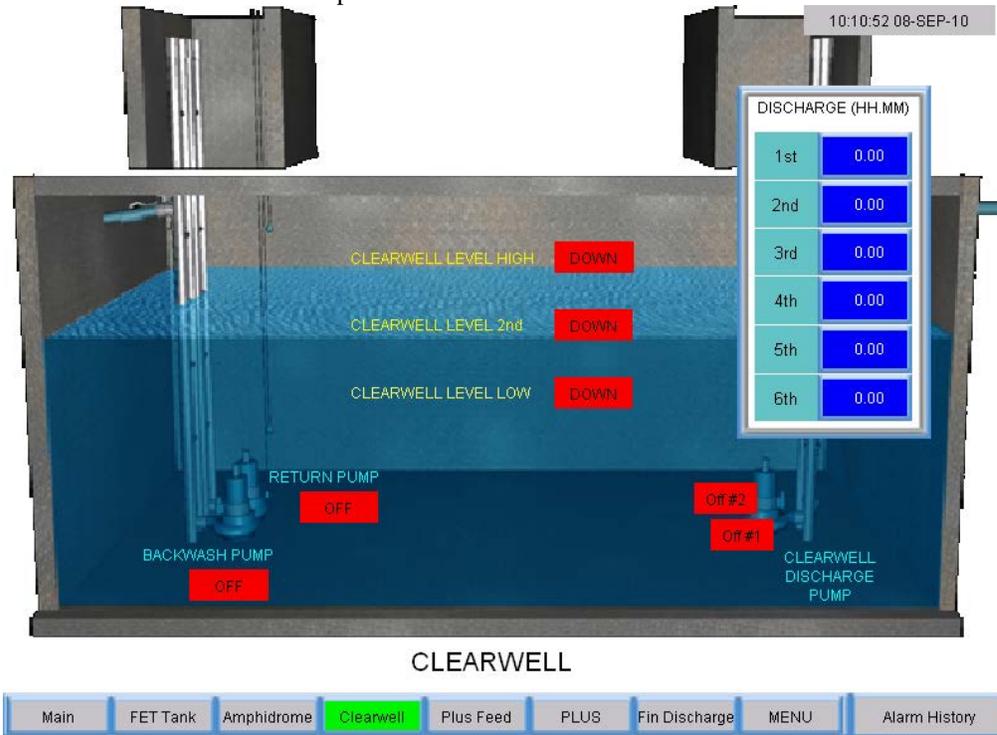
*Blower Controls should only be modified after consulting with FRMA.

The Backwash Control Screen is displayed above. This screen allows you to define the day of the week to institute a backwash as well as modify the time the blowers and pumps run in the event that the default backwash settings are not adequate. It also allows you to run a manual backwash of each reactor.

In order to modify the blower and pump times shown in grey, you must first enter the supervisor password and then will be taken to the 'change entry' screen. The default run setup should NOT be modified without first consulting FRMA.

Clear Well Status Screen

This screen is accessed by pressing on the Clear Well image on the Main Screen or from the “Clearwell” button at the bottom of the component screens.



The Clear Well Status screen will show the float status either “up”, “down” or “alarm”. The alarm float status is a time delayed float that may be “up” for a period of time in the operation before an alarm is signaled.

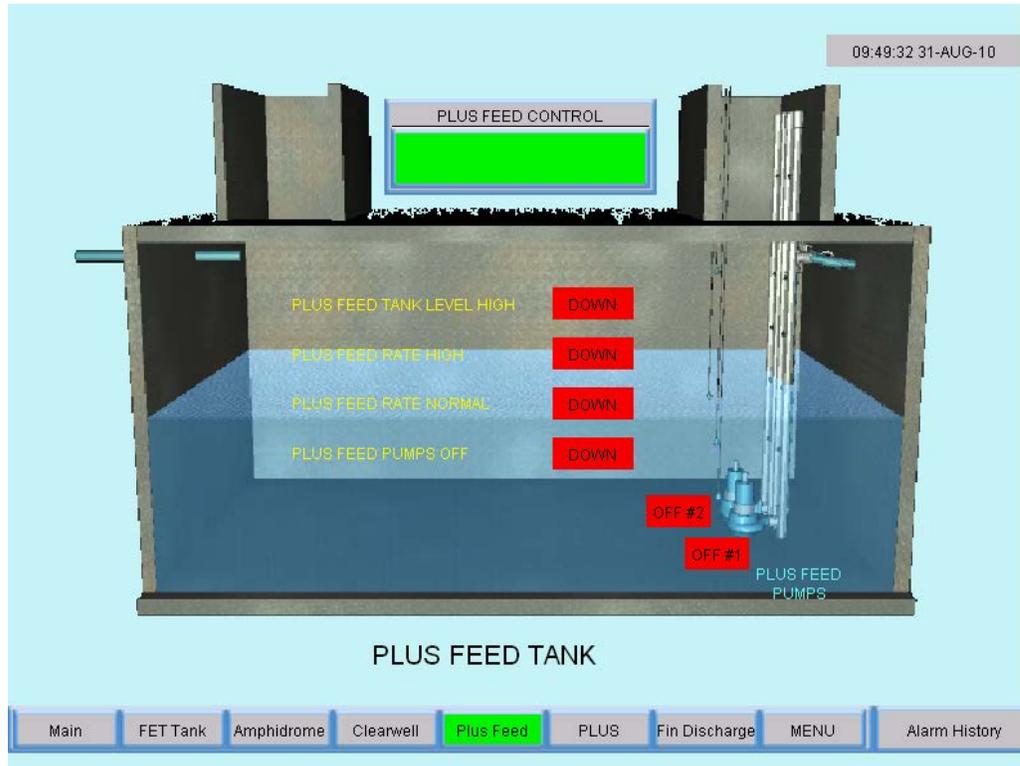
Pump status conditions are also shown on this screen. These pumps will indicate as “OFF” on “ON” and light green when running.

The time and date are displayed at the top right of the Clear Well Status Screen.

The discharge block over the clearwell discharge pumps allow you to define up to six (6) times during the day that the clear well will discharge to the Plus feed tank. A discharge will ONLY occur if the 2nd float in the clear well is elevated, and the pumps will run until the 2nd float drops out.

Plus Feed Tank

The Plus Feed tank receives flow from each Clear Well discharge and acts as a flow equalization tank for the Plus® Reactor. The Plus Feed tank then discharges to the Plus Reactor at pre-defined intermittent “on” and “off” cycles.



The float indicators will light green when the float is raised and each pump run status will show as “OFF” or “ON” and light green when the pump is on.

The time and date are displayed at the top right of the Clear Well Status Screen.

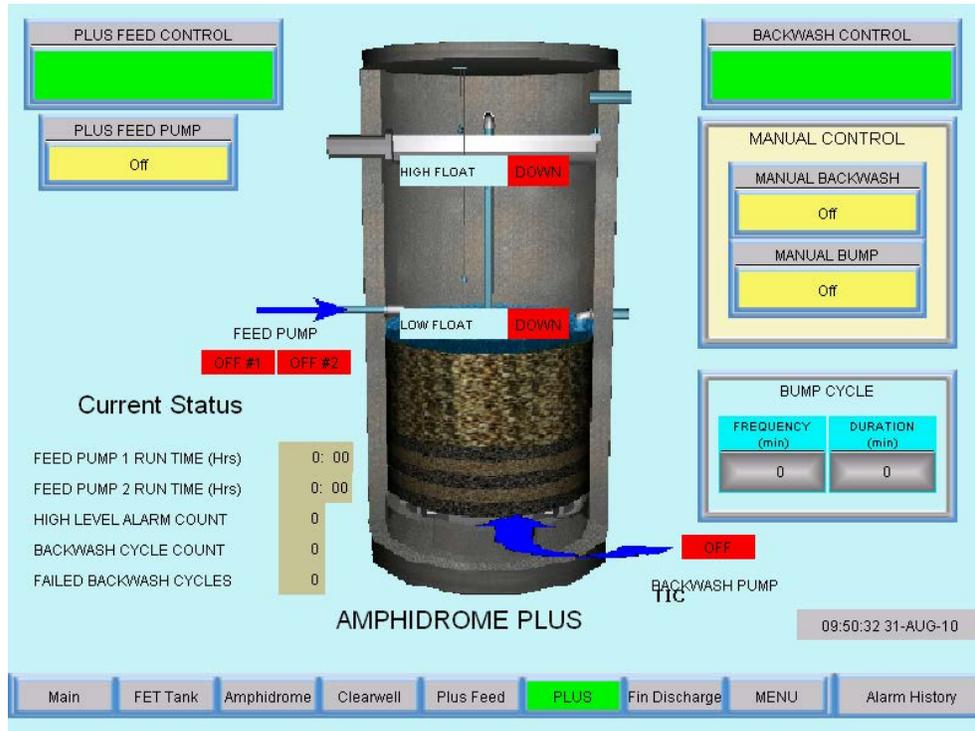
Selecting the Plus Feed Control button will pull up the following Plus Feed Control dialog screen.

Plus® Feed Control Dialog

The “Plus Feed Control” button will open the Plus® Feed Control Dialog. Controls for this screen are discussed in the section on the Amphidrome Plus® Reactor.

Plus® Reactor Screen

The Plus Reactor is the final denitrification polishing filter in the process. This screen shows system status conditions such as Feed Pump run times, High Level alarms, Backwash Cycle counts, etc.



Operator adjustable system controls for this reactor are accessible from the “Plus Feed Control” button (upper left) and “Backwash Control” (upper right). Manual override buttons for a system “bump” cycle (used to clear the underdrain and reactor of trapped nitrogen bubbles) and to start a backwash may be made from this screen as well.

The operator should inspect this Reactor daily and observe the presence of gas bubbles. If the filter is showing a prevalence of gas bubbles on the surface, a “bump” may be needed to release them from the filter and the frequency of the system “bump” may need to be increased. Once the “bump” cycle is initiated, it must be permitted to complete the full cycle and can not be stopped from this screen. Therefore this button is colored yellow as a caution to be used sparingly.

Manual backwashes may also be initiated from this screen if the filter requires a backwash for sampling or other filter condition that can not be managed through the system backwash schedule discussed later in this manual. Like the “bump” the backwash once initiated must be permitted to complete the full cycle and can not be stopped from this screen. Therefore this button is colored yellow as a caution to be used sparingly.

Plus® Feed Control Dialog

**AMPHIDROME PLUS
FEED CONTROLS**

ENABLE PLUS FEED CYCLE (HH.MM)

Start Cycle #1	End Cycle #1
12.34	12.34
Start Cycle #2	End Cycle #2
12.34	12.34

PUMP control if Clearwell level is Normal

ON	OFF
12 min	12 min

PUMP control if Clearwell level is HIGH

ON	OFF
12 min	12 min

09:43:00 31-AUG-10

DONE

This screen is used to setup the Influent Feed for Amphidrome PLUS Reactor #1

- You may have up to two (2) Plus Feed Cycles in a Day.
- Place the number 9999 into the "Time" field in order to disable that cycle.
- "Pump Cycles" (on/off times for Plus Feed Pumps) are defined for the following:
 - "High" level is defined as 3rd float UP.
 - "Normal" level is defined as 2nd float UP.

Using this dialog, you may define two separate start and end times during which the feed pumps will run. You will also define the two on-off cycles at which the pumps operate.

The pumps will operate at the "Normal" cycle any time the water level is above the "Off" float (the low float in a dedicated Plus Feed tank, the 2nd float in a clearwell feeding a Plus) and below the "High Rate" float (the 3rd float in the tank). The feed pumps will begin to 'cycle' on-and-off at the "Normal" rate when the "Enable" float (2nd float in a dedicated Plus Feed tank, the 3rd float in a clearwell feeding a Plus) is raised. It will continue operating at this on-off cycle until: 1) the "Off" float drops out and the pumps stop, or 2) the "High Rate" float is raised and the pumps cycle at the "High" feed rate.

Select "DONE" to exit this dialog.

Plus® Reactor Backwash Dialog

This screen is opened by pressing on the “Backwash Control” button in the top right of the screen

PLUS BACKWASH CONTROL

SET TIME TO START BACKWASH (HH.MM)

Backwash #1	Backwash #2
12.34	12.34

BLOWER CONTROLS

START BLOWER	STOP BLOWER
12	12

PUMP CONTROLS

START PUMP	MINs OVER TROUGH
12	12

SELECT DAYS TO BACKWASH

Su	Mo	Tu	We	Th	Fr	Sa
----	----	----	----	----	----	----

START MANUAL BACKWASH

DONE

This screen is used for Backwash Control for Amphidrome PLUS Reactor #1

- You may have up to two (2) backwashes in a day.
- Place the number 9999 into the "Time" field in order to disable that return.
- The value placed into "Time Over Trough" is the time (in minutes) for the pumps to continue to run AFTER the high float in the reactor is hit.
- The Blower Start and End times as well as the Pump start times are relative to the time that the backwash starts.
- A typical system has one (1) backwash every other day.
- Blower Controls and Pump Controls are advanced operator control and require a password to modify.

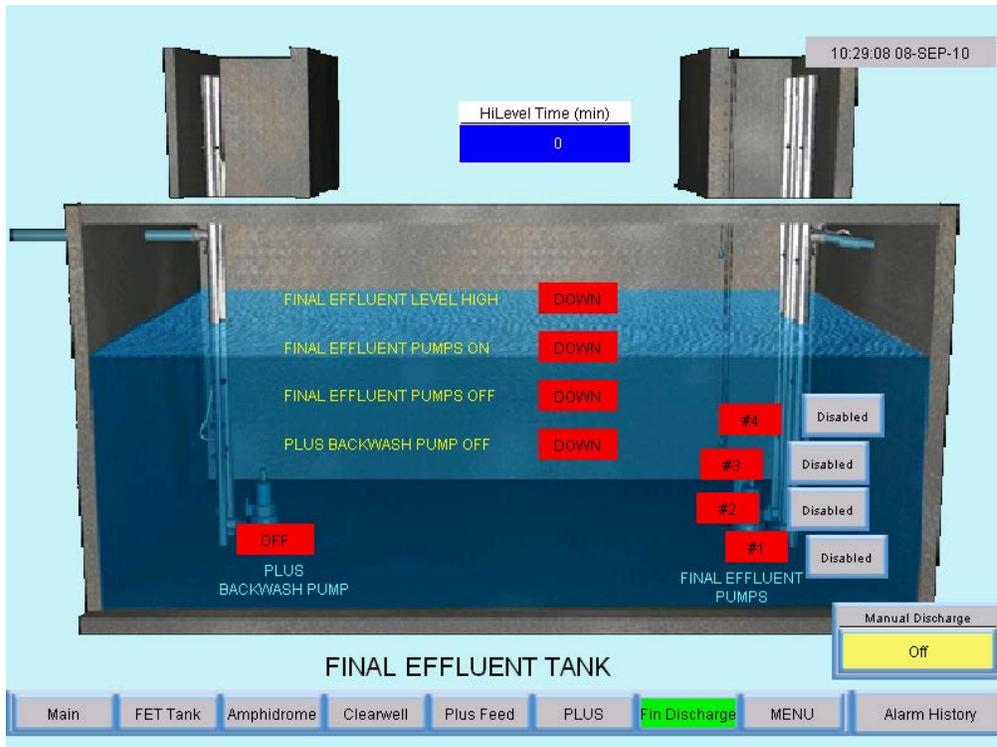
You may set up to two backwashes per day. Under normal conditions this filter should only require one daily backwash. The image above shows the values of 0000 in the screen. The actual display will show the values such as 1830 or 4:30 pm. The second cycle will normally be disabled with the value of 9999.

You may also enable or disable backwashes each day. At start up backwashes may be scheduled at certain days of the week or every other day to permit the filter to establish biological population. This may be adjusted depending on the performance of the filter and other variables such as swings in flow from weekday highs to weekend lows. Observance of the final effluent and filter drain time after scheduled backwashes will provide an indication of these times require adjustment.

Controls for the blowers and pumps for the Plus® backwash are, like the controls for the Amphidrome® backwash, advanced operations and require a password in order to modify. They are shown in grey on the screen.

Chemical feed of supplemental carbon is controlled at the Main Control panel and each carbon feed pump station. Chemical feed is not controlled by the touch screen. These controls are discussed elsewhere in the manual.

Plus Clear Well & Final Discharge Pump Station



The Final Effluent Tank stores sufficient volumes of clean water to be used for the backwash of the Plus. The remainder of the volume is discharged to the final effluent receiving system. There are a wide variety of effluent receiving options available which are dependent on the specific site conditions and discharge permit.

Generally these discharges are to sub-surface systems but may on occasion be to surface or other treatment systems. In the majority of applications the final discharges may go to any of the following systems:

- Discharge to Leachfield
- Discharge to Leaching trenches
- Discharge to Drip Dispersal system

These systems may be preceded by other treatment steps such as:

- UV Disinfection
- Membrane Filtration and UV Disinfection
- Chemical precipitation for Phosphorous or other waste prior to membrane filtration and UV disinfection or direct to UV disinfection.

This facility uses a combination of discharges directly from the Plus Clear Well & Final Discharge Pumping Station to Leaching Trenches. The pumps alternate and pump operation is demand-driven. That is, the effluent pump will start when the “Final Effluent Pump ON” float (3rd float) is raised and stops when the “Final Effluent Pump OFF” float (2nd float) drops out.

The final discharge pumps will show as “OFF” or “ON” and will light green when running. A pump may be disabled, if necessary.

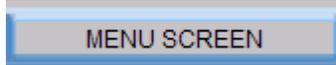
The tank also has a High Level Alarm float that will signal a priority alarm when the alarm float is tipped.

The time and date are displayed at the top right of the Final Discharge Screen.

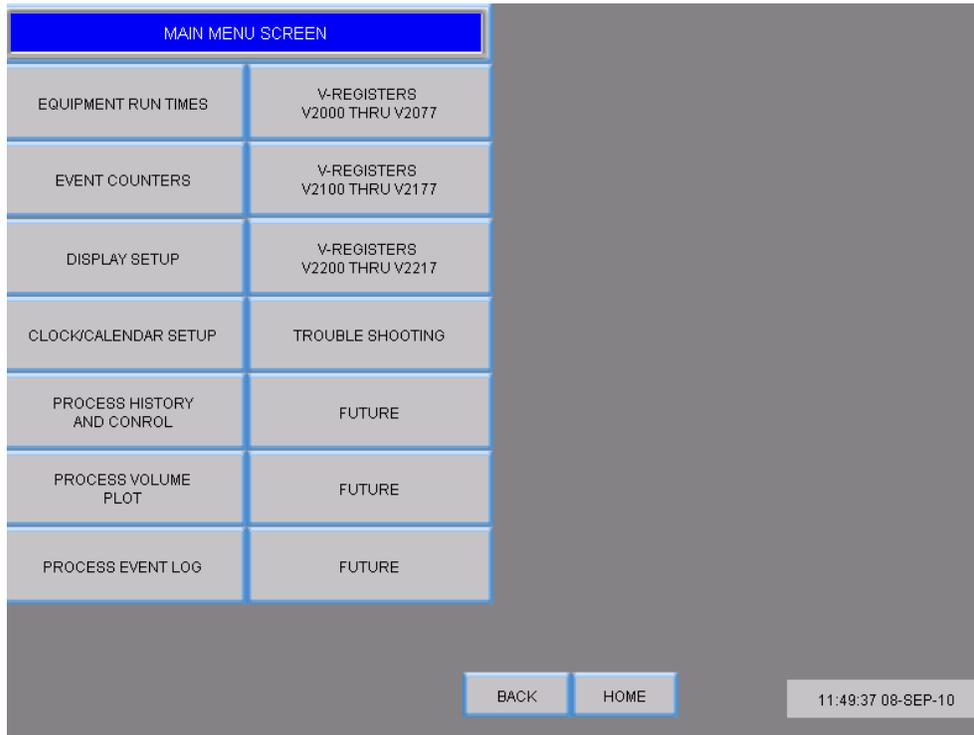
The Menu Screen will open a list of drop down options

Menu Screen

Located on the Reactor Screens, Clear Well Screens and the Plus Reactor Screens as well as the Main Screen there is a Menu Screen Tab.



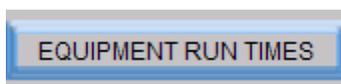
This button will open access to Menu Screen which will present operator enabled tabs which provide access to items such as Equipment Run Times and Event Counters.



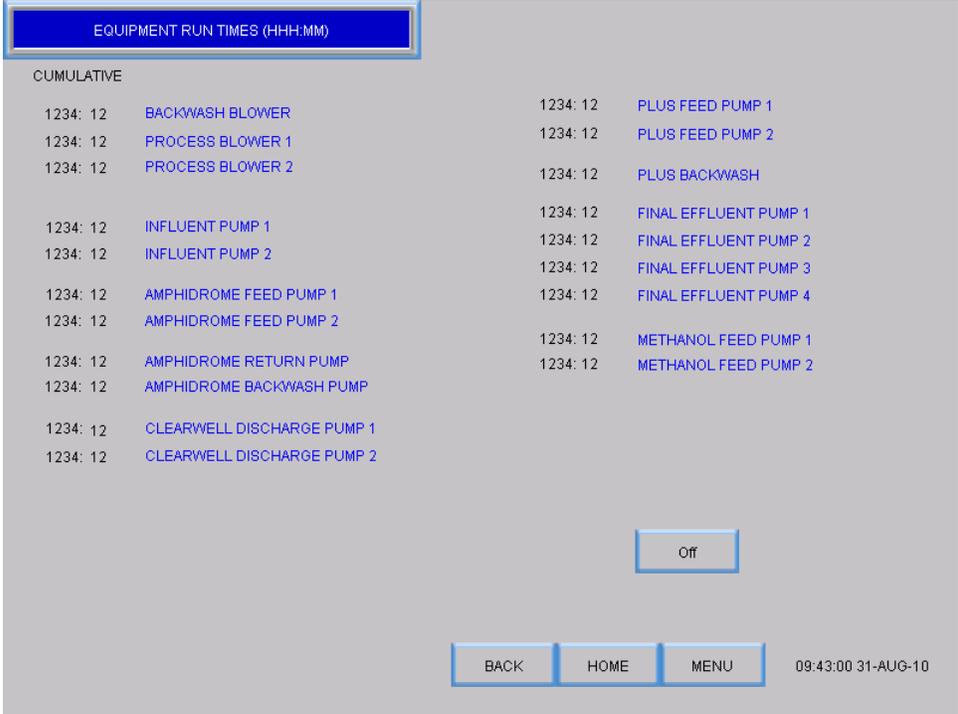
Pressing any of these tabs will open that next screen or press “Back”, “Home” or “Menu” to return to those main screens.

The time and date are displayed at the bottom right of the Menu Screen.

Equipment Run Time Screen

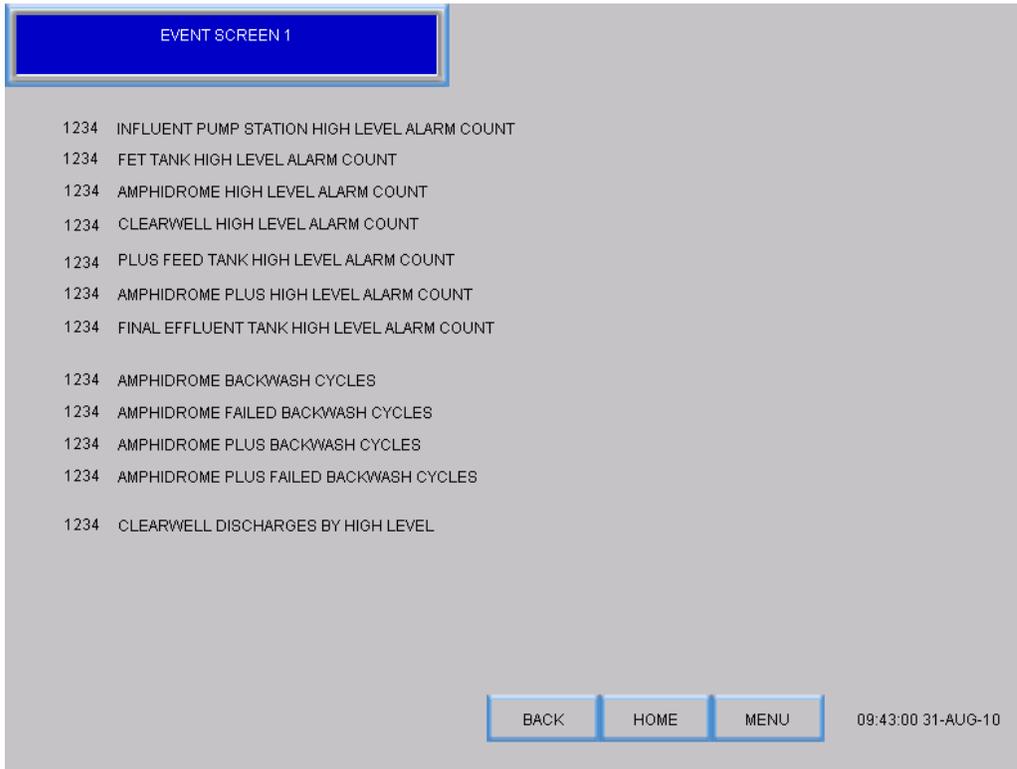


Run times are accumulated in hours and minutes for each piece of process equipment. Times recorded by the operator based on the daily inspections of the facility and used to determine if run times are within acceptable ranges. Run times are also used to schedule service intervals such as oil changes to blowers and so forth. Consult the applicable equipment manufacturer's sections of this manual for those recommended service intervals.



The operator should record these values with notation of the date taken and the **Time** shown in the bottom left of the screen. Taking these readings at the same time of day will provide more accurate evaluation of run time variables. These readings may be observed more often if the operator wishes to observe trends that might be linked to flow patterns or other system variables.

Event Counters



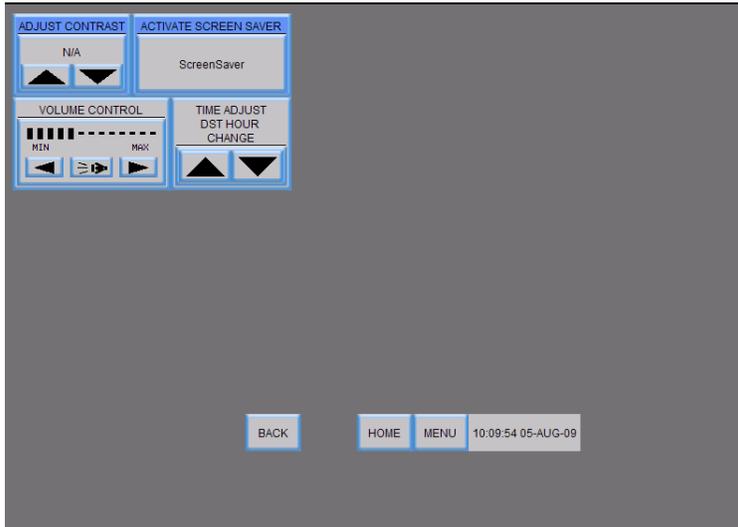
Pressing the Event Counter button will open this screen which shows the specific number of events such as alarms or failed backwashes. These values can be recorded each day, week or month depending on the frequency and compared to previous totals stored in operator log sheets.

Example: If backwashes are scheduled daily for Amphidrome # 1 the total should show one more each day and match with the program settings.

The operator may return to the Menu Screen or the previous screen by pressing "Back" or "Menu" or return to the Main Screen by pressing "Home".

The time and date are displayed at the bottom right of the Event Counter Screen.

Display Setup



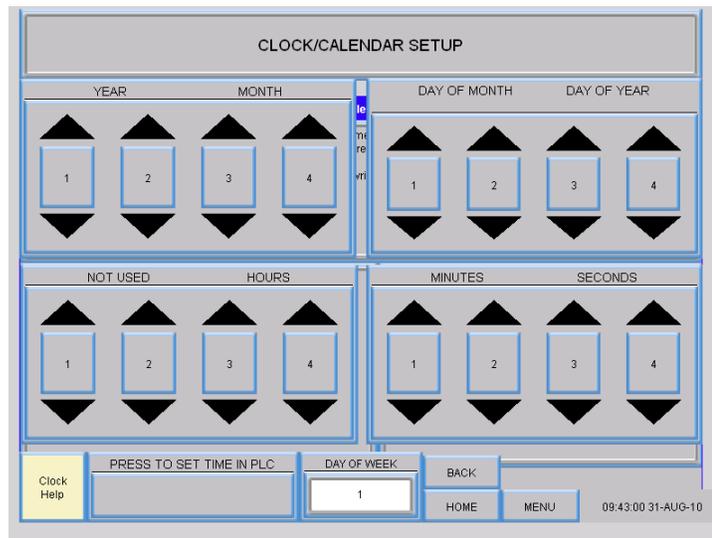
The appearance of the menu screen may be adjusted from this screen to settings such as contrast, screensaver use, volume when used and DST or Daylight Savings time adjustment.

The operator may return to the Menu Screen or the previous screen by pressing “Back” or go to the Menu Screen by pressing “Menu” or return to the Main Screen by pressing “Home”.

The time and date are displayed at the bottom right of the Manual Operation Screen.

Clock Calendar Setup Screen

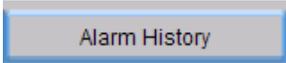
This screen is used to set the time and date and day of the week. This screen is typically used at setup and to change to/from daylight savings time. It is usually not necessary to set the time again unless the system



time gets out of ‘synch’.

All fields must be filled with valid values or the time will not update. Once the date and time is entered in the respective key pad locations, press “PRESS TO SET TIME IN PLC” button to update current time and date.

Alarm History Screen



Pressing the Alarm History tab will drop down a record of system alarms and a count of the number of times these have occurred. This Screen totals the alarms and accumulates the total alarms. The operator may chose to clear these alarms after they are recorded in operation logs. This will permit the operator to view alarms for this specified period of time for monitoring.

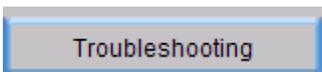
The alarms will also be stored in the Event Counter Screen accessed from the Menu Screen.

Alarm Count		Message
Alarm No	Cnt	
1	0	HEADWORKS HIGH LEVEL
2	0	AMPHIDROME 1 HIGH LEVEL
3	0	AMPHIDROME 2 HIGH LEVEL
4	0	CLEARWELL 1 HIGH LEVEL
5	0	CLEARWELL 2 HIGH LEVEL
6	0	DENITE FEED TANK HIGH LEVEL
7	0	DENITE FILTER HIGH LEVEL
8	0	AMPHIDROME 1 RETURN FLOW PUMP FAIL
9	0	AMPHIDROME 1 BACKWASH PUMP FAIL
10	0	MAPHIDROME 2 RETURN FLOW PUMP FAIL
11	0	AMPHIDROME 2 BACKWASH PUMP FAIL
12	0	DENITE FEED PUMP 1 FAIL
13	0	DENITE FEED PUMP 2 FAIL
14	0	DENITE BACKWASH PUMP FAIL
15	0	GRINDER FAIL
16	0	FINAL EFFLUENT HIGH LEVEL
17	0	BUILDING LOW TEMPERATURE
18	0	BLOWER 1 FAIL
19	0	BLOWER 2 FAIL
20	0	CLEARWELL 1 DISCHARGE PUMP 1 FAIL
21	0	CLEARWELL 1 DISCHARGE PUMP 2 FAIL
22	0	CLEARWELL 2 DISCHARGE PUMP 1 FAIL
23	0	CLEARWELL 2 DISCHARGE PUMP 2 FAIL
24	0	FINAL EFFLUENT PUMP 1 FAIL
25	0	FINAL EFFLUENT PUMP 2 FAIL
26	0	FINAL EFFLUENT PUMP 3 FAIL
27	0	FINAL EFFLUENT PUMP 4 FAIL

Alarm History Page Up Page Down Line Up Line Down Clear Clear All Exit

Troubleshooting Tab

A Troubleshooting tutorial is stored in the Touch Screen for ready access to the operator and should be used in conjunction with the operations and maintenance manual troubleshooting section to follow in this document.



Pressing the Troubleshooting tab on the MENU Screen will take you to the first troubleshooting screen. These troubleshooting tips are also available in the O&M appendix, but are presented on the touch screen for convenience. This manual will not attempt to demonstrate each drop down but will show an example of the access instructions and demonstrate typical information found there. *Example:* By choosing the “Automatic Valves” tab a screen will drop down with a list of “Problem”, “Probable Cause” and “Solution” options.

