Delaware Valley College

Research and Demonstration Center for On-Lot Sewage Systems

and

Small Flow Technologies

PSMA CONFERENCE
2023

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VW Consultants, LLC

RESEARCH AND DEMONSTRATION CENTER
ON-LOT SYSTEMS AND SMALL FLOW TECHNOLOGIES
DELAWARE VALLEY COLLEGE
DOYLESTOWN, PA

Project Funding Provided by:
Pennsylvania Dept. of Environmental Protection


AERIAL VIEW OF THE CAMPUS WHERE SYSTEMS ARE LOCATED

Phase I

Request for Proposal

Identify Six Technologies used in the USA or the world and determine their effectiveness for use in PA

- Research information and consolidate data on existing technologies used in USA and other countries.
- Select technologies which have application to PA climate, geology and soil.
- Construct full scale installations with three replicates of each technology.

Background

- Evaluate and sample the installations for three years in Phase I and three years in Phase II.
- Develop a final report with conclusions on systems applicability to PA soils, climate and geology. Reports are posted on the PADEP Web site

Research of Existing Data

- Literature search of published research
- Interview of state regulatory agencies that have statewide onlot regulations
- Complied state regulations for onlot sewage
- Attended the Ag Engineer Society meeting in Atlanta where the recent research is presented. This meeting occurs every two years

Technologies Selected

1. Constructed wetlands
2. Community at-grade system using sand filter pretreatment
3. Septic tank geometry and compartments
4. Media Filters: pressure sand filter; Gravity sand filter; Recirc Sand Filter; Up-flow sand filter

Technologies Selected

5. Shallow limiting zone at-grade systems

6. Drip irrigation

7. Renovation Thickness-Control Technology

   Septic tank effluent applied to a DEP at-grade system on a soil with no LZ to 72 inches

Phase I

Technology A

Constructed Wetlands

Two Cell Wetland

Two cell wetland system. Each cell is approximately 17 feet by 17 feet. Designed for 400 gallons per day, the cell in the foreground is the infiltration cell and the cell in the background is the treatment cell.

WL Cell 1 Lined

Treatment cell in foreground is completely lined with 20 mil PVC liner.

WL Cell 2 Infiltration

Second cell is an infiltration cell. It is lined only along the edges. The bottom is open. The infiltration cell is filled with aggregate.

WL Cell 1 and 2

Here the first cell has now been filled with aggregate and the second cell has a mulch layer over the aggregate and is ready for planting.

Finished WL Treatment Cells

System ready for planting. Effluent enters first cell from septic tank and is distributed by a header pipe buried along the full length of the first cell. The effluent then travels horizontally through the cell and into the second infiltration cell by way of the concrete flow control box in the center of the photo.

WL Cells Planted

Completed system with plants.   Flow is horizontal form treatment cell in foreground to infiltration cell in background.

Phase I

Technology B

Re-circulating sand filter
to a sloping at-grade community system (three houses) on a deep, moderately well drained soil.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Small community system handling three homes. Each home has its own denitrification sand filter (foreground) with effluent then going to two at grade pressure distribution beds (background).

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Septic tank in foreground sends effluent to rock filter tank (left background). From rock filter tank effluent is pumped to sand filter tank (right background) for nitrification then back to rock filter tank for denitrification.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Side view of one of systems. This site has three homes each with its own denitrification system feeding two common at grade pressure distribution beds.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

After passing through the denitrification systems the effluent is sent to at grade pressure distribution beds. Here vegetation has been removed and ridges and furrows are being placed in the bed on contour to prevent effluent migration downslope.

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TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Close up of unit used to make ridges and furrows in the bed.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Another view of bed after ridges and furrows have been made on contour.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Here stone is being placed on a prepared bed.

TECHNOLOGY B: SLOPING AT- GRADE PRESSURE DISTRIBUTION

Pressure distribution pipe within bed area.

TECHNOLOGY B - DENITRIFICATION SAND FILTER WITH AT- GRADE PRESSURE DISTRIBUTION

Soil cover being placed over beds.

Phase I

Technology C: Septic Tanks

- 1000 gal. Single Compartment Round
- 1000 gal. Single Compartment Rectangular
- 1500 gal. Dual Compartment Rectangular
- Two 1000 gal. round tanks in series

Phase I

Technology C: Sand Filter Bank

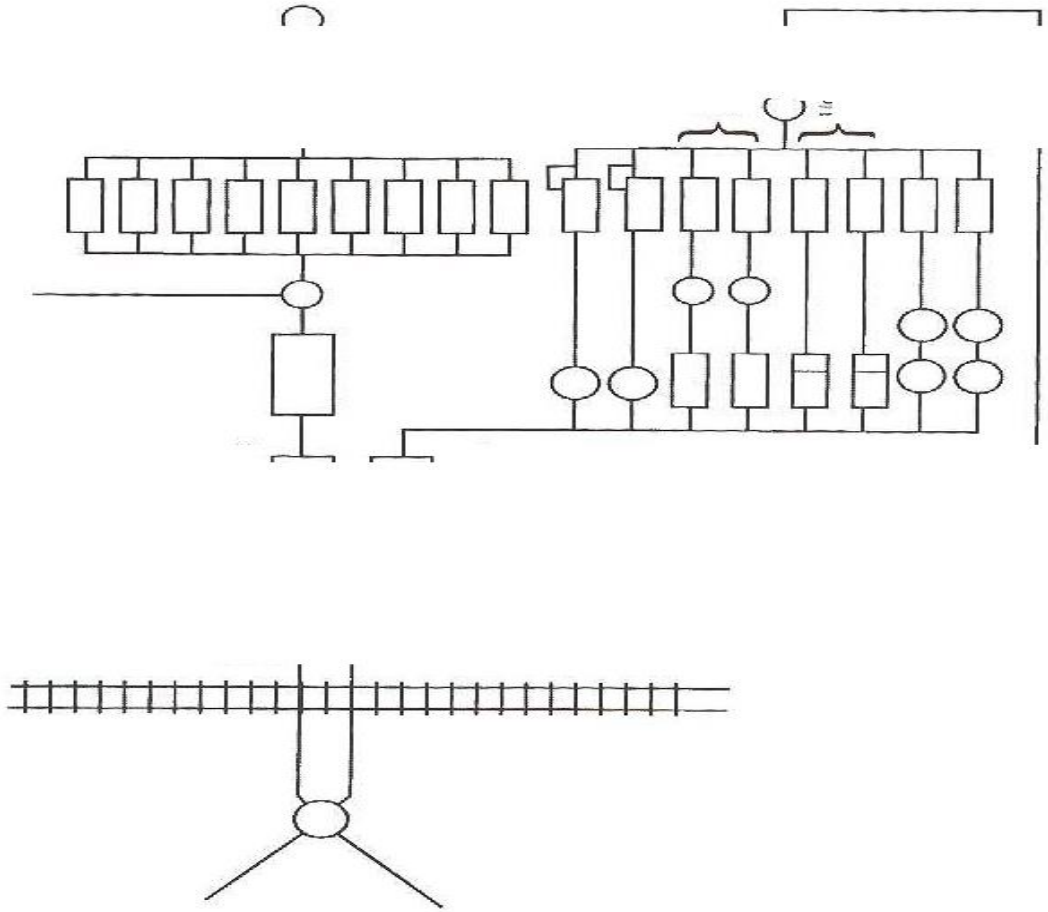
-Two Tank Recirc. Sand Filter with anoxic zoned for nitrogen removal

- Single Pass Sand Filter (pressure)

- Single Pass Sand Filter (gravity)

- Up Flow Sand Filter

Schematic



TECHNOLOGY C - SAND FILTER BANK

Construction of different types of sand filters for effluent treatment.

TECHNOLOGY C - SAND FILTER BANK

Interior view of sand filter.

TECHNOLOGY C - SAND FILTER BANK

Sand filter bank during construction. Gravity, upflow, intermittent, and recirculating sand filters are being tested. Also round, rectangular, and rectangular two compartment septic tanks are being tested. **Some septic tanks also have filters installed at the outlet.**

TECHNOLOGY C - SAND FILTER BANK

Sampling box for sand filters being installed in foreground.

Phase I

Technology D

Single pass sand filter (pressure dosed) effluent to an at-grade system on a deep, somewhat poorly drained soil.

TECHNOLOGY D - SOMEWHAT POORLY DRAINED SOIL WITH SAND FILTER EFFLUENT AND AT GRADE PRESSURE DISTRIBUTION

Stone being placed in bed. Bed construction similar to Technology B.

TECHNOLOGY D - SOMEWHAT POORLY DRAINED SOIL WITH SAND FILTER EFFLUENT AND AT GRADE PRESSURE DISTRIBUTION

Beds are time dosed as opposed to demand dosed. Time of day and amount of dose can be adjusted with this controller. Currently beds are dosed four times per day at 70 gallons per dose.

TECHNOLOGY D - SOMEWHAT POORLY DRAINED SOIL WITH SAND FILTER EFFLUENT AND AT GRADE PRESSURE DISTRIBUTION

Completed beds on somewhat poorly drained soils. Three beds have been constructed on this wooded site.

