Importing Soil Material on Marginal Soil treatment Area Footprints

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2019 Northeast Onsite Wastewater Short Course

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A Wide Array of Limitations in Many Missouri Soil/Sites for Decentralized Wastewater Systems

- Limited depth to a restrictive horizon (i.e claypan)
- Limited depth to fragipan
- Limited depth to fractured bedrock and/or karst
- Limited depth to a water table
- Limited area of suitable soil
- Small footprint.
- Little vertical separation available for treatment and hydraulic loading

Table Rock Lake Project

- Research Study on Installations in which Effluent in Pre-Treatment Train and in Imported Soil was Measured for Specific Parameters

- Individual Case Studies- Mostly Residential


Missouri
Omaha
Springfield
Kansas City
St. Louis
Springfield
Branson

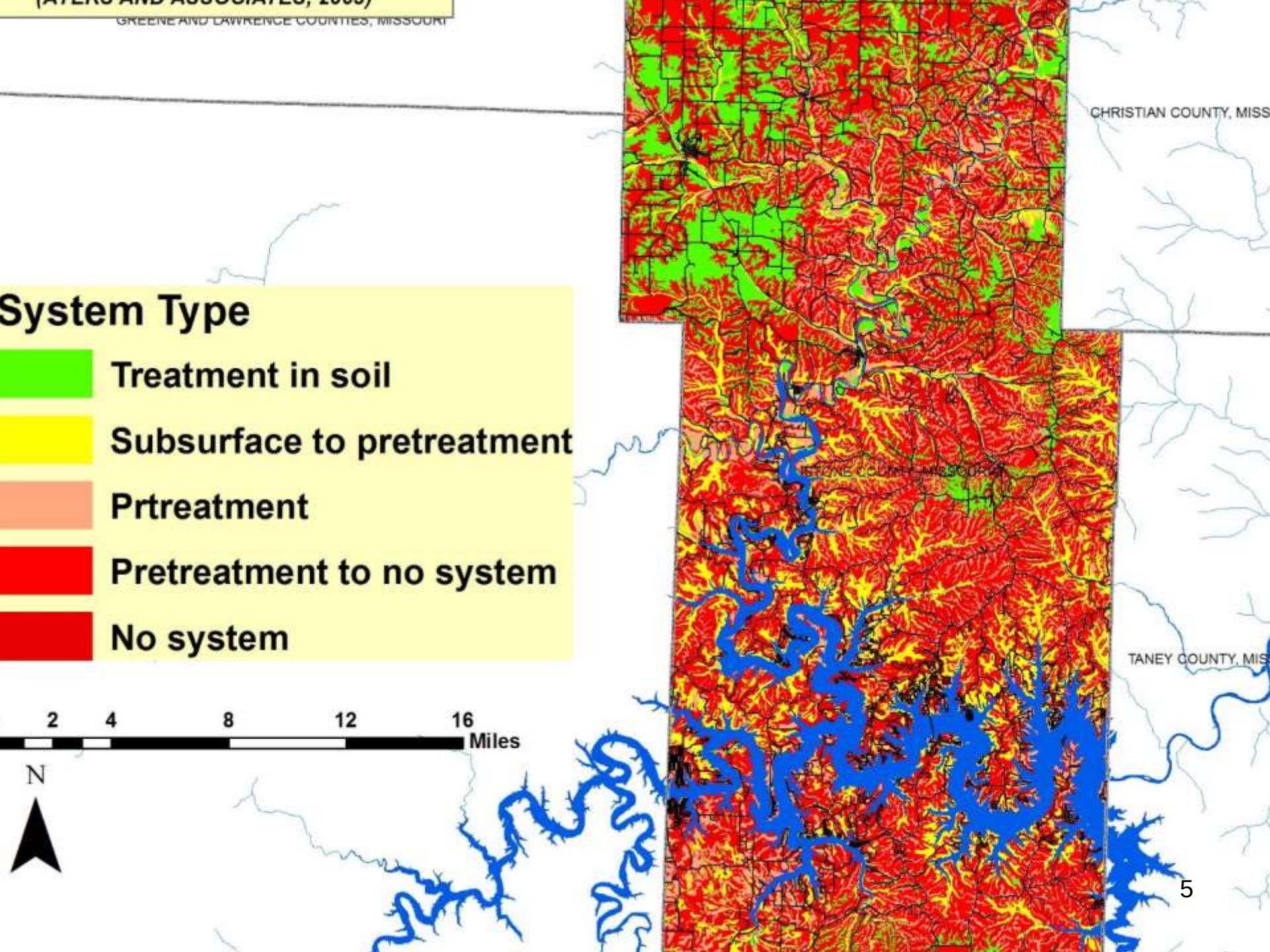

(AYERS AND ASSOCIATES, 2005)
GREENE AND LAWRENCE COUNTIES, MISSOURI
CHRISTIAN COUNTY, MISS
TANEY COUNTY, MIS
System Type
Treatment in soil
Subsurface to pretreatment
Prtreatment
Pretreatment to no system
No system
2
4
8
12
16
Miles
N

Table Rock Lake Water Quality, Inc. Study

- Three commercial establishments using imported soil and drip irrigation.
- Cape Fair Resort: 1,920 gpd
- Lampe Resort: 1,560 gpd
- Shell Knob Restaurant S. 1,500 gpd

Three Phases of Fundamentals for Use of Imported Soil for Onsite Wastewater Dispersal and Treatment

- Qualities of the initial soil material
- Handling of the soil material during harvesting and transport
- Handling of soil material during and after placement

The Ultimate Goal is for the Imported Soil Material to Possess Physical Characteristics Which are Uniform and Near the Original State

This means the soil material must have:

- Uniform texture
- Uniform structure
- Uniform pore space: size, connectivity and geometry

There are Three Mind-Sets You Must Have to Provide a High Probability for Fill Soil to Work

- Uniformity and consistence of the soil pores is a MUST. Based on principles of water movement in soil video.
- Patience, patience, and more patience
- **The loading rate for imported soil is about half of what it was under native conditions**

Soil Conditions/System Choice

- Deep, permeable soil
- Deteriorating soil conditions
- Shallow soil, Restrictive layers, Karst topography

