BIOTRICKLING FILTER FOR TREATING EMISSIONS OF ODORS, ORGANICS AND INORGANICS

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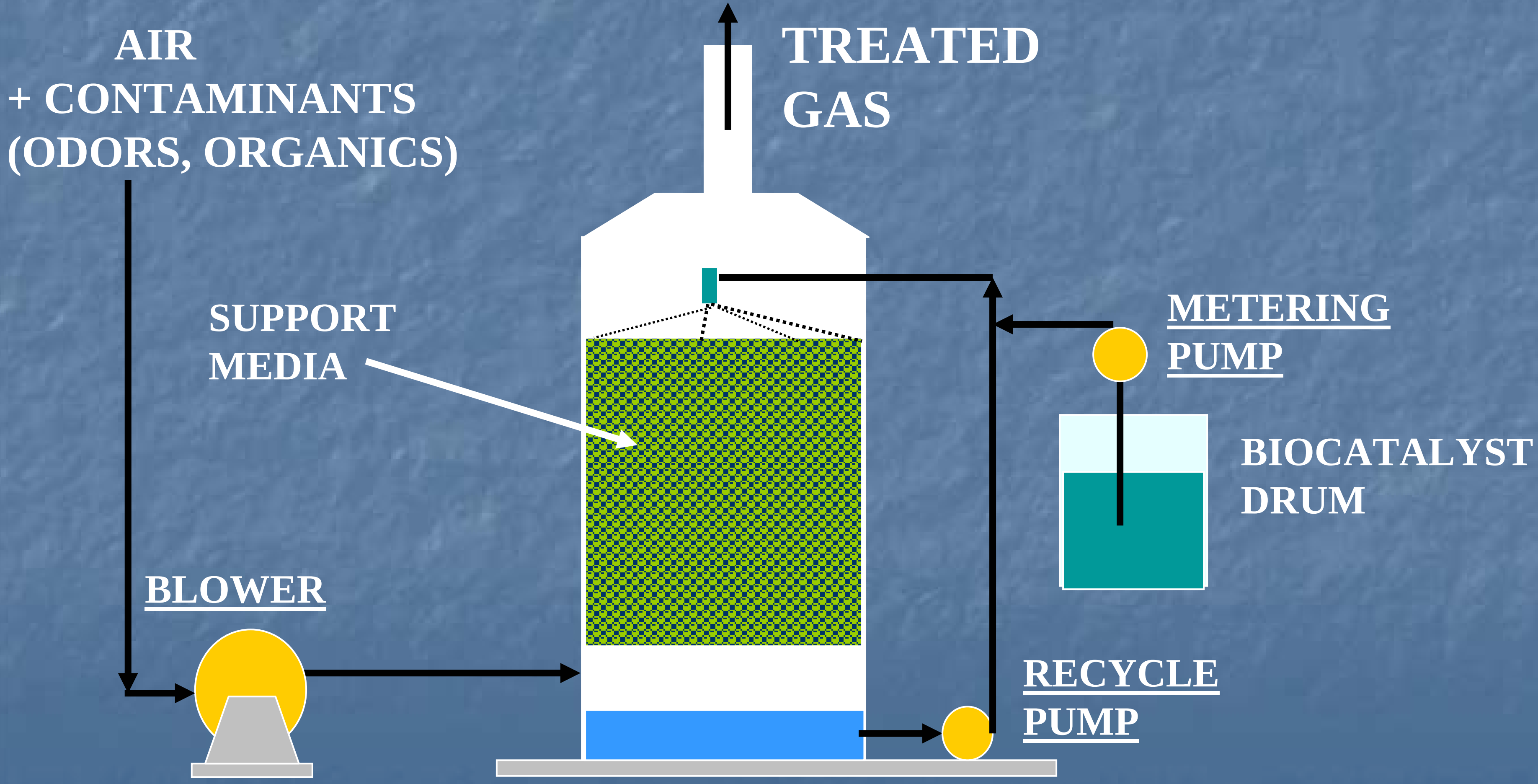
PROBLEM STATEMENT

- Organic (aldehydes, etc.) and Inorganic (hydrogen sulfide etc.). Odors are emitted from headworks, sludge handling operations, and anaerobic digesters.
- Volatile Organic Compounds (VOCs) are emitted from aeration basins and clarifiers.
- Odors are a nuisance to plant personnel and surrounding communities.
- VOCs may be toxic and result in environmental pollution of surrounding air

BIOFILTRATION

- Involves direct biological transformation;
  Gas-Phase Residence time - 0.1 - 10 seconds
- Can biodegrade organic volatile and odorous compounds - both Odor and VOC Control
- Can treat both hydrophilic (high water solubility) and hydrophobic (low water solubility) compounds
- Does not generate chemical by-products
- Environmentally Friendly Technology
- Lower Operating Cost
- Can handle hydrogen sulfide (converts to sulfate)

TYPICAL BIOFILTER SYSTEM



TECHNOLOGIES FOR TREATMENT OF ODORS & VOLATILE COMPOUNDS

1. **Chemical Oxidation - oxidation of odorous compounds by oxidizing agents, such as dissolved aqueous chlorine, hypochlorite, ozone, etc.**

2. **Thermal Destruction - destruction of odorous compounds at high temperature either catalytically or in gas combustors**

3. **Biological Treatment - conversion of odorous compounds to carbon dioxide and water by aerobic microorganisms**

CHEMICAL OXIDATION

- Requires oxidizing agents, such as hypochlorite, ozone, chlorine gas, etc. Chemical handling and storage is required.
- Increased operating cost due to cost of oxidizing agents.
- Use of chlorine gas and hypochlorite produces chlorine gas emissions; source of pungent odors and if dissolved chlorine water is returned to high BOD water, it results in the formation of volatile halo-carbons - carcinogenic compounds.

TYPES OF BIOFILTERS

- **Naturally Bioactive Media**
  Peat, Compost, wood chips, etc.

- **Synthetic Support Media**
  Plastic, Ceramic, etc.

NATURALLY BIOACTIVE MEDIA BIOFILTERS

- Settling of media due to biomass growth eventually causes gas by-passing, and increased gas-phase pressure drop
- Eventual partial or total replacement of support media (peat, compost, etc.) is required to replenish nutrients, and provide high void fraction to reduce pressure drop
- Media height is limited to prevent uneven drying of media; this results in very large cross-sectional areas for the biofilter system
- Natural bioactive media has limited capacity to biodegrade contaminants and odorous compounds; Can handle low concentrations (< 50 ppmv) in gas phase. Media also has limited capacity to neutralize acids.