Phase I

Technology E

Single pass sand filter (pressure) to a drip dispersal system on a deep, moderately well drained soil.

TECHNOLOGY E
DRIP IRRIGATION

Wooded site on slopes ranging from 14 to 21 percent. Soils are moderately well-drained. 20 inch plus LZ

TECHNOLOGY E - DRIP OR TRICKLE IRRIGATION

Installation of drip irrigation tubing using vibratory plow. Site receives **400 gallons per day** sand filter effluent. Emitters occur every two feet in tubing. System doses 10 times per day. Three systems have been constructed

TECHNOLOGY E - DRIP OR TRICKLE IRRIGATION

Tubing has been installed over one site. Look closely and you can see ends of tubing still to be connected in the foreground of picture. Minimal site disturbance during installation.

TECHNOLOGY E
DRIP IRRIGATION

Controller being installed for drip irrigation system.

Phase I

Technology F

Septic tank effluent to a DEP flat top at-grade system on a deep, well-drained soil

Experimental Control: Renovative thickness

All other technology results compared to the results of Tech F

TECHNOLOGY F - WELL DRAINED SITE WITH AT GRADE PRESSURE DISTRIBUTION

Site receives septic tank quality effluent. Bed construction shown in the photo. Three beds were constructed.

TECHNOLOGY F - WELL DRAINED SITE WITH AT GRADE PRESSURE DISTRIBUTION

Beds being covered with soil.

TECHNOLOGY F - WELL DRAINED SITE WITH AT GRADE PRESSURE DISTRIBUTION

Three completed beds.

Methods

- Soils were evaluated using backhoe excavated test pits.
- Soils were described and sampled by the staff of the USDA-NRCS (Ed White, John Chirbirka) and Dr. Robert Cunningham (retired) Penn State University.
- Percolation tests and hydraulic conductivity tests were performed by the staff of DelVal Soil and Delaware Valley College.

Methods

- At-grade absorption areas were constructed and dosed with effluent at 400 gpd.
- Gravity lysimeters were installed at 1, 2, 3 and 4 feet below the ground surface (two nests at each bed location)
- Lysimeters were sampled monthly for three years and analyzed for:
  - Nitrogen Series
  - Total Phosphorous
  - Fecal Coliform
  - Fecal Strep
  - Total Organic Carbon

SOIL PROFILE DESCRIPTIONS WERE WRITTEN FOR EACH LOCATION. DRAINAGE CLASSES INCLUDE WELL DRAINED; MODERATELY WELL DRAINED; SOMEWHAT POORLY DRAINED; AND POORLY DRAINED SOILS

PROFILE BEING WRITTEN FOR TECHNOLOGY F

PROFILE BEING WRITTEN FOR TECHNOLOGY B

PERMEABILITY TESTING FOR EACH SITE INCLUDED BOTH PERCOLATION TESTING AND HYDRAULIC CONDUCTIVITY TESTING. HERE SITE D IS BEING TESTED.

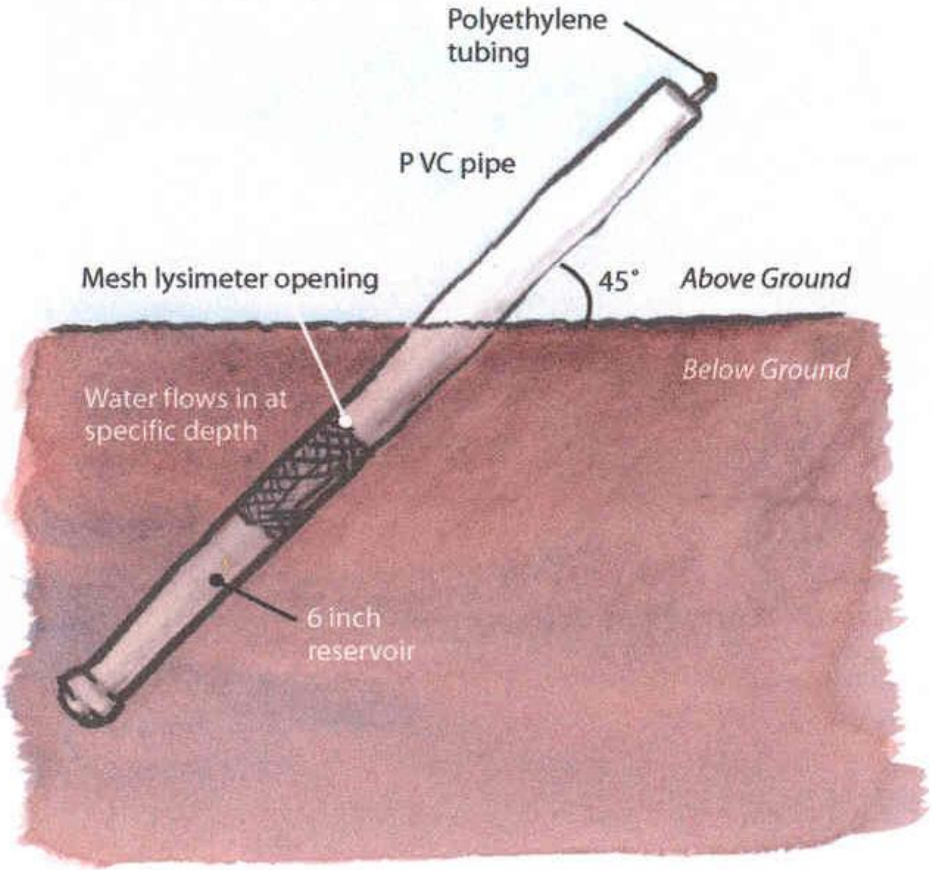

CASE


888

Water Quality Testing

Lysimeters – groupings of pipes cut to varying lengths to reach different soil depths – allow samples to be extracted easily and in a controlled way. The samples are tested for harmful bacteria levels.

Anatomy of a Lysimeter



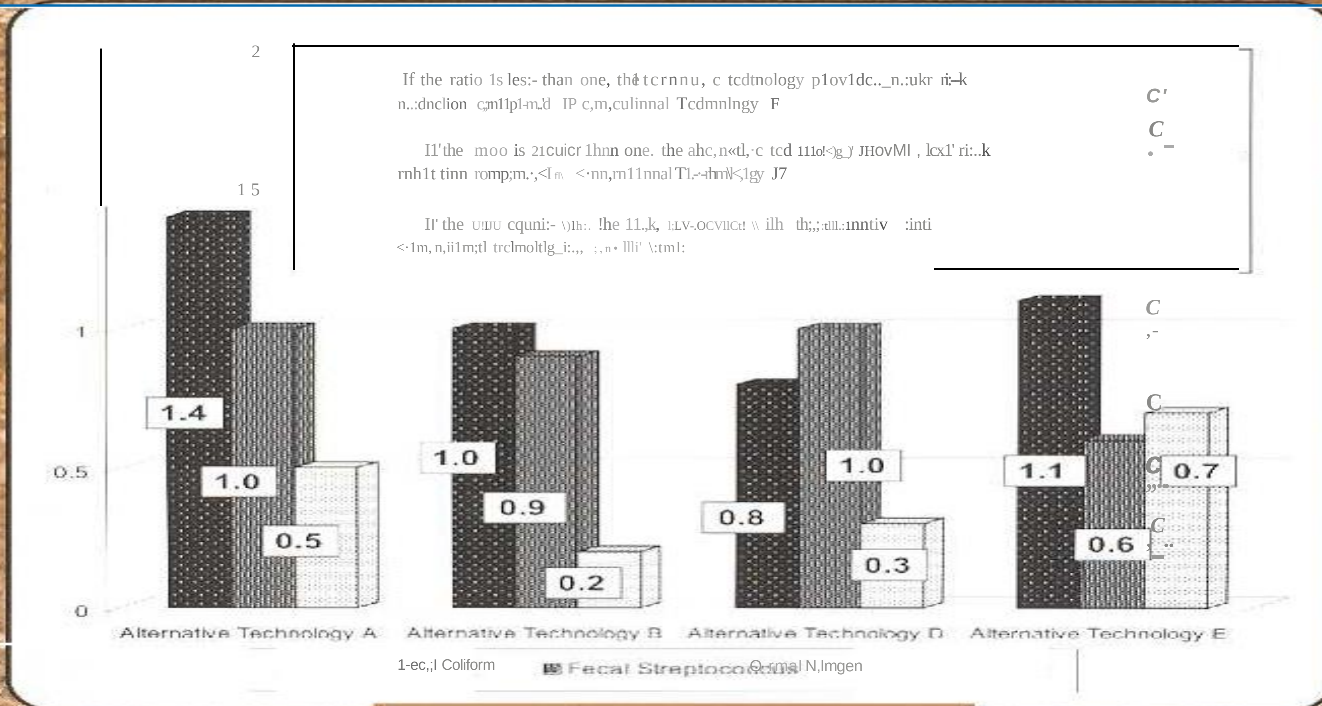
Lysimeters in the Field

SAMPLING

Installation of zero tension lysimeters at one, two, three, and four feet beneath the beds. All beds have two lysimeters at each depth.