Main	High TKN	High Ammonia	High Nitrates (NO3)	BOD Removal	TSS Removal	Supplemental Carbon	Alkalinity
Submersible Pumps	Blowers_1	Blowers_2	Blowers_3	Automatic Valves	Chart Recorders	Chemical Pumps	Flow Sensor & Metering

V2000	V2001	V2002	V2003	V2004	V2005	V2006	V2007
1234	1234	1234	1234	1234	1234	1234	1234
V2010	V2011	V2012	V2013	V2014	V2015	V2016	V2017
1234	1234	1234	1234	1234	1234	1234	1234
V2020	V2021	V2022	V2023	V2024	V2025	V2026	V2027
1234	1234	1234	1234	1234	1234	1234	1234
V2030	V2031	V2032	V2033	V2034	V2035	V2036	V2037
1234	1234	1234	1234	1234	1234	1234	1234
V2040	V2041	V2042	V2043	V2044	V2045	V2046	V2047
1234	1234	1234	1234	1234	1234	1234	1234
V2050	V2051	V2052	V2053	V2054	V2055	V2056	V2057
1234	1234	1234	1234	1234	1234	1234	1234
V2060	V2061	V2062	V2063	V2064	V2065	V2066	V2067
1234	1234	1234	1234	1234	1234	1234	1234
V2070	V2071	V2072	V2073	V2074	V2075	V2076	V2077
1234	1234	1234	1234	1234	1234	1234	1234

V-Registers V2000 thru V2077

BACK NEXT HOME MENU 09:43:00 31-AUG-10

The “Numeric Entry” screen will open. Using the keypad the operator may type in the desired change and

press “Enter” to accept the change. If an error is made the operator may press “Cancel” and type in a new value. Once the operator presses “Enter” the change will be logged into the program and saved.

V2000	V2001	V2002	V2003	V2004	V2005	V2006	V2007
0	0	0	0	0	0	0	0
V2010	V2011	V2012	V2013	V2014	V2015	V2016	V2017
0	0	0	0	0	0	0	0
V2020	V2021	V2022	V2023	V2024	V2025	V2026	V2027
0	0	0	0	0	0	0	0
V2030	V2031	V2032	V2033	V2034	V2035	V2036	V2037
0	0						
V2040	V2041	V2042					
0	0						
V2050	V2051	V2052					
0	0						
V2060	V2061	V2062					
0	0						
V2070	V2071	V2072					
0	0						

Numeric Entry

V2000

0

Minimum
0

Maximum
9999

Current
0

Cancel Enter

V-Reg

BACK NEXT >> HOME MENU 10:22:14 05-AUG-09

Automated Process Air

Process Air Computation:

The program will re-calculate the fixed ON and fixed OFF times based on the flow, the slope of the design curve, and the air that has already been placed into the system during the previous cycle.

- 1 There are six (6) Process Cycles in a 24-hour period. The Fixed ON / Fixed OFF times (process air) is re-calculated every four (4) hours, at the start of a new Process Cycle.
- 2 The "Volume to Treat" is determined from: 1) Influent Pumps; 2) Plus Feed Pumps; or 3) Final Effluent Pumps. IN THAT ORDER of preference. If a pump (e.g. influent pump) does not exist, then the next pump in order is used.
- 3 The "Total Process Air" required in 24 hours for the given "Volume to Treat" is calculated using a linear equation, similar to that shown in Figure 1.

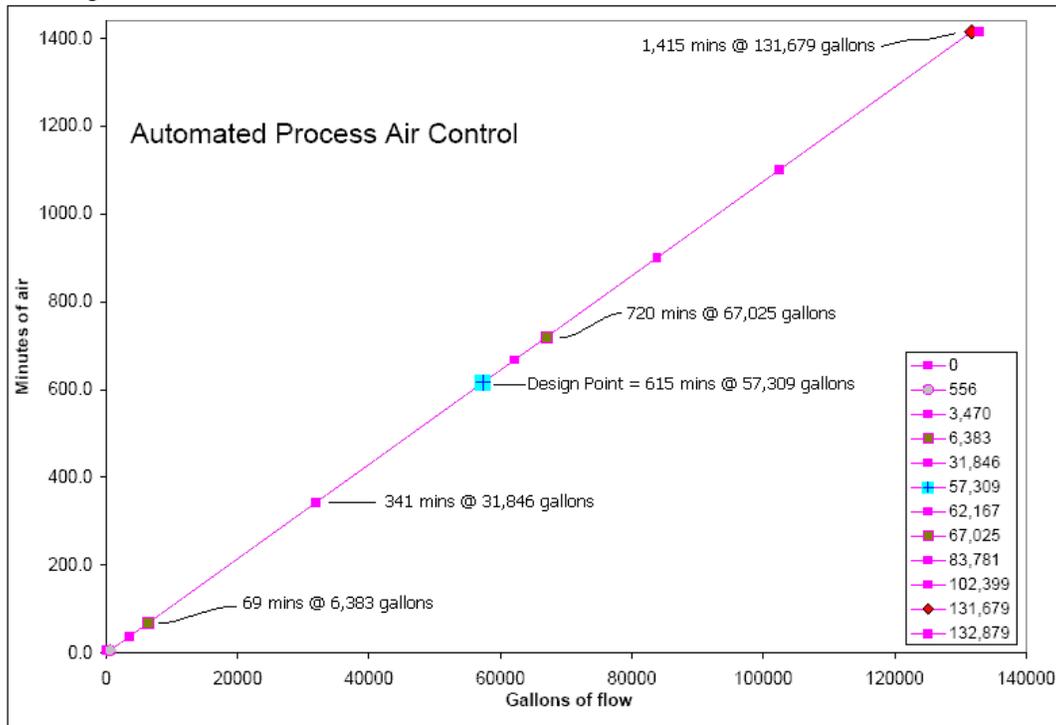


Figure 1. Minutes of process air required per 24 hours per gallon of flow.

The curve for each system is calculated based on the assumed influent load (BOD, TKN), the reactor volume and process air delivered. For the shown system, at the design flow of 57,309 gpd, a total of 615 minutes of process air would be required over the next 24 hours.

Operator Controls:

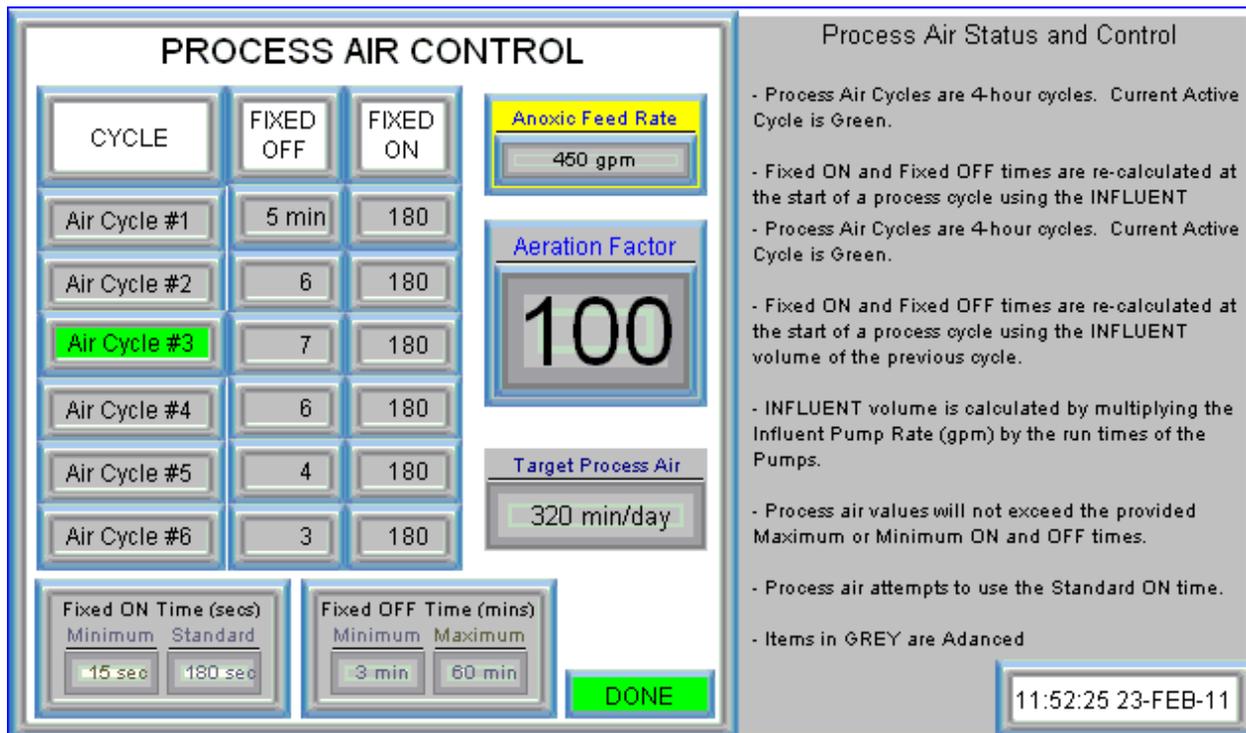


Figure 2. Process Air Control Dialog

The Process Air Control dialog is shown in Figure 2. This dialog shows both the current status and historical information related to the Process Air. It also provides operator control for process air. A description of the process air system is described in notes on the right hand side to serve as a reference for the operator.

The current process cycle is highlighted in green. The cycle information is overwritten at the start of a process cycle. The previous cycle as shown in Figure 2 is Cycle #2. *NOTE:* The process cycle information shown in Cycle #4 in this dialog is from 12:00PM to 4:00PM the previous day!



Design Pump run rate - Key to obtaining accurate process air settings is to define an accurate discharge rate (in gpm) for the pump used by the system. The pump rate should be verified at least once per year.

The system from which this dialog was obtained uses the raw lift pumps to determine the flow into the system. The discharge rate for these pumps is defined by the value in the “Anoxic Feed Rate” input button. The title of this button will reflect the pump being used for process air calculations within the program.



Aeration Factor – Consider the ‘air’ as simply another chemical you are injecting into the system. If this were a chemical feed pump, you might need to increase the feed rate by some percentage by increasing the stroke of the pump. Increasing the Aeration Factor will increase the amount of air provided per gallon of water and decreasing the Aeration Factor will decrease the amount of air provided per gallon of water. For example, if you decrease the Aeration Factor from a value of 100 to a value of 90, you will decrease the process air put into the system by 10%.

The Aeration Factor is a value between 1 and 999 and is initially set at 100. It is used by the program to determine the amount of process air to be applied in the next 24 hours to treat the volume of water seen by the plant during the previous ‘cycle’.

Figure 2 illustrates how changing the Aeration Factor affects the amount of air that will be placed into the system. Note that increasing the Aeration Factor above 300, or below 50 should signal a potential problem and you should contact FRMA to discuss the plant operations after taking a raw influent BOD and TKN sample.

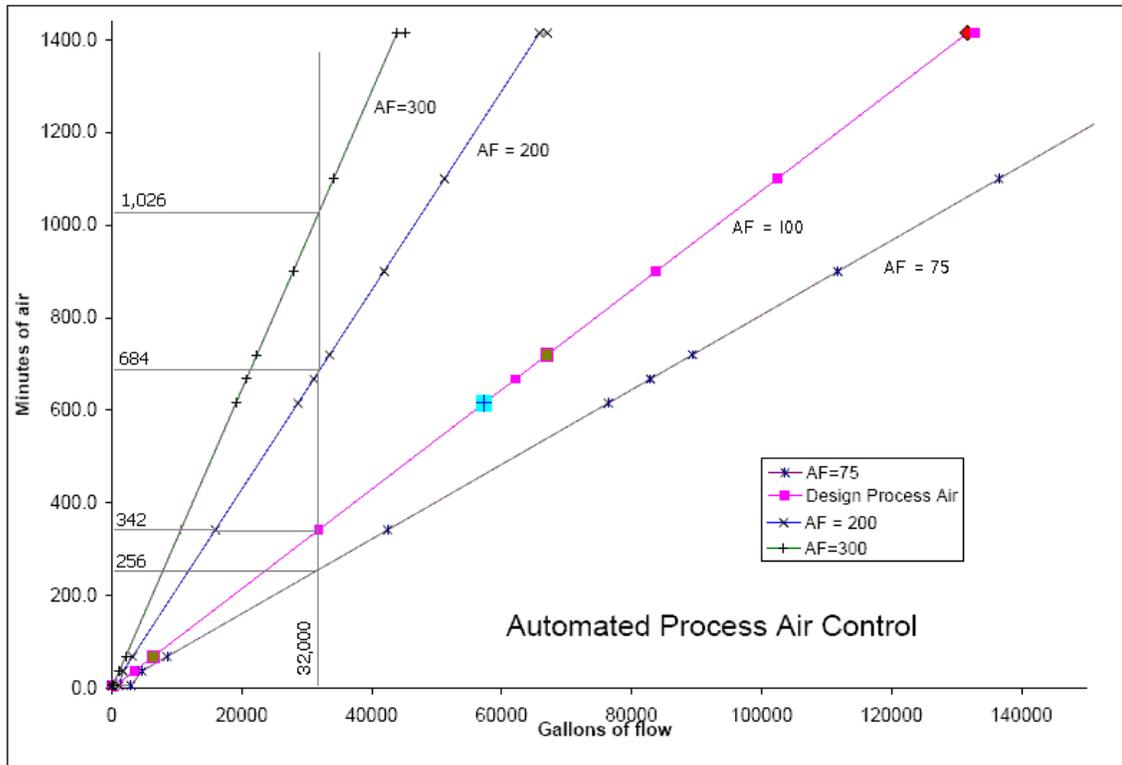
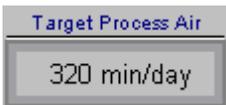


Figure 3. Effect of Aeration Factor changes on slope of process air control graph

Increasing the Aeration factor from 100 to 200 will DOUBLE the amount of air put into the system for a given volume of water.



Target Process Air – This is the total number of minutes of Process Air that will be applied to the system in the next 24 hours. This value is re-calculated at the start of a new process cycle and is determined based on the flow through the system and the time applied during the previous cycle.



Fixed ON and OFF controls:

Process air is provided to the system by a cycling the blower on and off. These on and off times are called the Fixed ON time and Fixed OFF time, respectively.

Four values are defined within the program to control the calculation of the Fixed ON and OFF times. These values are set at startup and the should NOT be modified by the operator without first consulting FRMA.

Standard Fixed ON Time – This value is the standard blower run time (in seconds) that is used for process air. It is **NOT** the maximum time for process air to be on.

Minimum Fixed ON Time. – This value is the minimum blower Fixed ON run time (in seconds).

Minimum Fixed OFF Time – This is the minimum Fixed OFF time (in minutes).

Maximum Fixed OFF Time. – This is the maximum Fixed OFF time (in minutes).

PROCESS CONTROL

Sampling

Since the Amphidrome® system operates as a sequencing batch reactor, effluent grab samples from each batch should be taken. Therefore, if a system discharges twice a day, two samples should be collected, one for each batch treated. If local regulations require a composite sample, then the grab samples from each batch should be blended together in proportionate amounts. The volumes may be apportioned based directly on the volume discharged for each batch, or based on the discharge pump run for each batch.

Operation

The Amphidrome® system is a submerged attached growth bioreactor (SAGB) process designed around a deep-bed sand filter. The Amphidrome® system has all tanks located below grade with access hatches or manhole covers at grade level to allow for inspection and maintenance of the system. To ensure proper operation of the system, the operator must do inspection of the system internals to ensure proper operation.

Start Up and Initial Tests

Upon taking over operation of an Amphidrome® system, the operator should conduct three tests on each Amphidrome® filter in the plant and two tests on each Amphidrome® Plus filter in the plant. The tests are designed to determine the volume flow rates of water through the filters, one in the forward direction and two or one in the reverse direction, depending on which filter is being tested.

Test 1: Forward Flow Test:

The purpose of the test is to determine the flow rate through the filter (i.e. hydraulic loading). This test must be conducted at the end of an automatically scheduled return flow cycle or after a manually initiated return flow. After the return flow pump shuts off, the liquid level in the Amphidrome® filter decreases and should be measured over equal increments of time until the forward flow slows down to less than a 1 inch change in ten minutes. (If the filter being tested is an Amphidrome Plus® filter, the Amphidrome® Plus feed pump must be used to raise the level in the filter). During the first portion of the test in which the liquid level in the filter is high and the flow rate through the filter is also high, measurements should be taken every 1 –2 minutes. As the flow rate slows down, the measurements may be recorded every 5 – 10 minutes. The total time, the total change in height and the surface area of the reactor, can be used to calculate the flow rate through the filter. The data should be recorded on a table similar to that labeled *Filter Flow Through Rate*, and shown in Appendix A.

Test 2: Return Flow Test:

The purpose of this test is to estimate the average volume flow rate for a return cycle. This value is necessary to control the amount of wastewater returned during each return cycle. This test must be conducted at the beginning of an automatically scheduled return flow cycle or at the beginning of a manually initiated return flow cycle. The level in the Amphidrome® filter should be low before the start of this test. After an initial measurement of the liquid level in the filter is recorded, the return flow pump should start or be started. Only the return flow pump is used for this test. During the test, the liquid level in the filter should be measured and recorded every minute. Once the liquid starts to flow over the return flow/backwash trough, the test may be stopped. The total time to reach the trough should be recorded. The data should be recorded on a table similar to that labeled *Filter Flow Through Rate*, and shown in Appendix A.

Test 3: Backwash Flow Test:

The purpose of this test is to estimate the average volume flow rate for a backwash. This value is necessary to control the amount of sludge that is removed from the reactor during a backwash. For the Amphidrome®

reactor, test 3 is a repeat of test 2, but with both the return flow pump and the backwash pump running. There is no test 2 for the Amphidrome Plus® reactor because the reactor does not have return cycles; and therefore, there is no return pump only a backwash pump. As in test 2, the level in the filter should be low before the start of this test. After an initial measurement of the liquid level in the filter is recorded, the return flow pump and the backwash pump should start. For the Amphidrome Plus® reactor, only the backwash pump is started. During the test, the liquid level in the filter should be measured and recorded every minute. Once the liquid starts to flow over the return flow/backwash trough, the test may be stopped. The total time to reach the trough should be recorded. The data should be recorded on a table similar to that labeled *Filter Flow Through Rate*, and shown in Appendix A.

Process Control

Efficient operation and effective process control of an Amphidrome® System, as with any wastewater treatment plant, requires comprehensive methods for collecting and recording all pertinent information regarding plant performance and equipment maintenance. This is accomplished with an equipment log, a sampling and analysis plan for both the required sampling and all field sampling and meticulous records of all observations regarding the daily operation of the plant. Examples of equipment logs are included in this manual.

Sampling and Analysis:

During the initial start up period (approximately 30-90 days), sampling and analysis, (both laboratory and field), should be performed more frequently than during routine operation. Since the typical treatment goals are the removal of BOD₅, TSS, TKN, NH₃, and NO₃⁻, these parameters, as well as pH, alkalinity, and flow should be closely monitored. Test kits for both NH₃, and NO₃⁻ are recommended so that the operator can test these parameters once or twice weekly for process control.

Equipment Run Times:

All the equipment run times are recorded and stored by the PLC. These values are totals; therefore, the operator should record both the total time and the difference between the previous and the current readings, (i.e. the daily average). By averaging the daily run time of equipment it is possible to detect any potential problems and to verify that the equipment is operating for the approximate prescribed time in the program. For example in the process blower, daily average run time can be used to confirm that aeration is occurring, as programmed. Additionally, averaging equipment run time shows trends in the process. For example, the duration of the aeration is a function of the fixed air on time and the flow based multiplier; therefore, aeration times vary with flow. Meticulous records of actual aeration times that may be compared with the results of sample analyses will allow for accurate process control decisions. **Recording of equipment run time is a critical and necessary part of operations and maintenance and should be performed diligently by the operator.**

Flow:

Typically, recording daily flow is a permit requirement on all systems over 10,000 gpd. Flow recording equipment (flow meter, totalizer and chart recorder) are typically supplied with these plants. In addition to the total and average daily flow, the operator should also record flow per batch. For plants with chart recorders, this is simply done by reviewing the flow chart. For plants set up to treat more than one batch per day, the operator should compare the flow per batch to ensure that each batch treats the same volume of wastewater. For example, if flow through a facility is 10,000 gpd and two batches per day are used, the flow per batch should be as close to 5,000 gpd as possible. This is accomplished by setting the PLC reset time to the appropriate time of day to split the diurnal flow. **See section in controls regarding the clock.** The flow chart also indicates the time of discharge, which should be periodically compared to the programmed time for discharge. **Since the facility is programmed to discharge due to high water level in the clear well, the chart will also indicate any discharges that have occurred out of sequence due to a high water level in the clear well.**

Sludge Wasting and Sludge Removal:

Sludge wasting refers to the removal of sludge from either the Amphidrome® reactor or the Amphidrome Plus® reactor and is achieved by backwashing. Both the frequency and duration of the backwash is operator adjustable. Unlike an activated sludge system in which the amount of viable biomass within the vessel is controlled by monitoring the MLVSS, no such single parameter exists for monitoring biomass in a submerged attached growth bioreactor. Therefore, determining whether or not enough biomass exists must be judged by four parameters: one, an effluent ammonia, (NH₃) analysis, two, the forward and reverse flow rates, three, the aeration pattern, and finally, both a visual and a laboratory analysis of the TSS in the backwash stream.

The first parameter that is influenced by insufficient biomass is the ammonia level in the effluent. Therefore, if all the other factors effecting nitrification, (i.e. alkalinity, air, pH...) are sufficient and nitrification is incomplete, the quantity of biomass within the filter must be suspect.

A significant decrease in the forward and reverse flow rates, from the original tests conducted by operator, may indicate that the filter is plugging. This may be resolved by increasing the frequency and/or duration of the backwashes.

The aeration pattern in the filter should be inspected with approximately 3 - 6 inches of water covering the media. **Even bubbles over the entire surface area should be observed.** Air bubbles that occur in separate discreet areas may indicate that the reactor is plugging or is plugged. In severe cases, air may be seen escaping several minutes after the blowers have been shut off. This may be resolved by increasing the frequency and/or duration backwash cycles.

Finally, to gauge the quantity of solids within the reactor, a sample at the beginning and ending of a backwash cycle should be collected and examined both visually and analytically for TSS. The first sample should be collected during a backwash just as the water starts to flow over the return flow/backwash trough. The second sample should be collected at the end of the backwash, just before the pumps shut off. Typically TSS values for the second sample range from 200 mg/l to 500 mg/l. However, it must be stressed that these numbers are typical, not absolute. Therefore, if a plant is meeting all discharge requirements with different values, than those specific values should be used for a guideline at that particular plant.

Sludge wasting is achieved by pumping stored sludge from the anoxic/equalization tank. The level of sludge within the anoxic/equalization tank should be checked every month.

Observation:

Several operational parameters may be determined by simple observation, which in conjunction with field-testing, can be extremely useful for process control. The Amphidrome® process should not have suspended solids in the effluent, nor should strong offensive odors be present in any of the tanks. Therefore, visual inspection of effluent turbidity and color may be an indication of process problems. It is recommended that along with the field sampling (i.e. test kit sampling), that the color and clarity of the effluent be noted in the operator's log.

Strong odors indicating a highly septic environment should not be present in the Amphidrome® system. Any odor present in any of the tanks should also be noted in the operator's log and should be investigated, as this indicates a potential problem.

TROUBLE SHOOTING

BOD Removal

Problem	Possible Cause	Solution
High effluent BOD	Denitrification carbon source carryover	Decrease supply of carbon to Amphidrome Plus® process if possible.
	High organic loading	Check actual vs. design organic loading. Investigate abnormally high influent organic loading. Increase number of returns.
	Insufficient dissolved oxygen	Troubleshoot air supply system Increase air supply.
	High hydraulic loading	Check actual vs. design hydraulic loading. Investigate abnormally high hydraulic loading.
	Insufficient biomass	Decrease number of backwashes if possible. Check BOD: N: P ratio.
	Total suspended solids in effluent	Troubleshoot TSS problem.
	Toxic material in influent	Investigate for toxins or biocides.

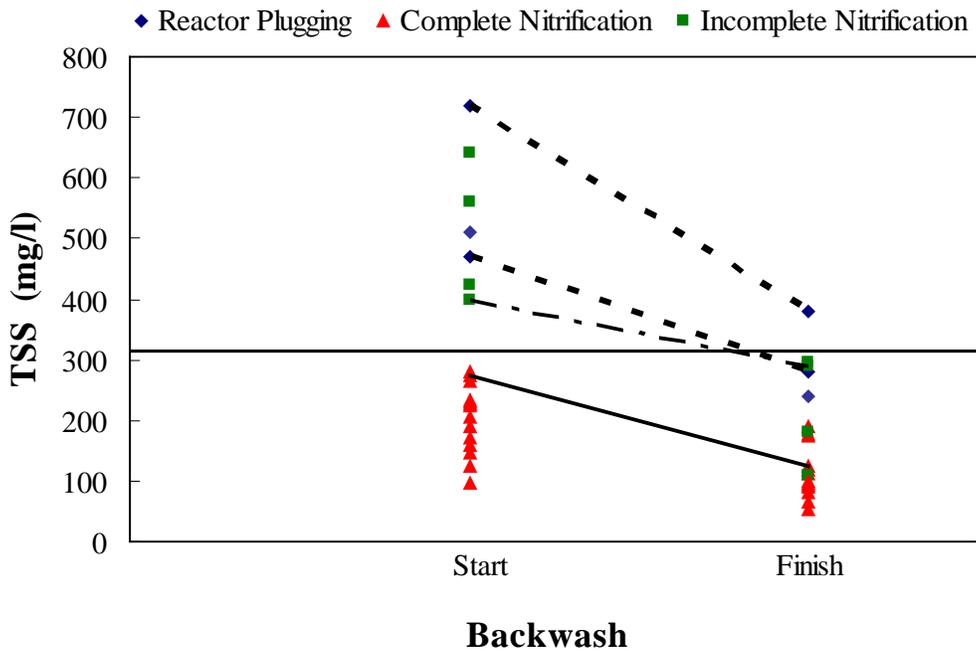
TSS Removal

Problem	Possible Cause	Solution
High Effluent TSS	High influent TSS	Check depth of blanket in anoxic tank – if within two feet of bottom of outlet tee, pump out anoxic tank.
	Excess Solids in reactor	Evaluate the reactor backwash.
	Dirty Amphidrome® reactor	Increase backwash of Amphidrome®.
	Dirty Amphidrome Plus® reactor	Increase backwash of Plus® reactor.

EVALUATING THE REACTOR BACKWASH

The reactor backwash cycles are set to maintain proper filter solids. A simple test is used to monitor the effectiveness of the backwash. Monitoring backwash solids using the chart below may be a way to determine the need to add backwashes if filter backwash solids reach undesirable levels. This chart provides a guide to monitor reactor solids before and after backwash cycles.

Backwash Solids



Nitrogen Removal -TKN

Problem	Possible Cause	Solution
High effluent TKN	Insufficient D.O	Increase air supply either by adjusting the fixed or the multiplier.
	Alkalinity Deficient	Check alkalinity in main clearwell. Verify it is above 80 mg/L
	High influent TKN loading	Check actual vs. design TKN loading.
	Insufficient biomass	Decrease Amphidrome® backwash if possible. Check BOD: N: P ratio.
	Low return frequency	Increase number of returns if possible.
	Toxic material in influent	Investigate influent for toxins or biocides.
	Low pH and or temperature	Check pH and temperature of process.

Nitrogen Removal – NH₃

Problem	Possible Cause	Solution
High effluent ammonia	Insufficient dissolved oxygen	Increase air supply. Troubleshoot air system if necessary.
	Insufficient alkalinity	Check effluent alkalinity. If less than 100 mg/l, begin addition of alkaline source.
	High influent ammonia loading	Check actual vs. design ammonia loading. Investigate abnormally high loading.
	Insufficient biomass	Decrease backwash of Amphidrome® if possible. Check BOD: N: P ratio.
	Low temperature	Check temperature of process. If abnormally low, investigate cause.
	Excessively high return rate over trough	Check the return flow to influent flow ratio.
	Toxic material present in process wastewater of influent	Investigate influent and process water for toxins and or biocides.
	High hydraulic loading	Check actual vs. design hydraulic loading. Investigate abnormally high hydraulic loading..

Nitrogen Removal – NO₃⁻

Problem	Possible Cause	Solution
High nitrate in effluent and fractional ammonia level	Excess dissolved oxygen in system	<p>Decrease air supply and recheck both nitrate and ammonia.</p> <p>Check anoxic tank, maintain anoxic conditions.</p> <p>Check return flow volume to influent ratio, adjust accordingly (i.e. DO ≤ .5 mg/e).</p>
	Insufficient biomass in Amphidrome Plus®	Decrease backwashing frequency of Amphidrome Plus® filter (if applicable).
	Low application rate to Amphidrome Plus® filter	<p>Check the start and stop times of feed pumps to determine the overall total operational time, and compare this against the actual run times of the Amphidrome Plus® feed pump.</p> <p>Check forward flow rate through filter.</p> <p>Increase backwash of Amphidrome Plus® filter to improve flow through rate.</p> <p>Troubleshoot Amphidrome Plus® feed pump.</p>
	Insufficient carbon source –Amphidrome Plus® filter or Amphidrome®	Increase carbon source supply to Amphidrome Plus®.

Supplemental BOD

Problem	Possible Cause	Solution
Supplemental BOD carryover causing elevated effluent BOD	Excessive addition of supplemental BOD	Check feed rate of supplemental BOD – adjust feed rate down to obtain lower effluent BOD level while maintaining proper nitrate removal.
	Insufficient mixing of BOD source and process wastewater	Check chemical feed line location – ensure located for sufficient mixing.
	Improper programmed run time for chemical feed system	Check programmed run times and adjust accordingly.
Insufficient nitrate removal	Inadequate supplemental BOD feed rate	Increase feed rate. Troubleshoot chemical feed system. Ensure correct concentration or solution of BOD source.

Alkalinity

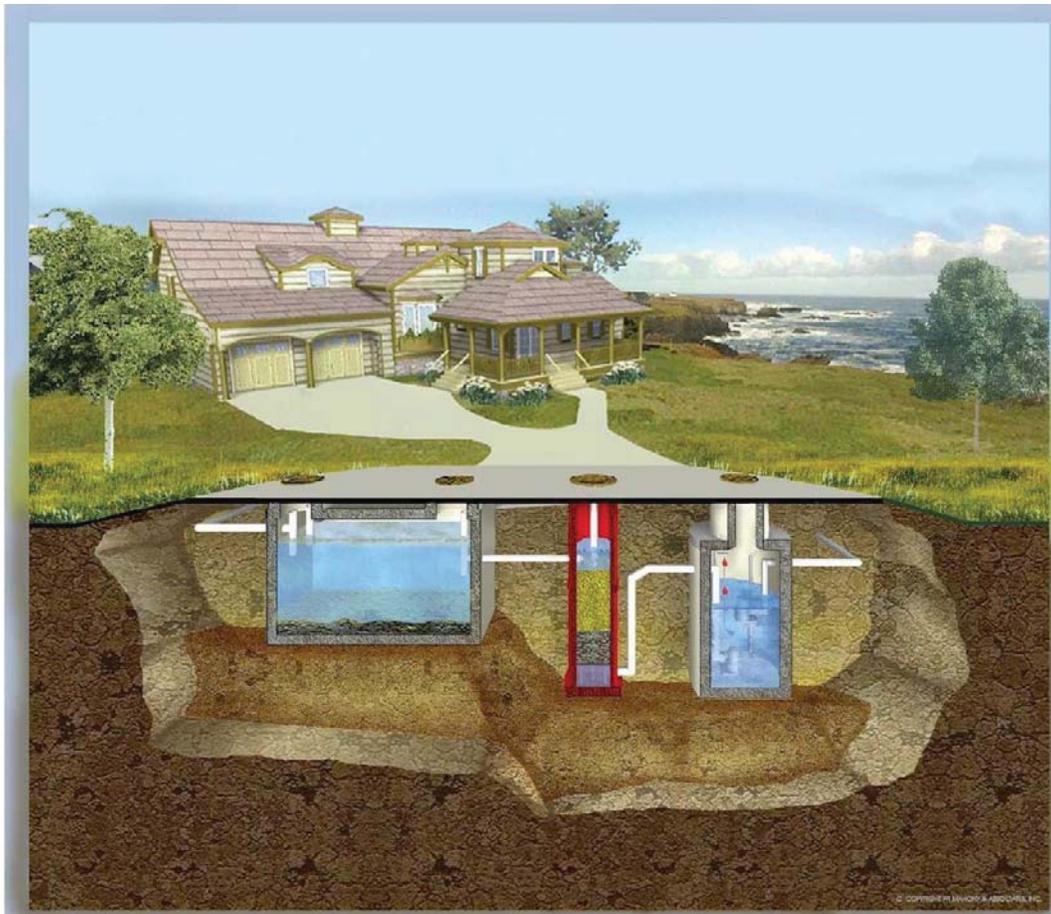
Problem	Possible Cause	Solution
Effluent alkalinity less than 100 mg/l	Low pH in influent to anoxic tank	Adjust pH on influent
	Insufficient alkalinity in influent wastewater	Supplement alkalinity in process by using alkalinity chemical feed system.
	Insufficient supplemental alkalinity feed	Increase alkalinity feed or solution strength. Troubleshoot feed system to ensure proper feed rates.