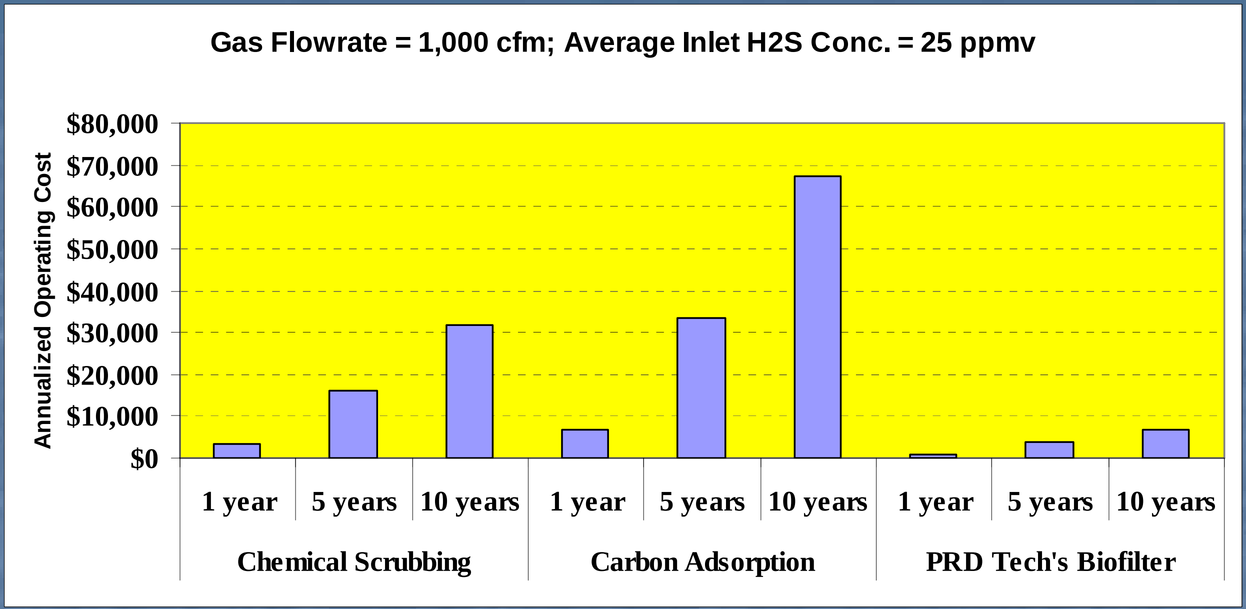
SYNTHETIC SUPPORT MEDIA

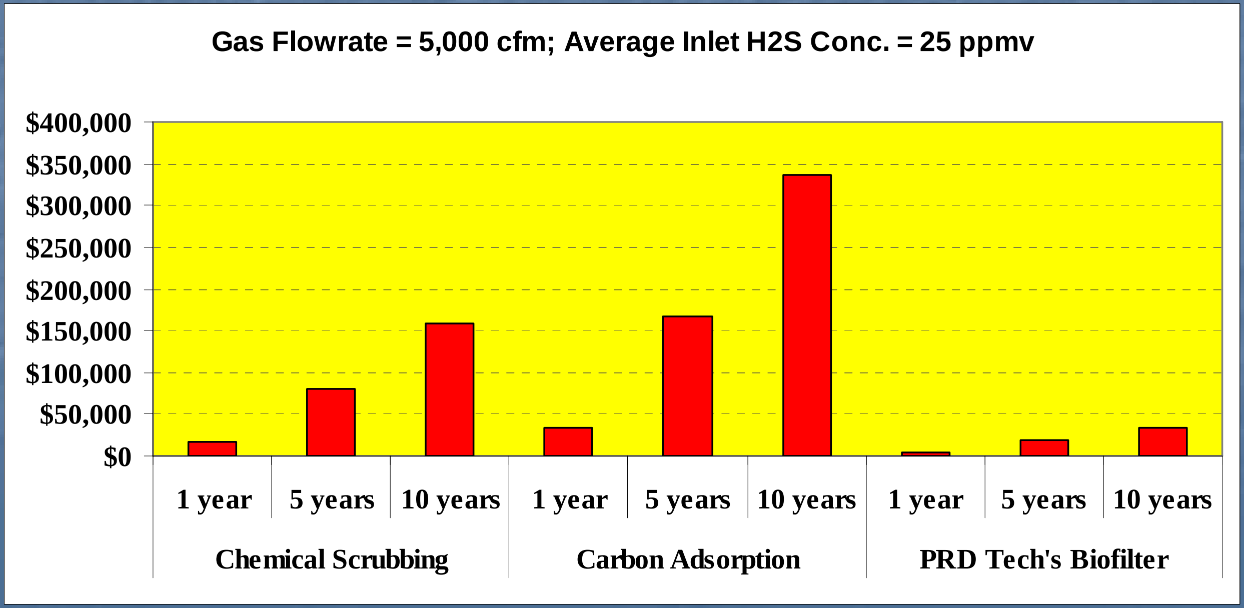
- Can be designed to provide high surface area per unit volume, high void fraction, and surface for attachment of biofilms
- Biomass growth is handled by constant sloughing-off of excess biomass growth, which is washed down by flowing nutrients
- Humidification of inlet gases is unnecessary; Nutrients and pH control buffers are supplied externally
- No height limitations; hence reasonable cross-sectional areas can be designed to minimize vessel cost

SYNTHETIC SUPPORT MEDIA cont'd.

- No media replacement necessary
- Cost of media is compensated by lower investment cost of smaller vessel and lower gas-phase pressure drop
- Significantly higher biodegradation rates as compared to naturally bioactive media; Handle higher organic and odorous compound(s) concentrations (25 - 5,000 ppmv)

ANNUALIZED COST COMPARISON





ANNUALIZED COST COMPARISON

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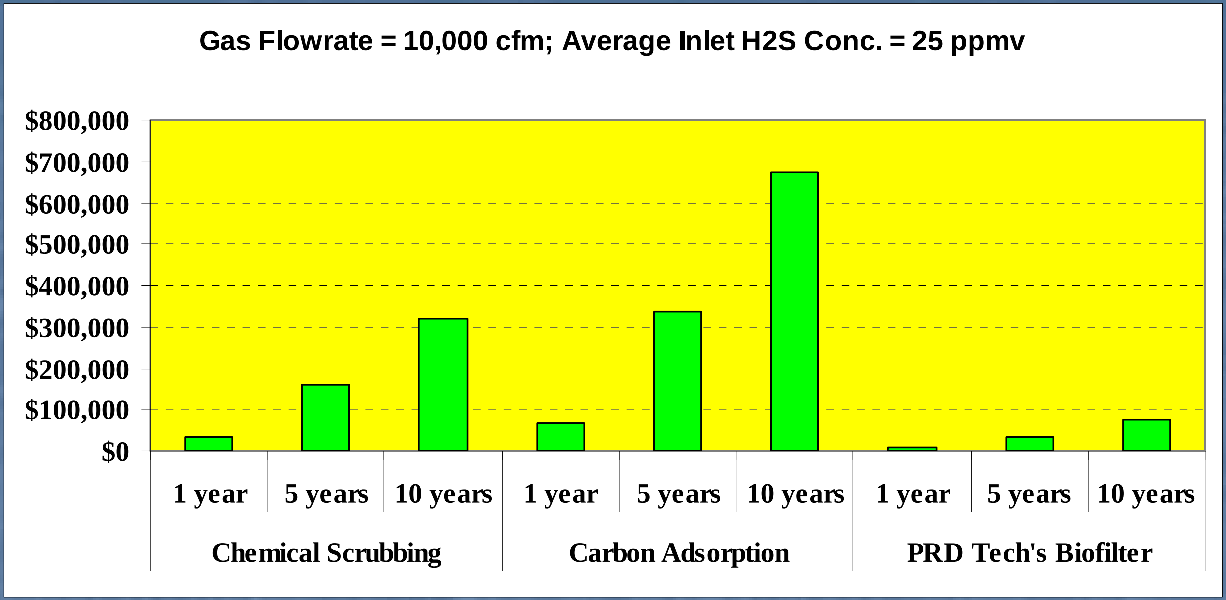
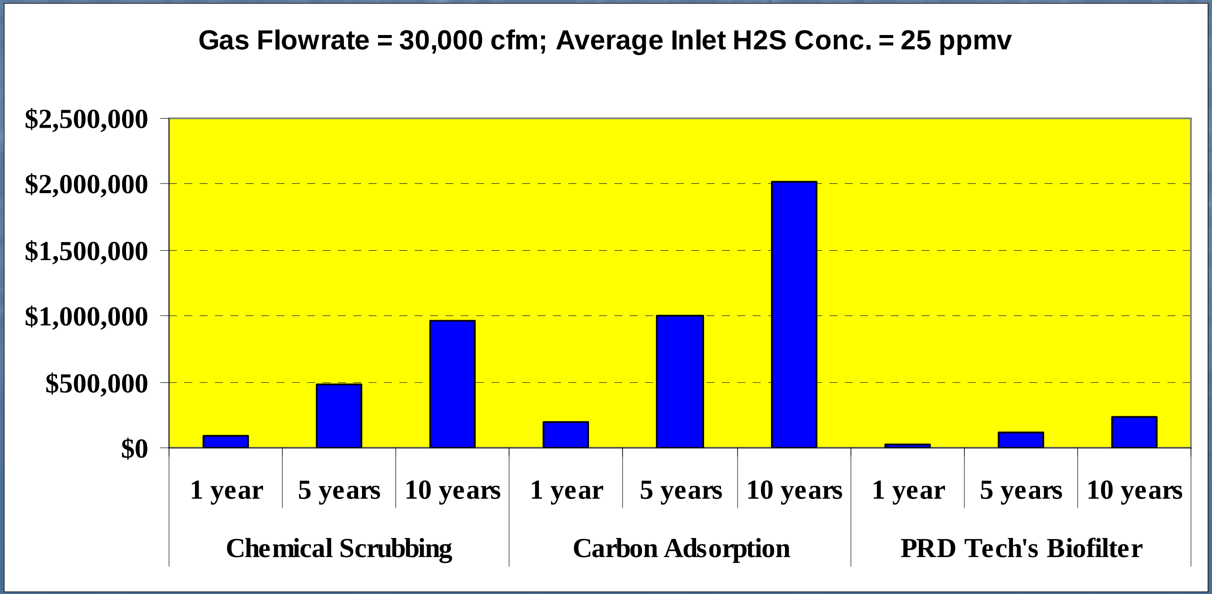
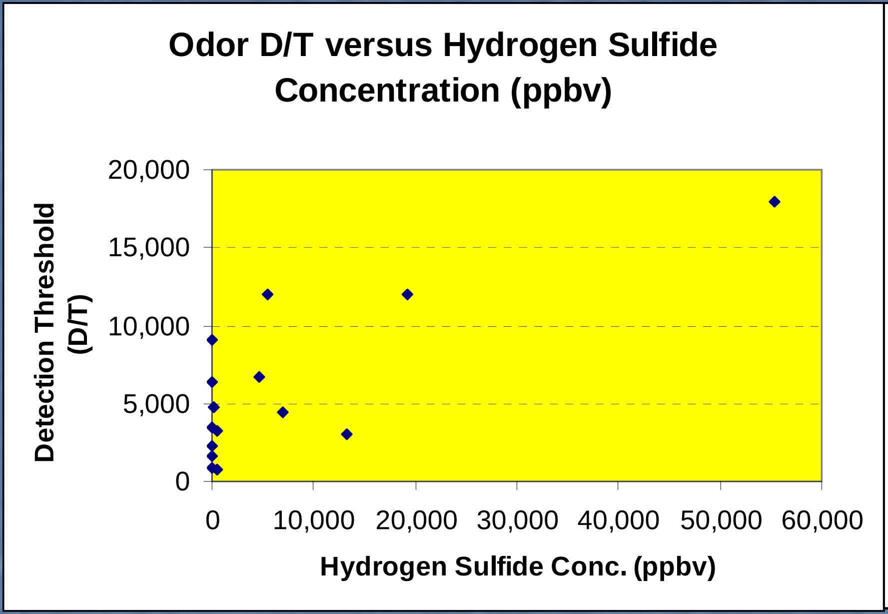


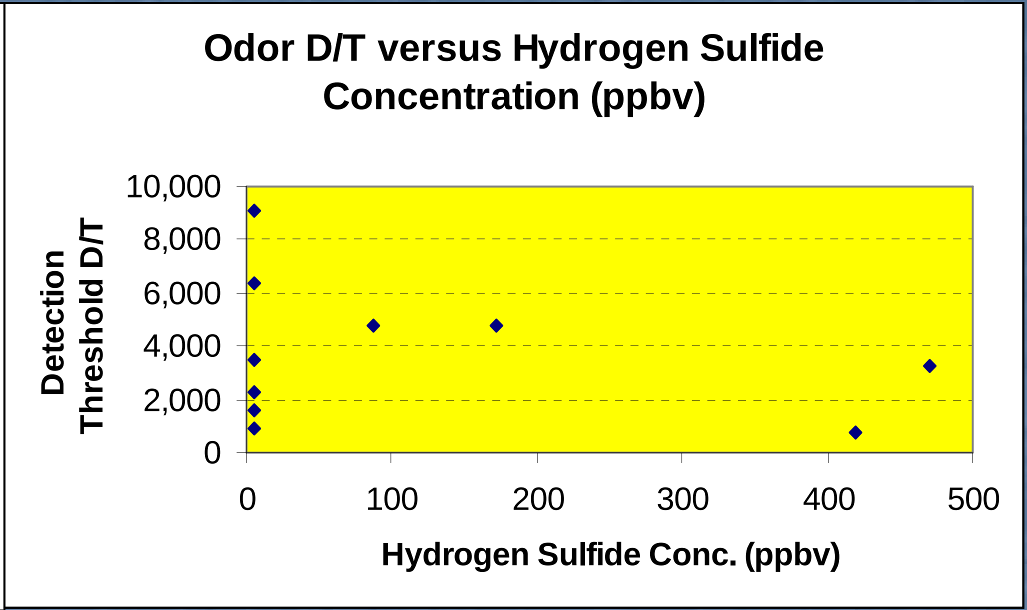


What is different about PRD Tech's Technology ?