RISK COMPARISOM OF PHASE I TECHNOLOGIES

Relative Hazard Ratios for Biological and Chemical Parameters
Technologies A, B, D, E, & F



Benchmarks
Fecal coliform > 200 mpn/100mL
Fecal streptococcus > 200 mpn/100mL
Total Nitrogen > 24mg/L
Total Phosphorous > 1 mg/L

A relative hazard ratio for comparative risk evaluation of five of the on-lot systems was computed. Data from Technology A and from the four foot lysimeters installed in Technologies B, D, E, and F are used for comparison.

Excedence frequencies for fecal coliform and fecal strep bacteria, using 200 bacteria/100mL as the reference base, were computed for each system. Excedence frequencies for total nitrogen, using 24mg/l (level of Technology F), were computed for each system.

Excedence frequencies are calculated by computing the number of months the baseline (200 bacteria or 24mg/l TN) is exceeded, and dividing by the total number of months with available data. Excedence frequency of experimental technologies A, B, D, or E is then divided by the excedence frequency of the conventional technology (Technology F) to calculate a relative hazard ratio.

What other Technologies in Phase I show favorable results

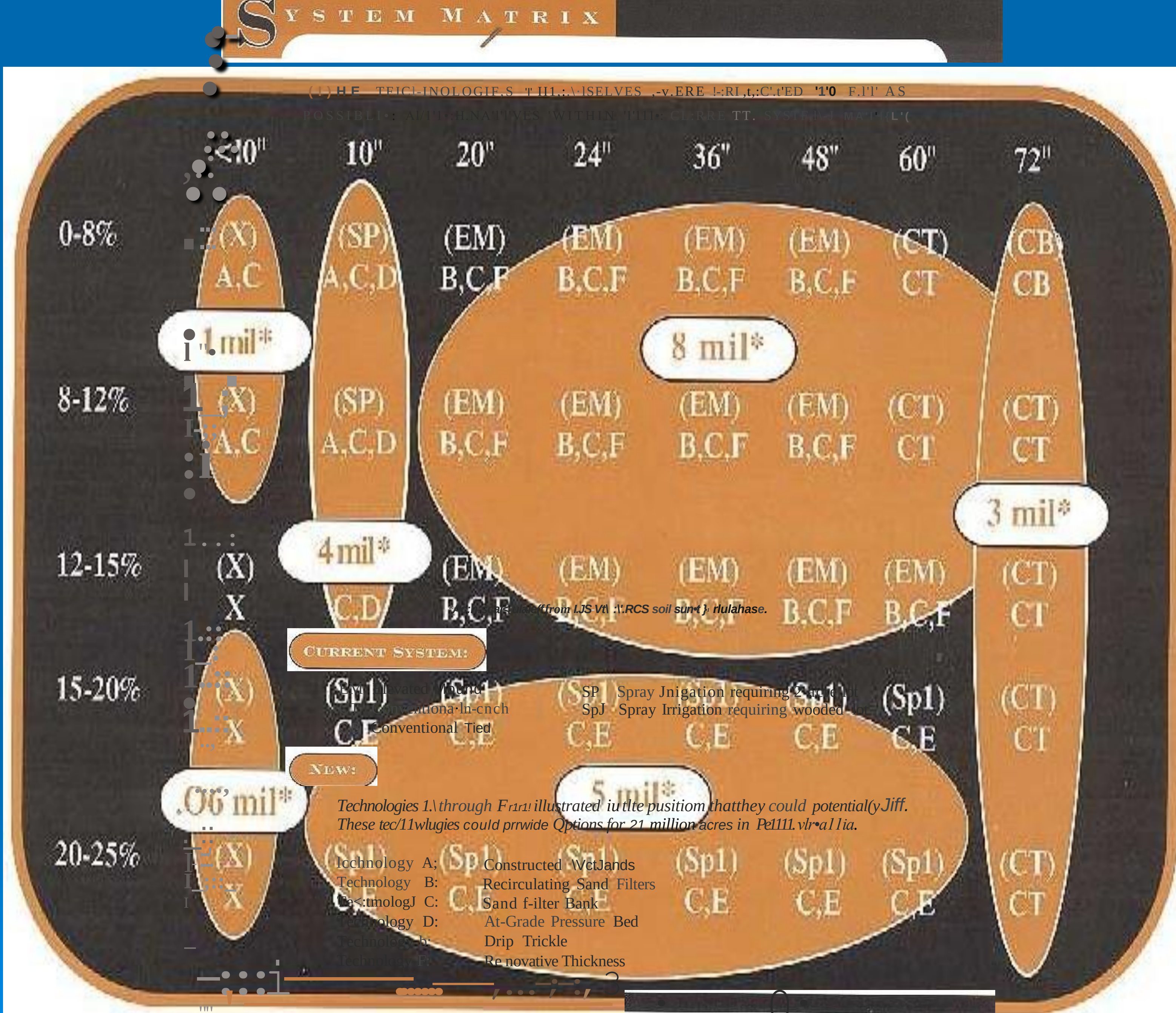
- Two Cell Constructed Wetland
- Shallow Limiting Zone At-Grade System using pretreated effluent (30:30)

What was implemented by DEP from Phase I

1. Sloping At-Grade System

2. Drip Irrigation with pre-treatment on a 20 inch or greater limiting zone soil

3. Gravity Sand Filter


SYSTEM MATRIX
THE TECHNOLOGIES THEMSELVES WERE RESTRICTED TO AS POSSIBLE ALTERNATIVES WITHIN THE CURRENT SYSTEM MATRIX
<10"
10"
20"
24"
36"
48"
60"
72"
0-8%
8-12%
12-15%
15-20%
20-25%
(X) A,C
(SP) A,C,D
(EM) B,C,F
(CT) CT
(CB) CB
(X) X
(Sp1) C,E
1 mil*
4 mil*
8 mil*
3 mil*
5 mil*
.06 mil*
Current System:
EM Elevated Mound
CT Conventional Trench
CB Conventional Tied
SP Spray Irrigation requiring 2 acre lot
Sp1 Spray Irrigation requiring wooded lot
New:
Technologies A through F illustrated in the positions that they could potentially fit.
These technologies could provide Options for 21 million acres in Pennsylvania.
Technology A: Constructed Wetlands
Technology B: Recirculating Sand Filters
Technology C: Sand Filter Bank
Technology D: At-Grade Pressure Bed
Technology E: Drip Trickle
Technology F: Renovative Thickness

This presentation will now focus on one aspect of the research

Does effluent quality affect the transport of fecal coliform through two different soils using an at-grade absorption area? Comparing Tech F & D

Tech F

A deep, well-drained soil: fine-loamy, mixed, mesic Typic Hapludalf 72 inch plus LZ

Lansdale Soil Series

Tech D

A deep, somewhat poorly drained soil: fine-loamy, mixed, mesic Aquic Fragiudalf 8 to10 inch LZ Chalfont Soil Series

Comparison of Effluent Quality on the Transport of Fecal Coliform through two SE Pennsylvania Soils

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Lawrence Hepner, Jr.
Delaware Valley College

Presented at the SSSA Meetings
Long Beach, CA
November 3, 2010

Tech D Site and System Characteristics

- Deep, somewhat poorly drained soil developed from loess over residuum
- Fine-loamy, mixed, mesic Aquic Fragiudalf
  - few faint depletions at 8-10 inches
  - common distinct depletions at 13 inches
  - Fragipan at 21 inches
- Slope 3 – 4 %
- Percolation rate: 70 – 197 MPI at 20” deep
- HC: 3/16 to 2 ¼ in/day at 20” depth using the Guelph permeameter method