- Septic tank / Soil absorption trenches
- Low Pressure Pipe
- Higher treatment
  - Packed bed filters
  - ATUs
  - Wetlands
- Drip Irrigation

Rules for the Initial Qualities of Soil to be Used for Import:

- A sandy to loamy material must be used (usually <20% clay): sandy loam, silt loam, loam, loamy sand
  - Do not use “topsoil”
  - Color does not count
- Texture of the imported material must be determined by a certified soil scientist (Structure at initial site and placement is important!)
- Platy or structureless-massive materials will not work
- Above ground plant growth and roots must removed from the harvest area before harvesting
- Removal and transport of the harvested soil must be performed under DRY conditions

Rules for Removal and Handling of Soil During the Harvesting and Transport Phase

- Material at the harvest site should be uniform
- All earthwork at the harvesting site must be performed under DRY conditions
- Removal of plant residue and roots from the fill area must be performed before removal of the soil

Rules for Placement of the Imported Soil at the Installation Site

- All earthwork at the construction site must be performed under DRY conditions
- Removal of plant residue and roots from the installation site must be performed before placement of fill
- Light scarification of remaining native soil interface may need to be scarified; chisel/shank implement is best; roto-tiller is not desirable
- Surface water diversions must be in place before placement
- Preference on transport directly from harvest site over stockpiled soil (variable moisture content)

Processed Imported Soil

- Has been sieved and screened!

Rules for Placement of the Imported Soil at the Installation Site

- Fill material must NOT be compacted to prevent formation of platy structure
- Place in small “lift” increments (~6 inches) instead to one big layer. (Prefer to not form platy structure!)
- Soil scientist may be needed to assure that the proper specified texture is delivered and that the destruction of soil structure has been minimized.
- Vertical separation for the soil dispersal and treatment field ideally should be the native soil with the fill being the cap. Not always possible.
- Establish grassy vegetation as soon as possible; provides not only erosion control but a more

Under A Drip Dispersal Soil Treatment Regime How Does One Collect Water Quality Samples?