SINGLE FAMILY

Amphidrome®

User Instructions

The highest level of Nitrogen removal available...



...and at a reasonable cost.



USER INSTRUCTIONS

Congratulations on your Amphidrome® investment. With proper care and following some basic precautions, your system should provide years of reliable service.

Basic Principals of Operation

This system is an advanced biological treatment process designed to reduce sanitary waste from your home to a desired permit level for discharge to the ground. This advanced treatment process is used to further treat wastewater beyond the normal levels typically achieved in a conventional septic system. The process requires a waste stream from your home free from hazardous materials or toxic cleaners. The process is designed to work with added air supplied by the process blower(s). At times the process will also operate without the addition of air.

An environment conducive to the biological consumption or reduction of the household waste is maintained in the system. The effectiveness of this process is directly related to the continued support of this environment. Should the system fall into disrepair, the result will be a loss of performance and possible violation of discharge permits.

Caring For Your System

Care should be made with this or any other waste treatment system to not dispose of strong chemicals, gasoline, lubricating oils/grease, glass, metal, seafood shells, goldfish stone, kitty litter, plastic objects, explosives, flammable materials, paint, or pharmaceuticals. Please keep in mind this is a biological process that requires the proper environment to perform correctly. Furthermore, you should not dispose of highly concentrated ammonia-based household cleaning products. These materials are high in nitrogen and could jeopardize the systems ability to meet the nitrogen discharge limits.

Proper maintenance of the anoxic tank requires routine pumping of the solids that accumulate in the bottom of the tank. This process is very similar to maintenance of a conventional septic system. Your operator will recommend a pumping frequency specific to your system. The level of solids will be measured annually. This tank must not be used to dispose of solid waste products such as disposable or cloth diapers, socks or cloth, sanitary napkins or tampon applicators, condoms, food wrappers, or other such items that are considered solid waste, trash or non-biodegradable material. The disposal of grease and cooking oil is also not recommended as this material will coat plumbing and drain lines and could also effect the operation of the system.

System Components

Many of the system components are located below ground, with only the control center and process and backwash blowers located above ground. All of the system tanks should have access through manhole covers to perform inspection and maintenance services.

The Anoxic Tank is the first tank in the process. This tank receives all of the wastewater flow from the home. Solids are permitted to settle in this tank and the liquid portion flows to the Amphidrome® Reactor. Routine pumping of this tank to maintain proper solids levels is required and the need to pump will be determined by the operator. The homeowner will be notified in writing as to the need for pumping the anoxic tank. It is the responsibility of the homeowner to schedule pumping.

The Amphidrome® Reactor provides the majority of the biological treatment. In the forward direction, flow is filtered and aerated. In the return direction, flow is used to clean the filter and return waste solids to the Anoxic Tank. The reactor also works in the absence of added air to further treat the waste to remove nitrogen.

Clear Well provides storage of treatment batches from the first two tanks and prior to discharge to the leaching system. Pumps in this tank direct the flow as needed in the process.

The Control Panel is a NEMA 4X panel, which may be located outdoors. It may also be placed indoors, in a garage, closet or utility room, provided an exterior communications access port to the panel is provided. This panel controls and monitors all of the process functions. The homeowner should be aware of this panel and the functions indicated on the cover. Indicator lights will show the status of the process. When calling for service or assistance, it will be helpful to describe what is happening as shown by the panel lights. Homeowner care is very limited to making certain that power is restored to the panel if the home lost electricity due to inclement weather or other event that affects the power supply to the home. A nameplate should be located on the cover of the panel providing service contact information.

Process and Backwash Blowers provide added air supply to support the systems biological needs. These blowers must be placed under some protective cover. The blowers must be placed at an elevation that is higher than the top of the Amphidrome® reactor. The blowers are usually in a shed, garage or small weatherproof housing away from the house. There is no homeowner maintenance required for these blowers.

Power Failure

The system is designed to provide storage in the system for normal power failures. Sufficient capacity is available for a conservative continued use of water in the home. When power is restored, high level alarms may sound. These alarms should clear once the system has resumed normal operation.

Alarm Lights

Alarm lights will indicate if a problem exists in the system. The alarm horn may be silenced locally. An automatic dialer will notify the operator of the alarm condition. If you do not hear from the system operator within 12 hours, please call F. R. Mahony & Associates at 800-791-6132.

Supplemental Instructions

Refer to the Installation Instructions and to the Operation and Maintenance Manual for additional information.

Scheduled Maintenance

Maintenance is scheduled based on the specific discharge permit requirements. Annual inspection is required to monitor the equipment functions and to verify the system's performance. These service calls generally do not require more than 2-hours during each service visit.

Contacts

Manufacturer: **F.R. Mahony & Associates, Inc.**
 273 Weymouth Street
 Rockland, MA 02370
Email: **info@frmahony.com**
Telephone: **781-982-9300**
 800-791-6132
Fax: **781-982-1056**

USER PRECAUTIONS

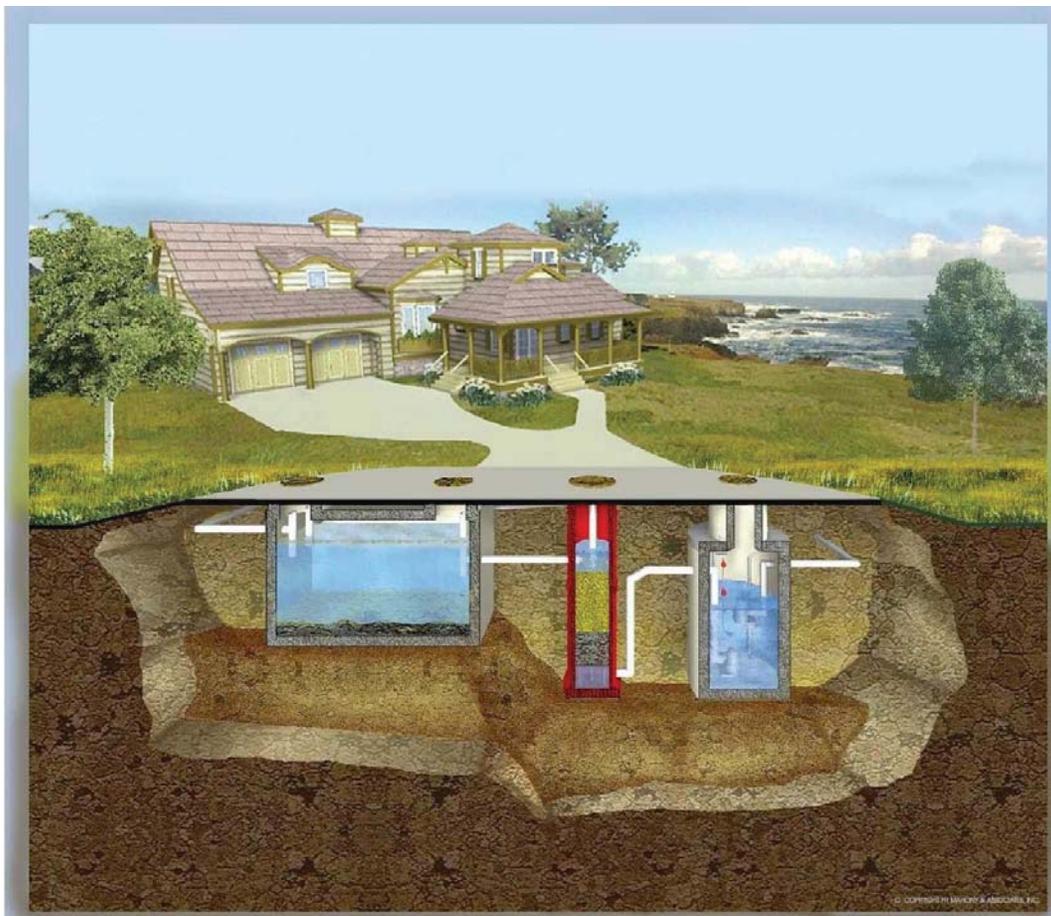
WE STRONGLY RECOMMEND AVOIDING THE INTRODUCTION OF THESE ITEMS INTO THE AMPHIDROME® SYSTEM.

- **STRONG CHEMICALS**
- **GASOLINE**
- **LUBRICATING OILS/GREASE**
- **SEAFOOD SHELLS**
- **GOLDFISH STONE**
- **PLASTIC OBJECTS**
- **GLASS**
- **METAL**
- **KITTY LITTER**
- **EXPLOSIVES**
- **FLAMMABLE MATERIAL**
- **PAINT**
- **PHARMACEUTICALS**
- **HIGH STRENGTH AMMONIA CLEANING PRODUCTS**
- **LIQUID FARIC SOFTENER**
- **DISPOSABLE OR CLOTH DIAPERS**
- **SOCKS OR CLOTH**
- **FOOD WRAPPERS**
- **SANITARY NAPKINS/TAMPON APPLICATORS**
- **CONDOMS**
- **COOKING OILS/GREASE**
- **OR ANY OTHER NON-BIODEGRADABLE MATERIAL**

Amphidrome®

Installation Instructions

The highest level of Nitrogen removal available...



...and at a reasonable cost.



INSTALLATION MANUAL INDEX

- 1. INSTALLATION INSTRUCTION**
- 2. BILL OF MATERIAL-CUT SHEET**
- 3. DRAWINGS**

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The Amphidrome® Process

The Amphidrome® system is a submerged attached growth bioreactor process, designed around a deep-bed sand filter. It is specifically designed for the simultaneous removal of soluble organic matter, nitrogen and suspended solids within a single reactor. Since it removes nitrogen, it may also be considered a biological nutrient removal (BNR) process.

To achieve simultaneous oxidation of soluble material, nitrification, and denitrification in a single reactor, the process must provide aerobic and anoxic environments for the two different populations of microorganisms. The Amphidrome® system utilizes two tanks and one submerged attached growth bioreactor, called the Amphidrome® reactor. The first tank, the anoxic/equalization tank, is where the raw wastewater enters the system. The tank has an equalization section, a settling zone, and a sludge storage section. It serves as a primary clarifier before the Amphidrome® reactor.

This Amphidrome® reactor consists of the following three items: underdrain, support gravel, filter media. The underdrain, constructed of steel, is located at the bottom of the reactor. It provides support for the media and even distribution of air and water into the reactor. The underdrain has a manifold and laterals to distribute the air evenly over the entire filter bottom. The design allows for both the air and water to be delivered simultaneously--or separately--via individual pathways to the bottom of the reactor. As the air flows up through the media, the bubbles are sheared by the sand, producing finer bubbles as they rise through the filter. On top of the underdrain is 18" (five layers) of four different sizes of gravel. Above the gravel is a deep bed of coarse, round silica sand media. The media functions as filter, significantly reducing suspended solids and provides the surface area for which an attached growth biomass can be maintained.

To achieve the two different environments required for the simultaneous removal of soluble organics and nitrogen, aeration of the reactor is intermittent rather than continuous. Depending on the strength and the volume of the wastewater, a typical aeration scheme may be three to five minutes of air and ten to fifteen minutes without air. Concurrently, return cycles are scheduled every hour, regardless of the aeration sequence. During a return, water from the clear well is pumped back through the filter and overflows into the energy-dissipating TEE. A check valve in the influent line prevents the flow from returning to the anoxic/equalization tank via that route. The energy-dissipating TEE is set at a fixed height above both the media and the influent line, and the flow is by gravity back to the front of the anoxic/equalization tank.

The cyclical forward and reverse flow of the waste stream and the intermittent aeration of the filter achieve the required hydraulic retention time and create the necessary aerobic and anoxic conditions to achieve the required level of treatment.

General

Installers of Amphidrome® systems should be versed in installation of subsurface disposal systems (SSDS). Installers must comply with Local, County and State Health certification requirements for SSDS installers including other applicable safety requirements such as licenses for equipment operators and truck drivers.

Construction of Amphidrome® systems require that the approved plans and instructions be followed. Engineered plans showing elevations of tanks and pipelines and the layout should be on site and referenced by the contractor and their agents. The manufacturer shall be consulted with regard to any conflicts or questions regarding clarification of plans, details, and any omissions or errors that may be encountered.

The Amphidrome® system is designed to use standard construction materials that may be found in any region. Tanks are typically concrete with rubber grommets, boots or gaskets for all pipe penetrations. Piping is standard PVC or cast iron or stainless steel material. The list of materials to be supplied by the contractor to be used in conjunction with the materials supplied by the manufacturer will state the standard sizes, schedules, ratings required.

Contractors will be required to follow the plans and prepare the site in the same manner as would be used with a conventional SSDS. The Amphidrome® system is an advanced wastewater treatment process that performs in much the same way as a conventional SSDS with certain modifications.

The process flow stream will enter an anoxic tank rather than a Septic Tank. The anoxic tank will provide the first function of primary settling and flow equalization. The flow will then proceed to the Amphidrome® Reactor for aerobic treatment and filtration in the forward flow direction. Treated waste will leave the bottom of the reactor and flow through the return pump line and the return pump into the clear well. The clear well will store a batch of treated effluent until a float switch is activated allowing the return pump to pump effluent in the return mode back through the reactor and then back to the anoxic tank. Once the return pump stops, the flow will then flow by gravity in the forward direction through the reactor and into the clear well. During this cycle the aeration blowers will be off causing an anoxic condition to occur. The process results in denitrification of the wastewater that will be stored in the clear well. The discharge pump will pump to the leach field or absorption field when the process is completed. For a more detailed process description, refer to the Operation and Maintenance Manual.

Contractors will be required to provide and set tanks as called for on the design plans and the associated piping. The contractor shall also complete field wiring of pumps and panels supplied by the manufacturer. All site work and site restoration shall be supplied by the contractor.

Start up services and inspection services of the manufacturer or authorized agents shall include:

1. Verification of invert and media elevations.
2. Inspection of air pattern in the reactor or “Air Pattern Test” prior to installation of media. See media installation instructions below.
3. Process startup including verification of wiring connections, operation of pumps, blowers and process controller.
4. Measurement of the level of sludge in the anoxic/equalization tank during annual inspections.

Contractor shall perform installation in conformance with all local, county and state inspection requirements for the setting of tanks, pipes, leaching system components, etc. The manufacturer’s inspections shall in no way imply approval to backfill components that must be inspected by other authorities without their inspection.

Installation Procedures

Each installation will vary based on individual site conditions and restrictions. The general procedures should be followed for placement of components. These instructions are not intended to instruct contractors on every aspect of an individual installation. It is expected that good construction practices will be followed with regards to excavation, setting of pipes and tanks and placement of bedding and backfill materials with proper grade, slopes, and compaction techniques. Field wiring shall be in accordance with Local and National Wiring Codes and the Manufacturer’s wiring diagrams.

Construction will most likely begin with setting of the deepest components first. The anoxic tank, reactor and clear well must be set on level, firm foundation of excavated material or properly compacted and stable fill material. Proper grade or elevations of pipes and tanks is essential to the functioning of this system. Improper grade of pipelines or tanks shall void process warranties.

It is recommended that the contractor verify measurements of each tank and verify the location of pipe penetrations and the size and elevation of these penetrations before placing each tank. It is important to install proper gaskets and seals as provided by the concrete supplier prior to backfilling and water testing the tank.

Refer to Appendix, Drawing 1, Amphidrome® Single Family Layout

Anoxic Tank Internals

The Anoxic Tank Internals consists of the return TEE and vent and discharge TEE assembly. The inlet line is 4-inch Schedule 40 PVC. The drop pipe or vertical discharge pipe shall be extended to 12-inches below the minimum water level (invert of the tank discharge line). The vent riser pipe (upper part of TEEs) shall extend at least six inches (6") above the maximum water level of the tank, ideally, into the riser of the tank.

All TEE's and inside piping must be properly installed with PVC cleaner and solvent and supported with suitable supports as shown or otherwise required to hold the pipe assemblies in place.

The discharge 2-inch Schedule 40 PVC TEE and check valve assembly shall be properly cleaned and PVC solvent shall be used to connect to the 2-inch Schedule 40 PVC discharge line. The vertical inlet pipe shall extend to 10-inches below the minimum water level. The vent riser pipe shall extend into the riser of the tank.

Return & Backwash line shall be 4-inch Schedule 40 PVC. The return TEE and energy dissipation header shall be installed with PVC pipe cleaner and solvent. The top of the energy-dissipating header shall be two inches (2") below the minimum water level of the tank so the header is fully submerged. The vertical drop pipe must be field measured and field cut to the proper length. Proper pipe hangers and supports shall be used to support this assembly. End caps are placed on each end of the energy-dissipating header.

Refer to Appendix, Drawing 2. 2000 Gallon Anoxic Tank

Clear Well Internals

The clear well internals shall consist of the three process control floats, a Return / Backwash pump with discharge pipe and connector, and a discharge pump enclosed in a sump with discharge pipe and connector. Separate conduit penetrations for floats and two pump power supply cables shall be provided in the tank and sealed to prevent water intrusion and harmful gasses from escaping. Each pump shall be fitted with a polypropylene lifting rope or stainless steel chain with hanger.

Refer to Appendix, Drawing 4, 1,000 Gallon Clear Well Tank

For specifications and pump curve for the return flow/backwash and effluent pumps, refer to Appendix: Pumps Cut Sheet.

Amphidrome® Clear Well Floats (3)

Amphidrome® Clear Well High Float

- The float serves as a high alarm float when it is elevated. The high float shall be set level to, or slightly below the clear well inlet.

Amphidrome® Clear Well Middle Float

- The middle float serves multiple purposes: it is the OFF float for the discharge pumps, it defines the storage level required for a reactor backwash, and it is used for some of the more advanced process controls for the Amphidrome system. This shall be set near the mid-point of the tank and field adjusted by the manufacturer during start-up.

Amphidrome® Clear Well Low Float

- The float stops the return pump cycle when liquid level drops to the level of the float. the low float shall be set one foot above the bottom of the tank floor.

The floats are mini-floats with counterweights. The floats are to be hung in the clear well with sufficient cable slack to permit for level adjustments. Loose cable is to be neatly coiled and fastened with nylon wire tie or suitable non-corrosive strap.

All conduits from tanks shall be sealed with appropriate material to prevent liquid and gas to travel from tank penetrations. Float cable shall NOT be run in the same conduit as the power cable.

Clear Well Air Bleed

The air bleeds for the return pipe and the discharge pipe in the clear well are required to prevent siphoning after the pumps shut down. This is accomplished by drilling a 3/16 inch hole near the top of the discharge and return piping.

Refer to Appendix, Drawing 10, Detail F: Return Pump Detail and Drawing 11, Detail G: Effluent Pump and Sampler Detail

Drill the 3/16 inch hole in both locations shown on the drawings. The hole should be drilled at an angle to direct the vented flow in a downward direction.

Tools Required: Drill and 3/16-inch bit.

Amphidrome® System Piping

Anoxic Tank Outside Piping

Pipelines for inlet and discharge to the anoxic tank and the return and backwash line should be installed to the slope and elevations marked on the plans. The inlet line from the house to the anoxic tank is 4-inch schedule 40 PVC unless otherwise indicated on the plans. The backwash and return line is 4-inch Schedule 40 PVC. The discharge line from the anoxic tank is 2-inch Schedule 40 PVC.

Pipes should penetrate the inside of the tank wall with sufficient length to connect inlet TEE (not supplied), Discharge TEE with check valve assembly and return & backwash return TEE with energy dissipating drop pipe and diffuser assembly provided by the manufacturer. Pipes shall be properly cleaned and glued with PVC solvent. Pipelines shall be watertight and airtight and tested prior to operation of the system.

Refer to Appendix, Drawing 2, 2000 Gallon Anoxic Tank

Amphidrome® Reactor Interconnecting Piping

The backwash and return line and inlet line may be connected to the Amphidrome® reactor after completion of the installation of air header, support gravel and media as described below. Depending on the reactor depth, the contractor may find it is easier to complete this work before adding the top reactor section that will receive the interconnecting pipes. The discharge line from the reactor (2-inch Schedule 80 PVC) is continued to the clear well providing sufficient pipe inside the clear well to connect the return pump discharge hose and quick disconnect coupler.

Clear Well Outside Piping

The piping to the clear well consists of the inlet line referenced above and a discharge line (2-inch Schedule 80 PVC) that will flow to the distribution box or dosing chamber if required. Sufficient pipe must be left inside the clear well to connect the discharge pump discharge hose and quick disconnect coupler.

Air Piping Outside

Air piping from the blower location to the clear well must be properly assembled to provide an airtight assembly from the Amphidrome® Reactor to the blower. The air piping shall be 1-1/2 inch Schedule 80 PVC.

Amphidrome® Reactor Internals

This Amphidrome® reactor consists of the following three (3) items: underdrain, support gravel, and filter media that are assembled in a concrete or fiberglass vessel. The underdrain, constructed of steel, is located at the bottom of the vessel. It provides support for the media and even distribution of air and water into the reactor. The underdrain has a manifold and laterals to distribute the air evenly over the bottom of the reactor. The design allows for both the air and water to be delivered simultaneously, or separately, via individual pathways, to the bottom of the reactor. As the air flows up through the media, the bubbles are sheared by the sand; producing finer bubbles as they continue to rise. On top of the underdrain is 18", (five layers), of four different sizes of gravel. Above the gravel is a deep bed of coarse, round, silica sand media. The media functions as a filter; significantly reducing suspended solids, and provides the surface area for which an attached growth biomass can be maintained.

It is critical that the reactor vessel be installed true and plumb to ensure proper air distribution within the reactor.

**Refer to Appendix, Drawing 3 Amphidrome® Reactor Construction Dimensions
Drawing 4, 1000 Gallon Clear Well Tank**

Amphidrome® Reactor Floats (2)

All conduits from tanks shall be sealed with appropriate material to prevent liquid and gas to travel from tank penetrations.

**PICTURE 1.
REACTOR FLOATS**



Amphidrome® Reactor High Float

- The high float signals that the water level in the reactor is at the level of the backwash/return line. If the float remains elevated for an excessively long time (typically twenty(20) minutes) after either a backwash or a return, a high level alarm is sent.

Amphidrome® Reactor Low Float

- The low float signals a low level in the reactor. If the low float option is enabled this float is used by the program to determine when to initiate a return.

Amphidrome® Reactor Installation Sequence

Pre-Installation Check

- The underdrain assembly is a single piece 23.5" in diameter. Measure the inside of the concrete vessel to be sure the underdrain assembly will fit.
- Check to see that the pipe penetrations are located properly.
- The reactor must be set plumb and level for the system to perform properly.

Underdrain Installation

- The influent, dirty backwash, effluent, and backwash air piping are not to be installed until the underdrain assembly is installed.
- Place the underdrain in the vessel so that it is centered in the vessel and completely level.
- Ensure pipe cutout on underdrain aligns with effluent pipe opening in reactor.

Piping

- Install the influent, dirty backwash, effluent, and backwash air piping as shown.
- Install the influent check valve at the anoxic tank.
- Pipe penetrations should be capped and the Reactor should be filled to verify that the reactor is water tight!

Air Pattern Test

- With the underdrain assembly in place, fill the basin with water to 2" above the top of the underdrain.
- Use either the process blower or an air compressor to provide a maximum of 3 CFM of air.
- If the air distribution is visually even across the bottom, proceed to the next step. If not, remove the underdrain and check for plugged holes. Repeat the test after clearing the plugged holes and leveling the underdrain.

Before backfilling, F.R. Mahony & Associates must be contacted to verify Elevations and verify the Air Pattern Test.

Gravel and Media Installation

Gravel and Sand

- Gravel and sand are to be installed in the reactor using buckets to place the material into place. **Do not drop gravel and media from the top of the reactor.**
- The bucket with two (2) ropes attached should be used: One rope is for lowering the bucket into place and the second is used to tip the bucket to dispense the gravel or media.
- Beginning with the proper size gravel for Layer # 1, carefully lower the bucket into the reactor to within 6" of the underdrain, tip the bucket and move the bucket as it is tipped in order to evenly distribute the material.
- Use a rod with a small plate on the end to move mounded material and to gently tamp the material level. Be careful not to tamp too much or too hard as this will cause the gravel to intermix. The top of each layer is to be level across the reactor.
- Repeat this process until each of the five (5) layers has been placed.

Layer No. 1 goes into the basin first, then Layer No. 2, and so on through Layer No. 5. A total of 18" of support gravel is placed in the basin. Layer No. 6, Filter Media, is 4'-0" in depth and is put in place last. Note that Layer 3 and layer 5 are the same size of media and are separated by layer 4 (a smaller size of media).

LAYER NO.	GRAIN SIZE	DEPTH	VOLUME Cubic Feet	# Bags
1	1 1/2" x 3/4" Gravel	0'-4"	1.0	2
2	3/4" x 1/2" Gravel	0'-2"	0.5	1
3	1/2" x 1/4" Gravel	0'-4"	1.0	2
4	1/4" x 1/8" Gravel	0'-4"	1.0	2
5	1/2" x 1/4" Gravel	0'-4"	1.0	2
6	Filter Media	4'-0"	12.5	25

Media

- Use the same method to install the media as was used for the gravel installation. Be careful not to get sand media into the influent pipe nozzle. Use a survey rod to determine the level of the media layer as each layer is added.
- **NOTE: A SILICA SAND WARNING FOR POTENTIAL LUNG HAZARD IS PRINTED ON THE BACK OF EACH BAG OF MEDIA. PRECAUTION SHOULD BE USED WHEN DISTRIBUTING THIS MATERIAL.**

Reactor Media Flushing

- After installation of gravel and media, the reactor is to be flushed with clean water and air to remove dust and fines. The backwash air blower and pump is used for this purpose. The reactor and clearwell are to be filled with clean water before flushing begins. Flushing shall continue for a minimum of 15 minutes or until the backwash water is clear of fines.

- After completion of flushing, cover the media with plastic, or close over the top of the reactor, until the reactor is placed into service. This will keep foreign contaminants out of the media.

Completion of the top access way cover and interconnecting external piping connections must be completed before backfilling around the top portion of the Reactor. Conduits for float wires, and air piping and Reactor vent piping must be properly bedded and backfilled prior to final grading around the Reactor.

Access Covers Manholes

There shall be a minimum of four (4) access covers – cast iron bolted and gasketed – for the entire Amphidrome® system.

- These are shown on the **Amphidrome® Single Family Drawings 1, 2, 3, and 4**.
- One access cover will be located over the discharge of the Anoxic Tank to permit the removal of waste sludge and to permit the inspection of the discharge TEE.
 - One riser to within 6” of finished grade shall be provided at the inlet of the Anoxic Tank.
- A single access cover shall be installed over the Amphidrome® Reactor to permit access to the reactor for service and inspection.
- Two access covers shall be placed in the clear well to access the pumps for service and to access the discharge end for sample collection.

All access ways and covers shall be securely fastened to each tank and grouted in place to provide watertight seals. Cast Iron manhole covers with a 24-inch clear opening are required.

Covers should not be buried, except as specifically shown on the plans. Access covers may be flush with finished grade to blend into the landscaping. **NOTE: Covers MUST be exposed. Inability to access the systems components via manhole covers may VOID warranty.**

Blowers and Controls

Blowers will include a process air blower and backwash blower. A single blower will operate to provide process air in the aerobic phase of treatment. During the backwash cycle, the second blower will run to provide additional backwash air. The blowers must be installed in a well-ventilated enclosure that provides shelter from rain and snow. The enclosure may be a separate shed or structure constructed to blend into the landscaping and architecture of the property. The blowers will generate some noise during operation. Placement of the blowers should be such that the noise can be reduced.

The blowers must be accessible for service and must not be placed in manholes or otherwise below grade where they may be subject to groundwater or surface water accumulations.

In order to reduce the length of power cables and conduits, the blowers should be located within reasonable distance of the Amphidrome® system and the Amphidrome® control panel. Each installation will be different, as homeowners will have different ideas on a suitable location for these components. The maximum distance between the blowers and the reactor is 75'.

Blower Piping

Blower piping shall be assembled with a common header. The header piping and blower placement are designed to reduce the space required. Piping consists of standard iron pipe thread fittings. Assembly should be made with Teflon paste or Teflon tape on all pipe joints. Air piping can be tested for leaks with soapy water. A dilution of dish soap and water in a small squirt bottle works well for this purpose.

Refer to Appendix, Drawing 12, Blower Detail A: Process Air Piping Assembly, and Drawing 13, Blower Detail B: Backwash Blower with Piping Arrangement

The blowers must be anchored to the floor of the enclosure to restrict vibration and stress on the blower piping. Anchors should be used that will permit the easy removal of a blower for service. Be sure to use the rubber isolation washers provided with the blowers. **The blowers must be placed at an elevation that is higher than the top of the Reactor manhole cover.**

The provided pipe unions permit removal of a blower with minimal disturbance to the air header.

Refer to Appendix, Drawing 12, Blower Detail A, Parts 8 and 12

Amphidrome® Control Panel

The Amphidrome® control panel is the central control of all processes in the system. **The Control Panel** is a NEMA 4X panel, which may be located outdoors in reasonable distance from other system components. It may also be placed indoors, in a garage, closet or utility room, on condition that an exterior communications access port to the panel is provided.

The Amphidrome® control panel is a complete assembly supplied by the manufacturer with field terminal connections and wiring connections to be made by a qualified, licensed electrician. No modification to this panel may be made by anyone other than the manufacturer. Main power supply to the panel must be 30 amp, 240 volt.

The panel contains breakers, disconnects, fuses, alarm lights and indicators for system operations, system program interface connection, programmable logic controller PLC, and process time clock. A main power supply from the household main service panel must be brought to this panel. All wiring from outside conduits must be made gas tight before the system is to be accepted by the owner and warranty begins.

Wiring must be completed in accordance with the manufacturer's wiring diagrams. All wiring must be placed in conduit. Cable splices should be avoided. When cable splices are required, proper junction boxes must be located above ground and above average snow cover levels. Splices that are subject to wet conditions shall be sealed with Scotchcast® or equal power cable splice kit. Splices should be made with enough cable slack to permit the disconnection of a pump or float for service repair.

***Junction Disconnect Boxes that are installed at grade, or below grade, will void warranty for pumps, and control panel.**

***Splices made to cords without use of FRMA approved splice kits will void warranty to pumps, and control panel.**

Refer to Appendix, Drawings: Control Panel Wiring and Control Panel Enclosure

Note: At any time, the manufacturer reserves the right to modify and to improve the Amphidrome® Control System wiring. Modified drawings would supersede drawings included in the Installation Instructions.

Automatic Voice/Pager Alarm Dialer System

The voice/pager alarm dialer system is used to transmit high clear well or filter high level alarms to one or more remote locations. The dialer features busy line and no answer detection to ensure prompt transmission of a prerecorded message, delivered sequentially to as many as four standard telephones, cellular telephones, and voice and/or numeric pagers.

The dialer is fully programmable, offering personalized customization for each individual project. Programming options include but are not limited to:

- Store up to four telephone/pager numbers. *
- Choose 1 to 9 calling efforts for the numbers dialed.
- Select 1 to 3 message repeats.
- Voice record an outgoing message in any language.
- Program voice messages to telephones and numeric code to pagers.

* Program the automatic alarm dialer system to call **508-765-3469** to enable the dialer to report weekly to FRMA's service office to insure that it is in operation.

The voice pager/alarm dialer is a standalone unit operating 24 hours per day. Monitoring fees are not required.

Refer to Appendix: AD2001 Owner's Manual and Operating Instructions

Contact Information

If additional information regarding the installation of the Amphidrome® Wastewater Treatment System is desired, F.R. Mahony will furnish it upon request.

Requests for information should be directed to:

F.R. Mahony & Associates, Inc.