Tech D Site and System Characteristics

- Effluent Quality: Single Pass Sand Filter

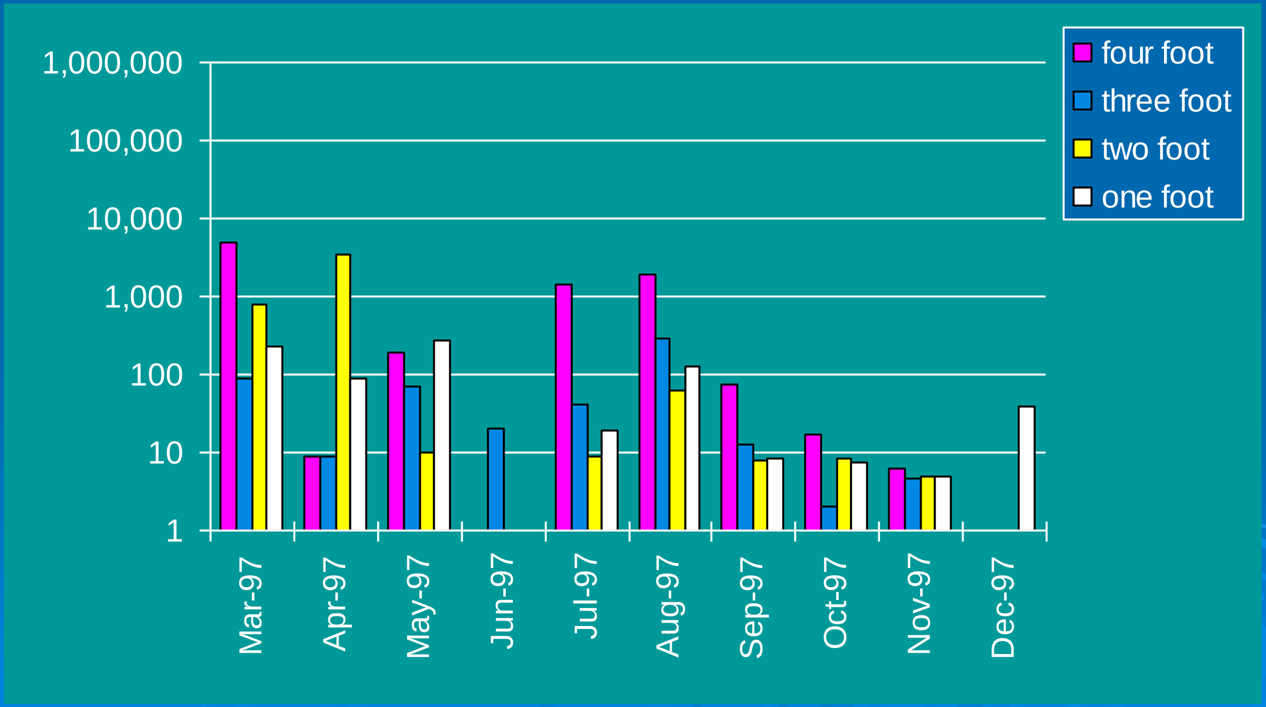
  BOD = 50 – 60 ppm

  TSS = Average 30 ppm

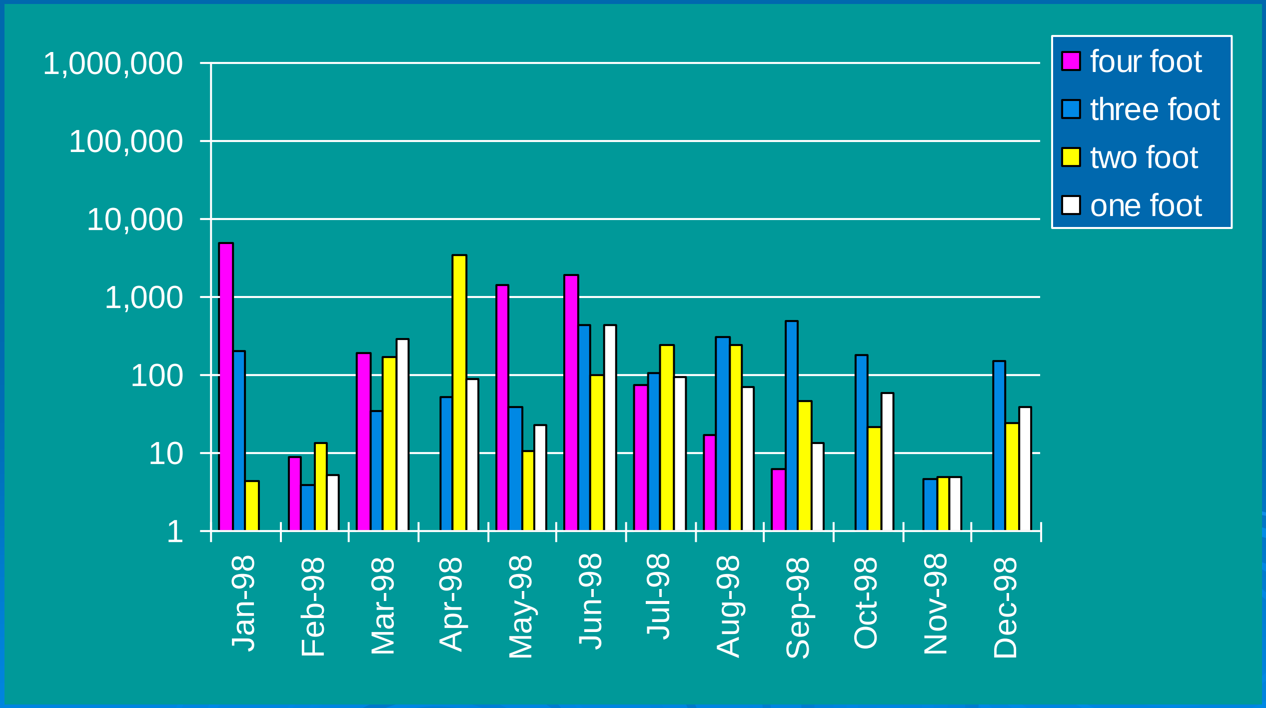
  Fecal Coliform = 10,000 – 100,000 mpn/100 ml
- 15' X 60' At-grade beds = 900 ft^2
- Dosed 4 x's/day at 400 gpd = .44 gal/ft^2
- Effluent breakout until reduced to 75 gpd

  @ 75 gpd = .08 gal/ft^2

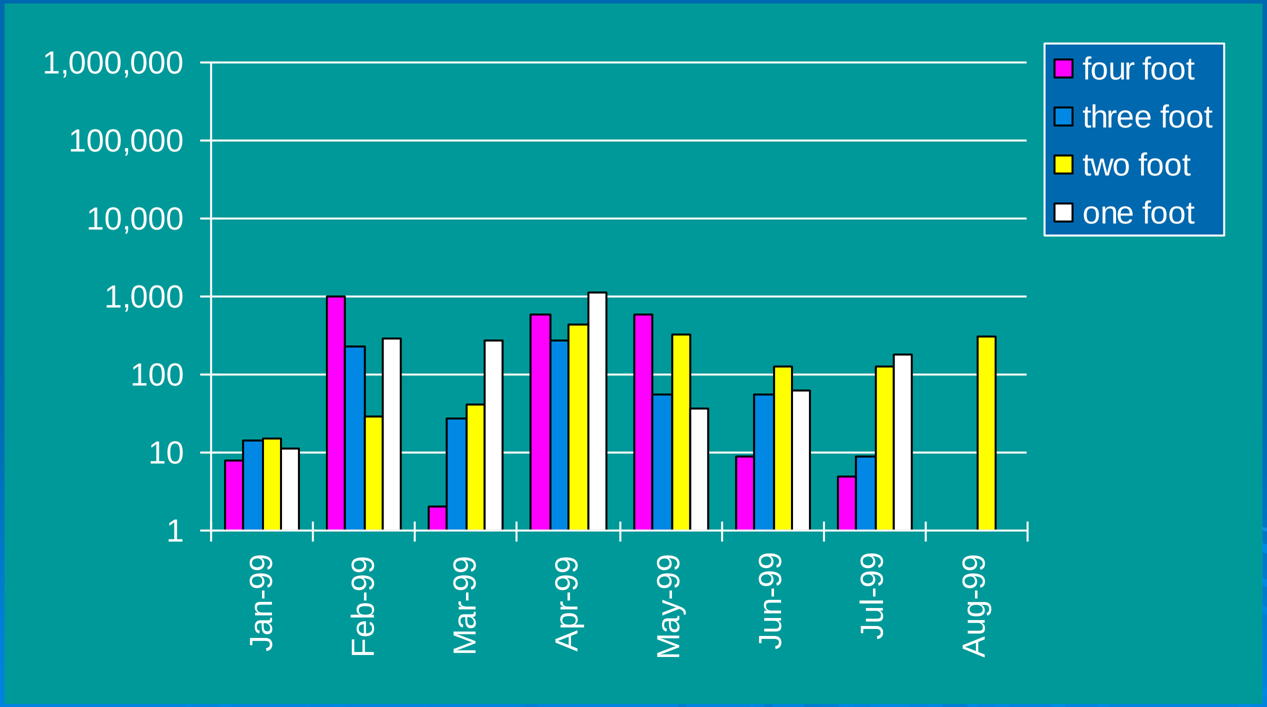
GEO MEAN FECAL COLIFORM
TECH. D: Lysimeters - 1997
(MPN/100ml)



GEO MEAN FECAL COLLIFORM
TECH. D: Lysimeters - 1998
(MPN/100ml)



GEO MEAN FECAL COLLIFORM
TECH. D: Lysimeters - 1999
(MPN/100ml)



Tech F Site and System Characteristics

- deep, well-drained soil developed from residuum sandstone parent material
- fine-loamy, mixed, mesic Typic Hapludalf
  - No redox depletions to a 72-inch depth
- Slope: 2 – 8 %
- Percolation rate: 11 – 18 MPI at 20inch depth
- HC: 10-40 in./day at 20” depth using the Guelph permeameter method

Tech F Site and System Characteristics

Effluent Quality: Septic Tank Effluent

BOD = 100 – 200 ppm

TSS = 120 – 210 ppm

Fecal Coliform=Ave.1,000,000 mpn/100 ml

15' X 40' at-grade beds = 600 ft.