- Small Footprint: Depending on inlet contaminant concentration, gas velocities in the range of 30 ft / min – 400 ft / min can be used;
- Operates at neutral pH: Converts hydrogen sulfide to Polythionic acid rather than sulfuric acid; Can simultaneously handle hydrogen sulfide, organic sulfur compounds and VOCs;
- Synthetic media is guaranteed against material deterioration and clogging due to excessive biomass growth for 10 years;
- Biomedia can be washed to remove excess biomass and sulfide precipitates while system is operating

H_2S CONTROL IS NOT ODOR CONTROL WHY ?





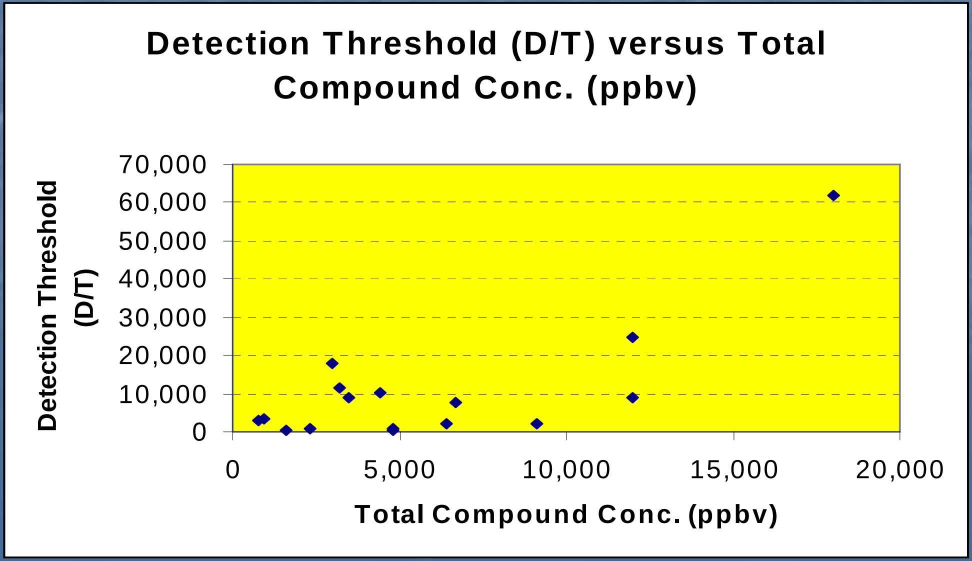


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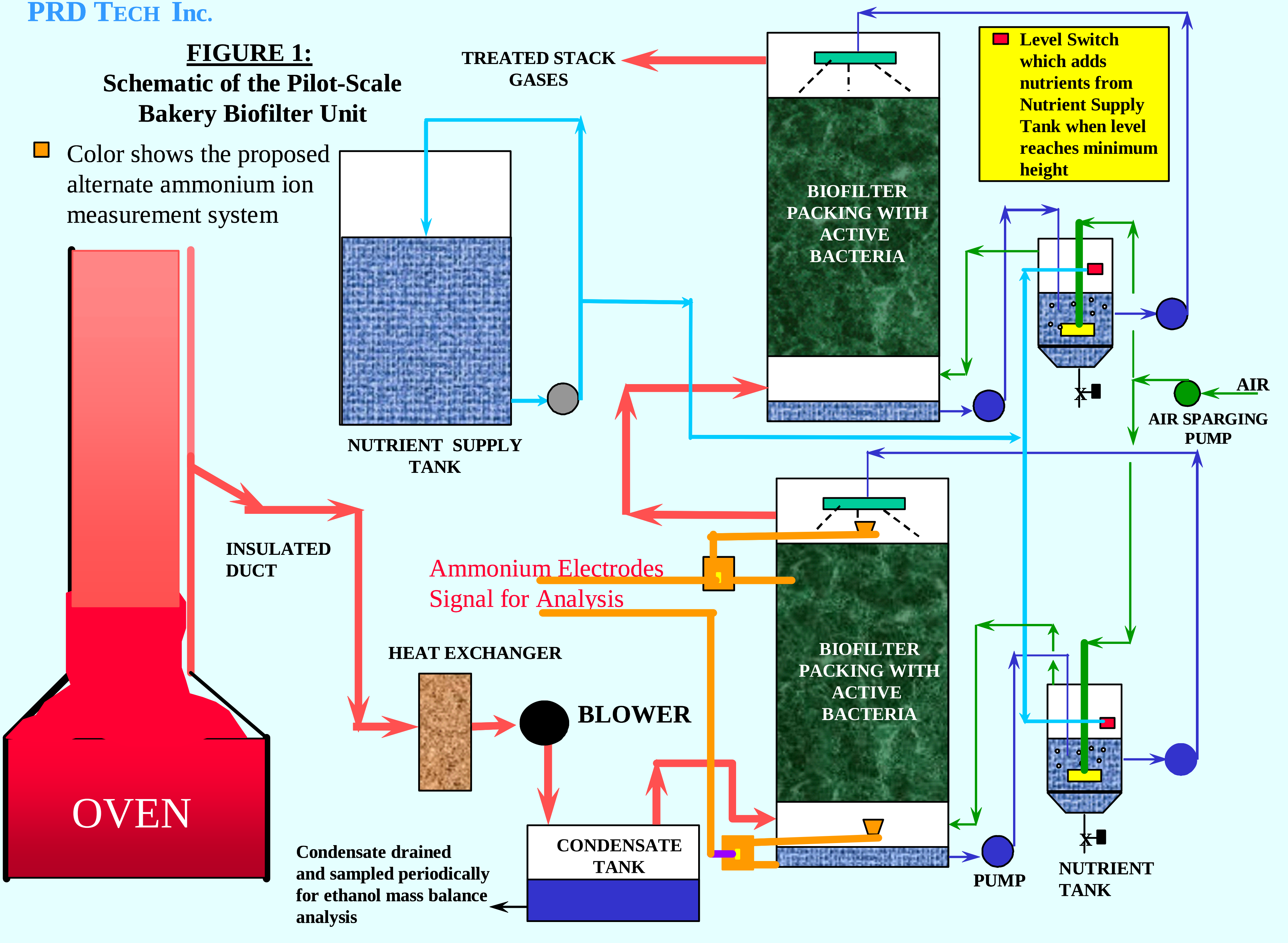
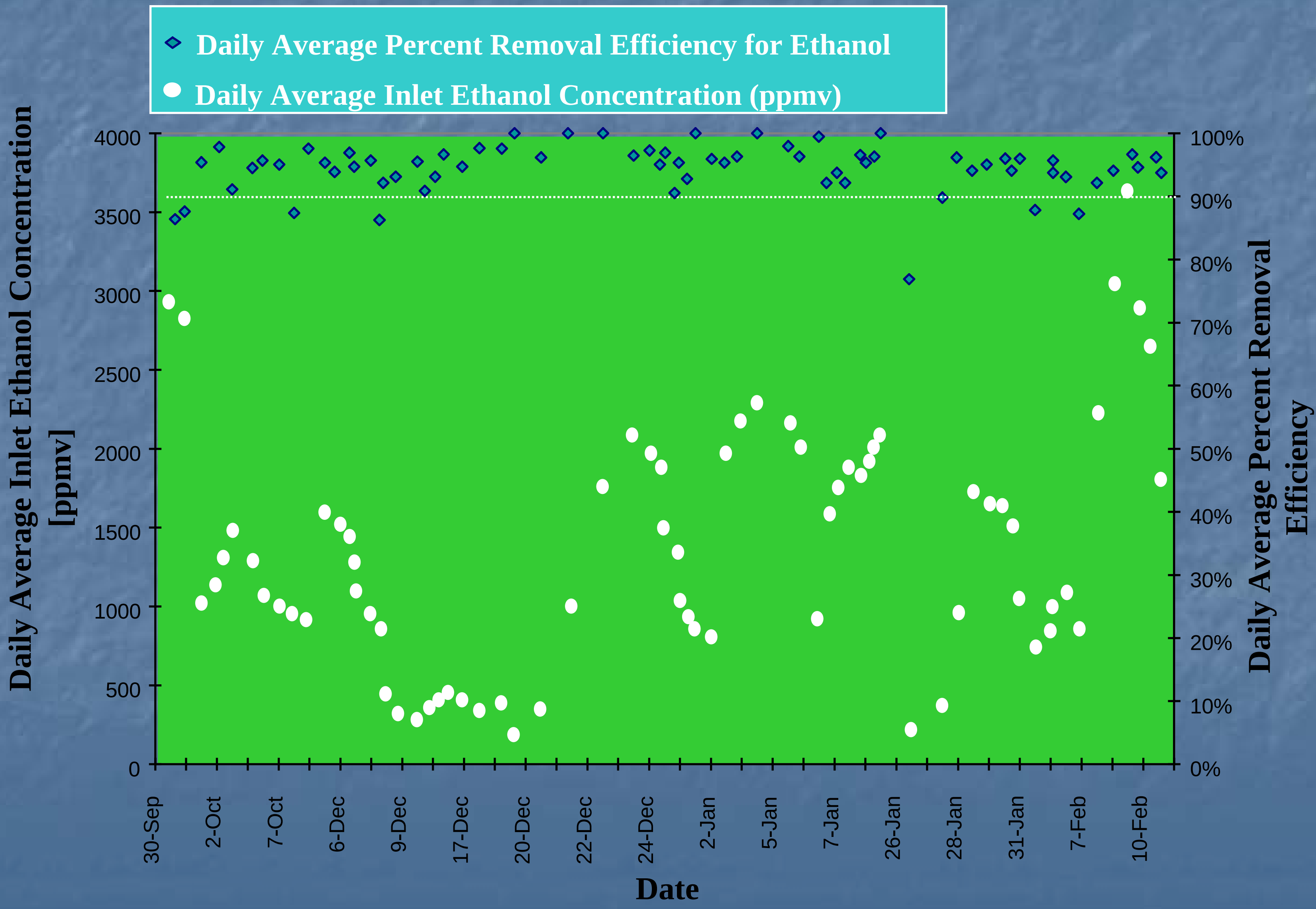
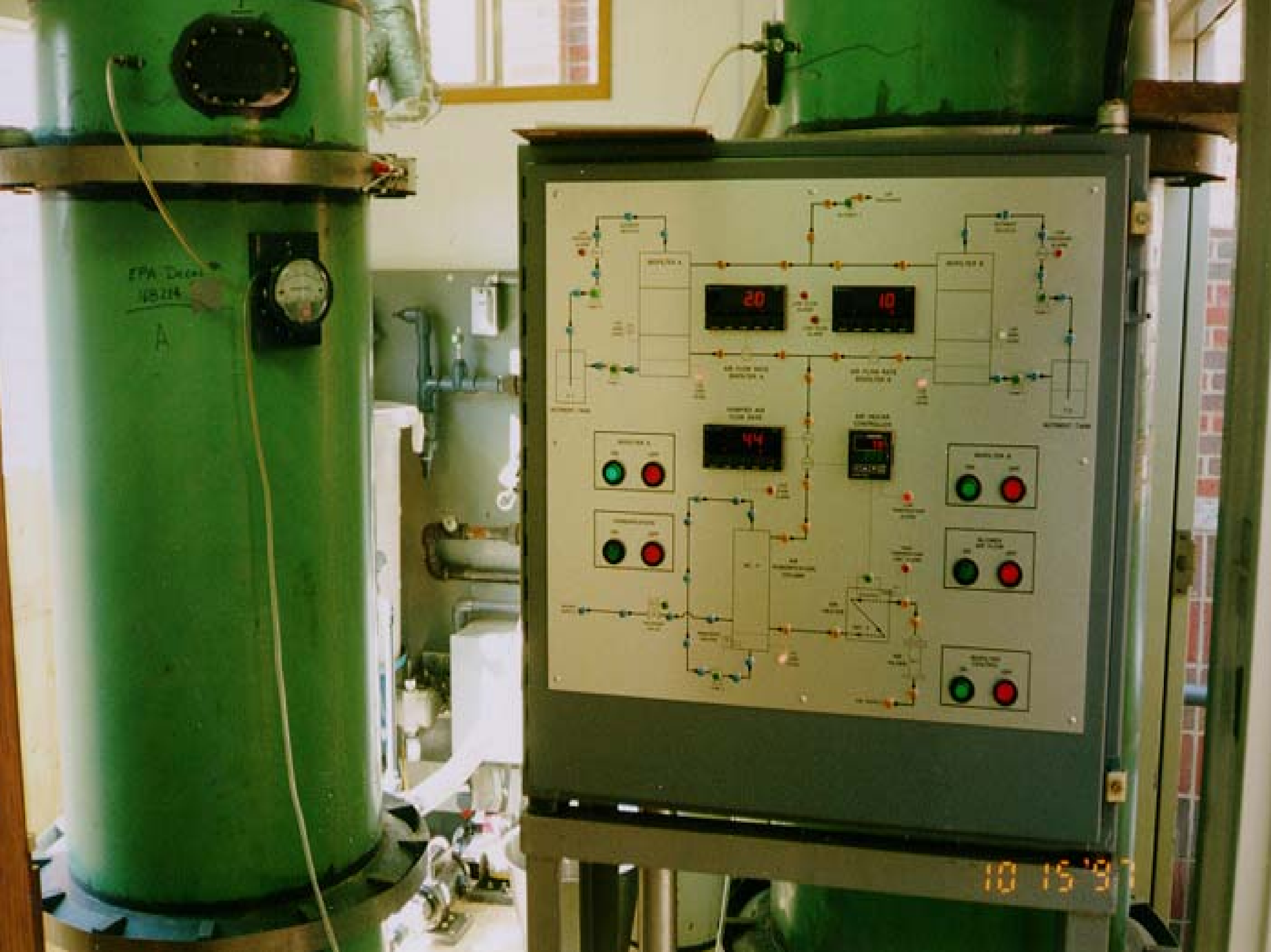
FIGURE 1:
Schematic of the Pilot-Scale Bakery Biofilter Unit