273 Weymouth Street

Rockland, MA 02370

Email: info@frmahony.com

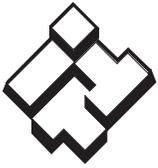
Telephone: 781-982-9300

800-791-6132

Fax: 781-781-982-1056

CLEAR WELL					
CONTRACTOR BILL OF MATERIALS			F. R. MAHONY BILL OF MATERIALS		
#	QUANT	DESCRIPTION	#	QUANT	DESCRIPTION
14	1	ITEMS 14-17 REFER TO DRAWING 4 1000 GALLON CLEAR WELL TANK WITH WATER TIGHT SEALS	F1	1	ITEMS F1- F5 REFER TO DETAIL F RETURN PUMP
15	2	TANK RISERS	F2	1	1 ½" X 2" COUPLING
16	2	TANK COVERS	F3	1	RETURN NON GUIDE RAIL DISCONNECT ASSEMBLY
17	2	2" SCH 80 PVC PIPE	F4	1	2" SCH 80 CAP
					ITEMS G1-G5 REFER TO DETAIL G
			G1	1	EFFLUENT PUMP
			G2	1	SUMP CONTAINER WITH LID
			G3	1	1 ½" SCH 80 CHECK VALVE ASSEMBLY
			G4	1	EFFLUENT NON GUIDE RAIL DISCONNECT ASSEMBLY
			G5	1	1 ½" X 2" INCREASER
					ITEMS 31-33 REFER TO CLEAR WELL TANK
			CW 1	3	MINI FLOATS W/50' CABLE
			CW 2	1	FLOAT MOUNTING BRACKET KIT

BLOWERS AND CONTROL SYSTEM					
CONTRACTOR BILL OF MATERIALS			F. R. MAHONY BILL OF MATERIALS		
#	QUANT	DESCRIPTION	#	QUANT	DESCRIPTION
18		CONDUIT FOR CONTROL PANEL			ITEMS 1-33 REFER TO BLOWER DETAIL A & B
			1	1	BACKWASH BLOWER
			2	1	PROCESS BLOWER
			3-10	1	BACKWASH BLOWER PIPING ARRANGEMENT
			11-15	1	PROCESS AIR PIPING ASSEMBLY
			16-27	1	DISCHARGE MANIFOLD ASSEMBLY
					CONTROL ASSEMBLY
				1	CONTROL PANEL
				1	AUTOMATIC DIALER (MAY BE OPTIONAL, CHECK WITH LOCAL REGULATIONS)
				1	ABOVE GRADE JUNCTION BOX (OPTIONAL)
				1	IRRIGATION/SPRINKLER BOX AND SCOTCH KIT (OPTIONAL)



ITT

Wastewater

Goulds Pumps

EP04 & EP05 Series Model 3871

Submersible Effluent Pumps



FEATURES

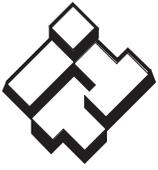
- **EP04 Impeller:** Thermoplastic semi-open design with pump out vanes for mechanical seal protection.
- **EP05 Impeller:** Thermoplastic enclosed design for improved performance.
- **Casing and Base:** Rugged thermoplastic design provides superior strength and corrosion resistance.
- **Motor Housing:** Cast iron for efficient heat transfer, strength, and durability.
- **Motor Cover:** Thermoplastic cover with integral handle and float switch attachment points.
- **Power Cable:** Severe duty rated oil and water resistant.
- **Bearings:** Upper and lower heavy duty ball bearing construction.



Goulds Pumps is a brand of ITT
Residential and Commercial Water.

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Engineered for life



ITT

GOULDS PUMPS Wastewater

APPLICATIONS

Specifically designed for the following uses:

- Effluent systems
- Homes
- Farms
- Heavy duty sump
- Water transfer
- Dewatering

SPECIFICATIONS

- Solids handling capability: 3/4" maximum.
- Capacities: up to 60 GPM.
- Total heads: up to 31 feet.
- Discharge size: 1 1/2" NPT.
- Mechanical seal: carbon-rotary/ceramic-stationary, BUNA-N elastomers.
- Temperature:
104° F (40° C) continuous
140° F (60° C) intermittent.
- Fasteners: 300 series stainless steel.
- Capable of running dry without damage to components.

Motor:

- EP04 Single phase: 0.4 HP, 115 or 230 V, 60 Hz, 1550 RPM, built in overload with automatic reset.
- EP05 Single phase: 0.5 HP, 115 V or 230V, 60 Hz, 1550 RPM, built in overload with automatic reset.
- Power cord: 10 foot standard length, 16/3 SJTW with three prong grounding plug. Optional 20 foot length, 16/3 SJTW with three prong grounding plug (standard on EP05).
- Fully submerged in high grade turbine oil for lubrication and efficient heat transfer.

Available for automatic and manual operation.
Automatic models include Mechanical Float Switch assembled and preset at the factory.

AGENCY LISTING

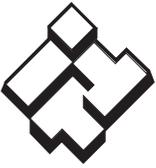


Tested to UL 778 and
CSA 22.2 108 Standards
By Canadian Standards Association
File #LR38549

Goulds Pumps is ISO 9001 Registered.

MODEL INFORMATION

Order No.	HP	Volts	Amps	Minimum Circuit Breaker	Phase	Float Switch Style	Cord Length	Discharge Connection	Minimum On Level	Minimum Off Level	Minimum Basin Diameter	Maximum Solids Size	Shipping Weight lbs/kg
EP0411	.4	115	12	20	1	Plug / No Switch	10'	1 1/2"	Manual	Manual	15"	3/4"	20 / 9.1
EP0411A						Piggyback / Wide-Angle	10'	1 1/2"	12"	6"	15"		21 / 9.5
EP0411F						Plug / No Switch	20'	1 1/2"	Manual	Manual	15"		20 / 9.1
EP0411AC						Piggyback / Wide-Angle	20'	1 1/2"	12"	6"	15"		21 / 9.5
EP0412	230	6	10	Plug / No Switch		10'	1 1/2"	Manual	Manual	15"	20 / 9.1		
EP0412F				Plug / No Switch		20'	1 1/2"	Manual	Manual	15"	20 / 9.1		
EP0511F	.5	115	13	20		Plug / No Switch	20'	1 1/2"	Manual	Manual	15"		22 / 10
EP0511AC						Piggyback / Wide-Angle	20'	1 1/2"	12"	6"	15"		23 / 10.4
EP0512F					Plug / No Switch	20'	1 1/2"	Manual	Manual	15"	22 / 10		



ITT

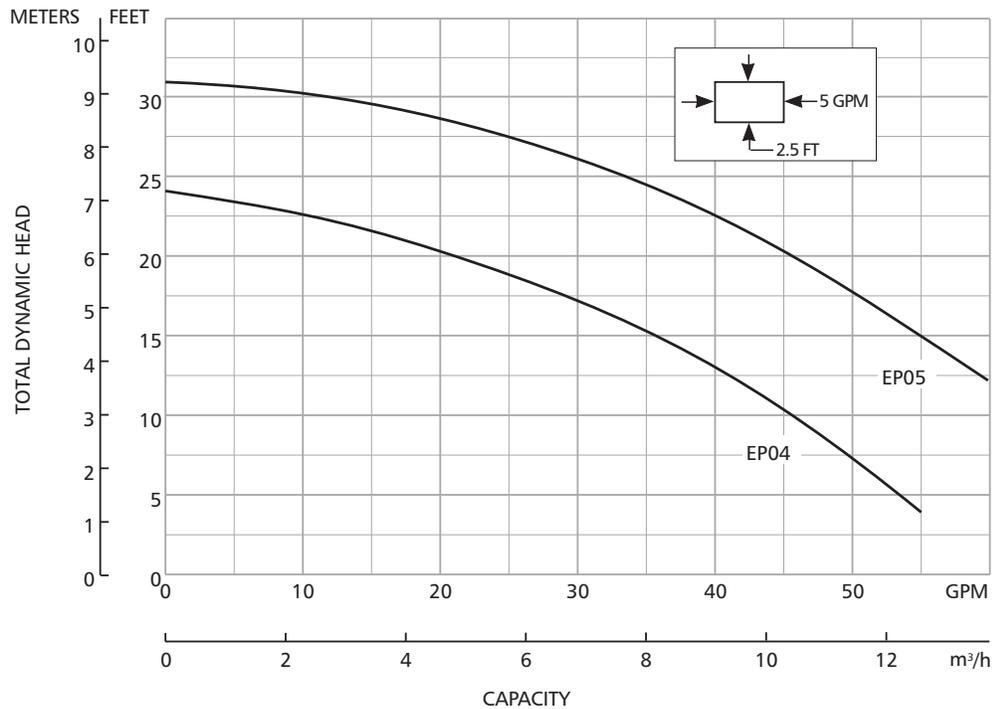
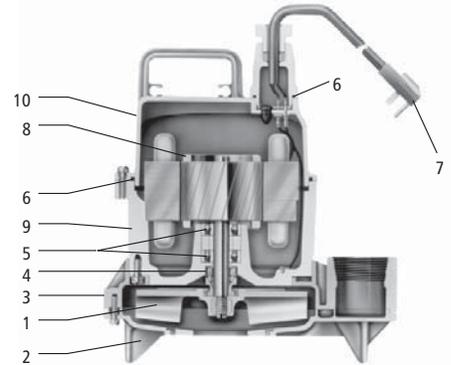
GOULDS PUMPS Wastewater

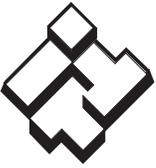
PERFORMANCE RATINGS

Total Head (ft. of water)	Gallons Per Minute	
	EP04	EP05
5	53	—
10	46	62
15	36	55
20	21	46
25	0	33
30	—	11

COMPONENTS

Item No.	Description
1	Impeller
2	Base
3	Pump Casing
4	Mechanical Seal
5	Ball Bearings
6	O-Rings
7	Power Cord
8	Oil Filled Motor
9	Motor Housing/ Stator Assembly
10	Motor Cover



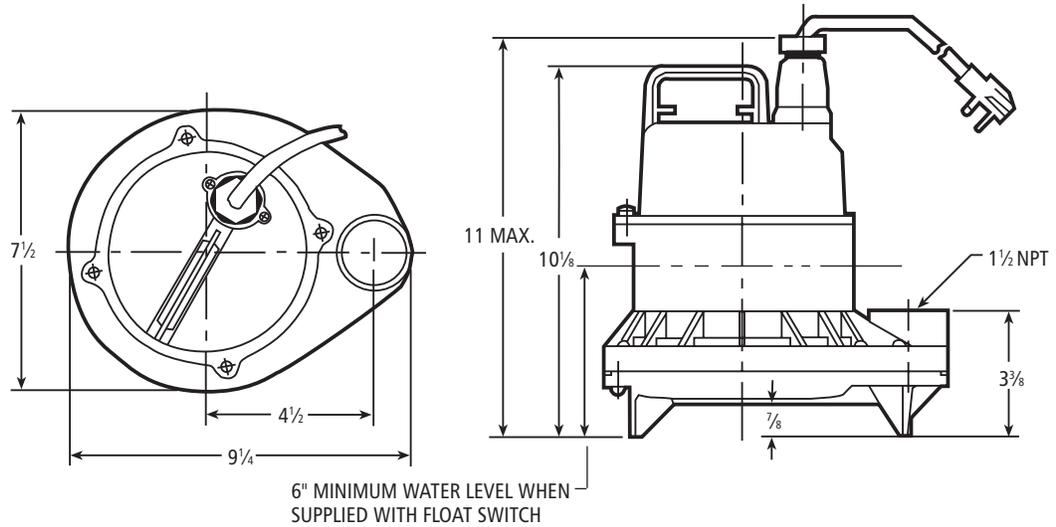


ITT

Wastewater

DIMENSIONS

(All dimensions are in inches. Do not use for construction purposes.)



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SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

B3871 July, 2006

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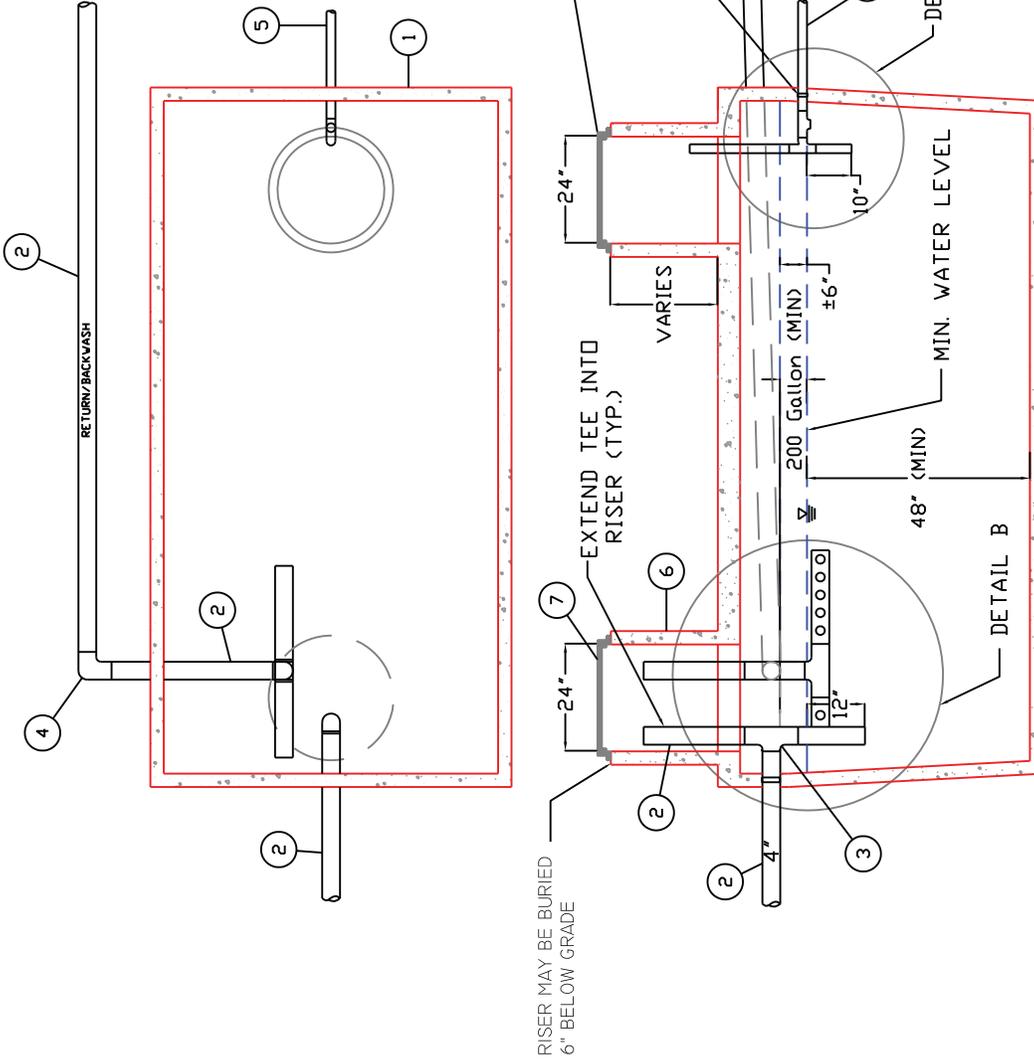
Engineered for life

INSERT 17 x 11 DRAWING 1

**AMPHIDROME® SINGLE FAMILY
LAYOUT**

NOTES:

1. TANK IS 4000 PSI STEEL-REINFORCED CONCRETE
2. CONCRETE CONFORMS TO ACI 318-16-4.5.1 AND ACI 318-16-4.5.2
3. TANK DESIGNED AND APPROVED FOR USE IN F.R. MAHONY AMPHIDROME SYSTEMS
4. REFER TO LAYOUT FOR ADDITIONAL NOTES REGARDING INSTALLATION AND TANKS
5. INFLUENT RISER MAY BE PLACED 6" BELOW GRADE WITH CONCRETE COVER, IF DESIRED.



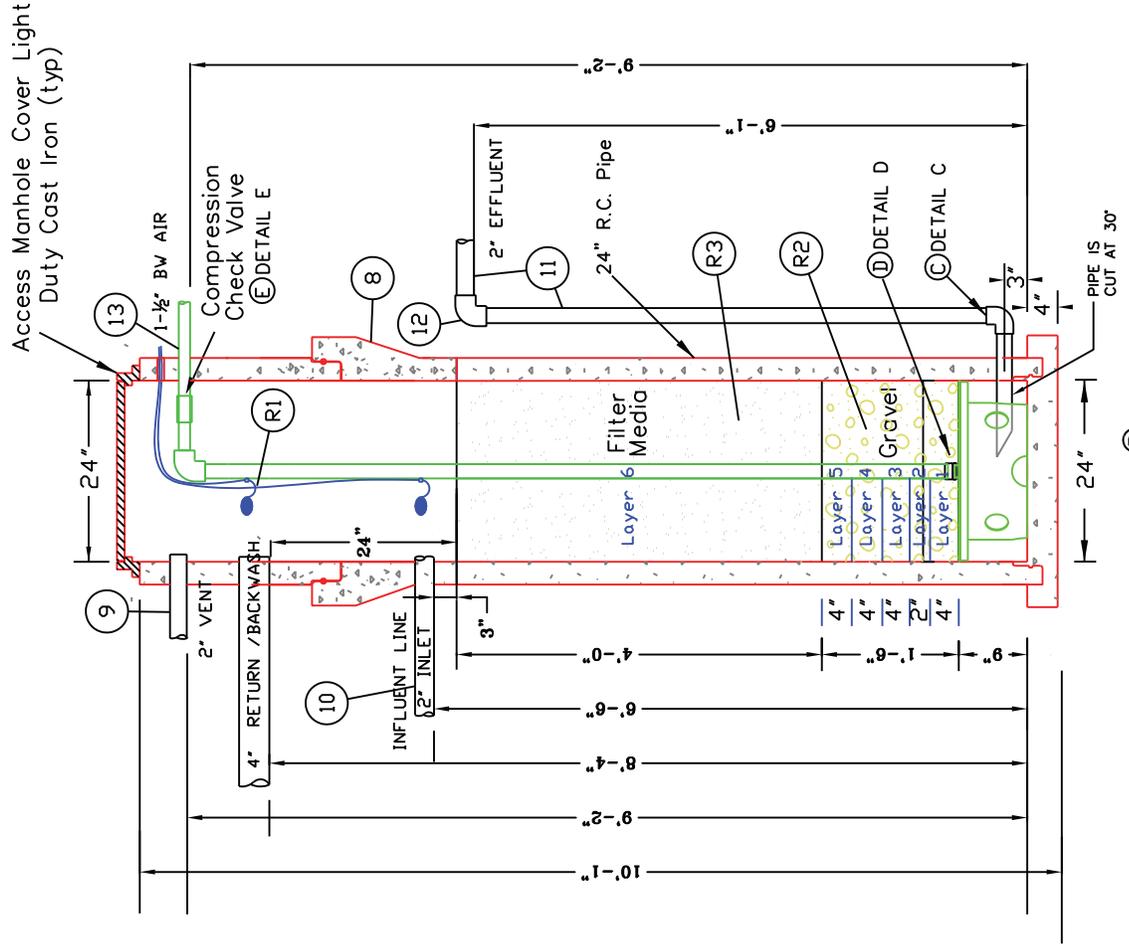
RISER MAY BE BURIED 6" BELOW GRADE

Rev	Date	By	Description
6	02/28/11	JAH	Renumber parts and revise

DWG: Drawing 2	2000 Gallon Anoxic Tank
Rev: 2008SCI	Tank
Drawn by: ADV	App'd by:
Scale: NTS	Date: 1/22/08

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Water Supply & Pollution Control Equipment & Associates, Inc.	
221 West 28th Street, Madison, Wisconsin 53702	
pg.	v.2

PROFILE VIEW



GRAVEL AND MEDIA LAYERS

LAYER	SIZE	MEDIA	DEPTH
LAYER 1	1 1/2" x 3/4"	GRAVEL	0'-4"
LAYER 2	3/4" x 1/2"	GRAVEL	0'-2"
LAYER 3	1/2" x 1/4"	GRAVEL	0'-4"
LAYER 4	1/4" x 1/8"	GRAVEL	0'-4"
LAYER 5	1/4" x 1/4"	GRAVEL	0'-4"
LAYER 6		FILTER MEDIA	4'-0"

DIMENSIONS FROM INSIDE BOTTOM OF TANK TO PIPE INVERTS

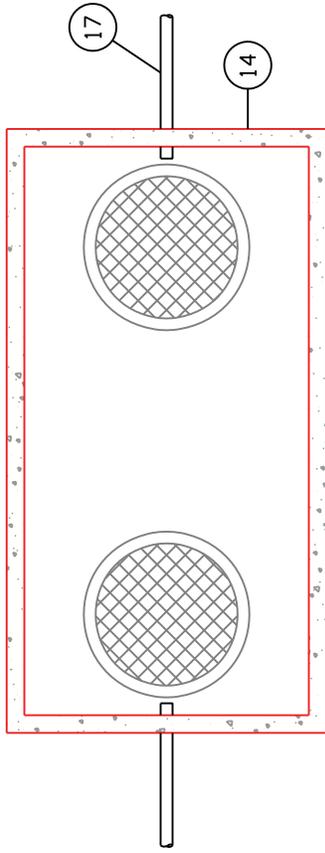
INFLUENT LINE	6'-6"
EFFLUENT LINE	0'-2"
RETURN/BACKWASH LINE	8'-4"
VENT LINE	9'-2"
BACKWASH AIR LINE	9'-2"

Rev.	Date:	By:	Description:
6	02/28/11	ARM	Renumber parts and revise

Scale: NTS	Drawn By: ARM	REV.: 6
Date: 11/16/10	App'd By:	Plan No: Drawing 3
2' Dia. Amphidrome® Reactor Construction Dimensions		

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AMPHIDROME® REACTOR

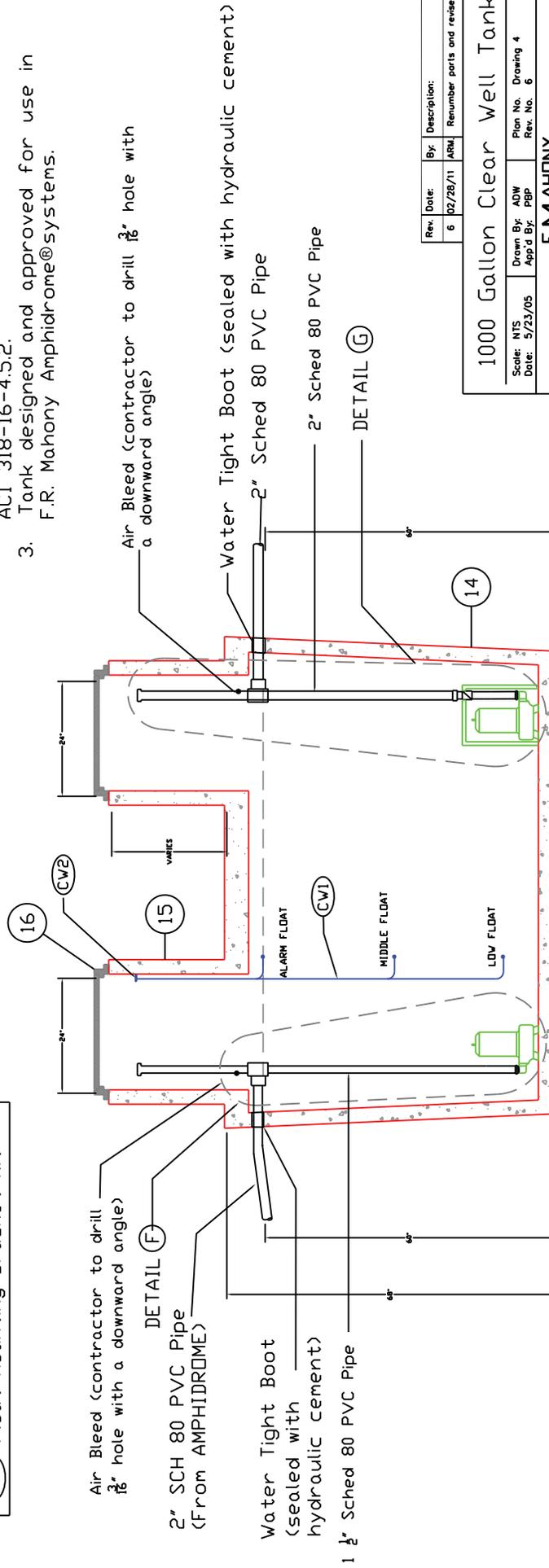


PARTS LIST

- (CW1) Mini Floats (3ea) with 50' Cable
- (CW2) Float Mounting Bracket Kit

Notes:

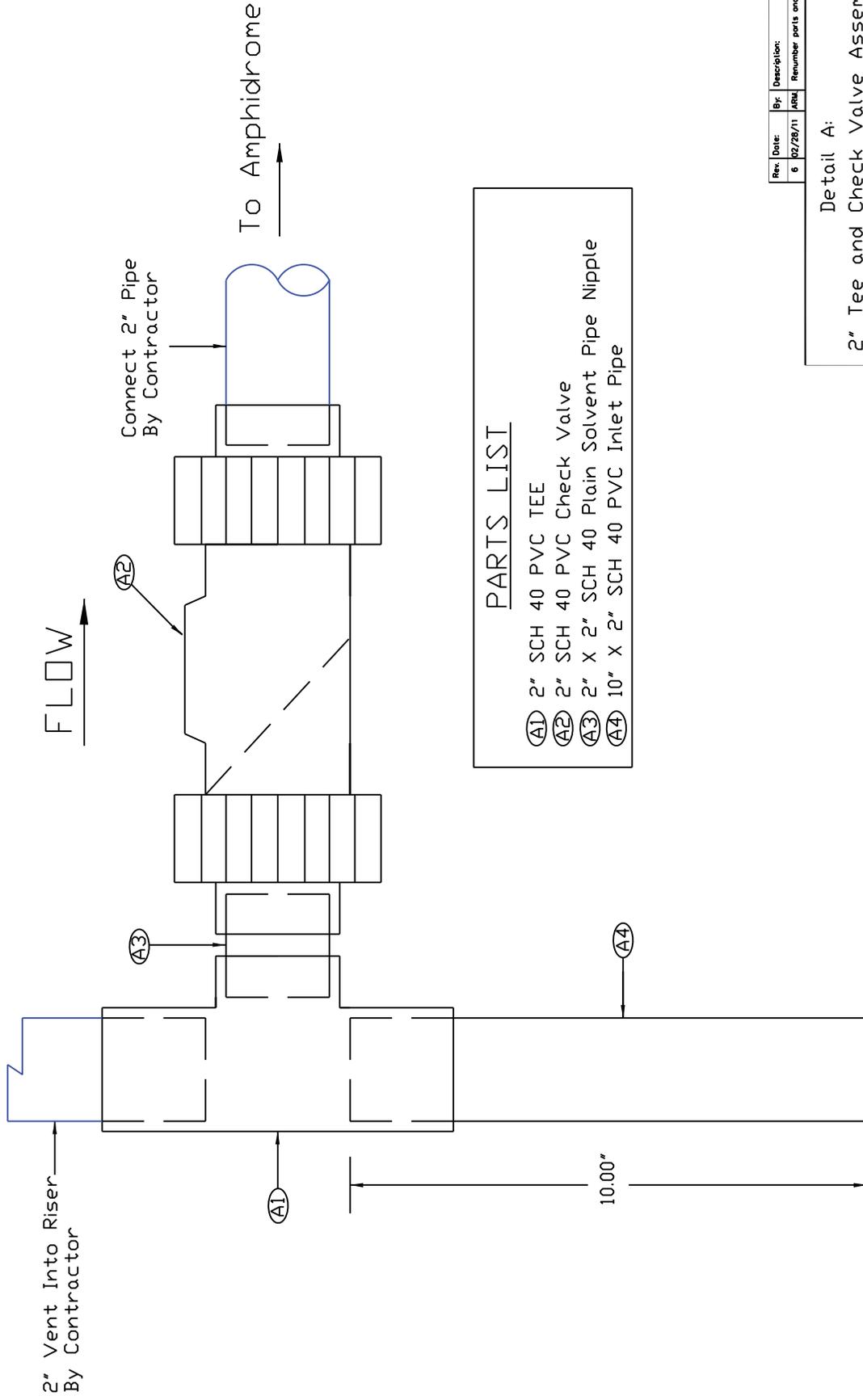
1. Tank is 4000 psi concrete-steel reinforced. Concrete conforms to ACI 318-16-4.5.1 and ACI 318-16-4.5.2.
2. Tank designed and approved for use in F.R. Mahony Amphidrome® systems.