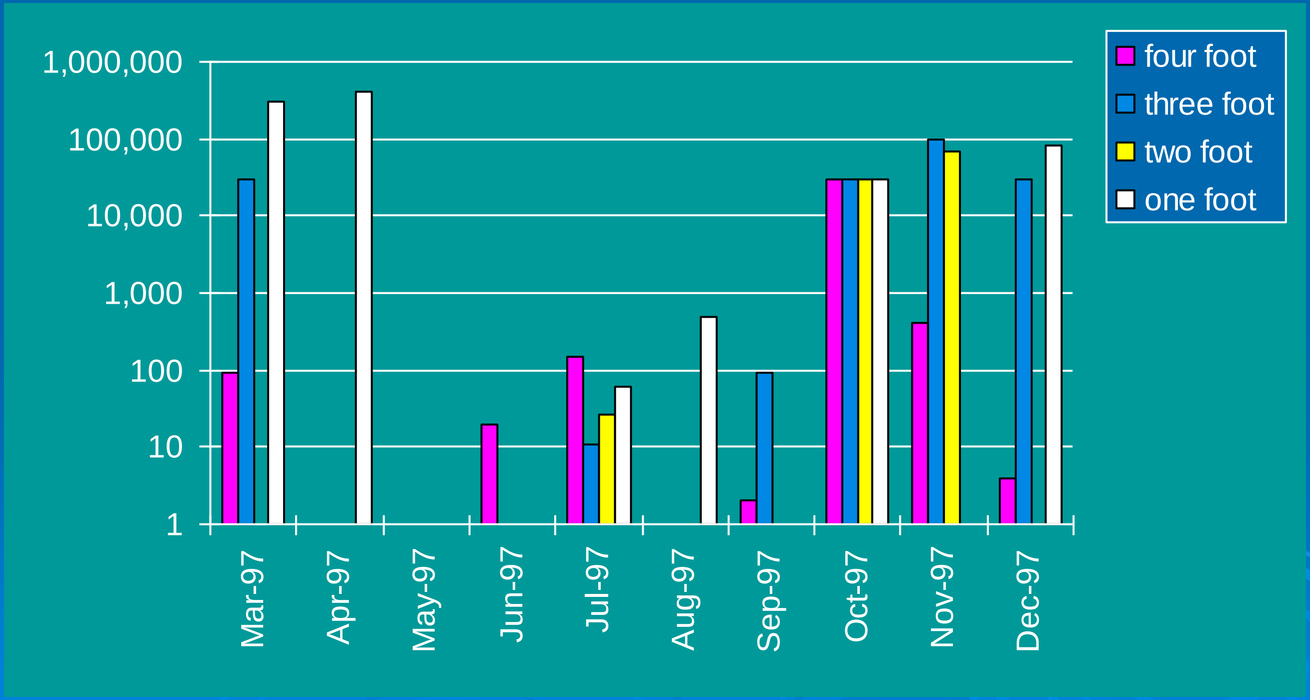
Dosed 4 x's/day at 400 gpd = .66 gal/ft^2

Effluent breakout with 60 days

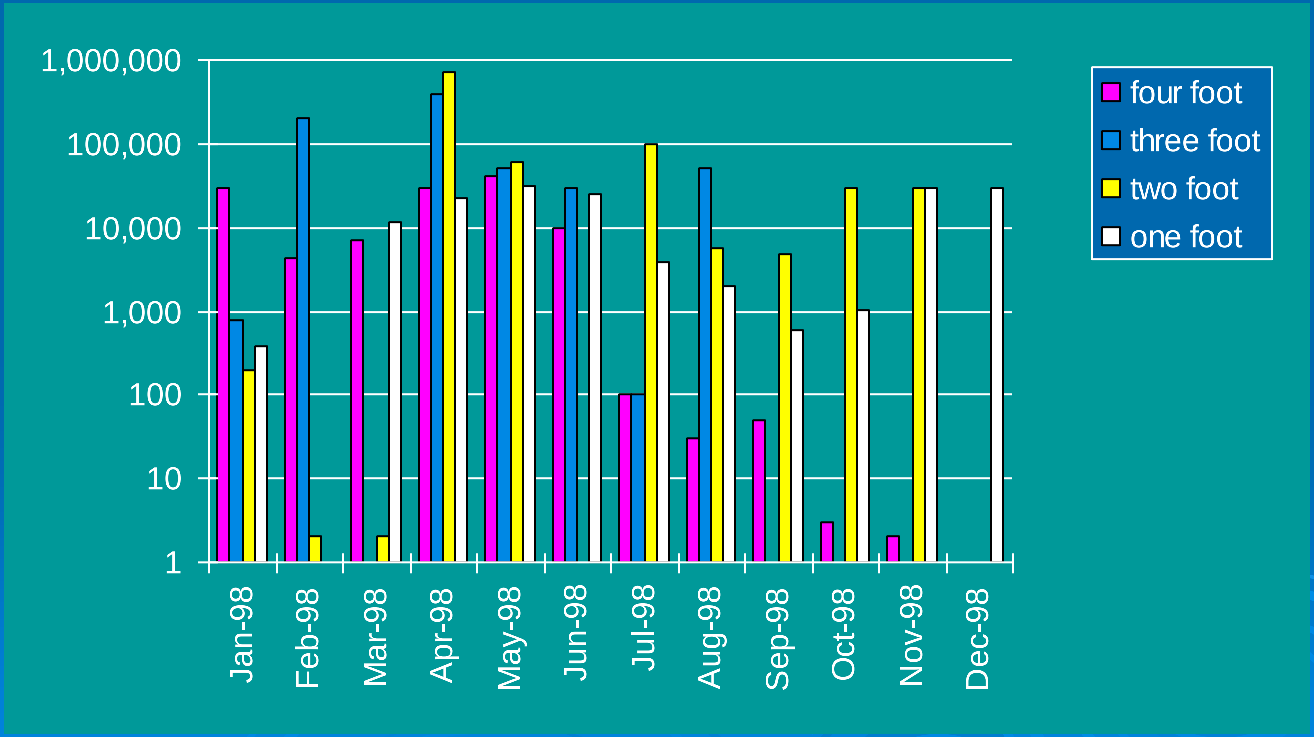
To stop breakout reduced loading to

300 gpd = .5 gal/ft^2

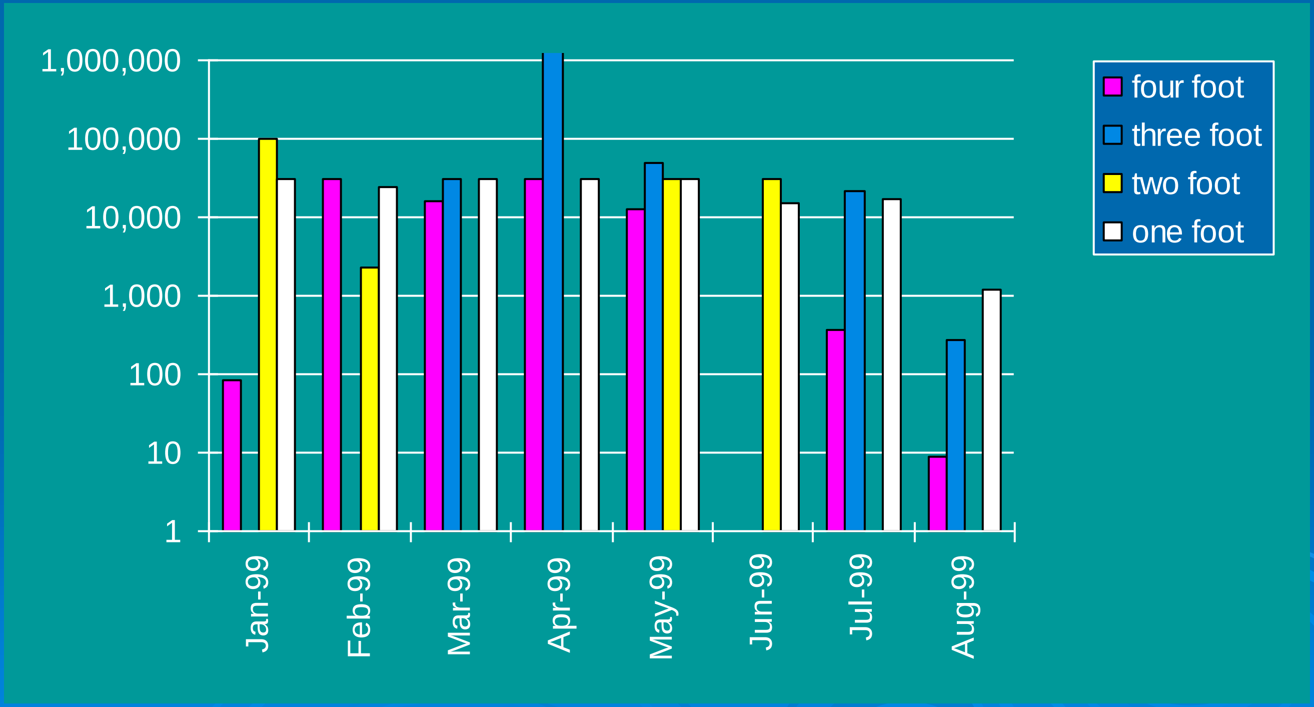
GEO MEAN FECAL COLIFORM
TECH. F: 1997
(MPN/100ml)