Color shows the proposed alternate ammonium ion measurement system



BIOTREATMENT OF ETHANOL FROM BAKERY EXHAUST GASES

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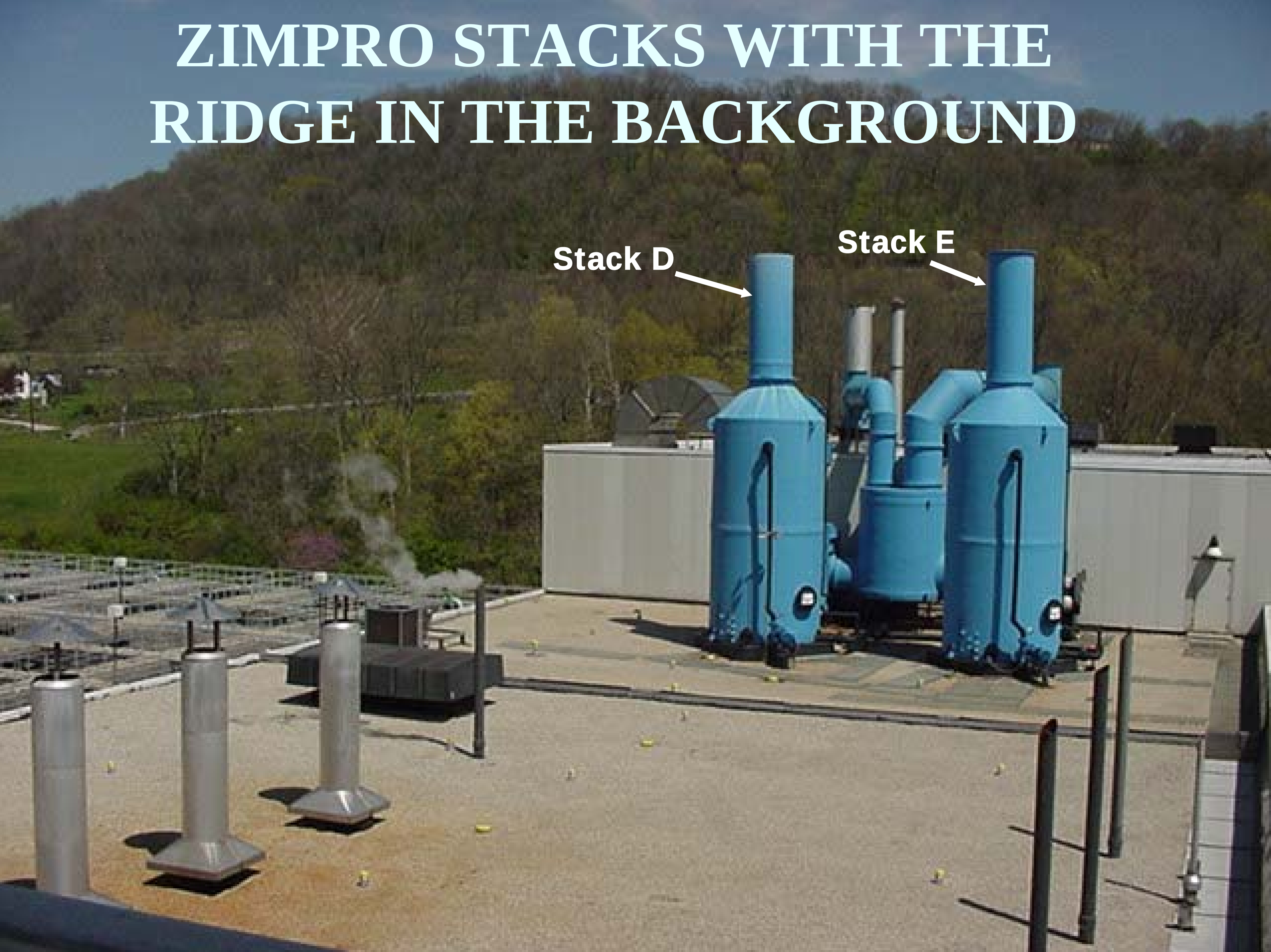
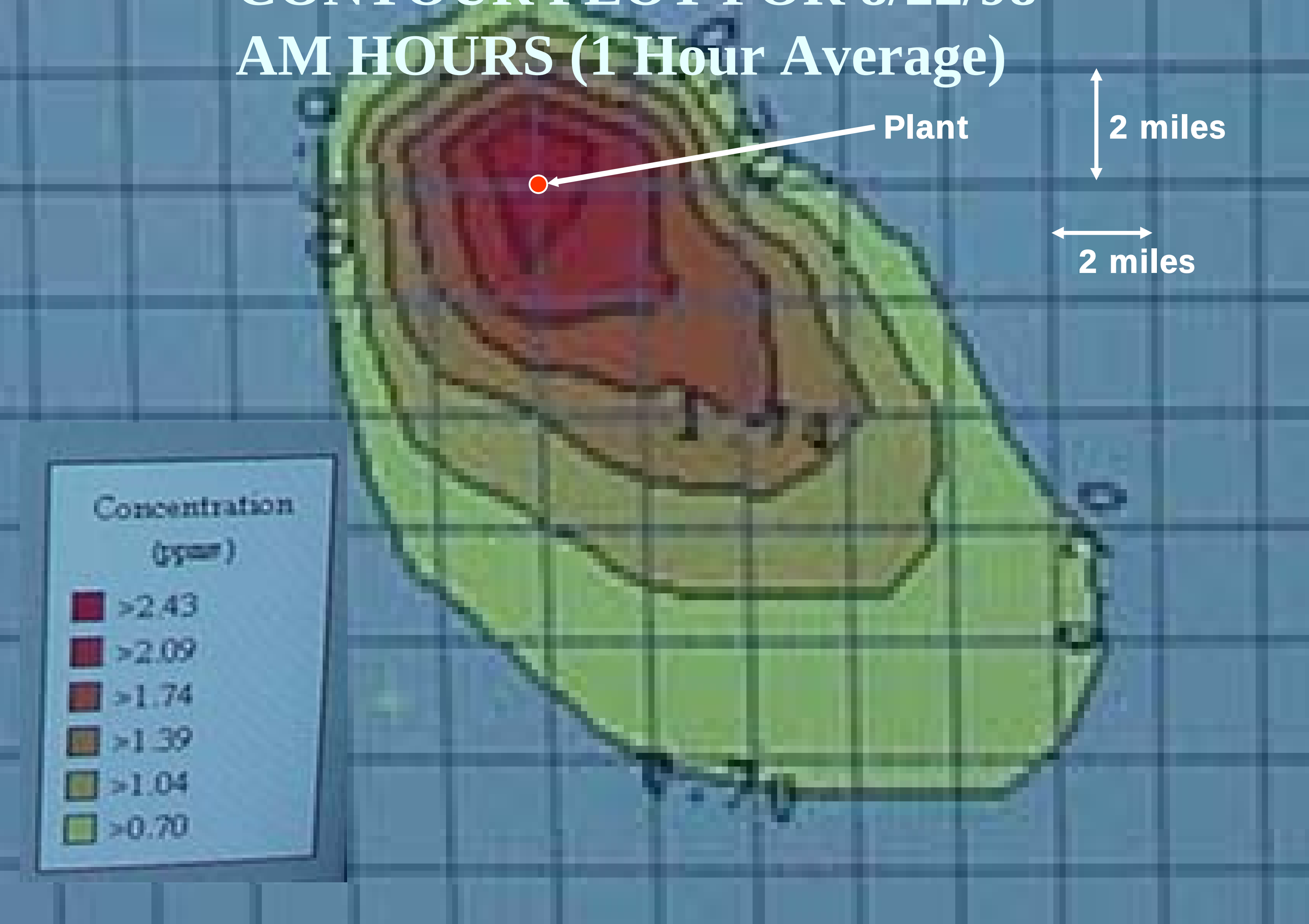
DRY CREEK TREATMENT PLANT