Rev.	Date:	By:	Description:
6	02/28/11	JARL	Renumber parts and revise

Scale: NTS	Drawn By: ADW	Plan No. Drawing 4
Date: 5/23/05	App'd By: PBP	Rev. No. 6
1000 Gallon Clear Well Tank		

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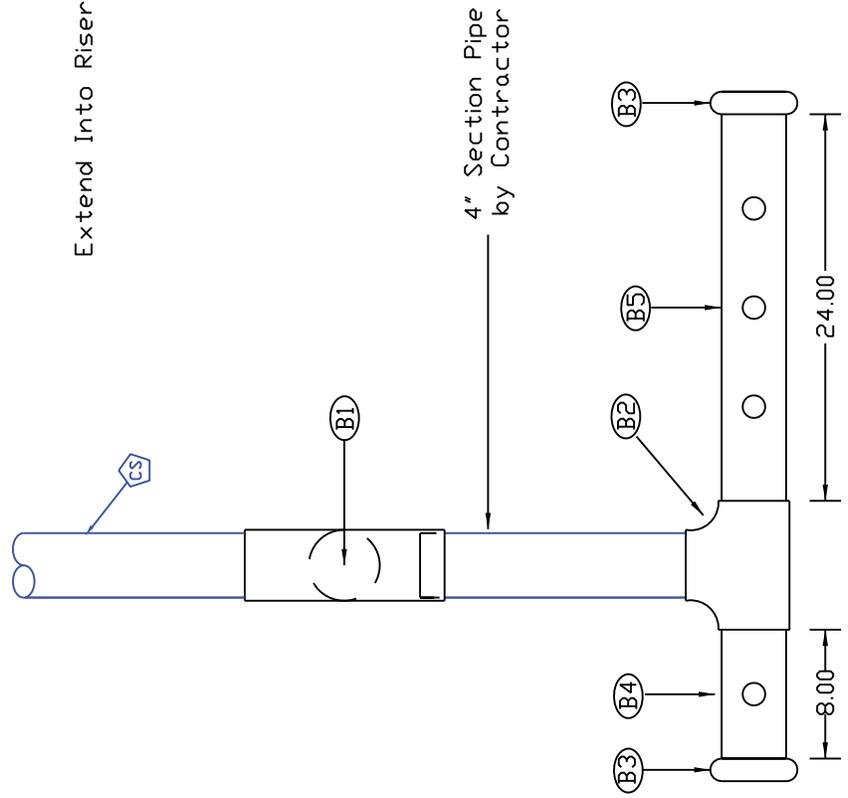
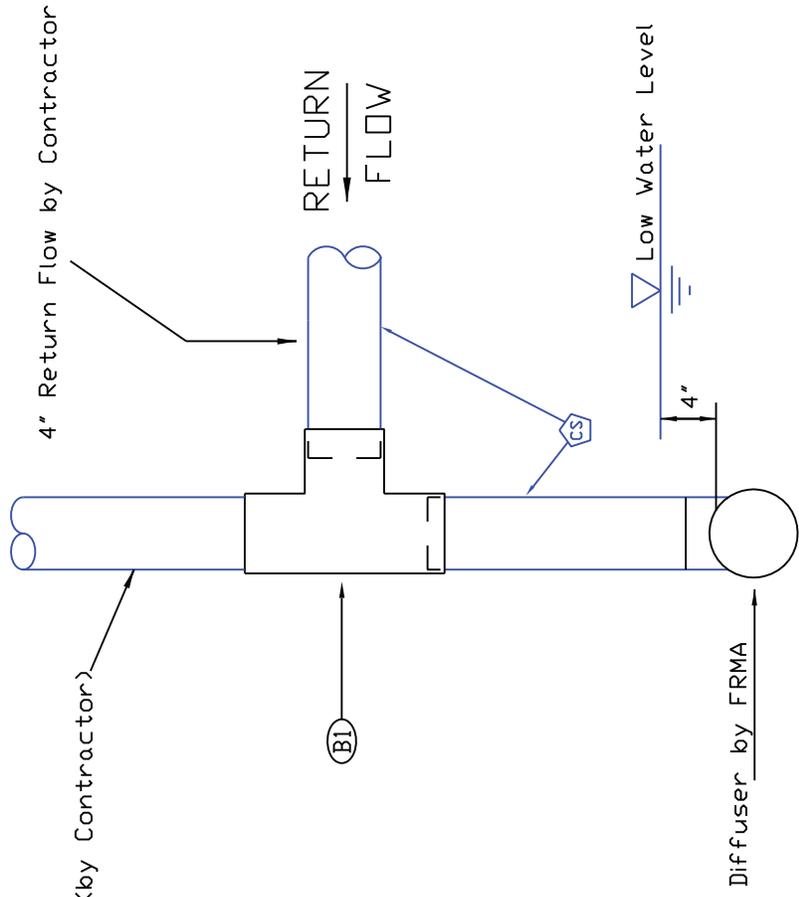
PARTS LIST

(A1)	2" SCH 40 PVC TEE
(A2)	2" SCH 40 PVC Check Valve
(A3)	2" X 2" SCH 40 Plain Solvent Pipe Nipple
(A4)	10" X 2" SCH 40 PVC Inlet Pipe

Rev.	Date	By	Description
6	02/28/11	JTB	Re-number parts and revise

Detail A:

2" Tee and Check Valve Assembly	
Scale: NTS	Drawn By: JTB
Date: 5/19/05	App'd By: PBP
EMAHONY	
<small> 1000 State Street Boston, Massachusetts 02109 617-552-3300 </small>	
Plan No. Drawing 5	Rev. No. 6



PARTS LIST

(B1)	4" X 4" SCH 40 TEE (Loose)
(B2)	4" X 4" SCH 40 TEE
(B3)	2ea. 4" SCH 40 PVC End Caps
(B4)	8" X 4" Perforated PVC Pipe
(B5)	24" X 4" Perforated PVC Pipe

Rev.	Date	By	Description:
6	02/28/11	ARH	Renumber parts and revise

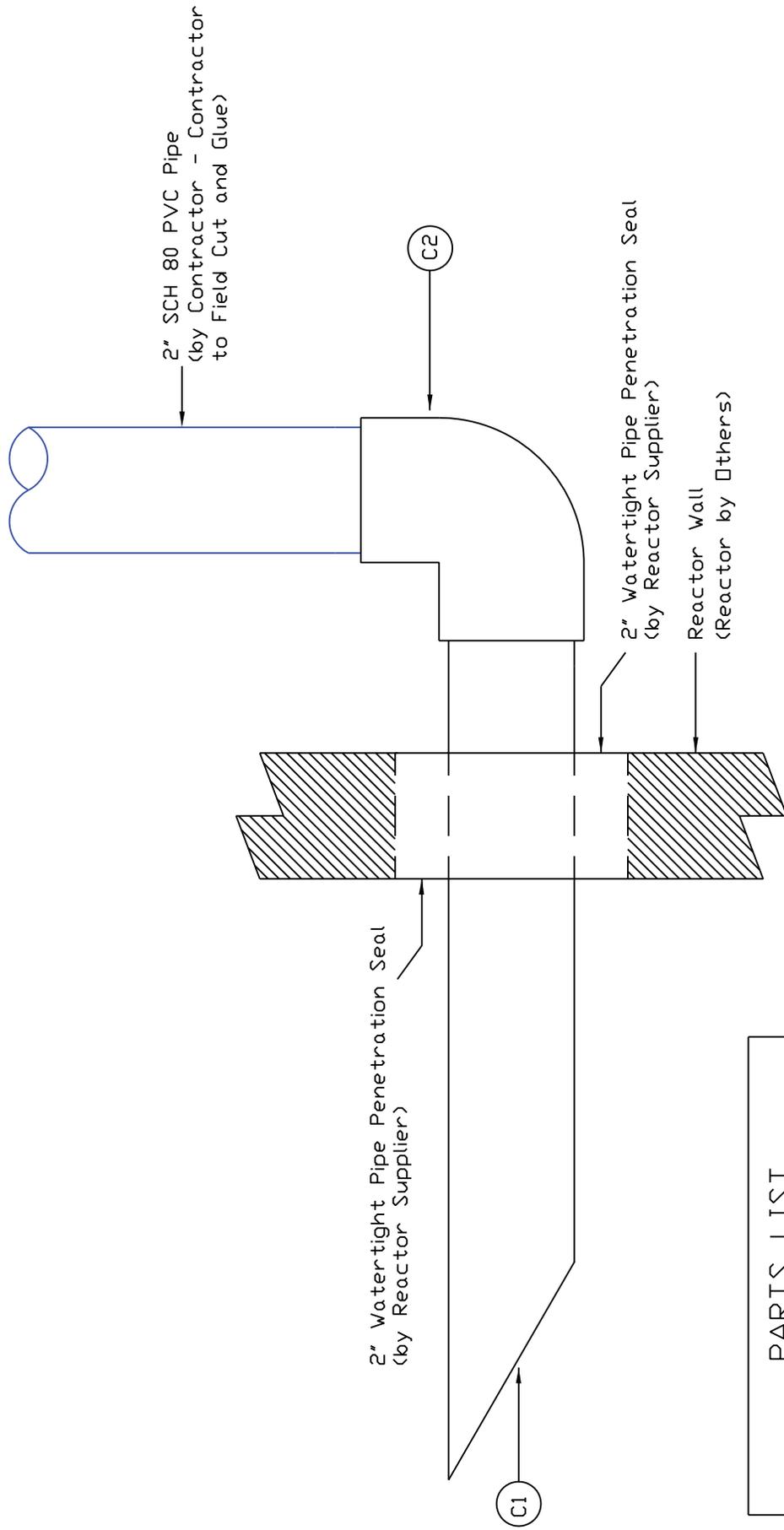
Detail B:
4" Energy Diffuser

Scale: NTS
 Date: 5/19/05

Drawn By: JTB
 App'd By: PBP

Plan No. Drawing 6
 Rev. No. 6

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 V.7



PARTS LIST	
C1	14" X 2" Schedule 80 PVC Pipe
C2	2" Schedule 80 Elbow

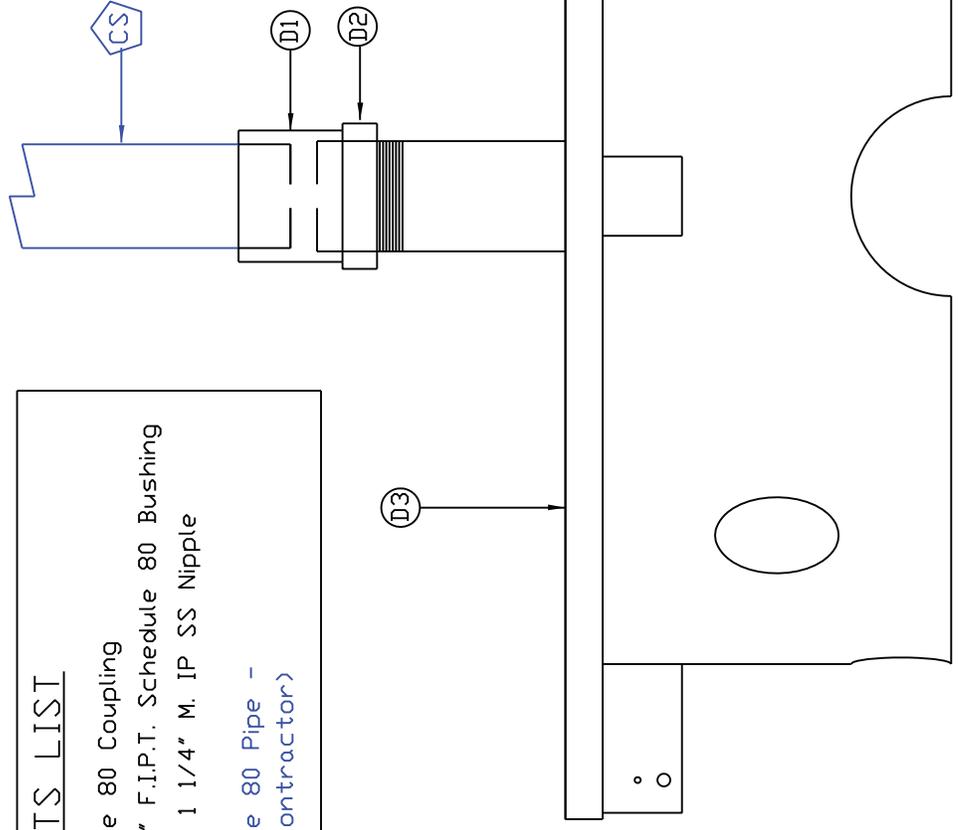
Rev.	Date:	By:	Description:
6	02/28/11	JRM	Renumber parts and revise

Detail C:
 Underdrain Discharge Assembly

Scale: NTS	Drawn By: JTB	Plan No. Drawing 7
Date: 5/19/05	App'd By: PBP	Rev. No. 6

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- PARTS LIST
- (D1) 1 1/2" Schedule 80 Coupling
 - (D2) 1 1/2" X 1 1/4" F.I.P.T. Schedule 80 Bushing
 - (D3) Underdrain w/ 1 1/4" M. IP SS Nipple
 - (CS) 1 1/2" Schedule 80 Pipe -
(Supplied by Contractor)

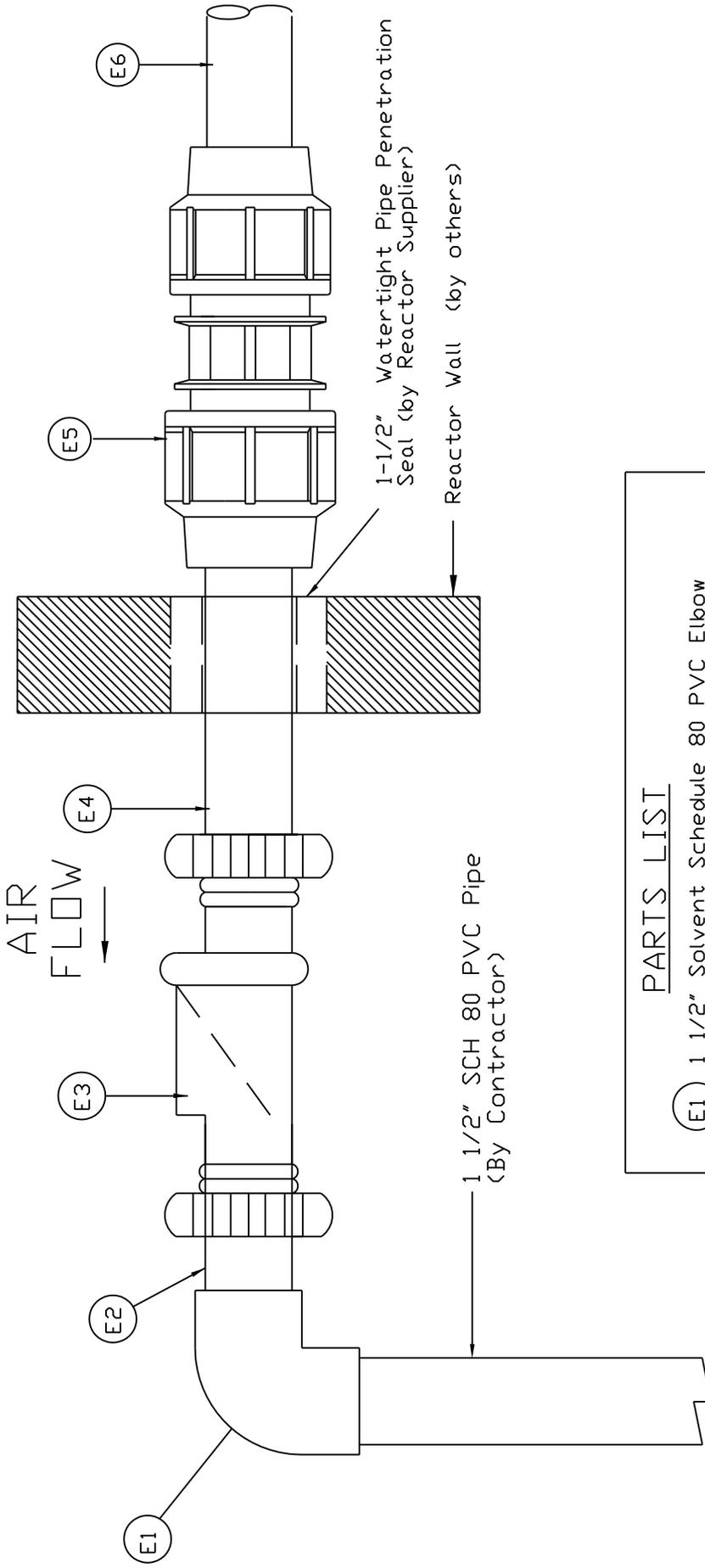


Rev.	Date	By:	Description:
6	02/26/11	ARH	Re-number parts and revise

Detail D:
Underdrain Adapter Assembly

Scale: NTS	Drawn By: JTB	Plan No. Drawing 8
Date: 8/19/05	App'd By: PBP	Rev. No. 6

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INC.
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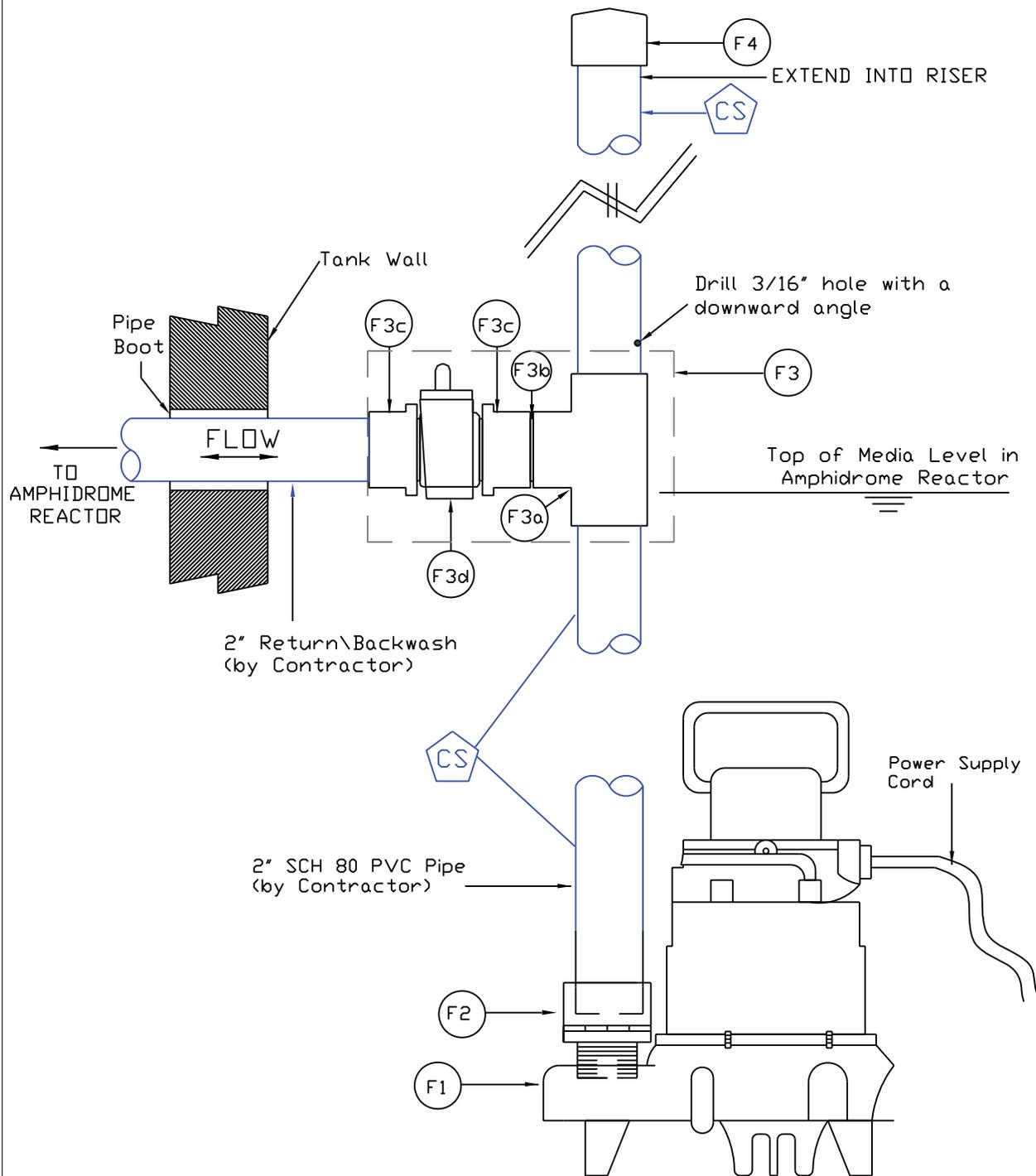
PARTS LIST

- Ⓔ1 1 1/2" Solvent Schedule 80 PVC Elbow
- Ⓔ2 1 1/2" x 3" Schedule 80 PVC Pipe
- Ⓔ3 1 1/2" PVC CHECK VALVE
- Ⓔ4 1 1/2" x 9" Schedule 80 PVC Pipe
- Ⓔ5 1 1/2" x 1 1/4" Comp. Fitting
- Ⓔ6 1 1/4" SDR 11 Air Line

Description:

Detail E: Inlet Air Check Valve Detail			
Scale: NTS	Drawn By: JTB	Plan No.	Drawing 9
Rev: 04/06/11 ARM	App'd By: PBP	Rev. No.	7

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PARTS LIST

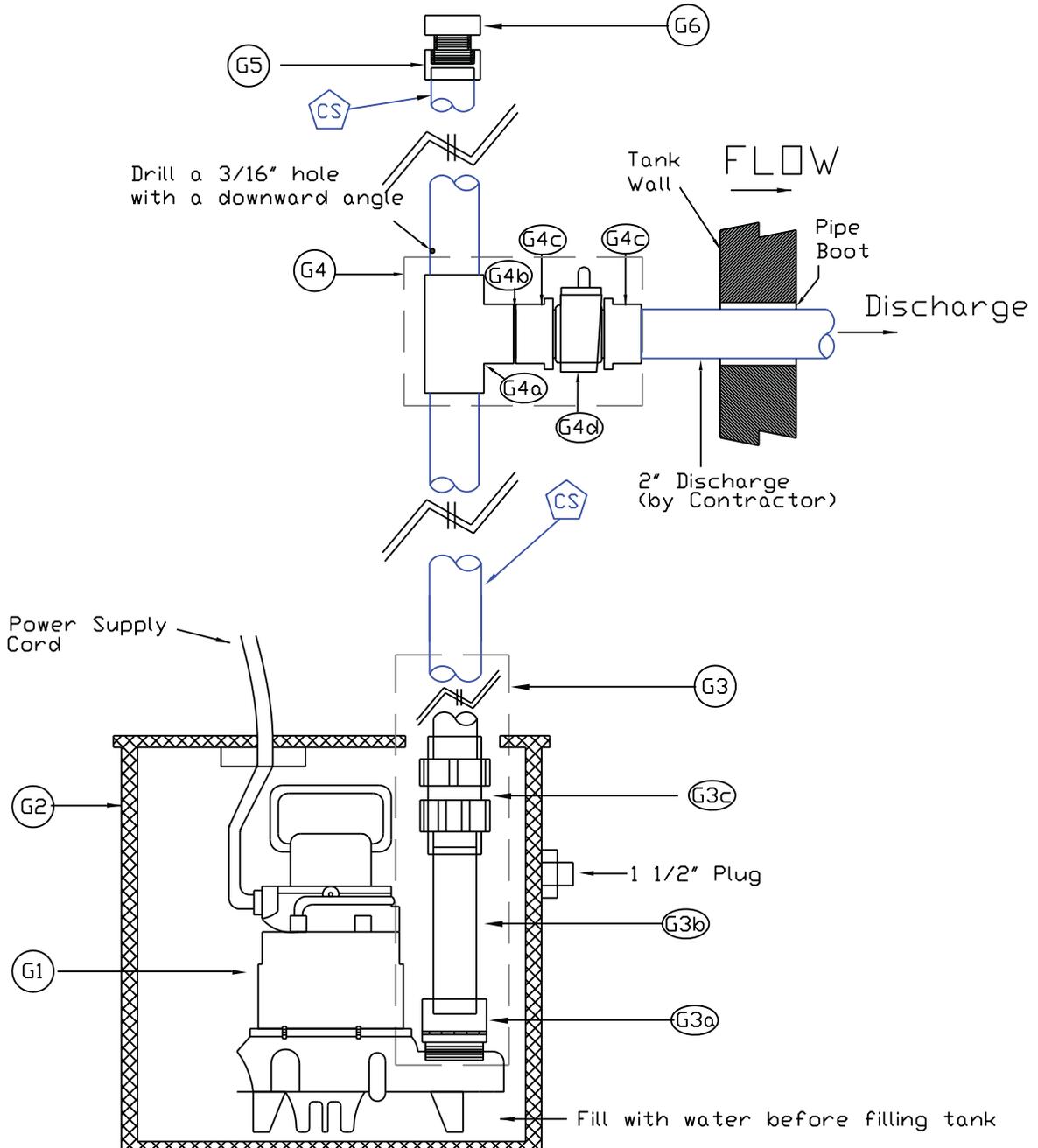
- F1 Return Pump
- F2 1-1/2" x 2" Coupling
- F3 Pump Non Guide Rail Disconnect Assy.
 - F3a 2" Schedule 80 TEE
 - F3b 2" Schedule 80 pipe (cut 3")
 - F3c 2" Schedule 80 Threaded Coupling (2ea)
 - F3d 2" EZ-Pull Quick-Disconnect
- F4 2" Schedule 80 PVC End Cap

Rev.	Date:	By:	Description:
6	03/18/11	ARM	Renumber parts and revise

Detail F: Return Pump Detail

Scale: NTS Date: 02/28/11	Drawn By: ARM App'd By:	Plan No. Drawing 10 Rev. No. 6
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 Meter Supply & Pollution Control Equipment
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Note: Sump lid will be notched for removal of Part No. G3, Check Valve Assembly.

PARTS LIST

- G1 Effluent Pump
- G2 Sump Container with Lid
- G3 Check Valve Assembly
 - G3a 2" Check Valve
 - G3b 1-1/2" Threaded - 2" Schedule 80 Coupling
 - G3c 2" Schedule 80 pipe (cut to approx 8" in warehouse)
- G4 Pump Non Guide Rail Disconnect Assy.
 - G4a 2" Schedule 80 TEE
 - G4b 2" Schedule 80 pipe (cut 3 ")
 - G4c (2ea) 2" Schedule 80 Threaded Coupling
 - G4d 2" EZ-Pull Quick-Disconnect
- G5 2" Threaded Adapter
- G6 2" Threaded Plug
- CS 2" SCH 80 pipe (By Contractor)

Rev.	Date:	By:	Description:
6	03/18/11	ARM.	ReNUMBER parts and revise

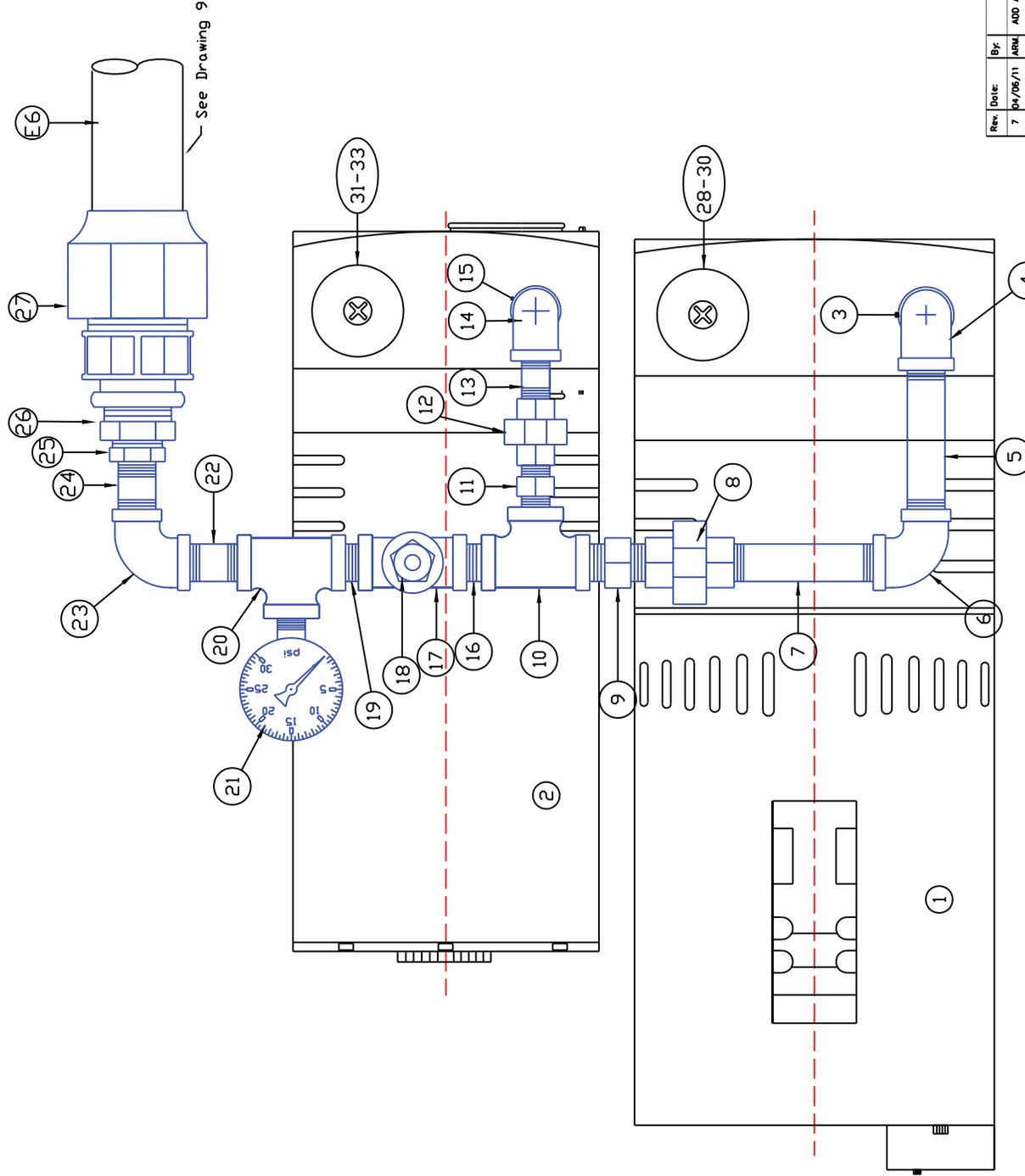
**Detail G:
Effluent Pump and Sampler Detail**

Scale: NTS Rev: 02/27/11 ARM	Drawn By: AKH App'd By: PBP	Plan No. Drawing 11 Rev. No. 6
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PARTS LIST

- ① Backwash Blower
- ② Process Blower
- ③ 3/8" x 1 1/2" Nipple
- ④ 3/8" 90° Elbow
- ⑤ 3/8" x 4" Nipple
- ⑥ 3/8" 90° Elbow
- ⑦ 3/8" x 4" Nipple
- ⑧ 3/8" Union
- ⑨ 3/8" Check Valve
- ⑩ 3/8" x 3/8" x 1/4" TEE
- ⑪ 1/4" Check Valve
- ⑫ 1/4" Union
- ⑬ 1/4" x 1" Nipple
- ⑭ 1/4" Elbow
- ⑮ 1/4" x 2" Nipple
- ⑯ 3/8" CL Nipple
- ⑰ 3/8" TEE
- ⑱ 3/8" Relief Valve
- ⑲ 3/8" CL Nipple
- ⑳ 3/8" x 3/8" x 1/4" TEE
- ㉑ 1/4" Pressure Gauge
- ㉒ 3/8" x 3/4" Nipple
- ㉓ 3/8" Elbow
- ㉔ 3/8" CL Nipple
- ㉕ 3/8" x 1/2" Bushing
- ㉖ 1/2" x 1 1/4" Bushing
- ㉗ 1 1/4" x 1 1/4" Compression
- ㉘ 3/8" CL Nipple
- ㉙ 3/8" x 3/4" Adapter
- ⑳ Filter
- ㉓ 1/4" CL Nipple
- ㉔ 1/4" x 3/4" Adapter
- ㉕ Filter



Rev.	Date	By	ADD Air Line and Fittings
7	04/06/11	ARM	Renumber parts and revise
6	02/26/11	ARM	

Blower Detail A:
 Process Air Piping Assembly
 Top View

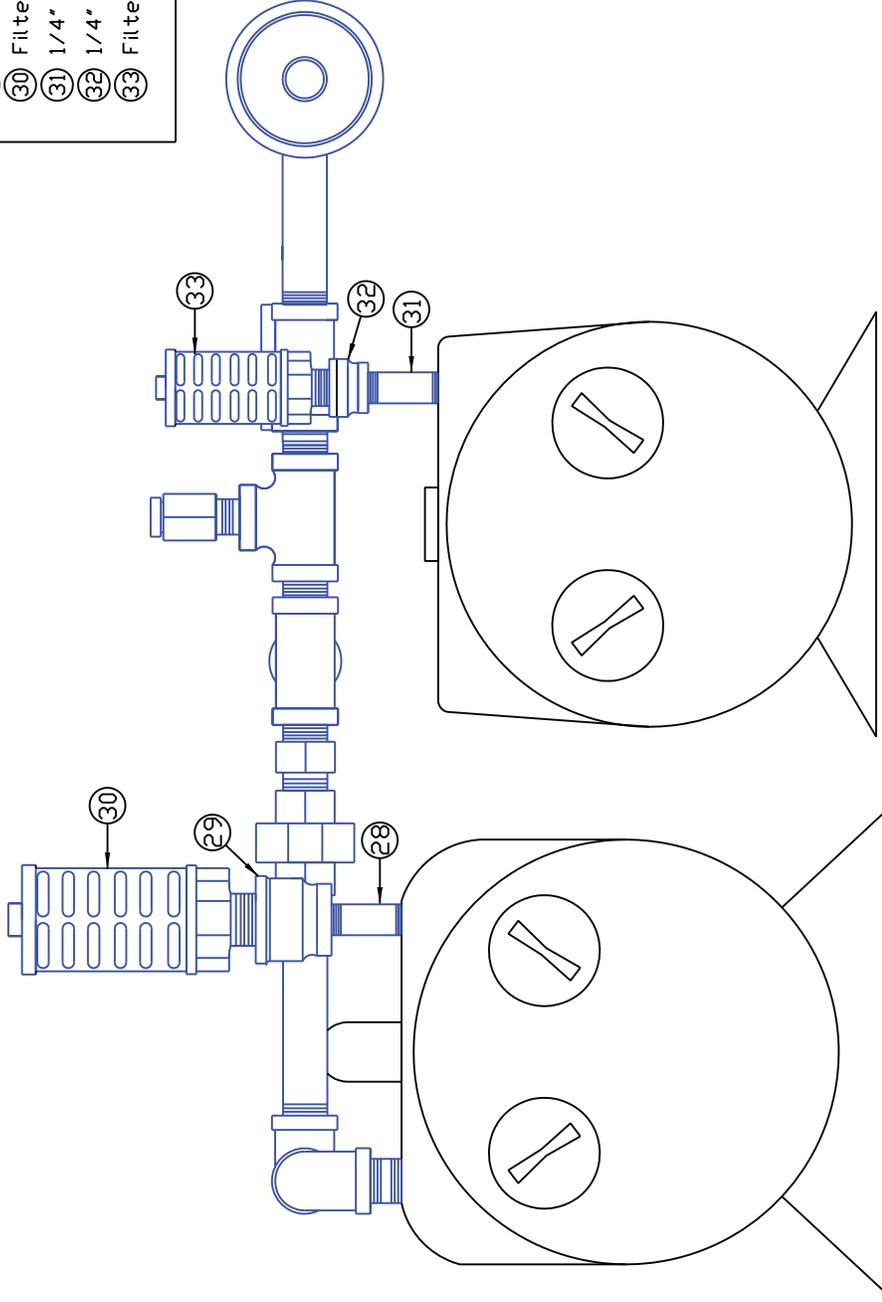
Scale: none	Drawn By: JTB	Plan No. Drawing 12
Rev: 04/06/11 ARM	Date: 5/19/05	Rev. No. 7

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NOTE: 1. PART NOS. 28 and 29, NOT SHOWN, CONNECT PART NO. 30 TO BACKWASH BLOWER.
 2. PART NOS. 31 and 32, NOT SHOWN, CONNECTS PART NO. 33 TO PROCESS BLOWER

PARTS LIST

- ②8 3/8" CL Nipple
- ②9 3/8" x 3/4" Adapter
- ③0 Filter
- ③1 1/4" CL Nipple
- ③2 1/4" x 3/4" Adapter
- ③3 Filter



Rev.	Date:	By:
7	04/06/11	ARM
6	02/28/11	ARM

ADD Air Line and Filings
 Re-number parts and revise

Blower Detail B:
 Backwash Blower with Piping Arrangement

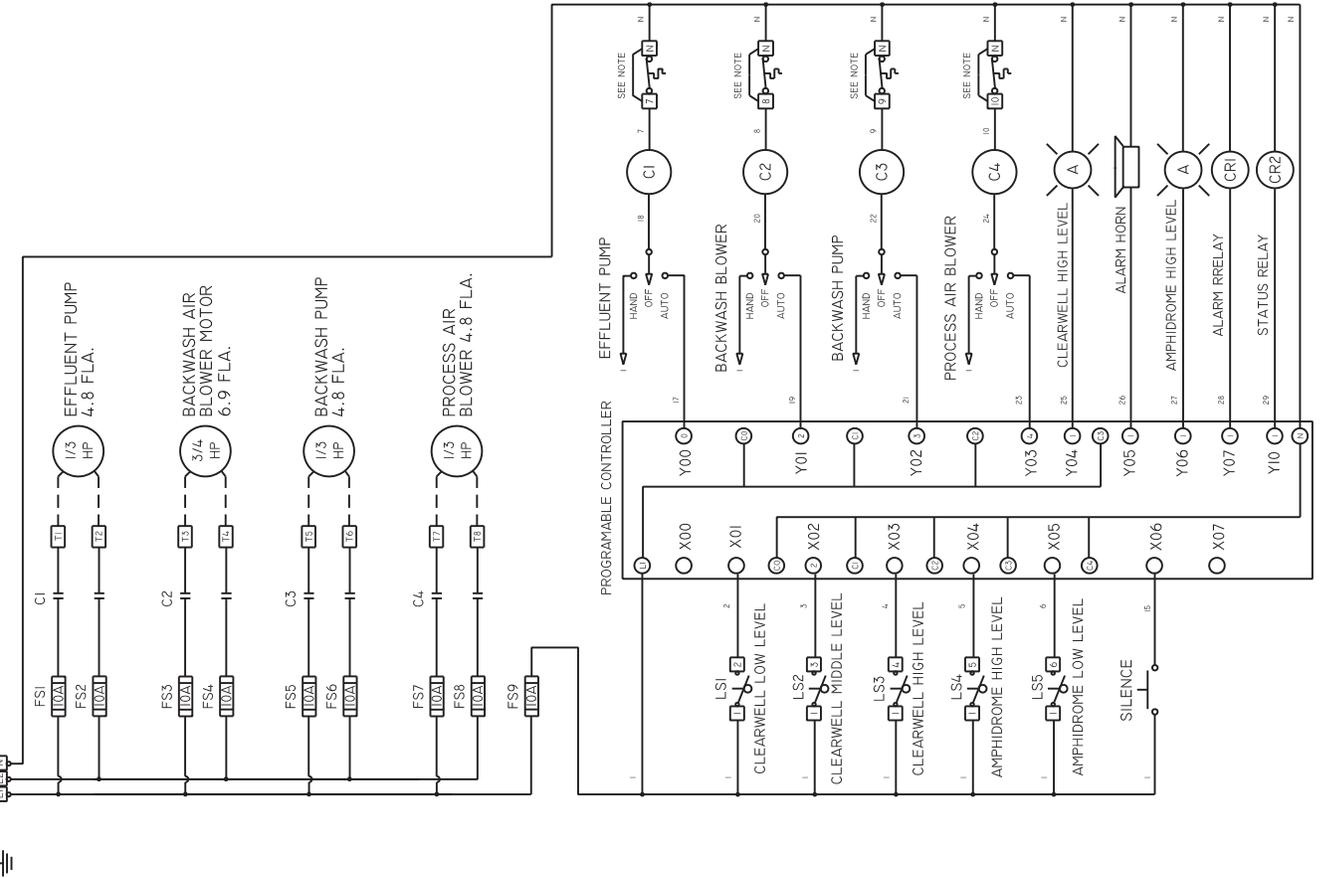
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 Rev: 04/06/11 ARM
 Drawn By: JTB
 Date: 5/19/05
 Plan No. Drawing 13
 Rev. No. 7

EMAHONY

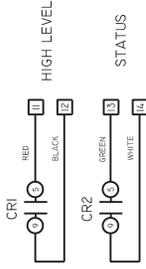
212 Weymouth Street, Rockland, Massachusetts 02390
 V. 7

INCOMING LINE
120/240 VOLT
1 PHASE, 3 WIRE
30 AMP

NOTE
USE 75° C COPPER WIRE ONLY
10 AWG TORQUE TO 35 IN. LB.