GEO MEAN FECAL COLIFORM
TECH. F: 1998
(MPN/100ml)



GEO MEAN FECAL COLIFORM
TECH. F: 1999
(MPN/100ml)



Comparison of Tech D and Tech F Results for Fecal Coliform at 4 foot

TECH D (10 in. LZ)

average fecal coliform at 4 feet

from1997 to 1999 = **1,025 mpn/100 ml**

TECH F (72 + LZ)

average fecal coliform at 4 feet

from1997 to 1999 = **13,333 mpn/100 ml**

Discussion of Variables

	Tech D	Tech F
Soils	fragipan slower HC	no aquitard faster HC
Effluent Quality	lower BOD FC	higher BOD FC
Loading Rates	lower applic .08 g/ft^2	higher applic .5 g/ft^2

Summary of Results

Tech D

Sand filter effluent to a somewhat poorly drained soil 10 inch limiting zone at rate of .08 gal/ft^2

@ **4 ft depth ave. 1025 mpn/100 ml**

Tech F

Septic tank effluent to a well-drained soil 72 inch plus limiting zone at a rate of .5 gal/ft^2

@ 4 ft depth ave. 13,333 mpn/100 ml

Conclusions

- Placement of systems on the ground surface (at-grade) maximizes the use of the bio-active soil horizons. Better renovation occurs in the surface bio-active zone due to better O_2/CO_2 exchange and a more robust microbial population.
- TSS, BOD and FC reduction by pre-treatment is needed to minimize FC transport through somewhat poorly drained soils with slow permeability.

Conclusions

- Loading rates well below measured saturated HC is needed to promote unsaturated flow and maximize effluent renovation.
- Placement of effluent on the soil surface vs. subsurface avoids macro pore flow when loading rates are well below measurable K_{sat} promoting unsaturated flow.

Conclusions

- Aquitards such as fragipans maybe beneficial in restricting FC transport.

- Shallow Limiting Zone soils such as the Chalfont series may be utilized for wastewater renovation if the effluent is pre-treated, applied to the soil surface and the loading rates are sufficiently low to promote unsaturated flow.

Conclusions

- Flush events may transport fecal coliform through the soil profile regardless of soil drainage class.

- The presence of a fragipan or aquitard may minimize flush events through the soil profile to the regional water table.

Additional Research Needed

- Does horizontal flow with contaminant transport occur in fine textured soils over aquitards (fragipans) during the wet season; late winter into early spring?

- Do systems placed over aquitards need some vertical flow (leakage) in order to hydraulically perform without break-out?

PHASE II TECHNOLOGIES

Tech A – Constructed Wetlands – somewhat poorly drained soil with a serial distribution to an at-grade bed

Tech B – Recirculation Sand Filter/Denitrification System with at-grade soil absorption – moderately well drained soil

Tech D – Intermittent sand filter with time dosed surface drip irrigation – somewhat poorly drained soil

Tech E – Septic tank effluent with subsurface drip irrigation – moderately well drained soil

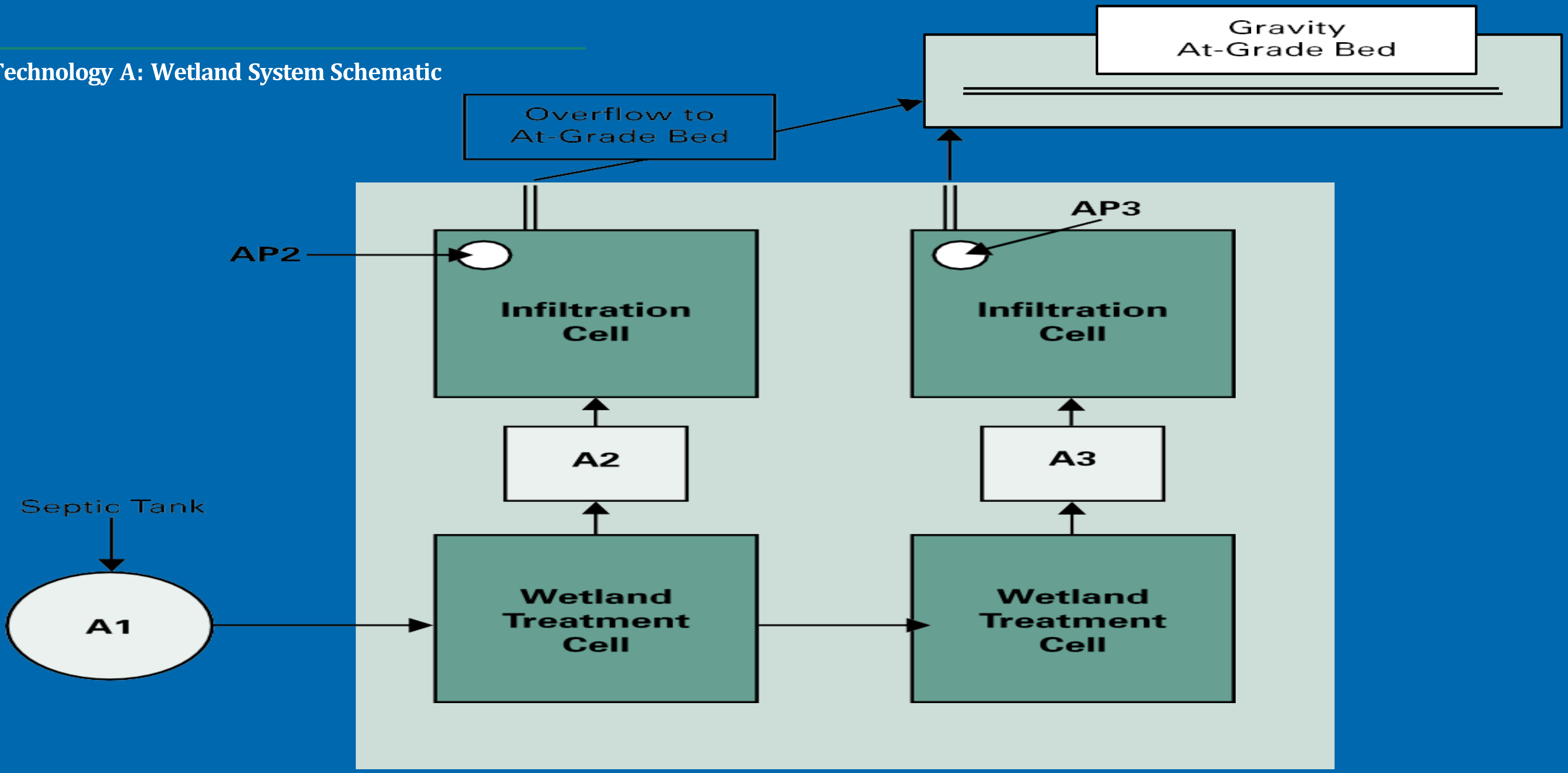
PHASE II TECHNOLOGIES

Tech F – Septic tank effluent with timed dosed soil distribution and modification of lateral design – well drained soil

Community Systems 2000 gpd– Septic tank effluent with subsurface drip irrigation – somewhat poorly drained soil