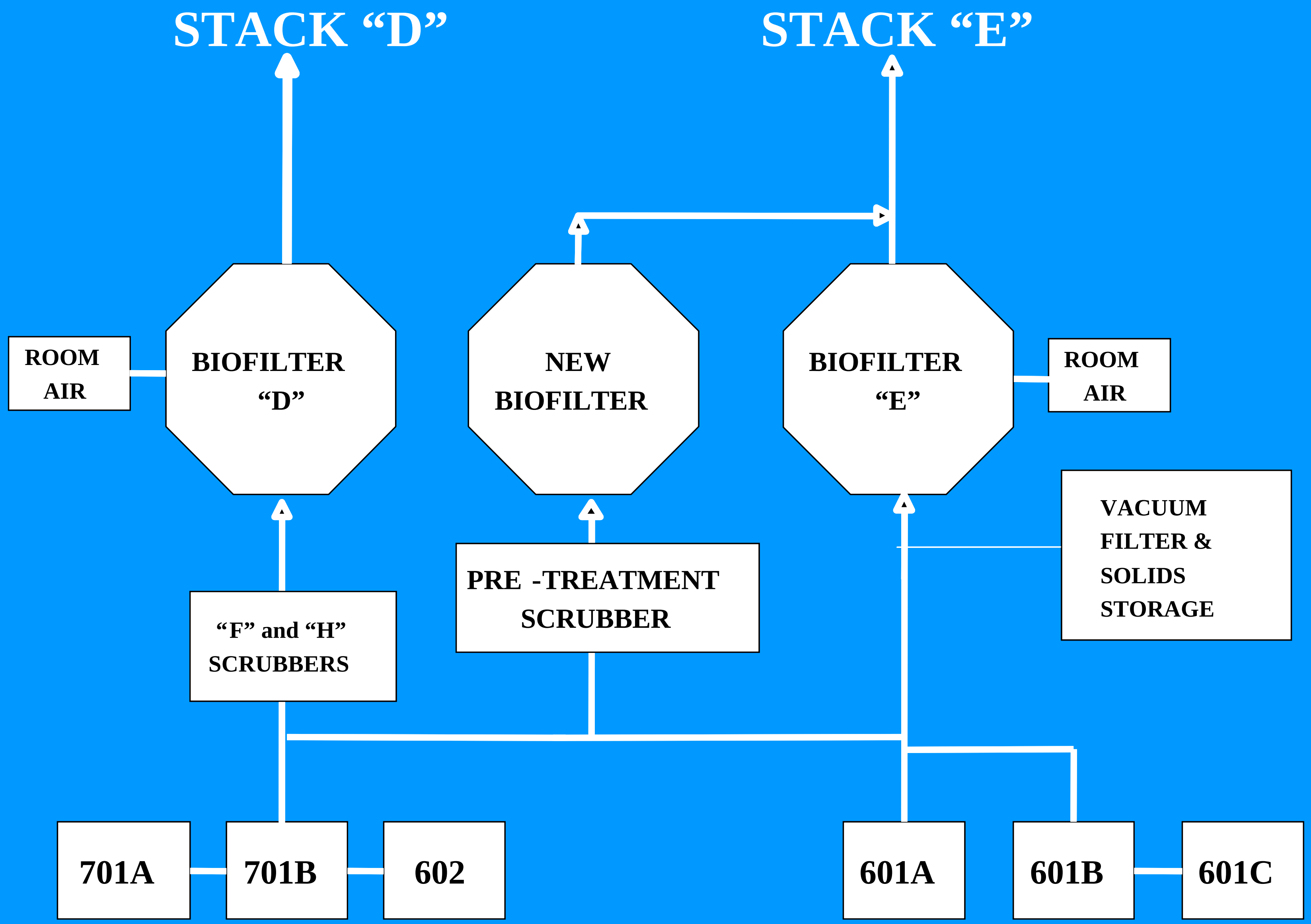
TERRAIN SURROUNDING THE DRY CREEK TREATMENT PLANT

ZIMPRO STACKS WITH THE RIDGE IN THE BACKGROUND



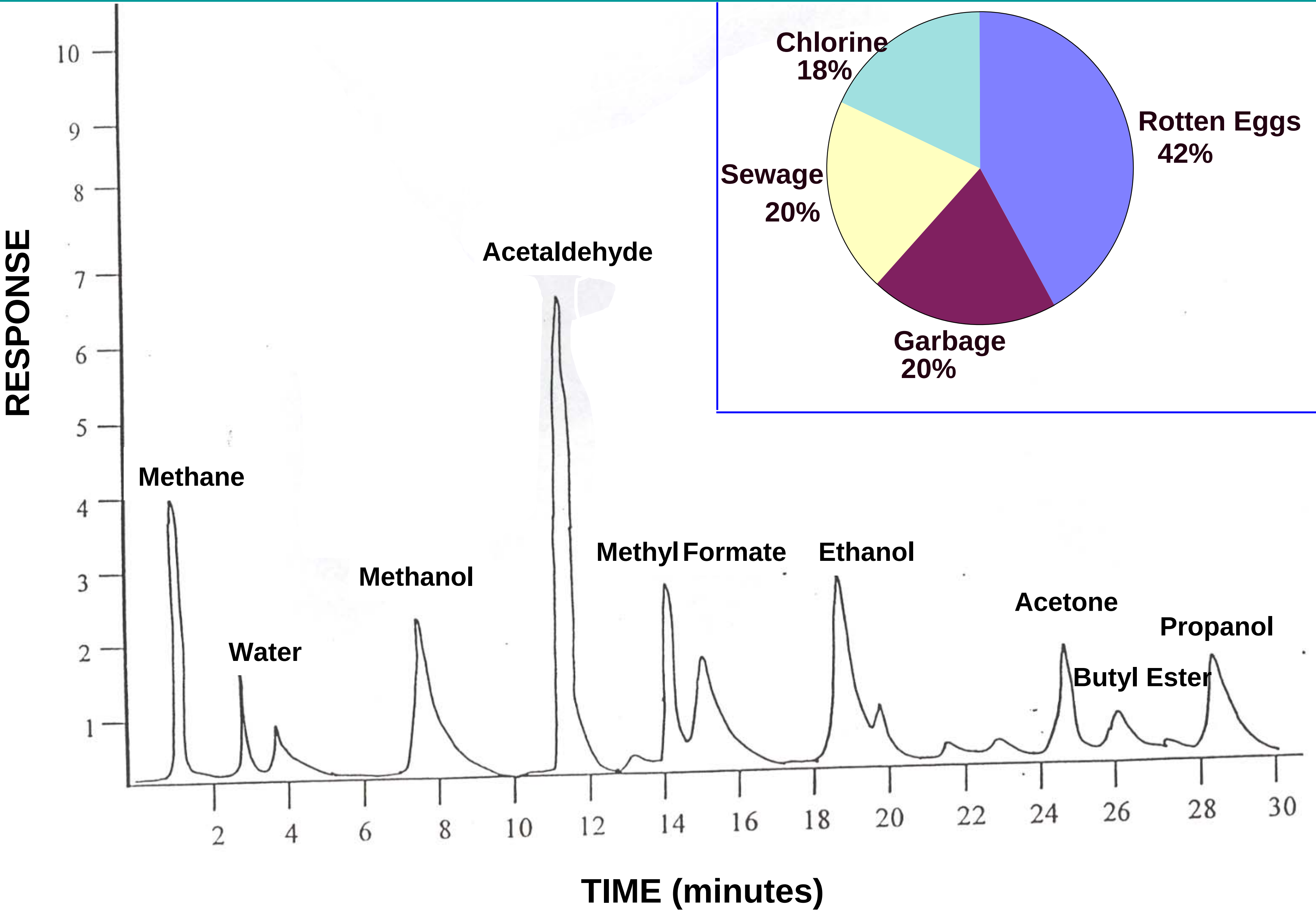
CONTOUR PLOT FOR 8/22/98 AM HOURS (1 Hour Average)