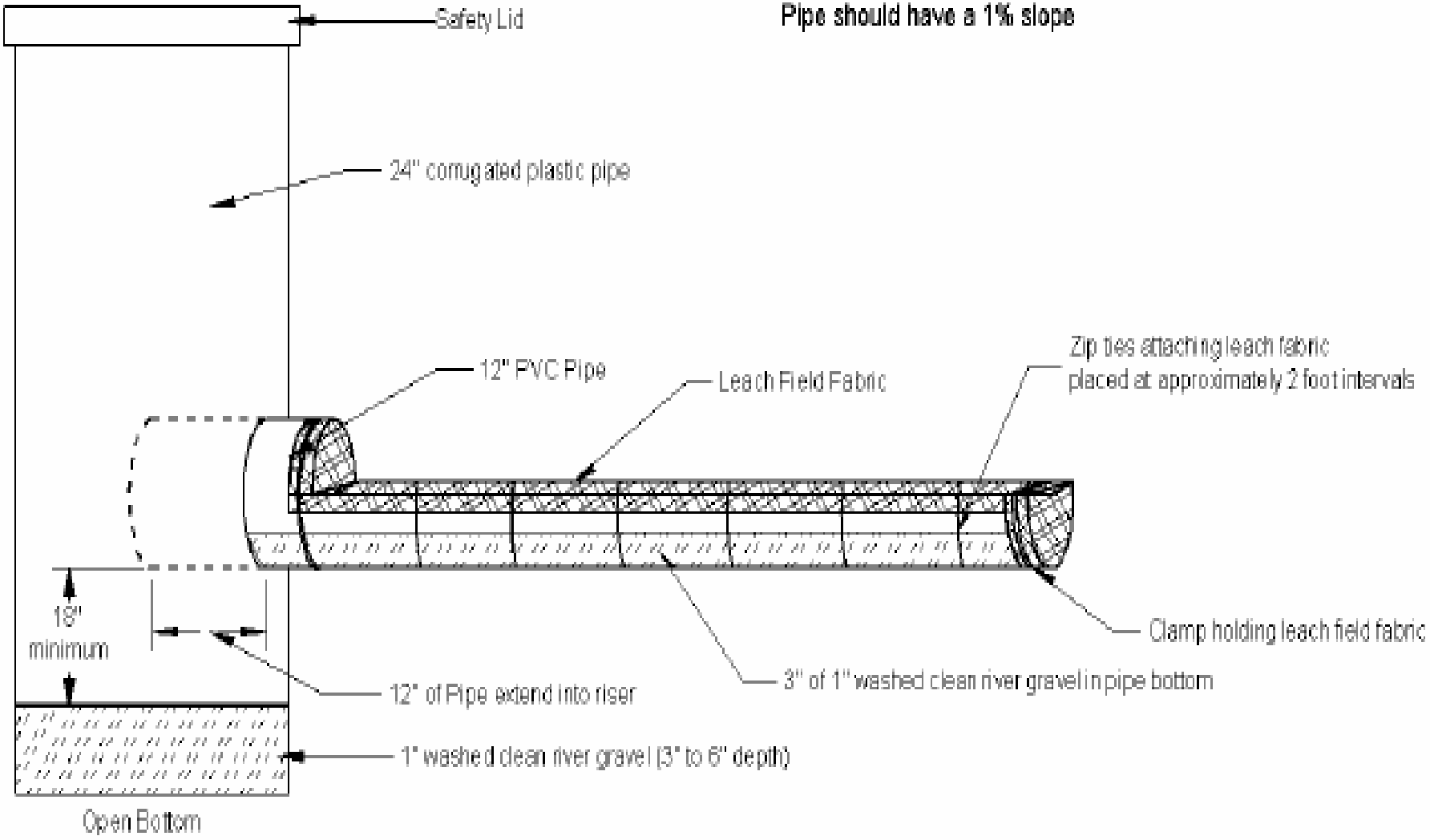
- Assuming unsaturated flow with drip dispersal.
- Piezometers measure a “point”.
- Need collection in a integrative manner.

Two Collection Methods were Fashioned for Implementation Where Imported Soil was used

- Half-pipe lysimeter.