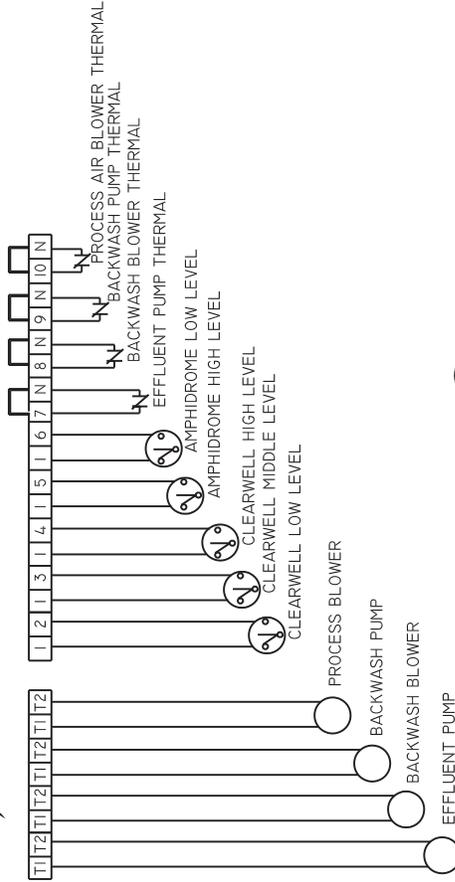
ALARM CONTACTS



FIELD CONNECTIONS

Wired Direct to Contactors

SEE NOTE 3

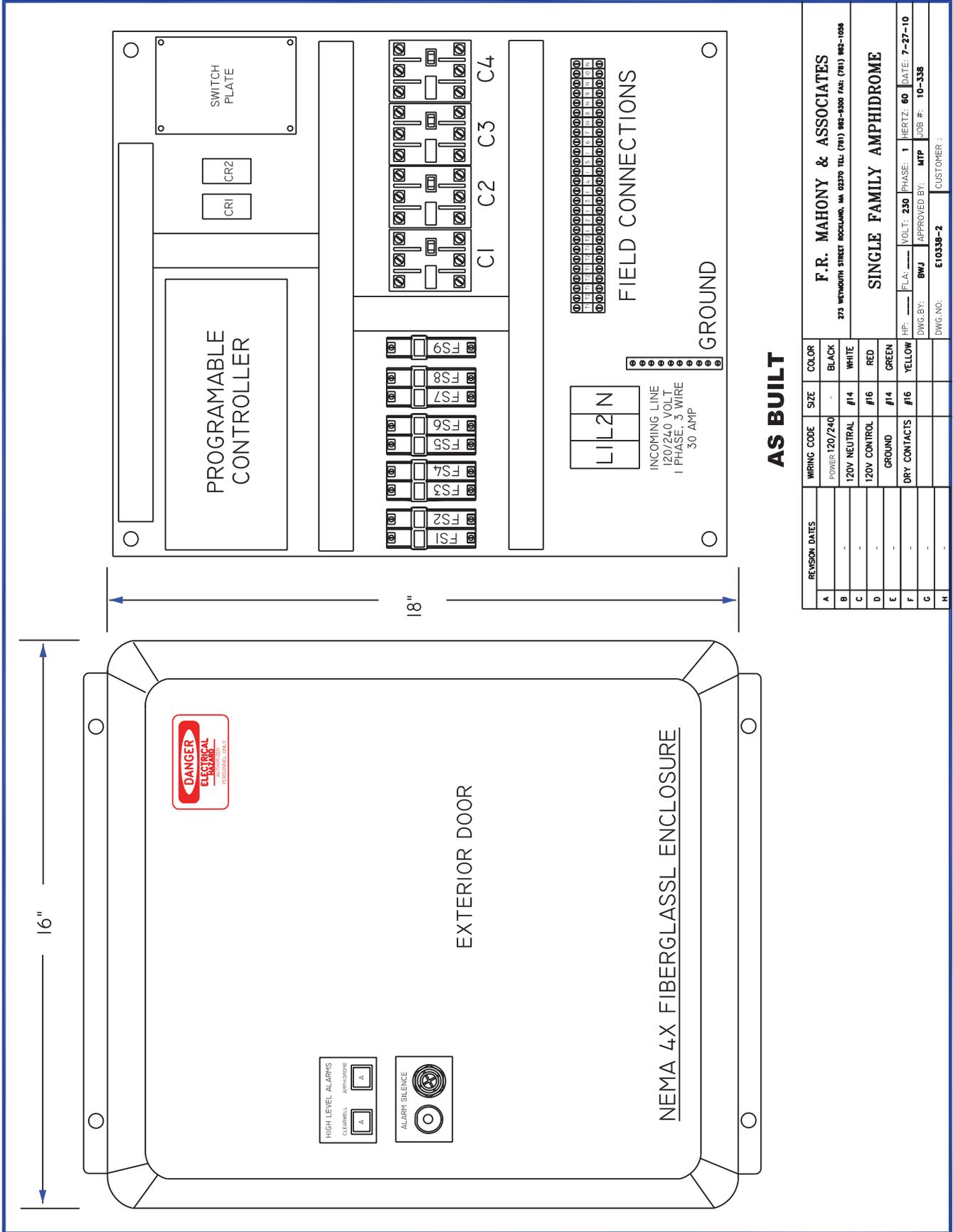


- NOTES:
- 1) TORQUE FIELD CONNECTIONS TO 20 IN. LB.
 - 2) ALL WIRING CONNECTIONS MUST BE 600 VAC 60 COPPER WIRE ONLY
 - 3) TEMPERATURE SWITCH TERMINALS ARE JUMPERED IN THE CONTROL PANEL. IF THERMAL SENSORS ARE PROVIDED, THE JUMPERS MUST BE REMOVED.

AS BUILT

REVISION DATES		WIRING CODE	SIZE	COLOR
A		POWER: 120/240	16	BLACK
B		120V NEUTRAL	#16	WHITE
C		120V CONTROL	#16	RED
D		GROUND	#14	GREEN
E		DRY CONTACTS	#16	YELLOW
F				
G				
H				

F.R. MAHONY & ASSOCIATES 273 WETWORTH STREET ROCKLAND, MA 02370 TEL: (781) 982-9300 FAX: (781) 982-1058				
SINGLE FAMILY AMPHIDROME				
HP:	FLA:	VOLT:	PHASE:	DATE:
		230	1	60
DWG. BY: BWJ	APPROVED BY: MTP	JOB #: 10-338		
DWG. NO: E10338-1		CUSTOMER:		



AS BUILT

REVISION DATES		WIRING CODE	SIZE	COLOR
A	-	POWER	120/240	BLACK
B	-	120V NEUTRAL	#14	WHITE
C	-	120V CONTROL	#16	RED
D	-	GROUND	#14	GREEN
E	-	DRY CONTACTS	#16	YELLOW
F	-			
G	-			
H	-			

F.R. MAHONY & ASSOCIATES	
273 WINDMOUNT STREET ROCKLAND, MA 02370 TEL: (781) 982-8300 FAX: (781) 982-1058	
SINGLE FAMILY AMPHIDROME	
HP: _____	DATE: 7-27-10
VOLT: 230	PHASE: 1
HEARTZ: 60	
APPROVED BY: MTP	JOB #: 10-338
DWG BY: BWJ	
DWG NO: E10338-2	CUSTOMER: _____

GUIDE FOR AMPHIDROME® “AS BUILT” DRAWING

F. R. Mahony & Associates is required by the Pinelands Commission to review and approve all Amphidrome® Systems installed in the Pinelands. This guide is designed as a check list for engineering firms to meet all of the documentation required by the Pinelands on “as-built” drawings.

ELEVATIONS TO BE SHOWN ON AS BUILT DRAWING:

ANOXIC TANK

- ELEVATION OF INVERT IN AND OUT OF TANK
- ELEVATION OF BACKWASH/RETURN LINE INVERT
- INSIDE BOTTOM ELEVATION

AMPHIDROME® REACTOR

- ELEVATION OF INVERT IN TO REACTOR
- ELEVATION OF TOP OF MEDIA
- ELEVATION OF VENT AND RETURN/BACKWASH LINES

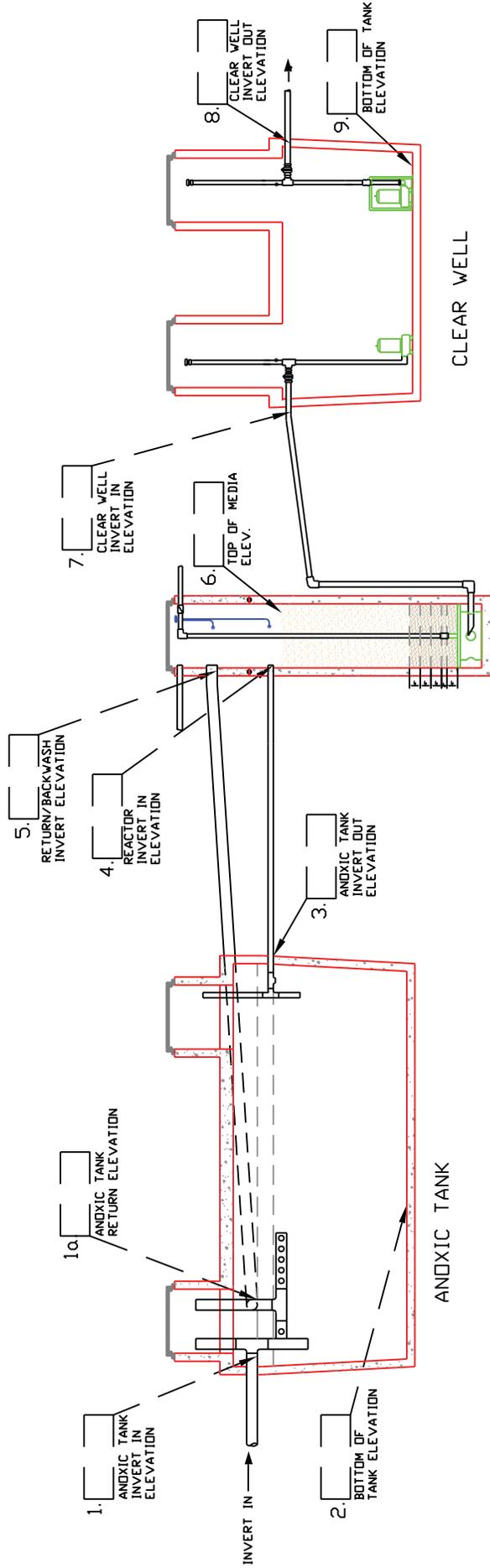
CLEAR WELL TANK

- ELEVATION OF INVERT IN AND OUT OF TANK
- INSIDE BOTTOM OF TANK

F.R. Mahony & Associates, Inc. is available for any questions regarding the requirements of the as-built drawings, please contact the Engineering Department at 781-982-9300.

Rev. 4/11/11

AMPHIDROME[®] AS-BUILT ELEVATIONS



THE FOLLOWING MINIMUM INFORMATION IS REQUIRED ON STAMPED AS-BUILT DRAWING.

1. ANDXIC TANK INVERT IN.
- 1a. ANDXIC TANK RETURN INVERT
2. BOTTOM OF ANDXIC TANK.
3. ANDXIC TANK INVERT OUT.
4. AMPHIDROME REACTOR INVERT IN.
5. AMPHIDROME RETURN/BACKWASH INVERT.
6. TOP OF MEDIA
7. CLEAR WELL INVERT IN.
8. CLEAR WELL INVERT OUT.
9. BOTTOM OF CLEAR WELL ELEVATION.

AMPHIDROME REACTOR

NOTES

1. ALL MEASUREMENTS SHOULD BE TAKEN USING A ROD THAT MEASURES IN FEET AND TENTHS OF FEET.
2. USE THE TOP OF THE REACTOR AS A BM IF THE TOP OF FLOAT BRACKET IS NOT AVAILABLE.

SITE LOCATION INFORMATION

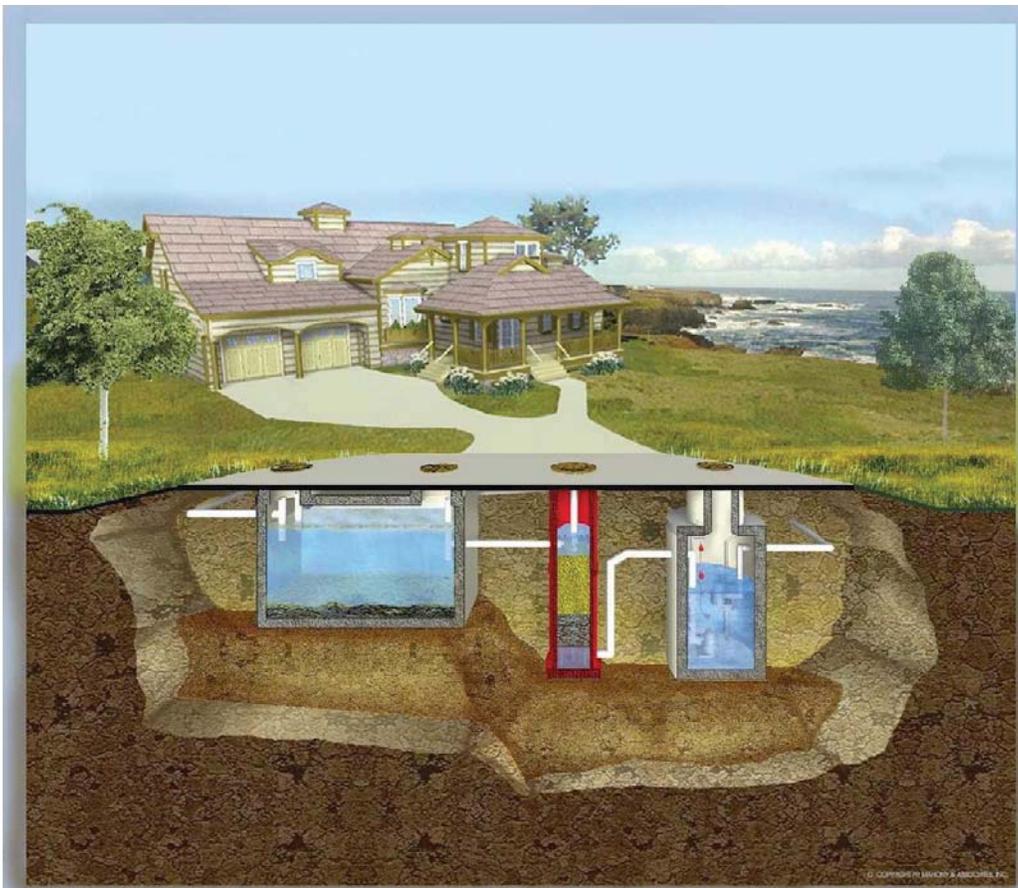
SITE ADDRESS _____ Block/Lot _____
 TOWN _____ TOWNSHIP _____
 INSTALLER NAME _____ PH: _____
 INSTALLER'S COMPANY _____
 FRMA REPRESENTATIVE _____
 DATE _____

DWG: FRMA/Drawings/Amphidrome	AS-BUILT GUIDE
Rev: 7-15-08	App'd by:
Drawn by: ARH	Date: 6/14/2006
Scale: NTS	
EMAHONY Environmental Water Supply & Pollution Control Equipment 273 Weymouth Street, Rockport, Massachusetts 02370	
	pg. 7

Amphidrome[®]

Operation & Maintenance Manual

The highest level of Nitrogen removal available...



..and at a reasonable cost.

f.r. mahony & associates inc.
frma
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1. FORWARD

This manual has been prepared to help meet the objectives of long equipment life, minimal equipment maintenance, and cost-effective performance. This manual must be read and understood by those responsible for the operation and maintenance of an Amphidrome® Wastewater Treatment System. Non-recommended or unauthorized operating or maintenance procedures may result in damage to the equipment, down time, substandard treatment, and voidance of any warranties. Included in this manual is a brief summary of biological nutrient removal, a description of the Amphidrome® process, and a detailed description of the control programming. Operation and maintenance procedures for all of the equipment used in an Amphidrome® system are also included. The specific manufacturer's literature should always be referenced when performing any maintenance or troubleshooting. This manual should be used in conjunction with the design or the "As-built" plans, when provided. All standard safety procedures must be observed.

If any special information, regarding the care and operation of the Amphidrome® Wastewater Treatment System, is desired, F.R. Mahony will furnish it upon request.

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2. Introduction

The removal of soluble organic matter (SOM) from wastewater was traditionally the primary objective of biological wastewater treatment. The removal of SOM occurs as microorganisms use it as a food source, converting a portion of the carbon in the waste stream, to new biomass and the remainder to carbon dioxide (CO_2) and water (H_2O). The CO_2 is released to the atmosphere as a gas and the biomass is removed by sedimentation, yielding a waste stream free of the organic matter.

Cultures of aerobic microorganisms are especially effective for waste streams, which have a biodegradable chemical oxygen demand (bCOD) ranging between 50-4,000 mg/l. To accomplish this task, treatment units were designed and operated to maintain a culture of heterotrophic bacteria, under suitable environmental conditions so that the bacteria utilized the organic carbon from the incoming waste stream. The biochemical unit operations were coupled with additional solid-liquid separations processes to remove the suspended and colloidal solids in the waste stream. The result was an effective method for the removal of both soluble and particulate organic matter from the waste stream.

However, since the discovery of the effects of eutrophication, the removal of inorganic nutrients from wastewater has become an important consideration, and has imposed additional challenges on the design of wastewater treatment plants. The two primary causes of eutrophication are nitrogen and phosphorus and a number of biological nutrient removal (BNR) processes have been developed to remove them. In seawater and in tidal estuaries, nitrogen is typically the limiting nutrient. Therefore, nitrogen discharge limits in coastal areas have been made especially stringent in recent years.

In domestic wastewater, nitrogen is present as ammonia (NH_3) and as organic nitrogen (NH_2^-) in the form of amino groups. The organic nitrogen is released as ammonia, in the process of ammonification, as the organic matter containing it, undergoes biodegradation. Two groups of bacteria are responsible for converting ammonia to the innocuous form, nitrogen gas (N_2). The completion of this process occurs in two steps, by completely different bacteria, and in very different environments. In the first step, bacteria oxidize ammonia to nitrate (NO_3^-) in a process called nitrification. The bacteria responsible for nitrification are chemolithotrophic, autotrophs that are also obligate aerobes; therefore, requiring an aerobic environment. Chemolithotrophic bacteria obtain energy from the oxidation of inorganic compounds, which in the nitrogen cycle, are ammonia (NH_3) and nitrate (NO_3^-). Autotrophic bacteria obtain their carbon source from inorganic carbon, such as carbon dioxide. In the second step, denitrification, facultative, heterotrophic bacteria convert nitrate to nitrogen gas, which is released to the atmosphere. This is accomplished only in an anoxic environment in which the bacteria use NO_3^- as the final electron acceptor. The ultimate electron acceptor being nitrogen, as it undergoes a stepwise conversion from an oxidation state of +5 in NO_3^- to 0 in N_2 . This process may be carried on by some of the same facultative, heterotrophic bacteria that oxidize the soluble organic matter under aerobic conditions. However, the presence of any dissolved oxygen inhibits denitrification, since the preferential path, for electron transfer, is to oxygen not to nitrate.

Since biological removal of nitrogen is both possible and economically viable, many of today's wastewater treatment plants require the removal of both soluble organic matter and nitrogen. To achieve this requires: a heterotrophic population of bacteria, operating in an aerobic environment to remove the SOM; a chemolithotrophic autotrophic population of bacteria, also operating in an aerobic environment, to convert the ammonia to nitrate; and finally a facultative heterotrophic population of bacteria, to convert nitrate to nitrogen gas, but in an anoxic environment. Therefore, typical treatment plant designs approach the removal of organics and nutrients in one of three ways. The first method is to combine the aerobic steps, (i.e. SOM removal and nitrification), into one operation and design the anoxic denitrification process as a separate unit operation. The second method is to design three separate unit operations for each step. The third method is to design a sequencing batch reactor (SBR), which has both aerobic zones and anoxic zones. The type of technology utilized greatly influences the number of unit operations to reach the desired effluent treatment level.

Biochemical operations have been classified according to the bioreactor type because the completeness of the biochemical transformation is influenced by the physical configuration of the reactor. Bioreactors fall into two categories depending on how the biological culture is maintained within: suspended growth or attached growth (also called fixed film). In a suspended growth reactor, the biomass is suspended in the liquid being treated. Examples of suspended growth reactors include activated sludge and lagoon. In a fixed film reactor, the biomass attaches itself to a fixed media in the reactor and the wastewater flows over it. Examples of attached growth reactors include rotating biological contactor (RBC), trickling filter and submerged attached growth bioreactor (SAGB).

During the last twenty years, different configurations of SAGBs have been conceived and advances in the understanding of the systems have been made. The advantages of SAGBs are that they may operate without a solids separation unit process after biological treatment and with high concentrations of viable biomass. Removal of sludge is usually achieved by backwashing the filter. In such bioreactors, the hydraulic retention time (HRT) is less than the minimum solids retention time (SRT) required for microbial growth on the substrates provided. This means that the growth of suspended microorganisms is minimized and the growth of attached microorganisms is maximized. The low hydraulic retention time results in a significantly smaller required volume to treat a given waste stream than would be achieved with either a different fixed film reactor, or a suspended growth reactor for the same waste stream.

3. The Amphidrome® Process

The Amphidrome® system is a BNR process utilizing a submerged attached growth bioreactor operating in a batch mode. The deep bed sand filter is designed for the simultaneous removal of soluble organic matter, nitrogen and suspended solids within a single reactor.

To achieve simultaneous oxidation of soluble material, nitrification and denitrification in a single reactor, the process must provide aerobic and anoxic environments for the two different populations of microorganisms. The Amphidrome® system utilizes two tanks and one submerged attached growth bioreactor, subsequently called an Amphidrome® reactor. The first tank, the anoxic/equalization tank, is where the raw wastewater enters the system. The tank has an equalization section, a settling zone, and a sludge storage section. It serves as a primary clarifier before the Amphidrome® reactor.

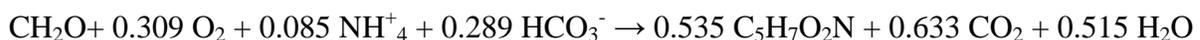
This Amphidrome® reactor consists of the following three items: underdrain, support gravel, and filter media. The underdrain, constructed of steel, is located at the bottom of the reactor. It provides support for the media and even distribution of air and water into the reactor. The underdrain has a manifold and laterals to distribute the air evenly over the entire filter bottom. The design allows for both the air and water to be delivered simultaneously, or separately, via individual pathways to the bottom of the reactor. As the air flows up through the media, the bubbles are sheared by the sand producing finer bubbles as they rise through the filter. On top of the underdrain is 18" (five layers), of four different sizes of gravel. Above the gravel is a deep bed of coarse, round, silica sand media. The media functions as a filter; significantly reducing suspended solids, and provides the surface area for which an attached growth biomass can be maintained.

To achieve the two different environments required for the simultaneous removal of soluble organics and nitrogen, aeration of the reactor is intermittent rather than continuous. Depending on the strength and the volume of the wastewater, a typical aeration scheme may be three to five minutes of air and ten to fifteen minutes without air. Concurrently, return cycles are scheduled every hour, regardless of the aeration sequence. During a return, water from the clear well is pumped back up through the filter and overflows into the return flow/backwash pipe. A check valve in the influent line prevents the flow from returning to the anoxic/equalization tank, via that route. The return flow/backwash is set at a fixed height above both the media and the influent line; and the flow is by gravity back to the front of the anoxic/equalization tank.

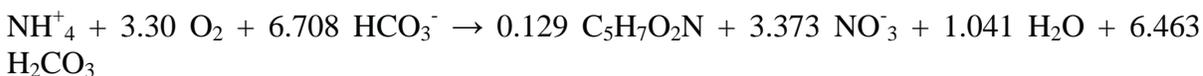
The cyclical forward and reverse flow of the waste stream, and the intermittent aeration of the filter, achieve the required hydraulic retention time and create the necessary aerobic and anoxic conditions to maintain the required level of treatment.

4. Biochemical Reactions

The removal of SOM is achieved by the oxidation of carbonaceous matter, which is accomplished by the aerobic growth of heterotrophic bacteria. The biochemical transformation is described by the following normalized mass based stoichiometric equation in which the carbonaceous matter is a carbohydrate (CH₂O) and the nitrogen source for the bacteria is ammonium (NH₄⁺).



The oxidation of ammonia to nitrate is accomplished by the aerobic growth of chemolithotrophic, autotrophic bacteria and is described by the following normalized mass based stoichiometric equation. The overall equation describes the two-step process in which ammonia is converted to nitrite by Nitrosifiers, and nitrite is converted to nitrate by Nitrifiers.



The final step in the removal of nitrogen from the waste stream occurs when carbonaceous matter is oxidized by the growth of heterotrophic bacteria utilizing nitrate as the terminal electron acceptor. The equation describing the biochemical transformation depends on the organic carbon source utilized. The following is the normalized mass based stoichiometric equation with the influent waste stream as the organic carbon source.



Biological removal of nitrogen has been the focus of much attention and many of today's wastewater treatment plants incorporate it. However, the difficulty in promoting these biochemical transformations in one reactor is the different environmental conditions required for each transformation.

This Amphidrome® process is designed to achieve the above reactions simultaneously within one reactor. The aerobic environment within the filter promotes the first two reactions. The return flow, to the anoxic/equalization tank, mixes the nitrates with organic carbon in the raw influent, and with organic carbon that has been released from the stored sludge. The anoxic environment within the filter promotes denitrification, the third reaction.

5. Wastewater Characteristics

The Amphidrome® process, like all wastewater processes, is designed to operate within design parameters of flow and wastewater characteristics. The first step to successful operation of any treatment facility is to characterize the wastewater through various analyses, which include: BOD, total suspended solids, settleable solids, COD, pH, alkalinity, DO, temperature, total solids, dissolved solids, nitrogen and phosphorus. Some of these parameters may not be specified by any imposed discharge limits; however, occasional sampling may prove prudent, should any problems arise. Maintaining a history of these analyses will prove helpful in following trends or anticipating changes in the treatment efficiency. Samples should be taken in the same locations and testing should follow "Standard Methods" or other approved regulatory testing procedures. Consistent techniques will provide more useful and valid information.

5.1. Wastewater Flow

Large fluctuations in wastewater flow may affect the treatment process; however, daily flows will fluctuate and should be expected. Major changes should be limited to the design capabilities of the treatment process. Wastewater flows may be monitored through water meter or pump run time. However, effluent flow metering is the most common and will provide an accurate measure of the flow actually processed at the facility.

Treatment plants are often designed based on expected flow rates from established literature, or from regulatory standards. These standards usually result in design flows that are greater than the actual flows. Once the facility is constructed, operating parameters must be set to treat actual flows; therefore, some adjustment may be required. Flows should not exceed the design permit flow.

5.2. pH, Alkalinity and Temperature

Typical domestic wastewater has a pH between 6.5 and 8.0. Biological microorganisms are affected by extreme variations in pH and in temperature. It has been shown experimentally that the reactions, of both nitrification and denitrification, are optimized at pH values in the range of 8. Therefore, it is recommended that supplemental alkalinity be used to maintain such a pH, as long as this does not put the plant in violation of any effluent limits. Maintaining such a pH will also insure that sufficient alkalinity is present for nitrification. The bacteria responsible for nitrification consume the inorganic carbon supplied by the bicarbonate dissolved in the wastewater. High bicarbonate alkalinity values indicate sufficient amounts for complete nitrification. Therefore, alkalinity is an important parameter in the monitoring treatment process in an Amphidrome® system. Two general rules may be used as operational guidelines: first, 7.4 mg/l of alkalinity is needed for each mg of ammonia to be nitrified, and second, a residual alkalinity value of 100 mg/l should be left after complete nitrification. Typically, both these conditions will be met if supplemental alkalinity is used to maintain the pH level at approximately 8.