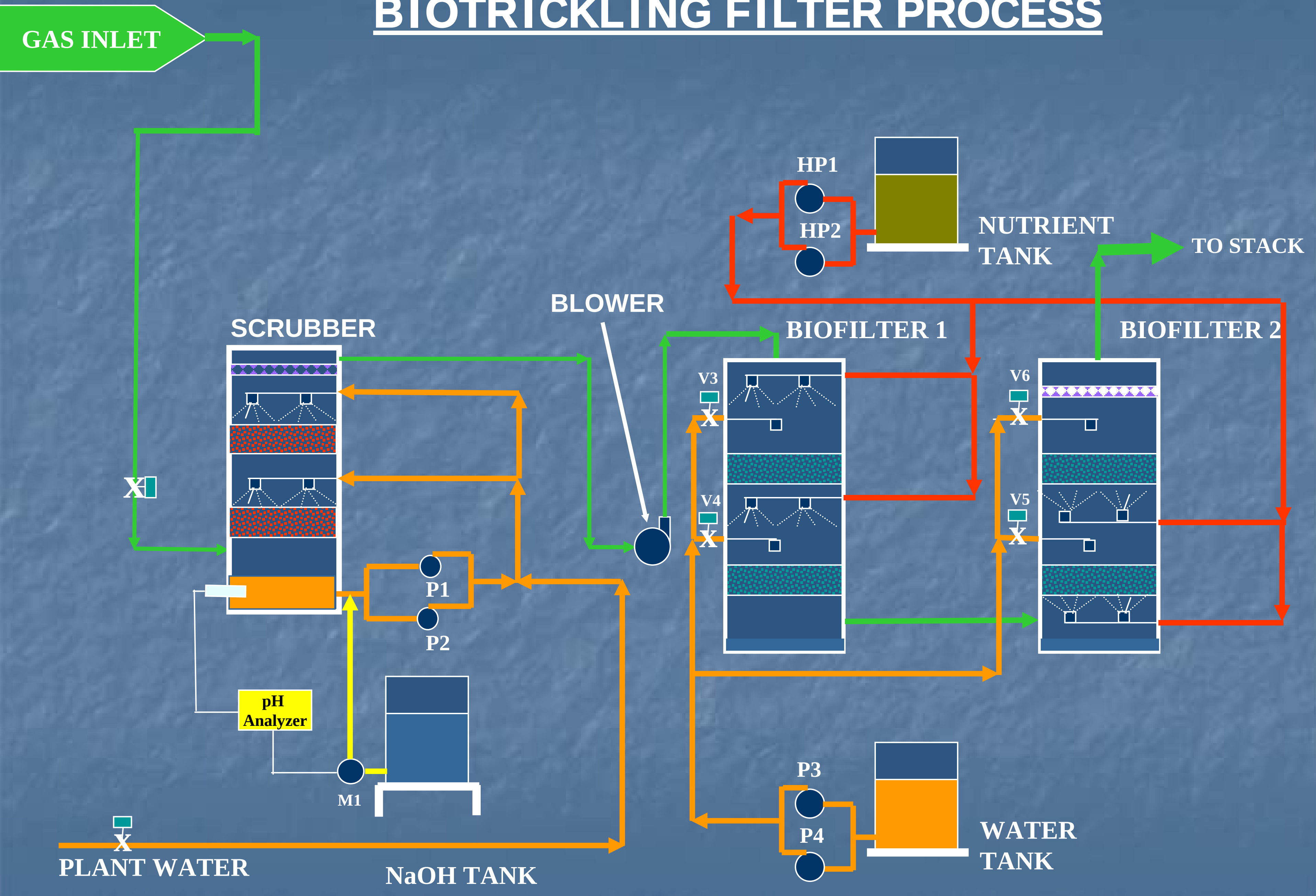


Tanks 701A, 701B, 602, 601A, 601B and 601C are raw and treated sludge storage tanks

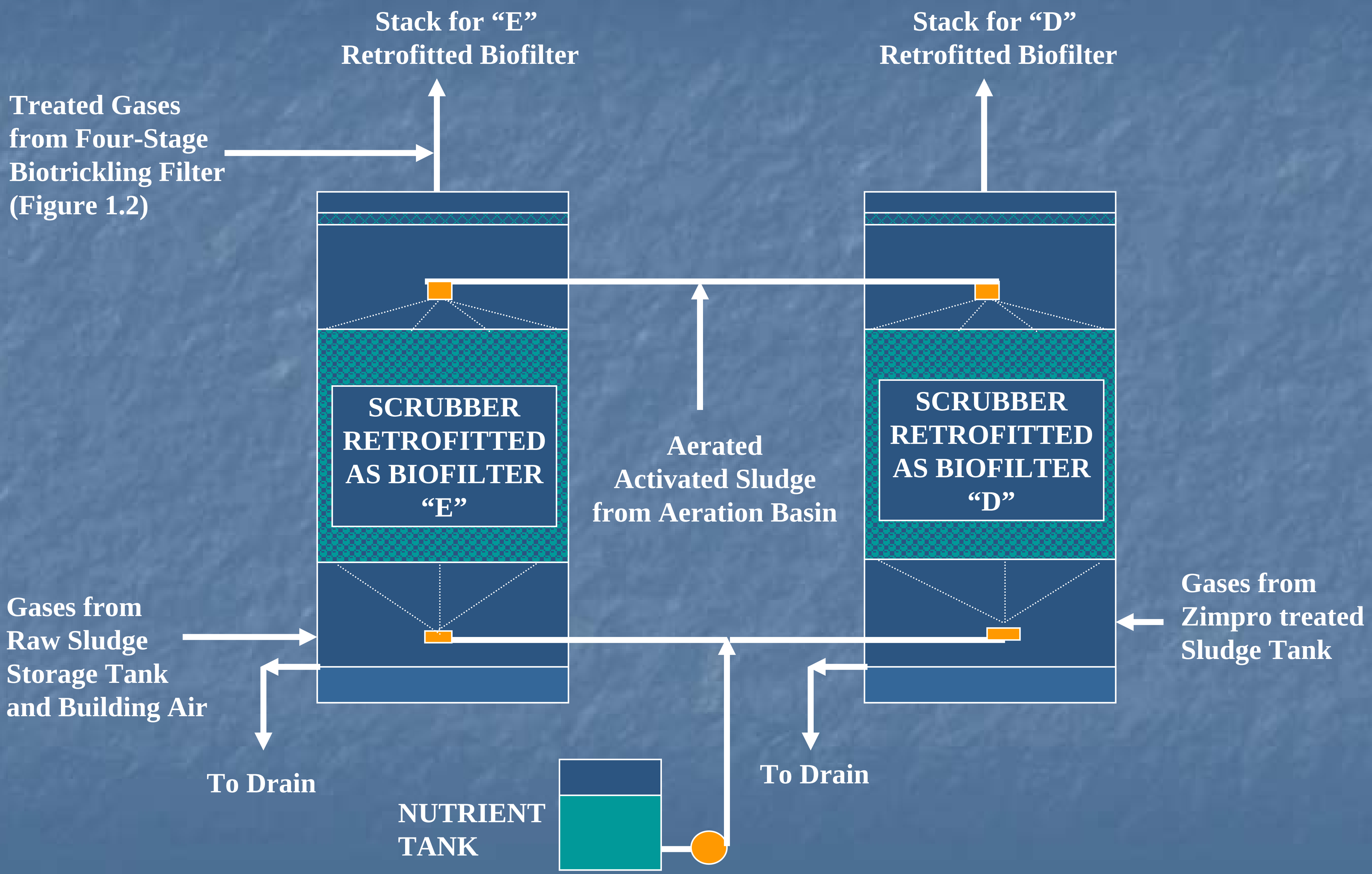
GC ANALYSIS OF ZIMPRO ODORS



BIOTRICKLING FILTER PROCESS



CHLORINE SCRUBBER RETROFITTED AS BIOFILTERS



Maximum Flow: 15,000 cfm

Maximum inlet DT of odors 31,000
Maximum Inlet RT of odors 38,300

Total height of media in 4 beds: 12 ft
Diameter of each vessel: 6 ft

Total volume of media in 4 beds: 340 ft^3

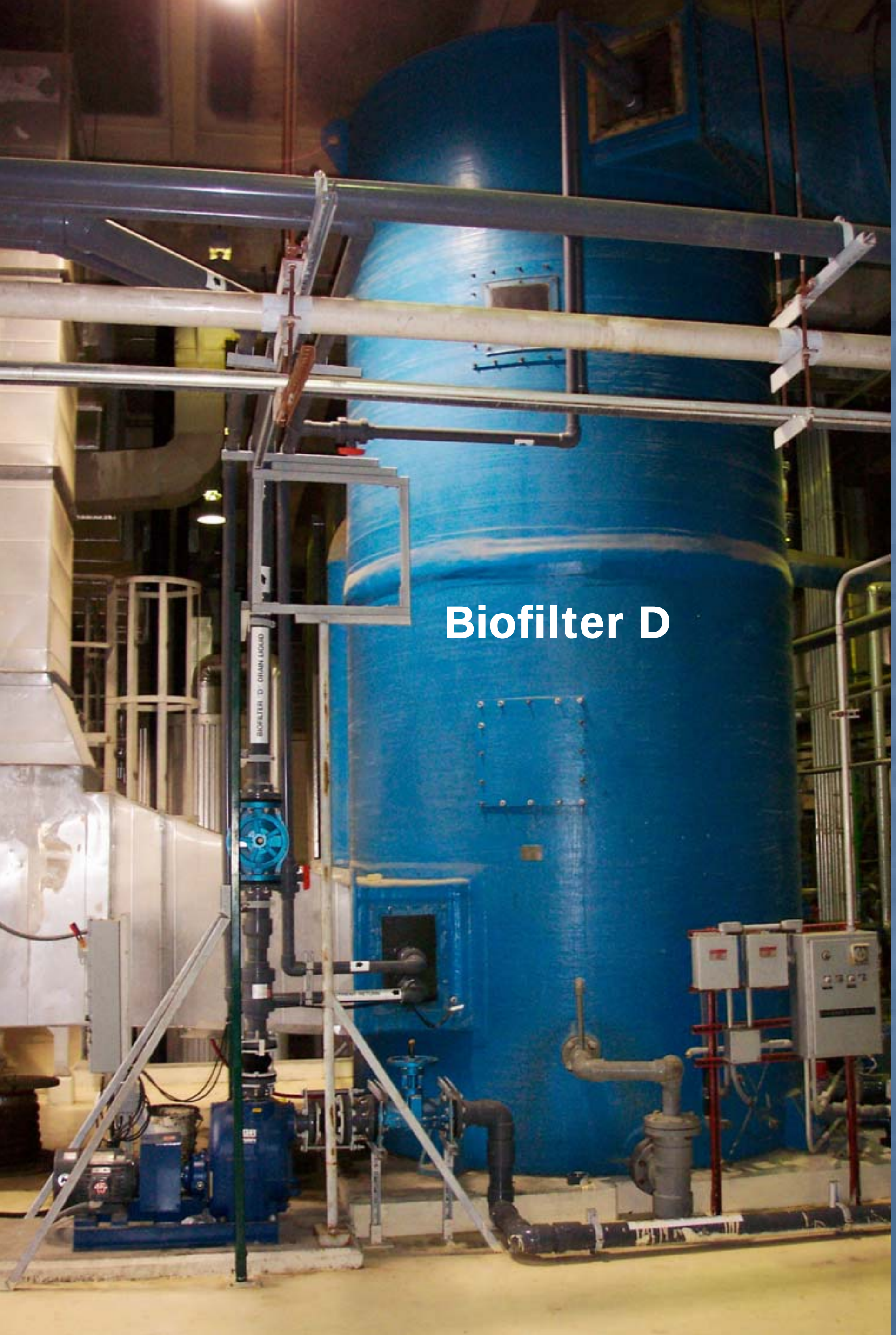
Empty Bed Residence Time: 2.3 seconds (at 9000 cfm)