- Sheet lysimeter

Half Pipe Lysimeter




S250

Soil Depth and Drip Tubing Placement Information

Descriptor	**Cape Fair Resort**	**Lampe Resort**	**Shell Knob South**
Approximate soil depth Above drip tubing	12 inches	12 inches	12 inches
Approximate soil Between drip tubing and lysimeters	5 inches	<1 inch	9 inches
Drip tubing placement Over lysimeters	Parallel	Perpendicular	Parallel

Number of Subsurface Samples Collected at Each Monitoring Site

Monitoring Site	Dispersal Field	Control
Cape Fair Resort		
Plastic Sheet Lysimeter	5	9
Half-Pipe Lysimeter	3	7
Lampe Resort		
Plastic Sheet Lysimeter	14	9
Shell Knob Restaurant S.		
Plastic Sheet Lysimeter	18	1
Half-Pipe Lysimeter	14	2

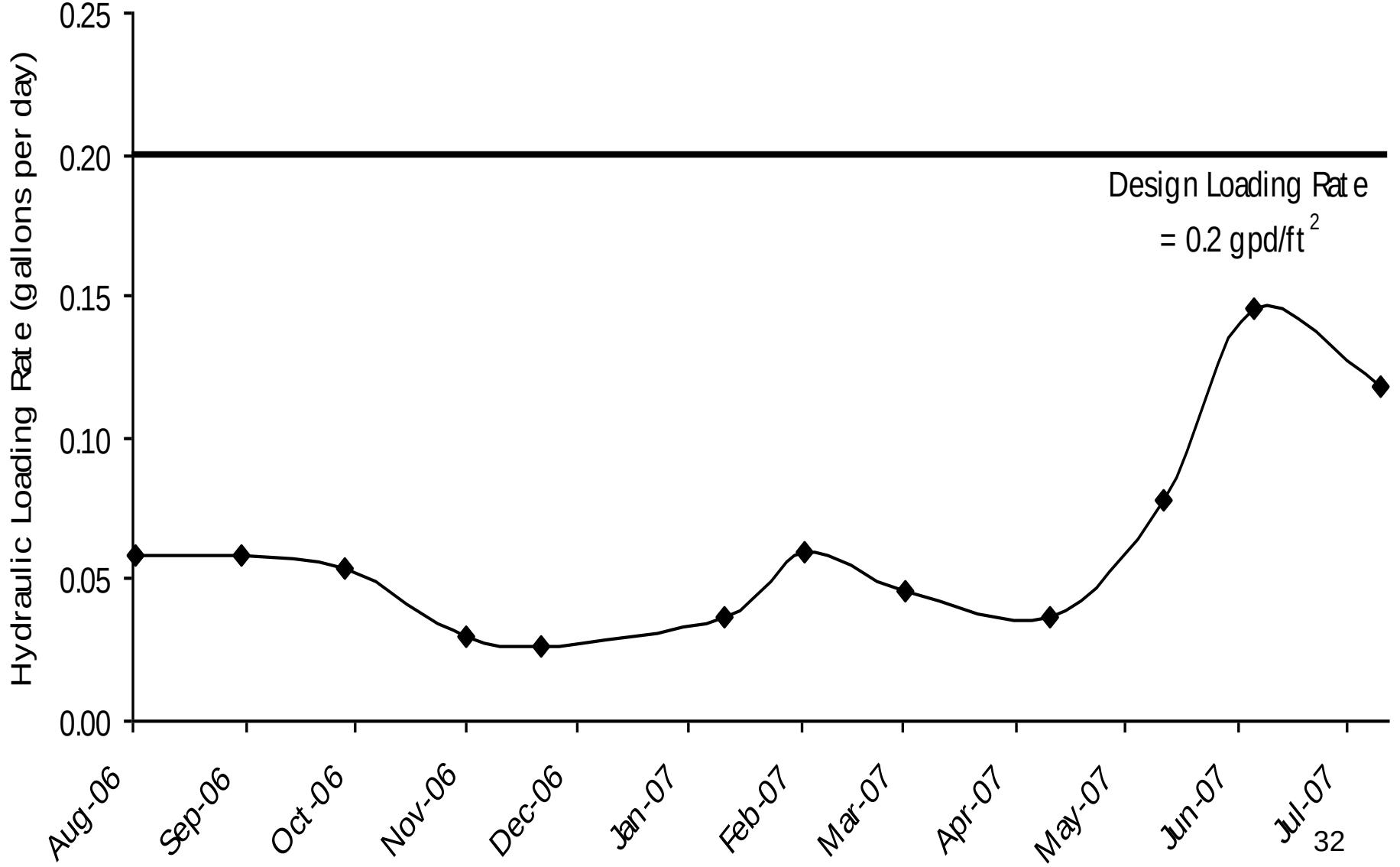
Original Lagoon at Cape Fair

Removal of Lagoon: Cape Fair

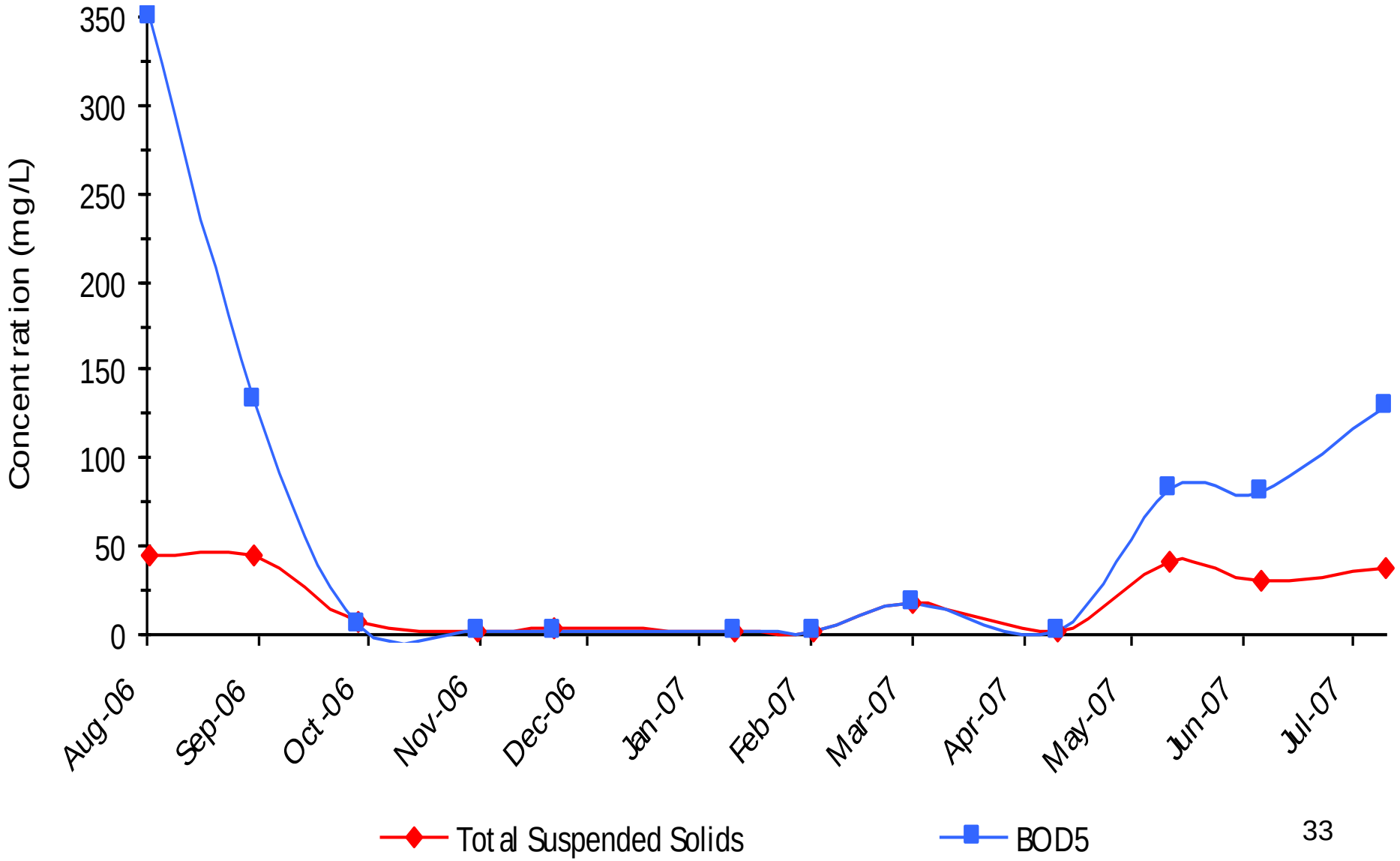
Drip Dispersal Field: Cape Fair

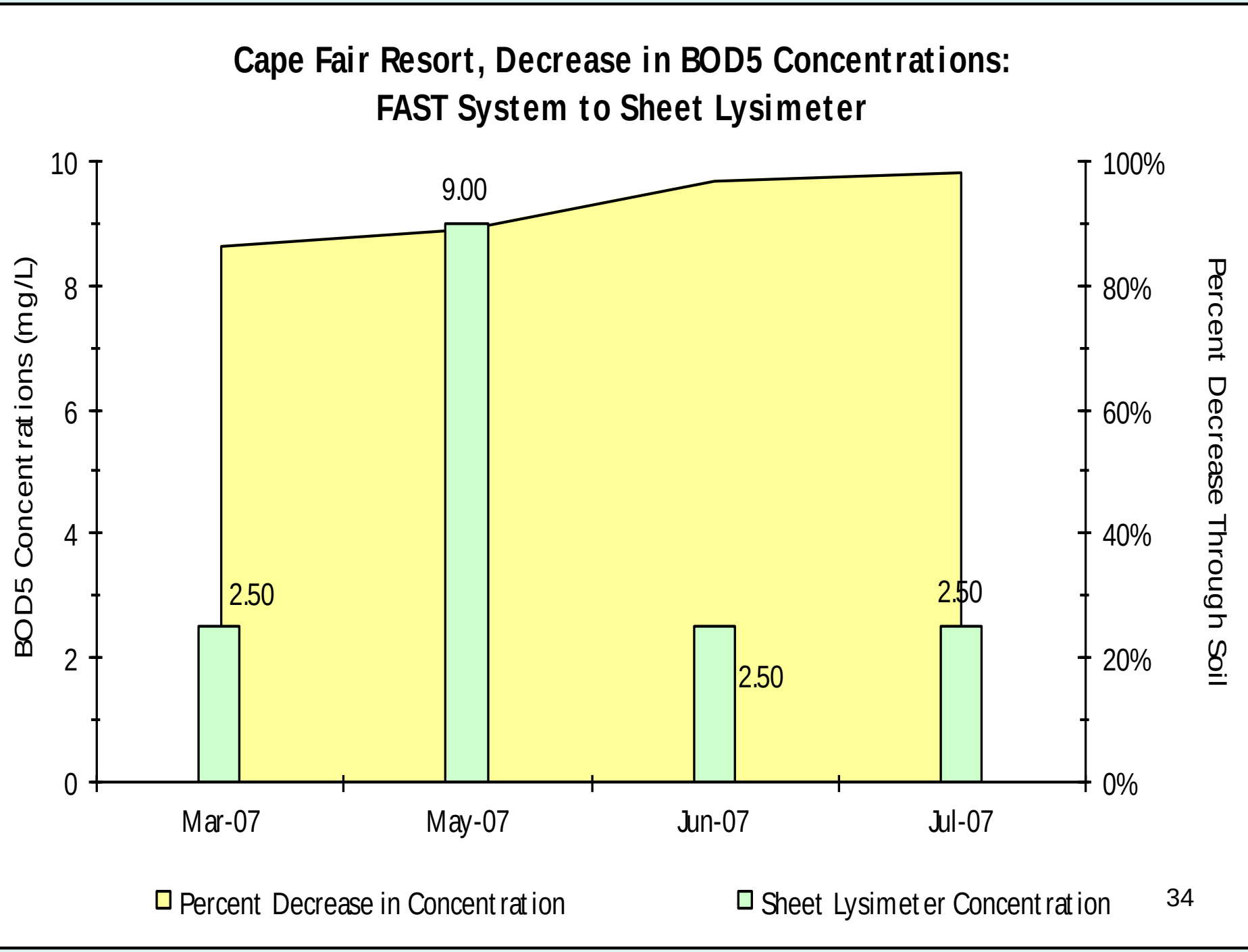
Drip Dispersal Field: Cape Fair

Cape Fair Resort - Dispersal Field Hydraulic Loading Rate



Cape Fair Resort - FAST System Effluent