Temperature fluctuations from weather conditions will have a minor affect on the Amphidrome® process because the process tanks are all underground and the air supplied during aeration is pumped. The pumped air is at a higher than ambient air temperature due to the pumping effects.

5.3. BOD, COD and Suspended Solids

Organic and solids loading are fundamental characteristics governing the size of treatment processes. BOD and COD are measures of the strength of the wastewater.

BOD (biochemical oxygen demand) measures the rate of oxygen uptake from the wastewater by microorganisms in biological reactions. These microorganisms are converting the waste materials to carbon dioxide, water and inorganic nitrogen compounds. The oxygen demand is related to the rate of increase in microorganism activity resulting from the presence of food (organic waste) and nutrients.

COD (chemical oxygen demand) measures the presence of carbon and hydrogen, but not amino nitrogen in organic materials. COD does not differentiate between biologically stable and unstable compounds. COD tests can be inhibited by chloride. Thus, wastewater containing high salt concentrations, such as brine, cannot be readily analyzed without modification.

The suspended solids parameter is a measure of the solids suspended in the wastewater. It is not a measure of the total solids which includes settleable and dissolved solids. The settleable solids are normally removed in the anoxic/equalization tank while suspended and dissolved solids are to be treated in the filtering and biological processes in the Amphidrome® reactor. As solids breakdown and are backwashed from the reactor, they settle and form a layer of sludge at the bottom of the anoxic/equalization tank. Periodic removal of the sludge is required.

5.4. Nitrogen

In domestic wastewater, nitrogen is present as ammonia (NH_3) and as organic nitrogen (NH_2^-) in the form of amino groups. The organic nitrogen is released as ammonia, in the process of ammonification, as the organic matter containing it undergoes biodegradation. To achieve biological nitrogen removal, bacteria must convert ammonia to the innocuous form, nitrogen (N_2) gas. However, the stepwise process produces nitrate (NO_3^-) as an intermediate compound. Nitrate in drinking water is of concern to infants because it has been linked to “methemoglobinemia,” which may result in death for infants. Monitoring of both ammonia and nitrate is extremely useful for process control and should be done once or twice weekly after the plant is in compliance and more frequently during startup, or after an upset.

6. Operation

The Amphidrome® system is a submerged attached growth bioreactor (SAGB) process, designed around a deep bed, sand filter. The Amphidrome® system has all tanks located below grade with access hatches or manhole covers at grade level to allow for inspection and maintenance of the system. To ensure proper operation of the system, the operator must inspect and test the system internals to ensure proper operation.

6.1. Start Up and Initial Tests

Upon taking over operation of an Amphidrome® system, the operator should conduct three tests on each Amphidrome® filter in the plant. The tests are designed to determine the volume flow rates of water through the filters, one in the forward direction and two in the reverse direction.

After the following tests are completed, the unit should be started and allowed to run for one month. At the end of the first month of operation, the operator should begin bimonthly inspections of the system. During these inspections, the operator should perform field tests to determine ammonia and nitrate concentrations on the effluent and adjust the air and

backwashes accordingly. Once the field tests indicate the desired levels, the results should be corroborated with laboratory analysis. Sampling should then be conducted in accordance with the regulatory guidelines.

6.1.1. Test 1: Forward Flow Test

The purpose of the test is to determine the flow rate through the filter, (i.e. hydraulic loading). This test must be conducted at the end of an automatically scheduled return flow cycle or after a manually initiated return flow. After the return flow pump shuts off, the liquid level decreases in the Amphidrome® filter, and should be measured over equal increments of time until the forward flow slows down to less than a 1 inch change in ten minutes. During the first portion of the test in which the liquid level in the filter is high and the flow rate through the filter is also high, measurements should be taken every 1 –2 minutes. As the flow rate slows, down the measurements may be recorded every 5 – 10 minutes. The total time, total change in height, and the surface area of the reactor can be used to calculate the hydraulic loading. The data should be recorded on a table similar to that labeled *Filter Flow Through Rate*, and shown in Appendix A.

6.1.2. Test 2: Return Flow Test

The purpose of this test is to estimate the average volume flow rate for a return cycle. This value is necessary to control the amount of wastewater returned during each return cycle. This test must be conducted at the beginning of an automatically scheduled return flow cycle or at the beginning of a manually initiated return flow cycle. The level in the Amphidrome® filter should be low before the start of this test. After an initial measurement of the liquid level in the filter is recorded, the return flow pump should start, or be started. During the test, the liquid level in the filter should be measured and recorded every minute. Once the liquid starts to flow over the return flow/backwash trough, the test may be stopped. The total time to reach the trough should be recorded. The data should be recorded on a table similar to that labeled *Filter Flow Through Rate*, and shown in Appendix 1.

6.1.3. Process Control

Efficient operation and effective process control of an Amphidrome® System, as with any wastewater treatment plant, requires comprehensive methods for collecting and recording all pertinent information regarding plant performance and equipment maintenance. This is accomplished with an equipment log, a sampling and analysis plan for both the required sampling and all field sampling, and meticulous records of all observations regarding the daily operation of the plant. Examples of equipment logs are included in this manual.

6.1.4. Sample Collection

Since the Amphidrome® system is a batch treatment process, effluent samples must be collected at the end of each batch. Effluent sample devices furnished with this process are designed to capture the most recent discharge from the Amphidrome® system. Section 7 below provided details on the proper sampling procedure.

6.1.5. Equipment Run Times

All the equipment run times are recorded and stored by the PLC. These values are totals; therefore, the operator should record both the total time and the difference between the previous and the current readings, (i.e. the daily average). By averaging the daily run time of equipment it is possible to detect any potential problems and to verify that the equipment is operating for the approximate prescribed time in the program. For example, the process blower, daily average run time can be used to confirm that aeration is occurring, as programmed. Additionally, averaging equipment run time shows trends in the process. For example, the duration of the aeration is a function of the fixed air on time, and the flow based multiplier; therefore, aeration times vary with flow. Meticulous records of actual aeration times, which may be compared with the results of sample analyses, will allow for accurate process control decisions. **Recording of equipment run time is a critical and necessary part of operations and maintenance and should be performed diligently by the operator.**

6.1.6. Sludge Wasting and Sludge Removal

Sludge wasting refers to the removal of sludge from the Amphidrome® reactor and is achieved by backwashing. Both the frequency and duration of the backwash is operator adjustable. Unlike an activated sludge system in which the amount of viable biomass within the vessel is controlled by monitoring the MLVSS, no such single parameter exists for monitoring biomass in a submerged attached growth bioreactor. Four parameters must be used to determine whether or not enough biomass exists: one, an effluent ammonia, (NH₃) analysis, two, the forward and reverse flow rates, three, the aeration pattern, and finally, both a visual and a laboratory analysis of the TSS in the backwash stream.

- The first parameter that is influenced by insufficient biomass is the ammonia level in the effluent. Therefore, if all the other factors effecting nitrification, (i.e. alkalinity, air, pH) are sufficient, and nitrification is incomplete the quantity of biomass within the filter must be suspect.
- A significant decrease in the forward and reverse flow rates from the original tests conducted by the operator may indicate that the filter is plugging. This may be resolved by increasing the frequency and/or duration of the backwashes.
- The aeration pattern in the filter should be inspected with no more than three inches (3”) of water covering the media. **An even pattern of bubbles over the entire surface area should be observed.** Air bubbles that occur in separate discreet areas may indicate that the reactor is plugging or is plugged, or that the air line has been compromised. An excessive pressure reading on the blowers also indicate possible plugging of the filter. In severe cases, air may be seen escaping several minutes after the blowers have been shut off. This may be resolved by increasing the frequency and/or duration of backwash cycles.

- Finally, to gauge the quantity of solids within the reactor, a sample at the beginning and ending of a backwash cycle should be collected and examined both visually and analytically for TSS. The first sample should be collected during a backwash just as the water starts to flow over the return flow/backwash trough. The second sample should be collected at the end of the backwash, just before the pumps shut off. Typically TSS values for the second sample range from 200 mg/l to 500 mg/l. However, it must be stressed that these numbers are typical, not absolute. Therefore, if a plant is meeting all discharge requirements with different values, then those specific values should be used for a guideline at that particular plant.

Sludge wasting is achieved by pumping stored sludge from the anoxic/equalization tank. The level of sludge within the anoxic/equalization tank should be checked routinely.

6.1.7. Observation

Several operational parameters may be determined by simple observation, which in conjunction with field-testing, can be extremely useful for process control. The Amphidrome® process should not have suspended solids in the effluent, nor should strong offensive odors be present in any of the tanks. Therefore, visual inspection of effluent turbidity and color may be an indication of process problems. It is recommended that along with the field sampling (i.e. test kit sampling), that the color and clarity of the effluent be noted in the operator's log.

Strong odors, indicating a highly septic environment, should not be present in the Amphidrome® system. Any odor present in any of the tanks should also be noted in the operator's log and should be investigated, as this indicates a potential problem.

7. Sampling

The primary objective of an Alternative Design Wastewater Treatment System is to meet the need of a particular permit level for treatment. Fundamental to that objective is reliable and accurate sampling and monitoring.

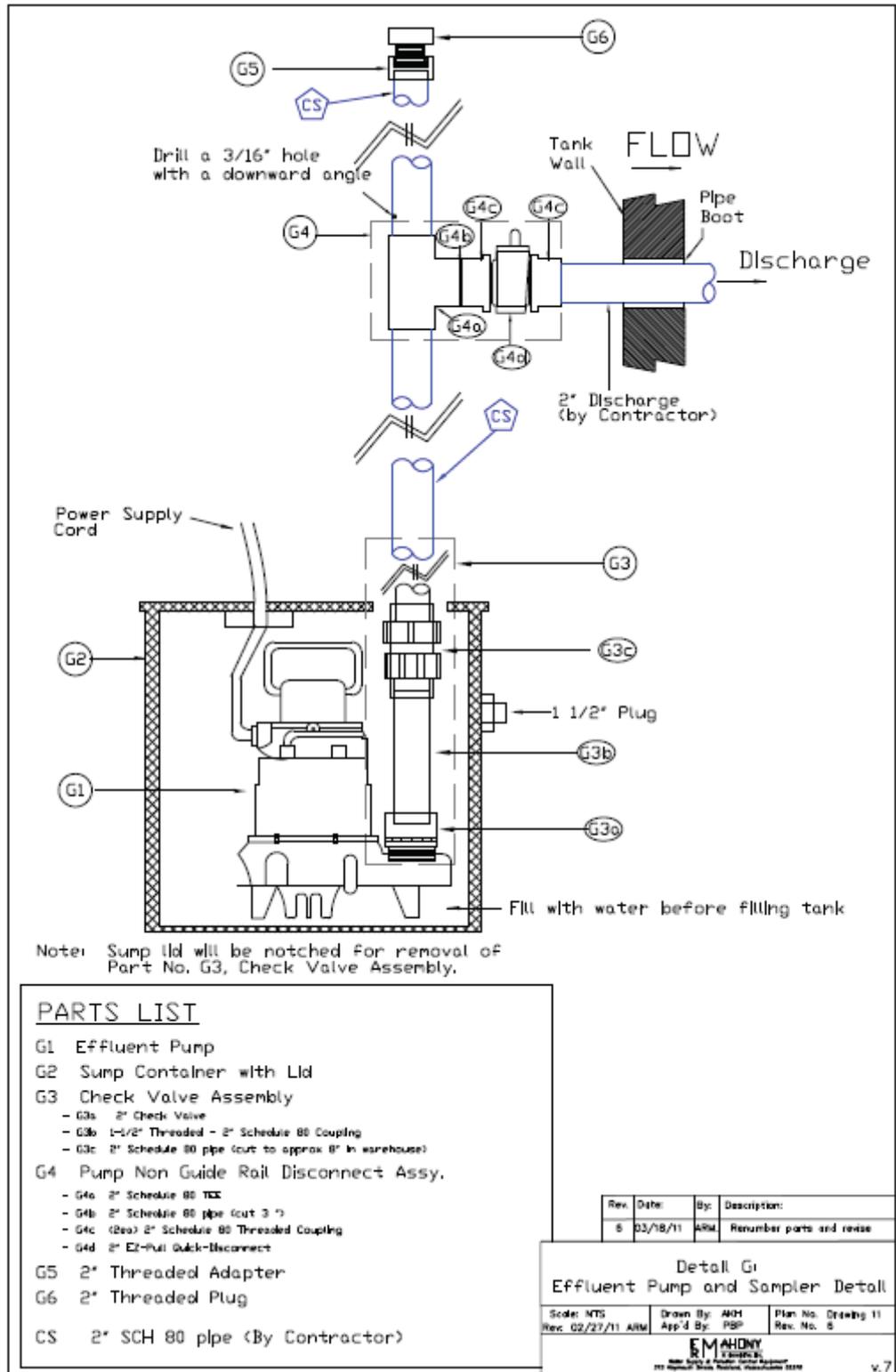
7.1. Amphidrome® Sampler

The Amphidrome® system is a batch process that is typically set to discharge at the end of each 24-hour cycle. The effluent sampler will hold a sample from the most recent batch that has been discharged. The vertical discharge pipe is provided with a check valve above the discharge pump. The discharge pipe riser sample chamber will hold a minimum of 1000 ml of volume.

The sample is drawn from the top of the sampler pipe by removing the manhole cover located at the discharge end of the clear well tank. A threaded plug must be removed from the top of the discharge sample pipe. A 1,000-ml disposable sample bailer is then inserted into the vertical discharge pipe and permitted to fill. The bailer device is provided with a check ball at the bottom to retain the sample when the bailer is removed from the sample chamber. The sample is then poured from the top of the bailer into an approved sample container with proper seal for handling and transport to an approved laboratory for analysis. The samples may be split as may be required for analysis.

The sample chamber plug is threaded back in place and the manhole cover is replaced over the clear well access. The next discharge will flush the chamber and retain a sample for the next period of sampling. Thus samples may be drawn as often as required, but no more than once per batch.

The sampler and piping are shown in **Drawing 11, Detail G: *Effluent Pump and Sampler Detail.***



**DRAWING DETAIL G
EFFLUENT PUMP AND SAMPLER DETAIL**

7.2. Sampling Procedure

The manufacturer recommends that sampling procedures be in accordance with all sampling protocols for the location of the system. It is not the intent of the manufacturer to establish sampling protocols as each State or County agency establishes the sample and testing protocol for their region. At a minimum, proper sample handling and preservation techniques are required and "chain of custody" paperwork for each sample, with information regarding the sample location including full address, date taken, sampler, analyses to be performed and so forth.

All system operators performing sampling procedures are required to be familiar with local sampling protocols.

1. The sample point shall be shown on the final design plans and subject to approval of the manufacturer and by the Pinelands Commission Executive Director. Engineering plans shall provide adequate detail to clearly illustrate the physical configuration of the sample collection port. The manufacturer shall provide standard details for use by the design engineer for the execution of the final design plans.
2. Samples should be collected directly into the containers in which they will be submitted for analysis. Where this is not possible, a dedicated disposable sampling device (e.g. polyethylene bailer) may be used, provided it is unwrapped immediately prior to use and properly disposed of after collecting the sample(s) from a single system.
3. A laboratory supplied chain-of-custody and sample analysis request form shall accompany all sample containers and shall document the name of all individuals in possession of the sample containers, the time, date, and reason for the sample container transfer. In addition, the form shall be used to specify each sample analysis request (e.g. TKN, Nitrate-nitrogen, chloride, etc.), method of sample preservation, and shall document the time of sample collection, the point of collection, the method used to induce sample flow and any anomalous events and observations which occur during the sample collection.
4. All sample containers shall be pre-labeled prior to sample collection. Labels shall provide the location of the sample source with an identity corresponding to the engineering plan designation (PP1), parameter sampled, date and time of sample collection, samplers initials, preservative, and site name or location (e.g. street address).
5. All samples shall be collected and immediately placed in a laboratory supplied cooler and chilled on ice to 4°C. All samples shall be accompanied by a temperature blank supplied by the laboratory. The temperature of the temperature blank shall be determined by the NJ Certified Laboratory at the time of sample relinquishment. The

laboratory shall record the temperature on the chain-of -custody and sample analysis request form.

6. All samples shall be collected as grab samples. Composite sampling is prohibited unless specifically authorized by the Executive Director.

The manufacturer is in agreement with the following statement of the Pinelands Commission and thus reserves the right to conduct additional sampling in accordance with the guidelines for sampling stated herein.

Pinelands Commission Policy as provided (8-27-02)

"The Commission recognizes the value of supplemental analyses for the purpose of determining process efficiencies (percent removal), system trouble shooting, research, etc. To this end, the Commission acknowledges that additional analyses may, at the discretion of the alternate design wastewater system vendor, be performed. Such additional parameters include but are not limited to BOD, CBOD, pH, DO, temperature and alkalinity. DO, pH and temperature are "analyze immediately parameters" (see N.J. A. C. 7:18) and as such need to be analyzed in the field immediately upon sample collection. As with all analytical parameters, the entity performing these "analyze immediately" tests must be certified by NJDEP to perform these analyses. All analytical data, including both the minimum required chemical analysis as well as supplemental analyses, shall be reported to the Commission in accordance with the requirements specified at N.J.A.C. 7:50-10.22(a)6.iv. "

8. Programmable Controllers

The Amphidrome® system is controlled by a programmable logic controller (PLC). PLCs are solid state members of the computer family that use integrated circuits instead of electromechanical devices to implement control functions. PLC's allow for the storing of instructions, such as sequencing, timing, counting, arithmetic, data manipulation, and communication, to control machines and processes.

The first programmable logic controller was specified in 1968, by the Hydramatic Division of General Motors Corporation. The requirements included, a solid state system with computer flexibility, the ability to survive in an industrial environment, be easily programmed, and be reusable. The early PLCs replaced the hardwired relay logic, which used electrically operated devices to mechanically switch electric circuits.

Programmable logic controllers today include many technological advances, in both hardware and software that have resulted in more capabilities than were ever anticipated. However, despite the level of sophistication in the design and construction, they still retain the simplicity and ease of operation that was intended in their original design.

FRMA will provide a direct logic programmable computer with external telephone dialer, which will have dial out capabilities for alarms, and dial in capabilities for troubleshooting. The system owner will provide a telephone line for this purpose.

8.1. Principles of Operation

A programmable logic controller consists of two basic sections, the central processing unit (CPU) and the input/output interface system (I/O). **See Figure 1.** The CPU consists of the processor, the memory system and the system power supply. It governs all the PLC activities. The I/O system is physically connected to the machinery (i.e. field devices) used in the control of a process. The field devices may be discrete or analog input/output devices, such as limit switches, pressure transducers, motor starters, solenoids, etc. The I/O interfaces provide the connection between the CPU and the information provided by the inputs and the controllable devices (i.e. outputs, such as pumps or blowers). **See Figure 2.**

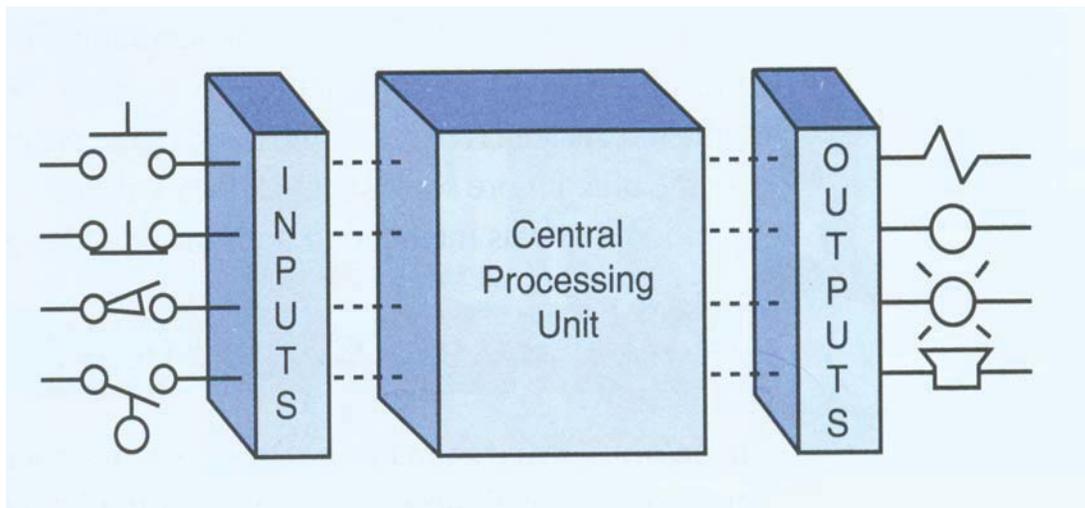


Figure 1. PLC Block Diagram

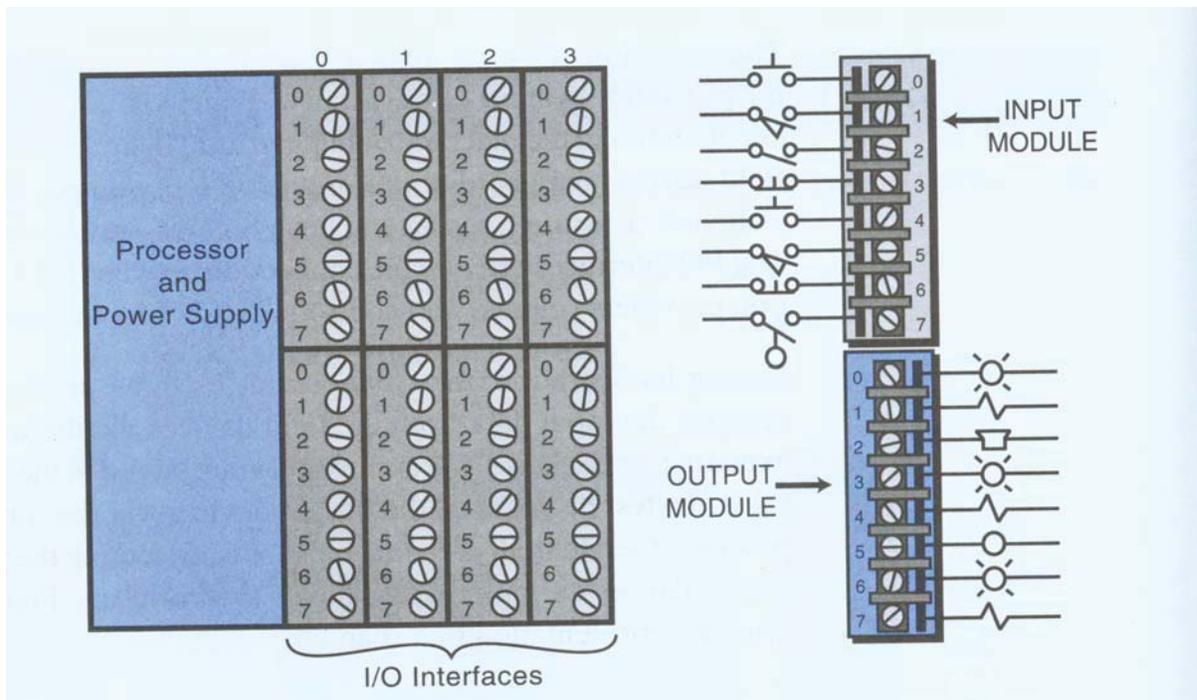


Figure 2. Input/Output Interfaces

During operation, the CPU does three things. First it reads the input data from the field devices via the input interfaces. Second, it executes the control program stored in the memory system, and finally, it updates the out devices via the output interfaces. The process of reading inputs, executing the program, and updating the outputs is known as scanning.

The input/output (I/O) section of the PLC acts as the interface to field devices and the CPU. Field sensing devices and controllers are wired to the I/O wiring terminals. The PLC power supply provides the necessary voltages for operation of the CPU and the I/O section of the controller.

Programmable controllers are available with either fixed or expandable I/O. Fixed I/O models, also referred to as "bricks", contain a fixed amount of I/O and are generally limited to about 20 or less I/O points in various configurations. Fixed I/O systems are well suited to applications with limited I/O requirements.

For systems with a large number of I/O points, expandable models are available. Expandable versions are modular in construction and consist of a rack or chassis containing a power supply and an assortment of I/O modules. The I/O modules are selected to meet the requirements of the various sensing devices and controllers used by the system. If the number of I/O points exceed the number of points that can be accommodated by a single chassis, further expansion is possible through the use of additional expansion racks.

Programming of a PLC is usually done with a personal computer or a manufacturer's mini-programmer, or "hand held programmer". All functions can be accomplished with either; however, it is more convenient with the computer. Programming and program changes refer only to modifications that affect the logic written into the program memory, not the operational settings that allow for optimization of the process.

9. The Amphidrome® System and Its PLC Control Panel

All Amphidrome® systems typically employ DirectLogic PLCs by AutomationDirect. This is a specific manufacturer's PLC hardware and software. Access to the main program logic is **not** possible, but access to all memory registers effecting the optimization of the process is possible. Thus the operator has a great deal of operational control over the process; however, in order to take advantage of this, a thorough understanding of both the Amphidrome® system and the biological processes involved is required.

To control the Amphidrome® process, the PLC continuously executes a 0 to 1440 minute cycle which corresponds to a 24 hour day. The time at which specific events occur during the process cycle, are controlled by entering values into memory location of the PLC referred to as V-memory registers. A listing of available V-registers with the associated function for each register is included with the Operation and Maintenance manual provided with the system.

As an example of how V-registers are used to control the process, assume that register V2200 has been assigned the function of initiating a backwash cycle and that the backwash cycle is to occur four hours into the cycle. The operator would load a value of 240 into register V2200, i.e. 4 hours x 60 minutes per hour = 240 minutes. If the system is set to reset to time zero at 5:00 AM, the backwash cycle would take place at 9:00 AM.

Access to the V-registers is through the hand held program loader (HP) shown in **Figure 4**. The HP connects to the PLC through the programming port using the cable supplied with the loader. The HP can be used to view the current status of all V-registers as well as changing the value of V-registers allocated for process control.

To view the status of any register, enter the following keystrokes on the HP:

SHFT, V, n, n, n, n, STAT

Where "nnnn" is the number of the register to be monitored, the above keystrokes will display the current value of the selected register. Once a register is displayed, consecutive registers can be monitored through the use of the **prev** and **next** keys.

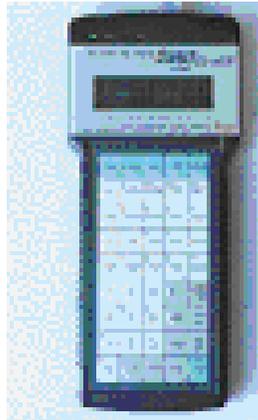


Figure 4. Hand Held Program Loader

Once a register is shown in the display, its value can be changed using the following keystrokes:

SHFT, K, #, #, #, #, ENT

Where "#" is the new value for the register, the new value for the selected register will now appear in the display.

9.1. Monitoring V-Memory Locations

The hand held programmer (HP) may be used to monitor and change V-memory locations. This is an especially useful feature, since almost all of the programmable controller's system data is mapped into V-memory. The following steps show how to monitor V-memory locations.

Press these Keystrokes

1. Select the location to monitor.

SHFT	V AND	C 2	A 0	A 0	A 0	STAT
-------------	------------------------	----------------------	----------------------	----------------------	----------------------	-------------

HP Display Results

	V	2	0	0	1	V	2	0	0	0
		4	5	5	2		4	F	5	0

The value "4F50" is the value stored in register V2000.

2. Use the PREV and NEXT keys to scroll through adjacent memory locations.

NEXT

HP Display Results

		V		2	0	0	2		V		2	0	0	1
				0	0	2	2				4	5	5	2

9.2. Changing V-Memory Values

Press these Keystrokes

1. Select the location to monitor.

SHFT	V	C	A	A	A	STAT
	AND	2	0	0	0	

HP Display Results

		V		2	0	0	1		V		2	0	0	0
				4	5	5	2				4	F	5	0

2. Use K (constant) to load a new value in memory location V2000.

SHFT	K	B	C	D	E
	JMP	1	2	3	4

HP Display Results

		V		2	0	0	1		V		2	0	0	0
K	1	2	3	4										

3. Press ENT to enter new value.

ENT

HP Display Results

		V		2	0	0	1		V		2	0	0	0
				4	5	5	2				1	2	3	4

9.3. Features of the Single Family Amphidrome® Control Panel

- 1) The Amphidrome® system operates on a 0 – 1440-minute cycle.
- 2) All Amphidrome® filters have the capability of 16 backwashes.
- 3) The total number of discharges is recorded.
- 4) The total number of backwashes is recorded.

- 5) The total number of failed backwashes is recorded.
- 6) All submersible pump total run times are recorded.
- 7) Total run times for both the process blower and backwash blower are recorded.
- 8) A counter to track failed backwashes
- 9) A counter to track discharges by the clear well high level
- 10) A counter to track clear well high level alarms
- 11) A counter to track filter high level alarms
- 12) The panel interface is provided for field connection of modem to transmit operating data to FRMA home office for diagnostic analysis and emergency trouble shooting.

10. Automatic Voice/Pager Alarm Dialer System

The voice/pager alarm dialer system is used to transmit high clear well or filter high level alarms to one or more remote locations. The dialer features busy line and no answer detection to ensure prompt transmission of a prerecorded message, delivered sequentially to as many as four standard telephones, cellular telephones, voice and/or numeric pagers.

The dialer is fully programmable, offering personalized customization for each individual project. Programming options include but are not limited to:

- Store up to four telephone/pager numbers. *
- Choose 1 to 9 calling efforts for the numbers dialed.
- Select 1 to 3 message repeats.
- Voice record an outgoing message in any language.
- Program voice messages to telephones and numeric code to pagers.

* The automatic alarm dialer system should be programmed to call **508-765-3469**. The dialer will report weekly to FRMA service office to insure that it is in operation.

* The voice pager/alarm dialer is a standalone unit operating 24 hours per day. Monitoring fees are not required.

11. Amphidrome® Control System

11.1. Cycle Control

The 24 hour Amphidrome® cycle is controlled by a 0 to 1440 minute counter CT0 in the programmable controller (PLC). This counter is reset by the internal clock/calendar of the PLC. Two V-registers are allocated for entering the desired time in hours and minutes for resetting the system to time zero.

In addition to the 24 hour counter, the program also includes a day of week counter in the PLC for selecting the days that backwash and discharge cycles will occur. The day of the week counter is CT30 and is advanced by 1 when the external 24 hour clock is activated.

The day of the week can be viewed in register V2006.

11.2. Backwash Cycle

The system is capable of 16 backwash cycles per day and backwashes can be set to occur on any or every day of the week. V2160 through V2166 are provided to enable/disable backwash cycles on Sunday through Saturday respectively. Backwash cycles are enabled for the day if the associated register for that day is set to a value of 1. If backwash cycles are disabled for any particular day, all backwash cycles for that day will be disabled.

Registers V2140 through V2157 are provided for setting the time to backwash for backwash cycles 1 through 16.

For the remainder of the description on control of the backwash cycle we will assume that registers V2160 through V2166 are set to 1 enabling backwash cycles for every day of the week.

Entering valid times into the backwash cycle control registers does not mean that all backwash cycles will occur daily.

Backwash cycles 1 through 16 are enabled automatically by the (PLC) logic depending on the amount of incoming flow. A measure of the incoming flow is how long it takes the system to return flow to the 2nd float in the clear well. A counter in the PLC (CNT20) records how long it takes for the system to return to the 2nd float. This counter is automatically reset to zero at the beginning of any return flow cycle. If the time to return to the 2nd float for the current cycle is greater than the time for the previous cycle the value in register V2250 is updated to reflect the longer return time. Register V2250 always contains the longest time to return to the 2nd float for a given day and is used to select the number of backwash cycles required for the next day. The value in V2250 is recorded and stored in register V2307 at the beginning of a new day for use in selecting the number of backwash cycles for that day. Once the previous days value is loaded in V2307 register V2250 is reset to zero and set to record the longest time to return to the 2nd float for the new day.

Note: If any return flow time is terminated by the high float in the filter before the system has returned to the 2nd float in the clear well the recorded value in CNT20 and V2252 will be equal to the total return flow time for that cycle.

If the system has discharged to the 2nd float in the clear well and there is not enough flow to elevate it again, there will be no backwash cycle for the following day. If flow is sufficient to elevate the 2nd float, but, not enough to cause the time to return to the 2nd float to be more than 1 minute, backwash cycles 1, 2, and 3, will take place.