% Odor Treatment Efficiency: 99.6 % (DT)

% Odor Treatment Efficiency: 99.5 % (RT)

Liquid flow rate: 3.5 gallons per minute per ft^2

RETROFIT CONVERSION OF SCRUBBERS D & E TO BIOFILTERS



Gas flow rate:	30,000 cfm ea.
Diameter:	10 ft
Height of media:	5 ft
Volume of biomedia:	393 ft^3
Empty Bed Residence Time:	0.8 sec.
Liquid flow rate:	2.4 gpm/ft^2

Scrubber D → Biofilter D

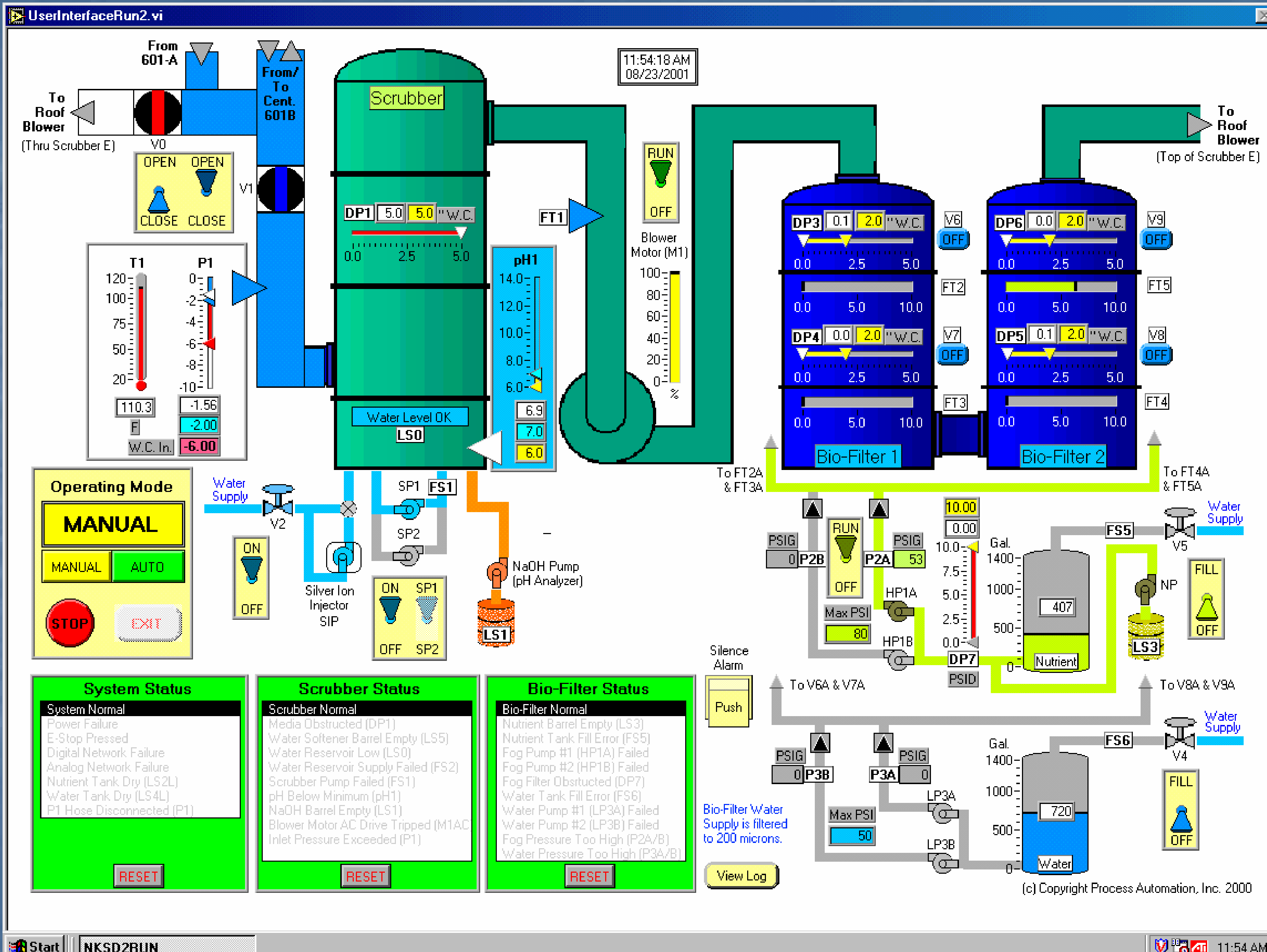
% Treatment: 99.9% (DT)
99.8% (RT)

Scrubber E → Biofilter E

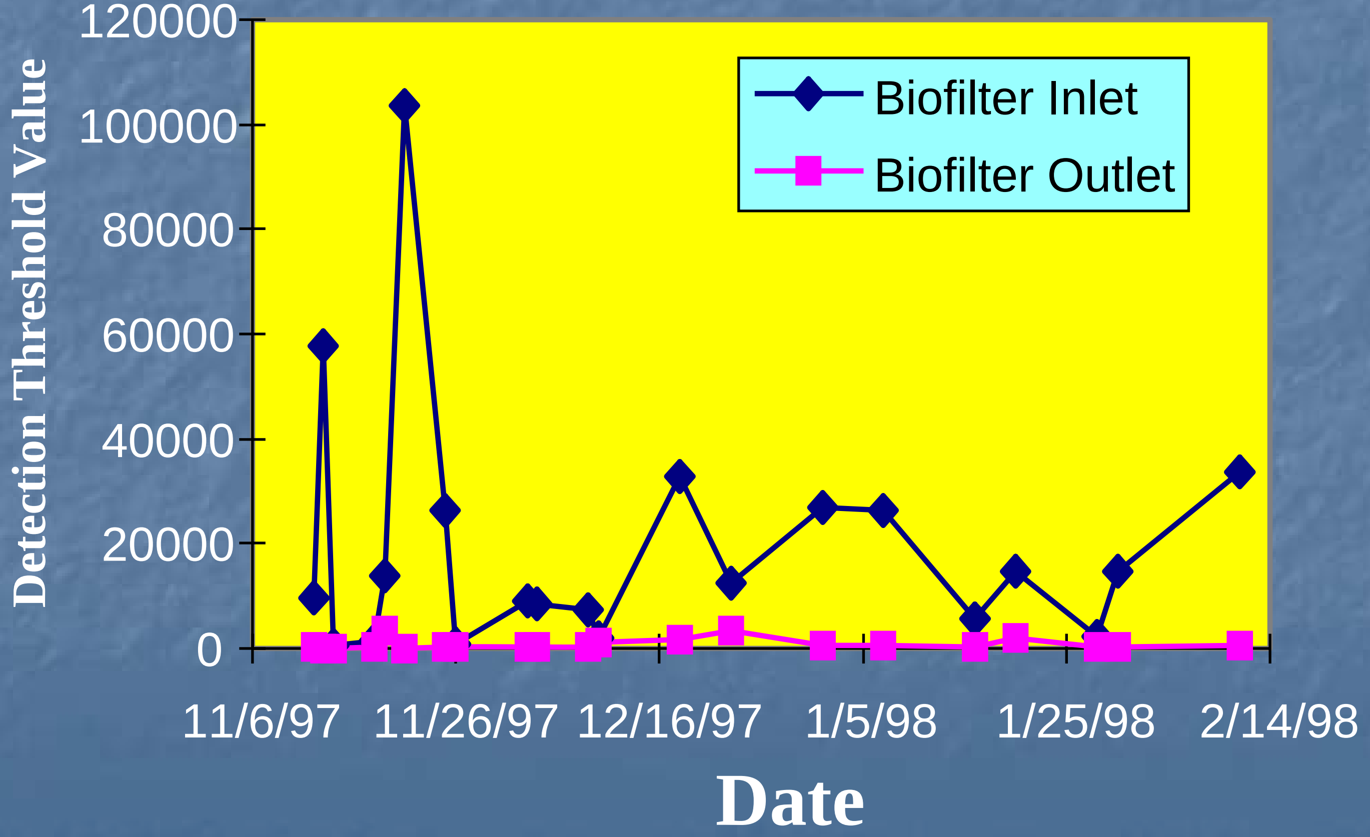
% Treatment: 99.7% (DT)
99.6% (RT)

COMPUTER CONTROL SYSTEM

COMPUTER CONTROL SCREEN



INLET AND OUTLET DETECTION THRESHOLD VALUES



ADVANTAGES OF BIOFILTRATION

- Ambient temperature and pressure technology

- Produces no toxic by-products
  Chlorine (aqueous) scrubbing → Halocarbons
  Hypochlorite and NaOH → Chlorine & Halocarbons
  Thermal oxidation → combustion by-products

- Substantial cost savings
  Chemical treatment → Chemical Costs
  Thermal oxidation → Natural gas cost
  Short payback time

- Existing chemical scrubbers can be retrofitted
  No emission of by-products (halocarbons are carcinogenic)
  Saves chemical costs