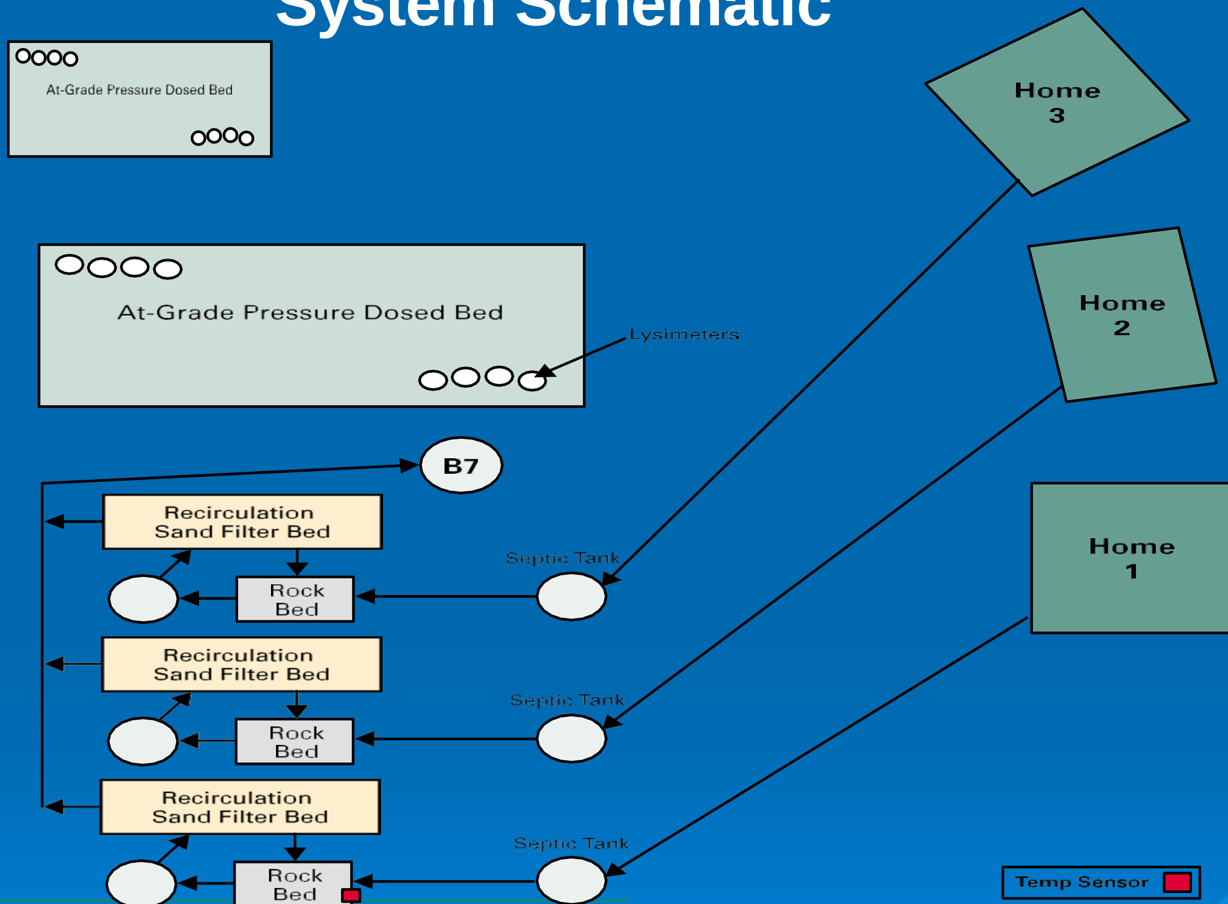
- Aerated Turf
- Non-aerated Turf
- Crops
- Pasture

Technology A: Wetland System Schematic



Wetland Treatment Cell

Technology B: Recirculation/Denitrification System Schematic



Technology D:

The Intermittent Sand Filter System with time dosed surface drip irrigation received effluent from the campus sewer system. Raw effluent was passed through one of two 3000-gallon single compartment septic tanks hooked in parallel and through one of 9 single pass intermittent sand filters with uniform (coefficient of uniformity <2) 2mm sand. Effluent was then dosed on the at-grade soil absorption area using drip tubing.

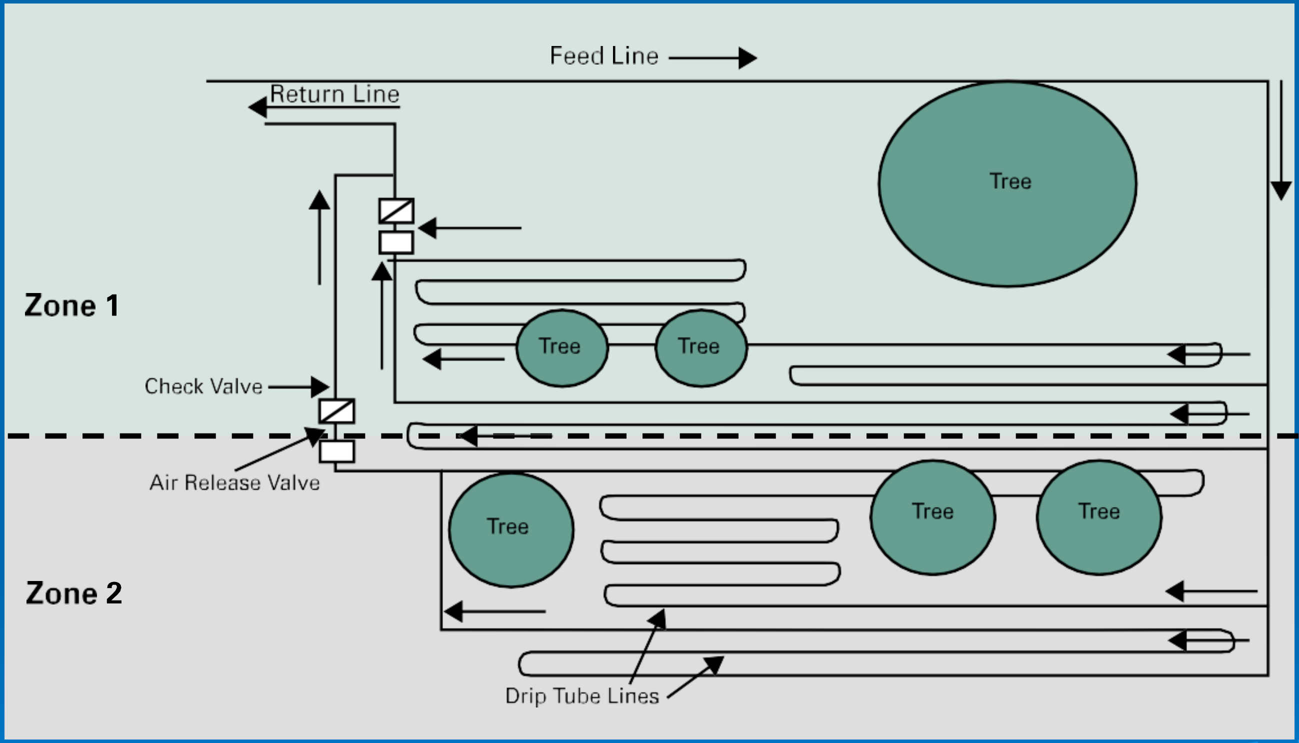
Soil absorption bed with lysimeters

- 1200 lineal feet of drip tubing was laid on the soil surface.
- 6ft of spacing was left between drip tube lines.
- Total absorption area was approximately 7200 sq ft.
- Dosing cycle: Dosed 4 times each day at 100 gallons per dose to equal 400gpd.

TECHNOLOGY E
DRIP IRRIGATION

Wooded site on slopes ranging from 14 to 21 percent. Soils are moderately well-drained. 20 inch plus LZ

Technology E: Subsurface Drip Irrigation System switched to septic tank effluent



Technology F
At-grade Flat Top on 72 in + LZ Renovation Thickness-Control Modified Distribution System

- One inch laterals
- 1/8 inch holes
- Holes on 2 foot centers
- Time Dosed

Technology F:

Three **at-grade pressure distribution systems** received septic tank quality effluent. Effluent from the campus sewer system was sent through two parallel 3000-gallon single compartment septic tanks. Effluent was then sent to a common pump chamber and timed dosed on the three at-grade pressure absorption areas four times per day.

- Dosing cycle: 4-75 gallon doses per day per system.
- Loading rate: 300 gallons per day per system.
- Bed size: 15x40 feet

A standard absorption bed design was used with the following changes initiated to improve effluent treatment.

- Additional PVC pipes added with decreased distance between pipes to provide a more even distribution of effluent (6ft spacing decreased to 2ft).

Tech F construction

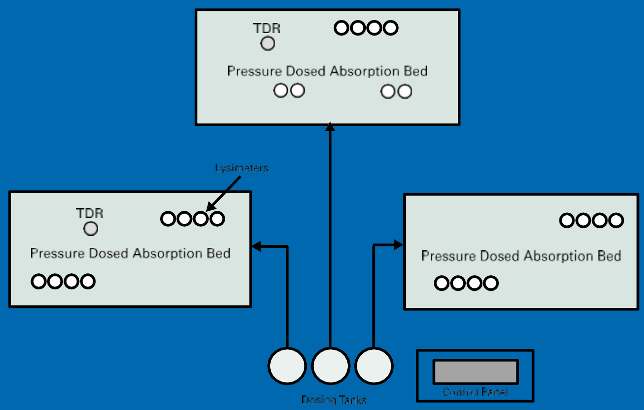
- 7 laterals with 19 holes per lateral = 133 holes total.

PVC distribution pipes

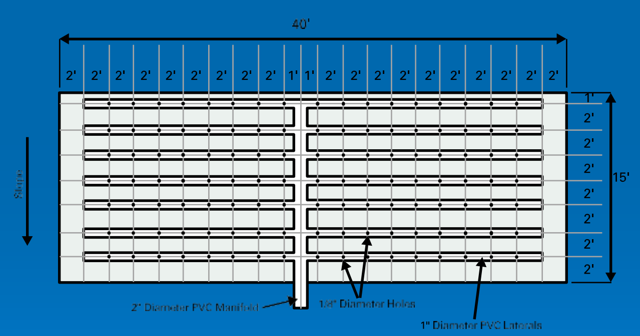
- 600 sq ft per 133 holes = 4.51 sq ft per hole.