The next 13 backwash cycles are selected based on the value stored in V2400 which represents the longest time to return to the 2nd float for the previous day.

If V2400 is equal to or greater than 1 minute backwash cycles 4, 5, and 6 are enabled.

If V2400 is equal to or greater than 2 minutes backwash cycles 7, 8, and 9 are enabled.

If V2400 is equal to or greater than 3 minutes backwash cycles 10, 11, and 12 are enabled.

If V2400 is equal to or greater than 4 minutes backwash cycles 13, 14, 15, and 16 are enabled.

Once a backwash cycle is initiated it is controlled by the values entered in registers V2171 through V2174. Typical values for these registers are listed below:

V2171 - Time to start blowers for backwash - set for 1 minute

V2172 - Time to stop blowers for backwash - set for 11 minutes

V2173 - Time to start pump for backwash - set for 6 minutes

V2174 - Time to backwash over trough – 5 minutes

With the above settings the blowers will start 1 minute into the backwash cycle and run alone. At 6 minutes into the cycle the backwash pump will start and run with the blowers. At 11 minutes into the cycle the blowers will stop and the backwash pump will run alone until the high float in the filter is elevated for 5 minutes.

11.3. Return Flow Cycles

There are provisions for 16 return flow cycles. The times for these cycles are set in registers V2050 through V2067. The return flow cycles will be automatically locked out for ½ hour prior to a backwash.

Once a return flow cycle is initiated it will continue to run until the low float in the clear well drops out, or until the high float in the filter has been elevated for the amount of time entered in register V2250 (time to return after high float in filter).

11.4. Process Air Cycle

There are 12 adjustable process air enable\disable periods. Enable\disable times for the 12 cycles are set in registers V2020 through V2047.

The process air off time is set in register V2017 and is common to all 12 individual process air cycles.

The process air on time is automatically calculated by the PLC logic and is dependent to some degree on the position of the 2nd float in the clear well.

If the system has discharged to the 2nd float in the clear well and this float has not become elevated again due to a lack of incoming flow the process air on time will be equal to the value in seconds entered in register V2115.

If the system has discharged to the 2nd float in the clear well and the 2nd float has become elevated again because of incoming flow the on time becomes a calculated value based on the amount of time to return flow to the 2nd float in the clear well. This calculated value is automatically adjusted throughout the day and at any given time is the product of the longest time to return to the 2nd float in the clear well times a multiplier in register V2117 plus a fixed run time in register V2116.

An option to disable the process air blower during a return flow\backwash cycle is provided. If register V2114 is set to 1 the process air blower will automatically shut down during a return flow\backwash cycle.

11.5. Discharge Cycle

Discharge cycles can be set to occur on any or all days of the week by entering a 0 through 6 into registers V2070 through V2076. The numbers 0 through 6 represent the days Sunday through Saturday respectively.

To disable the discharge cycle for any given day set the value in the associated V register for that day to 9999.

If enabled, the discharge cycle will occur at the beginning of a new day when the clock resets the system. The discharge will be to the 2nd float in the clear well.

If at any time during the day, a high level condition should occur in the clear well the system will automatically discharge for 3 minutes or until the 2nd float in the clear well drops out regardless of whether or not the discharge cycle was enabled for that day.

If the clear well high level float does not drop out within 3 minutes a high level alarm will be activated.

11.6. Filter High Level Alarm

If the high level float in the filter is elevated for 20 minutes a high level alarm is initiated.

The high level alarm timer is disabled whenever the backwash pump is in operation.

11.7. Clear Well High Level Alarm

If the high level float in the clear well becomes elevated a discharge cycle will be initiated. If the high level condition is not corrected in 3 minutes the high level alarm will be activated.

11.8. Accumulated Run Times

The following run times are recorded:

Description	Seconds (0 to 3600)	Minutes
Effluent Pump	V2012	V2000
Backwash Air Blower	V2013	V2001
Backwash Pump	V2014	V2002
Process Air Blower	V2015	V2003

11.9. Event Recorders

The following events are recorded:

Clear Well High Level Alarm Counter	V2004
Backwash Cycle Counter	V2005
Day of Week	V2006
Time Into Cycle	V2007
Number of Discharge Cycles	V2011
Filter High Level Alarm Counter	V2107
Number of Times Clear Well High Level Float is Activated	V2106

Note: In addition to the above registers V2200 through V2227 record the longest return flow times for the previous 24 days. Register V2200 contains the most recent data.

12. Operational Scenario of the Amphidrome® System

To achieve simultaneous oxidation of soluble material, nitrification, and denitrification in a single reactor, the process must provide aerobic and anoxic environments for the two different populations of microorganisms. The Amphidrome® system achieves this by using two tanks and one submerged attached growth bioreactor whose process is controlled by a sophisticated PLC computer program. The following outline provides a description of the structural framework of any Amphidrome® system. The control details of each particular

Amphidrome® configuration are described in the controls' section of the Forward and in the Controls' section of the O & M manual.

- All Amphidrome® systems are setup with the ability to return flow from the clear well to the anoxic/equalization tank twenty four (24) times per day. The cycle clock operates on a time of 0 –1440 minutes. The returns are set up to occur every hour on the hour, (i.e. at times 0, 60, 120, 180,....).
- Typically, the systems are setup to treat in one batch per day.
- The programmable controller (PLC) includes an internal clock/calendar for control of the process cycle. Registers are allocated for setting the time of day in hours and minutes at which the cycle time will be reset to time zero. The PLC clock is adjusted and records time in the 24 hour format. Refer to the memory allocation sheet specific to the system to be adjusted for the registers assigned to this function. For example, assume that register **V2200** is allocated for setting the "hour to reset the cycle to time zero" and that the desired time for the cycle to reset to zero is 2:45 PM. Using the hand held loader, the operator would load a value of 14 into register **V2200** (2:00 = 14 hours) and a value of 45 into register **V2201**.

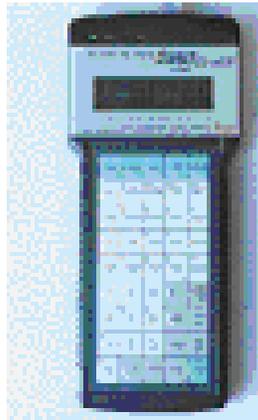


Figure 4. Hand Held Program Loader

12.1. Setting the Clock and Calendar

The **AUX 52** function allows you to set the Real-time clock and calendar using the following format.

- Date - Year, Month, Date, Day of week (0-6, Sunday through Saturday)
- Time - 24 hour format, Hours, Minutes, Seconds

If the date is changed without updating the day of the week (0-6), the CPU will not automatically correct any discrepancy between the date and the day of the week. For example, the date is changed to the 15th of the month and the 15th is on a Thursday. The day of the week will also need to be changed unless the CPU already shows the date as Thursday. Use the following example to change any component of the date or time settings.

Note: Verify that the clock and calendar is supported by your CPU before attempting to use this Auxiliary function.

Press these Keystrokes

1. Clear Complete Display Screen

CLR	CLR
-----	-----

HP Display Results

2. Select AUX 57

F	C	
5	2	AUX

HP Display Results

A	U	X		5	*		C	P	U		C	F	G	
A	U	X		5	2		C	A	L	E	N	D	A	R

3. Select Date and Clock Display

ENT

HP Display Results

A	U	X		5	2		C	A	L	E	N	D	A	R
9	6	/	0	1	/	0	1	/	6	(S	A	T)

4. Enter New Date if Required

→	→	→	→	A	C
				0	2

HP Display Results

A	U	X		5	2		C	A	L	E	N	D	A	R
9	6	/	0	1	/	0	2	/	7	(S	U	N)

5. To Accept Press ENT Twice

ENT	ENT
-----	-----

HP Display Results

A	U	X		5	2		C	A	L	E	N	D	A	R
T	I	M	E		0	0	:	0	6	:	0	0		

6. Enter New Time if Required

B	C	D	A
1	2	3	0

HP Display Results

A	U	X		5	2		C	A	L	E	N	D	A	R
T	I	M	E		1	2	:	3	0	:	0	0		

7. To Accept New Entry Press ENT Twice

ENT	ENT
-----	-----

HP Display Results

				9	6	/	0	1	/	0	2		
					1	2	:	3	0	:	1	5	

- The shaded area indicates cursor position.
- Press the CLR key to exit date and clock function.

Note: If the CPU is without power for an extended period of time a battery is required to maintain the proper date and time.

- Typically, at startup all aeration periods are utilized and the sequences are set up so that process blower fixed on time is 3 – 5 minutes and the process blower off time is 10 – 15 minutes.

13. The cyclical forward and reverse flow, of the waste stream, and the intermittent aeration of the filter, should be used in conjunction with one another to achieve the necessary aerobic and anoxic conditions required to meet the effluent permit requirements. Troubleshooting Guidelines

13.1. Equipment

13.1.1. Blowers

Problem	Possible Cause	Solution
No air supply to reactor, when called for OR Low air supply	Blower not operating Incorrect rotation Broken/missing drive belt Closed valve Blockage in air line Broken air discharge line	Ensure blower switch is on. Check circuit breaker and reset. If breaker continues to trip have circuit checked by qualified technician Check for proper rotation. Replace belt Ensure correct valve is open Ensure check valves have been installed correctly and are working properly. Check operating pressure clear blockage Check pressure relief for open or closed condition Investigate for breaks in discharge line and repair
Blower does not operate or ceases to operate	Not called for Switch in the off position Breaker tripped	Check program to confirm blower should be operating Ensure correct switch is in the on or auto position Check circuit breaker and reset. If breaker continues to trip have circuit

		checked by qualified technician.
--	--	----------------------------------

Blowers (cont'd)

Problem	Possible Cause	Solution
Blower running abnormally hot	Inadequate lubrication	Ensure proper lubrication – consult manufacturers lubrication instructions
	Low inlet air supply	Check inlet piping for blockage Check inlet filter(s) and replace if necessary
	Poor ventilation	Ensure adequate ventilation
High discharge pressure	Valve closed	Check valves
	Obstruction in discharge line	Clear obstruction
	Check valve installed improperly, broken or stuck	Inspect check valve
	Reactor plugged	Backwash (filter) reactor
	Relief valve improperly set	Adjust relief valve
Blower abnormally noisy	Improper lubrication	Ensure proper lubrication
	Bearing noise (could be the blower or the motor)	Replace bearings if necessary
	Belt hitting guard	Adjust guard
	Loose belts, guards, etc.	Tighten all equipment
	Valve closed	Check discharge valves

13.1.2. Submersible Pumps

Problem	Possible Cause	Solution
Pump will not operate	Circuit breaker tripped or switch in off position (If it continues to trip)	Check breaker. Reset if tripped. Check switch. Circuit should be checked by a qualified technician. If necessary, remove pump from tank and inspect
Pump will not operate in automatic	Switch not in auto position Low float not made	Check switch Check floats
Low flow rate	Improper rotation Valve partially closed Pump not seated properly Check valve stuck or clogged Discharge line clogged Discharge head too high Pump dirty or clogged Impeller spinning on shaft	Check rotation Check valves Check pump connections Inspect check valve and discharge line Review pump curve Check discharge head Remove pump from tank and inspect

13.1.3. Flow Sensor and Meter

Problem	Possible Cause	Solution
No display on screen	Circuit breaker tripped	Check breaker and reset
	Improper wiring	Have wiring checked by a qualified technician
	Meter malfunctioning	Replace meter
Improper flow rate and totalization	Meter programmed improperly	Consult manufacturer's literature for proper programming
	Sensor malfunctioning or broken	Remove sensor and inspect
	Incorrect sensor installation	Consult manufacturer's installation instructions
	Pump malfunctioning	Troubleshoot pump
No flow rate or totalization	Sensor broken or clogged	Remove sensor, inspect and clean if necessary
	Improper wiring	Check wiring
	Pump off	Check pump

13.2. Controls

13.2.1. Floats

Problem	Possible Cause	Solution
Equipment not responding to floats	Bad wiring or connections	Check wiring and connections for complete circuit
	Improper float application (Normally open)	Make sure floats are correct for application
	Improper signal input location	Have qualified technician troubleshoot signal input at panel
	Bad float	Replace float
	Equipment not in automatic position	Check H/O/A switches
	Float hung up in improper position	Check float positions

Process Control

13.2.2. BOD Removal

Problem	Possible Cause	Solution
High effluent BOD	High organic loading	Check actual vs. design organic loading Investigate abnormally high influent organic loading. Increase number of returns and possibly decrease number of batches.
	Insufficient dissolved oxygen	Troubleshoot air supply system Increase air supply
	High hydraulic loading	Check actual vs. design hydraulic loading Investigate abnormally high hydraulic loading Increase number of batches Limit 2 / 24 hour period if possible
	Insufficient biomass	Decrease number of backwashes if possible Check BOD: N: P ratio
	Total suspended solids in effluent	Troubleshoot TSS problem
	Toxic material in influent	Investigate for toxins or biocides

13.2.3. TSS Removal

Problem	Possible Cause	Solution
High Effluent TSS	High influent TSS	Check depth of blanket in anoxic tank – if within two feet of bottom of outlet tee, pump out anoxic tank.
	Dirty Amphidrome® reactor	Increase backwash of Amphidrome®

13.2.4. Nitrogen Removal – TKN

Problem	Possible Cause	Solution
High effluent TKN	Insufficient D.O	Increase air supply either by adjusting the fixed or the multiplier
	High influent TKN loading	Check actual vs. design TKN loading
	Insufficient biomass	Decrease Amphidrome® backwash if possible Check BOD: N: P ratio
	Low return frequency	Increase number of returns if possible
	Toxic material in influent	Investigate influent for toxins or biocides
	Low pH and or temperature	Check pH and temperature of process

13.2.5. Nitrogen Removal – NH₃

Problem	Possible Cause	Solution
High effluent ammonia	Insufficient dissolved oxygen	Increase air supply Troubleshoot air system if necessary
	High influent ammonia loading	Check actual vs. design ammonia loading Investigate abnormally high loading
	Insufficient biomass	Decrease backwash of Amphidrome® if possible Check BOD: N: P ratio
	Insufficient alkalinity	Check effluent alkalinity If less than 100 mg/l add sodium bicarbonate to system.
	Low temperature	Check temperature of process If abnormally low, investigate cause
	Excessively high return rate over trough	Check the return flow to influent flow ratio
	Toxic material present in process wastewater of influent	Investigate influent and process water for toxins and or biocides
	High hydraulic loading	Check actual vs. design hydraulic loading Investigate abnormally high hydraulic loading Increase number of batches to 2/24 hr. period maximum if necessary

13.2.6. Nitrogen Removal – NO₃

Problem	Possible Cause	Solution
High nitrate in effluent and fractional ammonia level	Excess dissolved oxygen in system	Decrease air supply and recheck both nitrate and ammonia Check anoxic tank, maintain anoxic conditions Check return flow volume to influent ratio, adjust accordingly (i.e. DO ≤ .5 mg/e)

14. Appendix 1. Filter Flow Through Rate

Project/Location:

Date:

Filter

Size	Diameter (ft)	Area (sq ft)

Forward Flow Rate

Time (min.)	Level (in.)	Change (in.)	Del. Vol. (gal.)	Flow Rate (gpm)
0-3				
3-6				
6-9				
9-12				
12-15				
15-18				

Average Flow Rate: _____ gpm
Average Hydraulic Loading: _____ gpm/sq ft

Backwash Flow Rate

Time (min.)	Level (in.)	Change (in.)	Del. Vol. (gal.)	Flow Rate (gpm)
0-2				
2-4				
4-6				
6-8				
8-10				
*				

* Continue for every two minutes until liquid reaches the overflow pipe.

Average Flow Rate: _____ gpm
Average Hydraulic Loading: _____ gpm/sq ft

15. Appendix 2. Automatic Voice/Pager Dialer System
– TROUBLESHOOTING

The automatic alarm dialer system, programmed to call **508-765-3469**, alerts service personnel of a system error to identify and remedy operational problems. Costs for long distance telephone service are the responsibility of the owner/resident. A dedicated line is recommended but not required, however any resulting delays or interruptions in transmission are the responsibility of the owner/resident.

Refer to Section Tab 8
Owner's Manual and Operating Instructions

for
Installation
Programming
Testing
Specifications
Dialer Accessories

IMPORTANT INFORMATION

Care And Precautions

LOCATION

Place the dialer on a flat level surface or mount the unit on the wall, away from extreme cold or heat, direct sunlight, excessive humidity and away from equipment that generate strong magnetic fields. Avoid placing near large metal objects and areas that produce smoke, dust and mechanical vibrations.

CARE

Clean the housing with a soft cloth lightly moistened with water or mild detergent solution. Never use solvents such as alcohol or thinner. Do not allow liquids to spill into the unit.

OPTIONAL BACKUP

To ensure continuous operation during power outages, hookup to a 12VDC backup battery pack is recommended. (PP-1) Available from United Security Products.

CAUTION

Do not use the dialer if a gas leak is suspected or during lightning.

PROBLEMS

If liquid or a foreign object penetrates the unit, disconnect it immediately and contact your installer or other qualified technician.

Before calling USP, please make sure...

- You have read this manual and understand how to operate the dialer.
- Your phone line is working.
- You check out the entire system, including external hook-up wiring and sensors attached.

If you still have questions or concerns, call our USP Technical Service Department between the hours of 7:30 AM and 4:00 PM, PST, Monday through Friday.

Federal Communications Commission Radio And Television Interference Statement For A Class 'B' Device

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance

with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class 'B' computing device in accordance with the specifications in Subpart B of FCC Rules and Regulations (as outlined in the Code of Federal Regulation, Title 47), which are designed to provide reasonable protection against such interference in a residential installation.

User Instructions

If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off, then on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate radio or television.
- Increase the separation between the equipment and receiver.
- Connect the equipment into a different outlet so that the equipment and receiver are on different branch circuits.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by United Security Products, Inc. could void the user's authority to operate the equipment.

ALARM DIALER TROUBLESHOOTING

If the alarm dialer is not functioning as expected, the first course of action should be to verify that the telephone line is operational and capable of providing long distance telephone service. To verify the telephone service, disconnect the dialer and test the line using a regular telephone. If the telephone service is operational but the dialer is not functioning, then the following should be checked.

STEP 1 Verify that the dialer is correctly programmed and that the telephone numbers programmed into the dialer are valid numbers, and that the LCD display of the dialer reads "Operate".

- Channel 1 should be programmed to report an alarm condition to the necessary personnel.
- Channel 2 is programmed to report that the system is operating satisfactorily.

The dialer should be programmed with the following settings:

T-LINE	TONE
PBX	Off
Attempts	3
Message Repeat	3
Outgoing messages	2
Channel 1 Enable	Yes
Channel 2 Enable	Yes
Channel 1 Exit Delay	No
Channel 2 Exit Delay	No
Channel 1 Entry Delay	No
Channel 2 Entry Delay	No
Channel 1 Activation	N.O.
Channel 2 Activation	N.O.
Channel 1 Dial Number	As Required
Channel 2 Dial Number	As Required
Channel 1 Play Outgoing Message	1
Channel 2 Play Outgoing Message	2

STEP 2 Test the dialer. Press the "M" button on the dialer repeatedly until

TEST: T-LINE
1 (YES) 2 (NO)

appears in the display. Press 1. The dialer should automatically scroll through the following displays:

TEST: T-LINE

TONE

**TEST: T-LINE
PBX=OFF**

**TEST: T-LINE
ATTEMPTS = 3**

**TEST: T-LINE
REPEATS = 3**

The last screen to be displayed will be:

**TEST CHANNELS
1 (YES) 2 (NO)**

Press 1. The display will change to:

**SELECT: 1 OR 2
3 (BOTH) 0 (DONE)**

Select 3. The dialer will automatically scroll through the following screens:

**CH1:
ENABLE**

**CH1:
NO EXIT DELAY**

**CH1:
NO ENTRY DELAY**

**CH1:
N.O.**

**CH1:
MOMENTARY**

**CH1:
PROGRAMMED NUMBERS WILL BE DISPLAYED**

**CH1:
OUTGOING MESSAGE WILL BE PLAYED**

**CH2:
ENABLE
CH2:
NO EXIT DELAY**

**CH2:
NO ENTRY DELAY**

**CH2:
N.O.**

**CH2:
MOMENTARY**

**CH2:
PROGRAMMED NUMBERS WILL BE DISPLAYED**

**CH2:
OUTGOING MESSAGE WILL BE PLAYED**

NOTE: The above test should be done with the telephone line disconnected. Once it is determined that the dialer is properly programmed, the test can be repeated with the dialer connected to the telephone line to confirm that it is operating properly.

The telephone line is connected between the telephone company jack and the “In” jack of the dialer. When looking at the front of the dialer, the “In” jack is the left jack on the top of the dialer. The telephone line does not connect to the programmable controller Port 1 jack.

STEP 3 Test the dialer alarm and status channels.

- To test the dialer alarm channel (channel 1), place a jumper wire across the small red and black wire on relay CR1. Relay CR1 is the left gold colored cube shaped relay in the control panel. The red and black wires are connected to the right most top and bottom rear terminals of the relay socket.
- To test the dialer status channel (channel 2), place a jumper wire across the green and white wire on relay CR2. Relay CR2 is the right gold colored cube shaped relay in the control panel. The green and white wires are connected to the right most top and bottom rear terminals of the relay socket.

The jumper used for this test must be a solid wire. Do not attempt to jump these terminals with a multimeter. The meter resistance will be too high to activate the dialer.

16. Appendix 3. Glossary of Terms

ADVANCED WASTE TREATMENT Any process of water renovation that upgrades treated wastewater to meet specific reuse requirements. May include general cleanup of water or removal of specific parts of wastes insufficiently removed by conventional processes. Typical processes include chemical treatment and pressure filtration. Also called **TERTIARY TREATMENT**.

AERATION The process of adding air to water. With mixture of wastewater and activated sludge, adding air provides mixing and oxygen for the microorganisms treating the wastewater.

AEROBES Bacteria that must have molecular (dissolved) oxygen (DO) to survive. Aerobes are aerobic bacteria.

AEROBIC A condition in which atmospheric or dissolved molecular oxygen is present in the aquatic (water) environment.

AEROBIC BACTERIA Bacteria which reproduce in an environment containing oxygen which is available for their respiration (breathing), namely atmospheric oxygen or oxygen dissolved in water. Oxygen combined chemically, such as in water molecules (H₂O), or nitrate (NO₃⁻), cannot be used for respiration by aerobic bacteria.

AEROBIC DECOMPOSITION The decay or breaking down of organic material in the presence of “free” or dissolved oxygen.

AEROBIC PROCESS A waste treatment process conducted under aerobic (in the presence of “free” or dissolved oxygen) conditions.

ALKALINITY The capacity of water or wastewater to neutralize acids. The capacity is caused by the water’s content of carbonate, bicarbonate, hydroxide, and occasionally borate, silicate, and phosphate. Alkalinity is expressed in milligrams per liter of equivalent calcium carbonate. Alkalinity is not the same as pH because water does not have to be strongly basic (high pH) to have a high alkalinity. Alkalinity is a measure of how much acid must be added to a liquid to lower the pH to 4.5.

ANOXIC A condition in which the aquatic (water) environment does not contain enough dissolved molecular oxygen, which is called an oxygen deficient condition. Generally refers to an environment in which chemically bound oxygen, such as in nitrate, is present.

ANOXIC DENITRIFICATION A biological nitrogen removal process in which nitrate nitrogen is converted by microorganisms to nitrogen gas in the absence of dissolved oxygen.

ATTACHED GROWTH PROCESS Wastewater treatment processes in which the microorganisms and bacteria treating the wastes are attached to the media in the reactor.

The wastes being treated flow over the media. Trickling filters and rotating biological contactors are attached growth reactors. These reactors can be used for BOD removal, nitrification and denitrification.

AUTOTROPHIC Describes organisms, plants, and some bacteria that use inorganic materials for energy and growth.

BOD Biochemical Oxygen Demand. The rate at which organisms use the oxygen, in water or wastewater, for oxidation of organic matter. In decomposition, organic matter serves as food for the bacteria and energy results from its oxidation. BOD measurements are used as a measure of the organic strength of wastes in water.

BACTERIA Bacteria are living organisms, microscopic in size, which usually consist of a single cell. Most bacteria use organic matter for their food and produce waste products as a result of their life processes.

BATCH PROCESS A treatment process in which a tank or reactor is filled, the wastewater (or other solution) is treated or a chemical solution is prepared, and the tank is emptied. The tank may then be filled and the process repeated. Batch processes are also used to cleanse, stabilize or condition chemical solutions for use in industrial manufacturing and treatment processes.

BIOCHEMICAL OXYGEN DEMAND (see BOD)

COD Chemical Oxygen Demand. A measure of the oxygen-consuming capacity of organic matter present in wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in mg/l during a specific test. Results are not necessarily related to the biochemical oxygen demand (BOD) because the chemical oxidant may react with substances that bacteria do not stabilize.

CARBONACEOUS A stage of decomposition that occurs in biological treatment processes when aerobic bacteria, using dissolved oxygen, change carbon compounds to carbon dioxide. Sometimes referred to as “first-stage BOD” because the microorganisms attack organic or carbon compounds first and nitrogen compounds later.

CHEMICAL OXYGEN DEMAND (see COD)

DO Abbreviation of Dissolved Oxygen. DO is the molecular (atmospheric) oxygen dissolved in water and wastewater.

DENITRIFICATION (1) The anoxic biological reduction of nitrate nitrogen to nitrogen gas. (2) The removal of some nitrogen from a system. (3) An anoxic process that occurs when nitrite or nitrate ions are reduced to nitrogen gas and nitrogen bubbles are formed as a result of this process. The bubbles attach to the biological floc in the activated sludge process and float the floc to the surface of the secondary clarifiers. This

condition is often the cause of rising sludge observed in secondary clarifiers or gravity thickeners.

DISSOLVED OXYGEN (see DO)

EFFLUENT Wastewater or other liquid – raw (untreated), partially or completely treated – flowing FROM a reservoir, basin, treatment process, or treatment plant.

F/M RATIO Food to microorganism ratio. A measure of food provided to bacteria in an aeration tank or reactor in relation to the microorganism population expressed as follows:

$$\frac{\text{Food}}{\text{Microorganisms}} = \frac{\text{BOD, lbs/day}}{\text{MLVSS, lbs}}$$

FIXED FILM Process in which the bacteria attach to a media from a film. The film is fixed to the media being used.

HEADER A large pipe to which the ends of a series of smaller pipes are connected. Also called manifold.

HETEROTROPHIC Describes organisms that use organic matter for energy and growth. Animals, fungi and most bacteria are heterotrophs.

INFLUENT Wastewater or other liquid – raw (untreated) or partially treated, flowing into a treatment plant.

LOADING Quantity of material applied to a device at one time. Hydraulic loading is a measure of liquid flow into a vessel.

MLSS Mixed Liquor Suspended Solids expressed as mg/l of solids usually measured in an aeration tank.

MANIFOLD A large pipe to which the ends of a series of smaller pipes are connected (see HEADER).

MEDIA The material in a trickling filter or biologically aerated filter on which organisms grow and become attached.

MICROORGANISMS Very small organisms that can be seen only through a microscope. Some microorganisms use the waste in wastewater for food and thus remove or alter much of the undesirable matter.

MILLIGRAMS PER LITER mg/l Measure of the concentration of a substance per unit volume. For practical purposes, one mg/l of a substance in water is equal to one part per million parts (ppm)

MIXED LIQUOR SUSPENDED SOLIDS When the activated sludge in an aeration tank is mixed with primary effluent or the raw wastewater and return sludge, this mixture is then referred to as mixed liquor measured in solids in mg/l or ppm.

MIXED LIQUOR VOLATILE SOLIDS The organic or volatile suspended solids in the mixed liquor of an aeration tank. This volatile portion is used as a measure or indication of the microorganisms present.

MOLECULAR OXYGEN The oxygen molecule, O₂, that is not combined with another element to form a compound.

NITRIFICATION An aerobic process in which bacteria change the ammonia and organic nitrogen in wastewater into oxidized nitrogen (usually nitrate). The second-stage BOD is sometimes referred to as the “nitrogenous BOD” (first-stage BOD is called the “carbonaceous BOD”)

NITRIFICATION STAGE A stage of decomposition that occurs in biological treatment processes when aerobic bacteria, using dissolved oxygen, change nitrogen compounds (ammonia and organic nitrogen) into oxidized nitrogen (usually nitrate). The second-stage BOD is sometimes referred to as the “nitrification stage” (first-stage BOD is called the “carbonaceous stage”).

NITRIFYING BACTERIA Bacteria that change the ammonia and organic nitrogen in wastewater into oxidized nitrogen (usually nitrate).

NITROGENOUS A term used to describe chemical compounds (usually organic) containing nitrogen in combined forms. Proteins and nitrate are nitrogenous compounds.

NUTRIENT CYCLE The transformation or change of a nutrient from one form to another until the nutrient has returned to the organic form, thus completing the cycle. The cycle may take place under either aerobic or anaerobic conditions.

NUTRIENTS Substances, which are required to support living plants and organisms. Major nutrients are carbon, hydrogen, oxygen, sulfur, nitrogen and phosphorous. Nitrogen and phosphorous are difficult to remove from wastewater by conventional treatment processes because they are water-soluble and tend to recycle.

O & M MANUAL Operation and Maintenance Manual. A manual that describes detailed procedures for operators to follow to operate and maintain a specific wastewater treatment or pretreatment plant and the equipment of that plant.

ORGANIC WASTE Waste material comes mainly from animal or plant sources. Bacteria and other small organisms generally can consume organic wastes. Inorganic wastes are chemical substances of mineral origin.

ORGANISM Any form of animal or plant life.

PROGRAMMABLE LOGIC CONTROLLER (PLC) A small computer that controls process equipment (variables) and can control the sequence of valve operations.

RESPIRATION The process in which an organism uses oxygen for its life processes and gives off carbon dioxide.

RETENTION TIME The time water, or solids are retained or held in a process tank

SCFM Cubic Feet of air per Minute at Standard conditions of temperature, pressure, and humidity (0 degrees C, 14.7 psia, and 50% relative humidity).

SECONDARY TREATMENT A wastewater treatment process used to convert dissolved or suspended materials into a form more readily separated from the water being treated. Usually the process follows primary treatment by sedimentation. The process commonly is a type of biological treatment process followed by secondary clarifiers that allow the solids to settle out from the water being treated.

SENSOR A device that measures (senses) a physical condition or variable of interest. Floats and thermocouples are examples of sensors.

SEPTIC A condition produced by anaerobic bacteria. If severe, the wastewater produces hydrogen sulfide, turns black, gives off foul odors, contains little or no dissolved oxygen, and the wastewater has a high oxygen demand.

SERIES OPERATION Wastewater being treated flows through one treatment unit and then flows through another similar treatment unit.

SET POINT The position at which the control or controller is set. This is the same as the desired value of the process variable.

SEWAGE The used household water and water-carried solids that flow in sewers to a wastewater treatment plant. The preferred term is Wastewater.

SHOCK LOAD The arrival at a plant of a waste which is toxic to organisms in sufficient strength to cause operating problems. Possible problems include odors loss of treatment efficiency with excess solids and BOD discharge.

SLUDGE The settleable solids separated from liquids during processing.

SOLUBLE BOD Soluble BOD is the BOD of water that has been filtered in the standard suspended solids test.

SUSPENDED GROWTH Wastewater treatment processes in which the microorganisms and bacteria treating the wastes are suspended in the wastewater being treated. The wastes flow around and through the suspended growths. The various modes

of the activated sludge process make use of the suspended growth reactors. These reactors can be used for BOD removal, nitrification, and denitrification.

SUSPENDED SOLIDS Solids that are suspended in water, wastewater, or other liquids, and which are largely removable by laboratory filtering.

TOC Total organic carbon. Measures the amount of organic carbon in water.

TERTIARY Any process of water renovation that upgrades treated wastewater to meet specific reuse requirements. May include general cleanup of water or removal of specific parts of wastes insufficiently removed by conventional treatment processes. Typical processes include chemical treatment and pressure filtration. Also called **ADVANCED WASTE TREATMENT**.

TOTALIZER A device or meter that continuously measures and calculates (adds) as process rate variable in cumulative fashion, such as a flow meter.

TURBIDITY Turbidity units measure of the cloudiness of water. If measured by a nephelometric (deflected light) instrumental procedure, turbidity units are expressed in nephelometric units (NTU) or simply TU.