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Biotrickling Filters

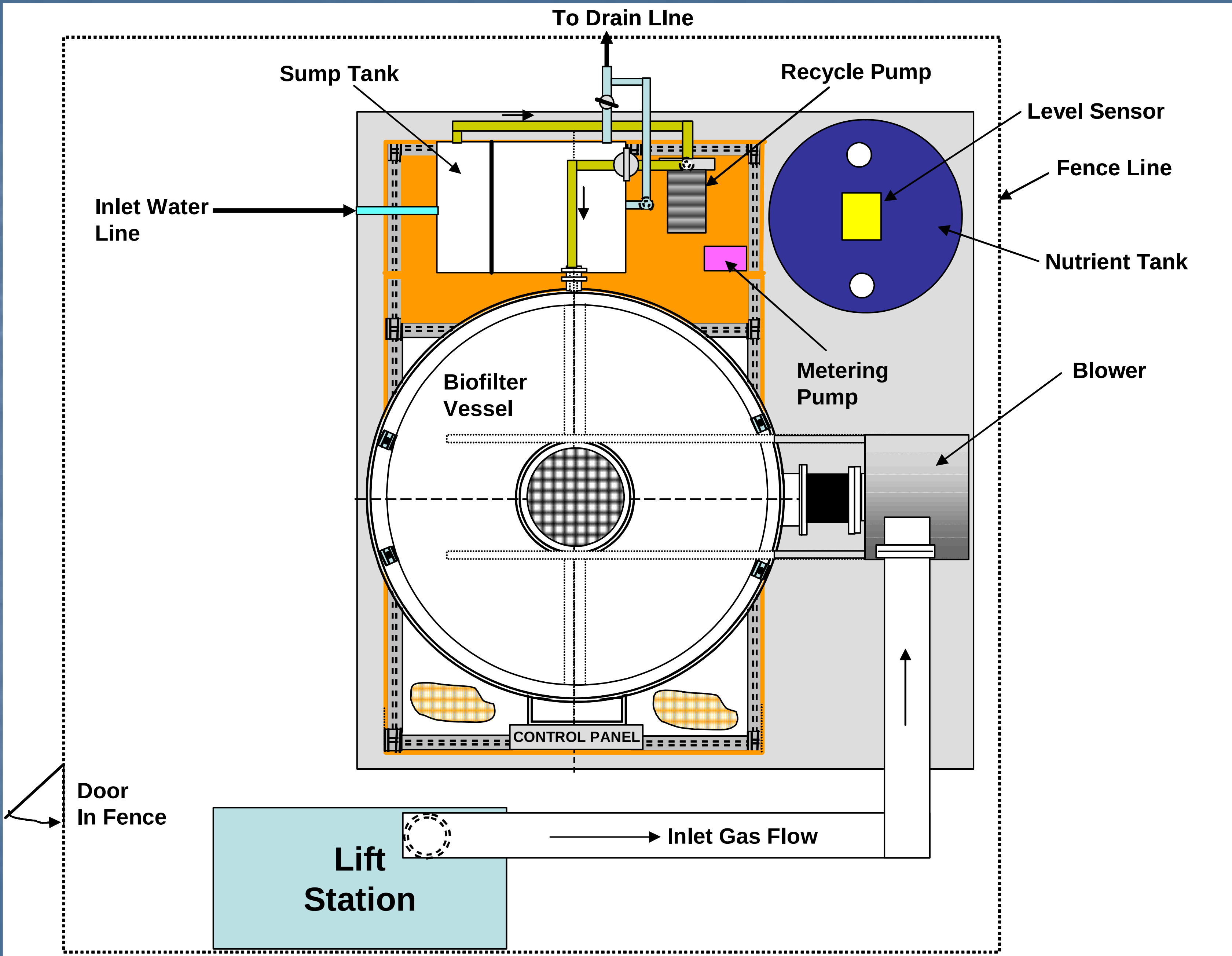
Customer	Engineer	Biotrickling Filter Capacity / Size / Source of Odors / Installation Date
Interstate Brands Corporation Wonder Bread Bakery Columbus, Ohio	American Bakers Association Washington, DC (202) 789-0300	104 cfm [pilot-scale] (2) 2' dia. x 6' high vessels Bakery oven ethanol emissions Pilot study: Sept. 1997 – Feb. 1998
Sanitation District No.1 of Northern Kentucky Dry Creek Wastewater Treatment Plant Villa Hills, Kentucky (859) 331-6674 Nick Dornbusch – Plant Manager	Sanitation Dist. No.1 of Northern Kentucky Fort Wright, Kentucky (859) 578-7450 Mike Kendall – Director, Special Projects	15,000 cfm (2) 6' dia. x 14' high FRP vessels Zimpro heat treated sludge process Installation date: 2001
Sanitation District No.1 of Northern Kentucky Dry Creek Wastewater Treatment Plant Villa Hills, Kentucky (859) 331-6674 Nick Dornbusch – Plant Manager	Sanitation Dist. No.1 of Northern Kentucky Fort Wright, Kentucky (859) 578-7450 Mike Kendall – Director, Special Projects	60,000 cfm (2) 10' dia. x 30' high existing FRP vessels Raw sludge & heat treated sludge tanks Retrofit conversion date: 2001
JEA [Jacksonville Electric Authority] Lift Station S727 Jacksonville, Florida (904) 665-4432 Kim Thornton	JEA Jacksonville, Florida (904) 665-6736 Colin Groff, P.E. – Manager, Maintenance & Technical Services	400 cfm 6.5' dia. x 9' high FRP vessel Lift station wet well Installation date: March 2005
Seminole Hard Rock Hotel & Casino Lift station with surge tank Tampa, Florida	PBS&J Tampa, Florida	400 cfm 4' dia. x 17' high FRP vessel 40,000 gallon surge tank Delivery date: April 2005

PRD Tech, Inc.
Biotrickling Filters

Owner	Engineer	Biotrickling Filter Capacity / Size / Source of Odors / Installation Date
Town of Ocean City Wastewater Treatment Plant Ocean City, Maryland	Whitman, Requardt and Associates, LLP Baltimore, Maryland (410) 235-3450 William Bingley, P.E.	400 cfm 6.5' dia. x 9' high FRP vessel Sludge blending & holding tanks Delivery date: June 2005
Louisville Metropolitan Sewer District Morris Forman Wastewater Treatment Plant Louisville, Kentucky (502) 540-6753 Norm Robinson	Webster Environmental Associates, Inc. Louisville, Kentucky (502) 253-3443 Neil Webster – President	9,200 cfm (2) 14' dia. x 39' high FRP vessels Solids receiving & thickened WAS tanks Delivery date: July 2005
Louisville Metropolitan Sewer District Morris Forman Wastewater Treatment Plant Louisville, Kentucky (502) 540-6753 Norm Robinson	Webster Environmental Associates, Inc. Louisville, Kentucky (502) 253-3443 Neil Webster – President	2,000 cfm [pilot scale] 4' dia. x 17' high FRP vessel Bioroughing towers Pilot study: June – Nov. 2005
Clermont County Water and Sewer District Lower East Fork Wastewater Treatment Plant Batavia, Ohio	BBS Corporation Cincinnati, Ohio (513) 489-0779 Jim Gagnon	1,000 cfm 6' dia. x 21' high FRP vessel Sludge dewatering building Delivery date: November 2005

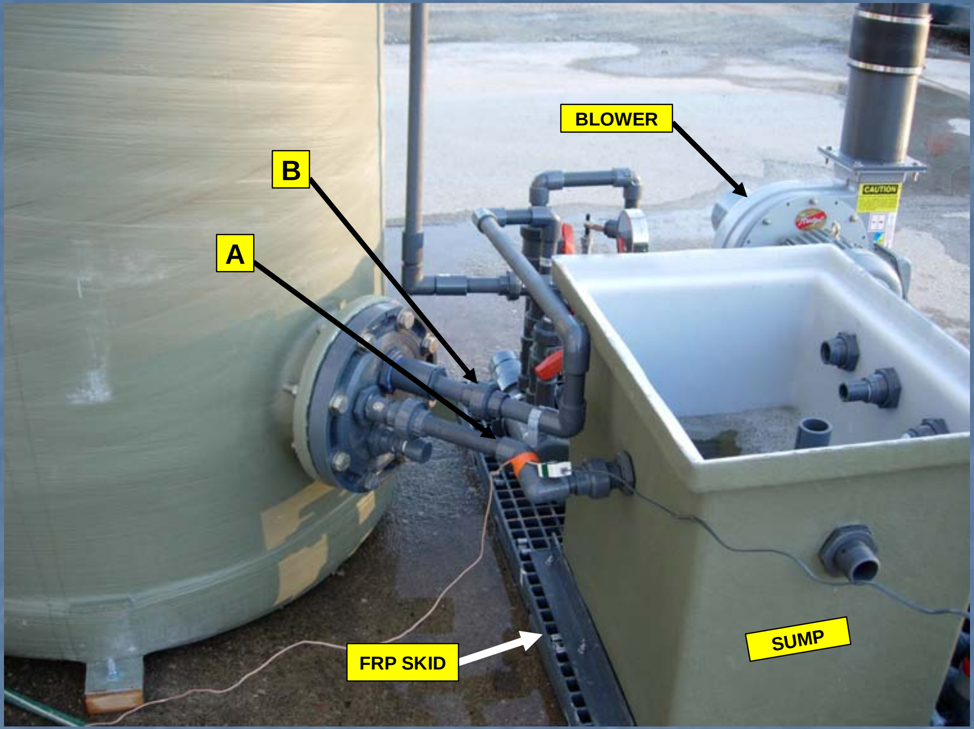
JACKSONVILLE SKID MOUNTED SYSTEM

400 cfm LIFT STATION



To Drain LIne
Sump Tank
Recycle Pump
Level Sensor
Fence Line
Inlet Water
Line
Nutrient Tank
Metering
Pump
Biofilter
Vessel
Blower
CONTROL PANEL
Door
In Fence
Inlet Gas Flow
Lift
Station

PRD TAMPA ODOR CONTROL SYSTEM
200 – 600 cfm



CONCLUSIONS

- Biotrickling Filters (new and retrofitted) were able to treat over 99.5% of the incoming odor levels
- Complaints, which were being received daily before, became non-existent after installation
- Substantial savings in chlorine costs and associated corrosion impacts
- No emission of toxic by-products
- Easy to operate system; Minimal operator need
- Consumes $6,000 per year of nutrients to treat about 69,000 cfm of odorous gases