- 1-inch PVC pipe with 1/8 in holes for dosing with optional switch to 2 inch PVC pipe with 1/4 in holes if clogging occurs.
- If 2-inch PVC pipes used, two lines are dosed at a time.
- Pressure gauges used to indicate clogged lines.

Technology F: Timed Dose System Schematic



Technology F: Absorption Bed PVC Distribution Pipe Diagram



BENIFICAL USE
DRIP IRRIGATION AND LANDSCAPING

BENIFICAL USE COMMUNITY SYSTEMS

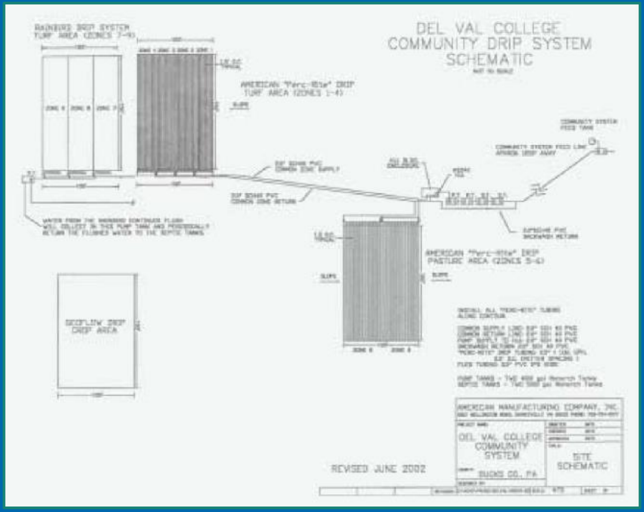
- The non-aerated turf and pasture systems utilized Netafim drip tubing that was forward flushed every 50 cycles.
- The aerated turf system utilized Rainbird drip tubing that was continually forward flushed.
- To maintain aerated conditions, a constant flow of air was blown through the 8100 ft. of Rainbird tubing at 127cfm.
- The cropland zones utilized GeoFlow tubing.

These **subsurface drip irrigation systems** received septic tank effluent that was dosed onto four drip fields each 15000 sq. ft. that represented the following areas: aerated turf, non-aerated turf, pasture, and crops. Installation specifics are as follows:

- Drip tubing installed at a depth of 9-11 inches.
- Drip tube spacing at 2 ft. apart.
- Loading rate: .08gpd/sq. ft. or .9in/wk. during months of May-Nov. and .04gpd/sq. ft. during months of Dec.-Apr.
- Dosing rate: each zone was dosed 3 times per day at .026gal/sq. ft. per dose during months of May-Nov. and .013gal/sq. ft. per dose months of Dec.-Apr.

- The non-aerated turf and pasture systems utilized Netafim drip tubing that was forward flushed every 50 cycles.
- The aerated turf system utilized Rainbird drip tubing that was continually forward flushed.
- To maintain aerated conditions, a constant flow of air was blown through the 8100 ft. of Rainbird tubing at 127cfm.
- The cropland zones utilized GeoFlow drip tubing.
- Soil profile: Chalfont soil series with faint redox features at 11 inches, common distinct redox features at 18 inches, and a fragipan at 25 inches.

Community System Schematic:



11. Connecting feed and return lines that supply wastewater to the tubing.

12. Preparing the soil over the tubing for seeding.

13. Seed being broadcast over the tubing areas.

14 Turf growing over tubing

Community System Construction:

(Continued from Page 55)

4. After subsoiling, chisel plowing will loosen compaction closer to the surface.

5. After chisel plowing, disking is done to smooth the surface

6. Soil structure now has a nice granular appearance for good air and water movement.

7. The drip tubing is then installed at 9 to 11 inches beneath the surface.

8-9-10. Drip tubing being installed

Community System Construction:

(Continued from Page 57)

15. Tubing emitting wastewater

16. Sampling lysimeters over turf areas.

17. Installing tubing in the pasture area.

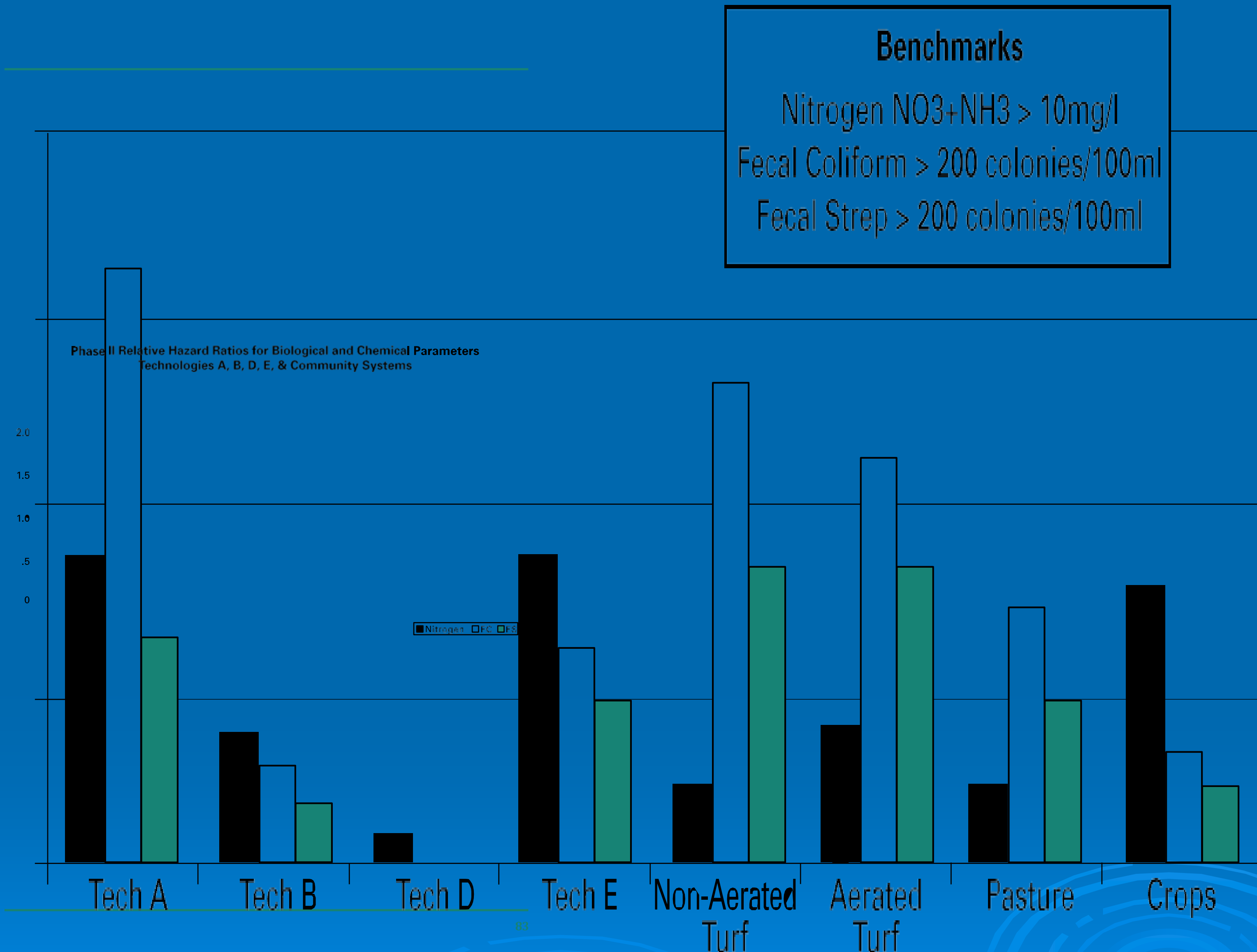
19. Cows grazing over wastewater area.

18. Tubing installed in the pasture.

20. Area receiving wastewater is much greener in the summer compared to the rest of the pasture.

21. No-till corn being planted in cropland area over tubing.

RISK COMPARISOM OF PHASE II TECHNOLOGIES


Benchmarks
Nitrogen NO3+NH3 > 10mg/l
Fecal Coliform > 200 colonies/100ml
Fecal Strep > 200 colonies/100ml
Phase II Relative Hazard Ratios for Biological and Chemical Parameters
Technologies A, B, D, E, & Community Systems
2.0
1.5
1.0
.5
0
Tech A
Tech B
Tech D
Tech E
Non-Aerated Turf
Aerated Turf
Pasture
Crops

What was implemented by DEP from Phase II

Drip Irrigation with septic tank effluent on a 20 inch or greater limiting zone soil

What other Technologies in Phase II showed favorable results

- Two Cell Constructed Wetland with at-grade use in wet season
- Recirc Sand Filter for N reduction
- A modification of the pressure distribution design
- Beneficial use of wastewater using septic tank effluent and aerated drip irrigation

Phase I and II Reports are available on the PADEP Web Site

https://www.dep.pa.gov/Business/Water/CleanWater/WastewaterMgmt/Act537/OnlotDisposal/Pages/default.aspx

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Thank you

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Questions and Discussion