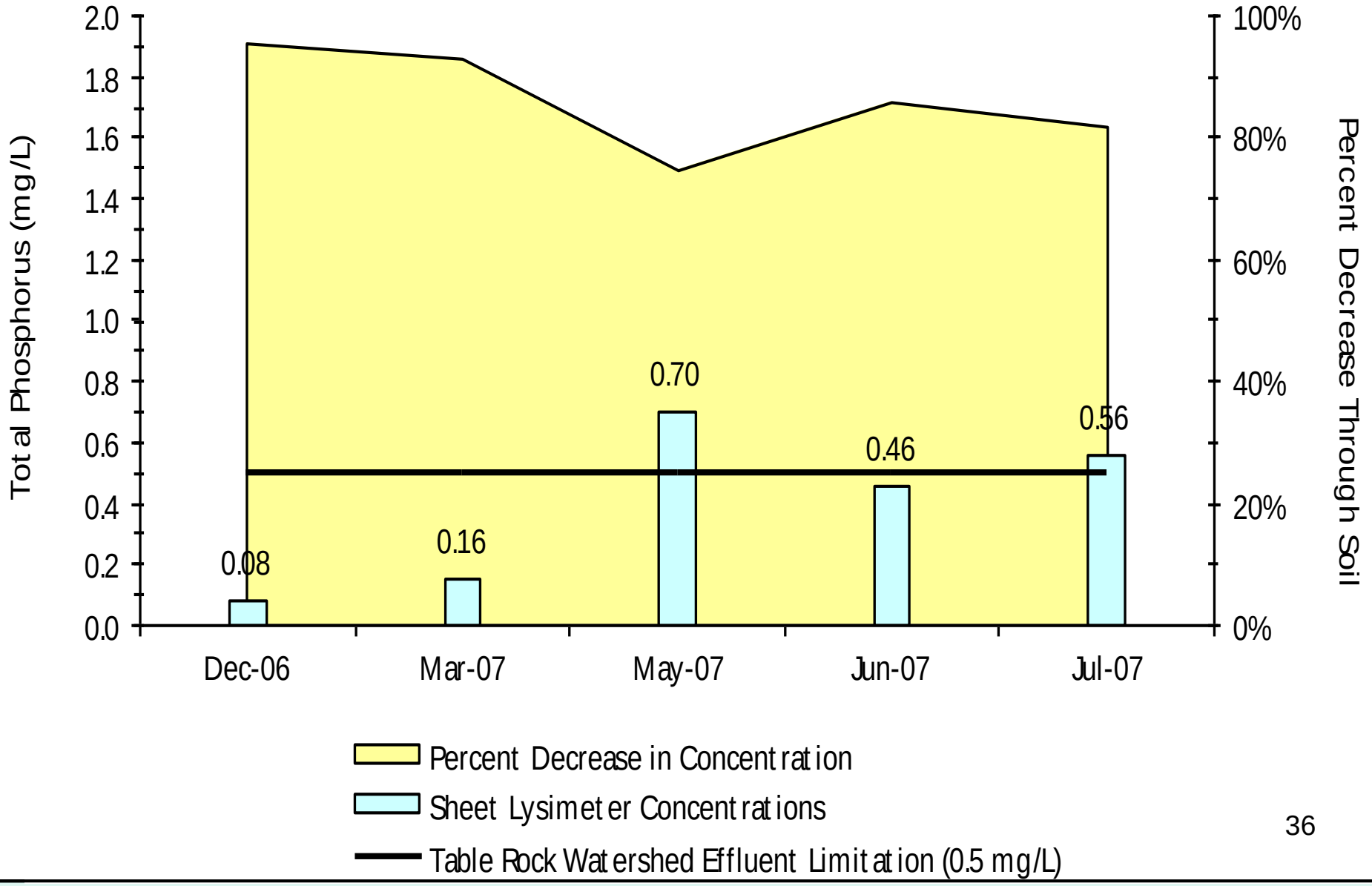



Cape Fair Resort, Decrease in BOD5 Concentrations:
FAST System to Sheet Lysimeter
BOD5 Concentrations (mg/L)
Percent Decrease Through Soil
10
8
6
4
2
0
100%
80%
60%
40%
20%
0%
9.00
2.50
2.50
2.50
Mar-07
May-07
Jun-07
Jul-07
Percent Decrease in Concentration
Sheet Lysimeter Concentration

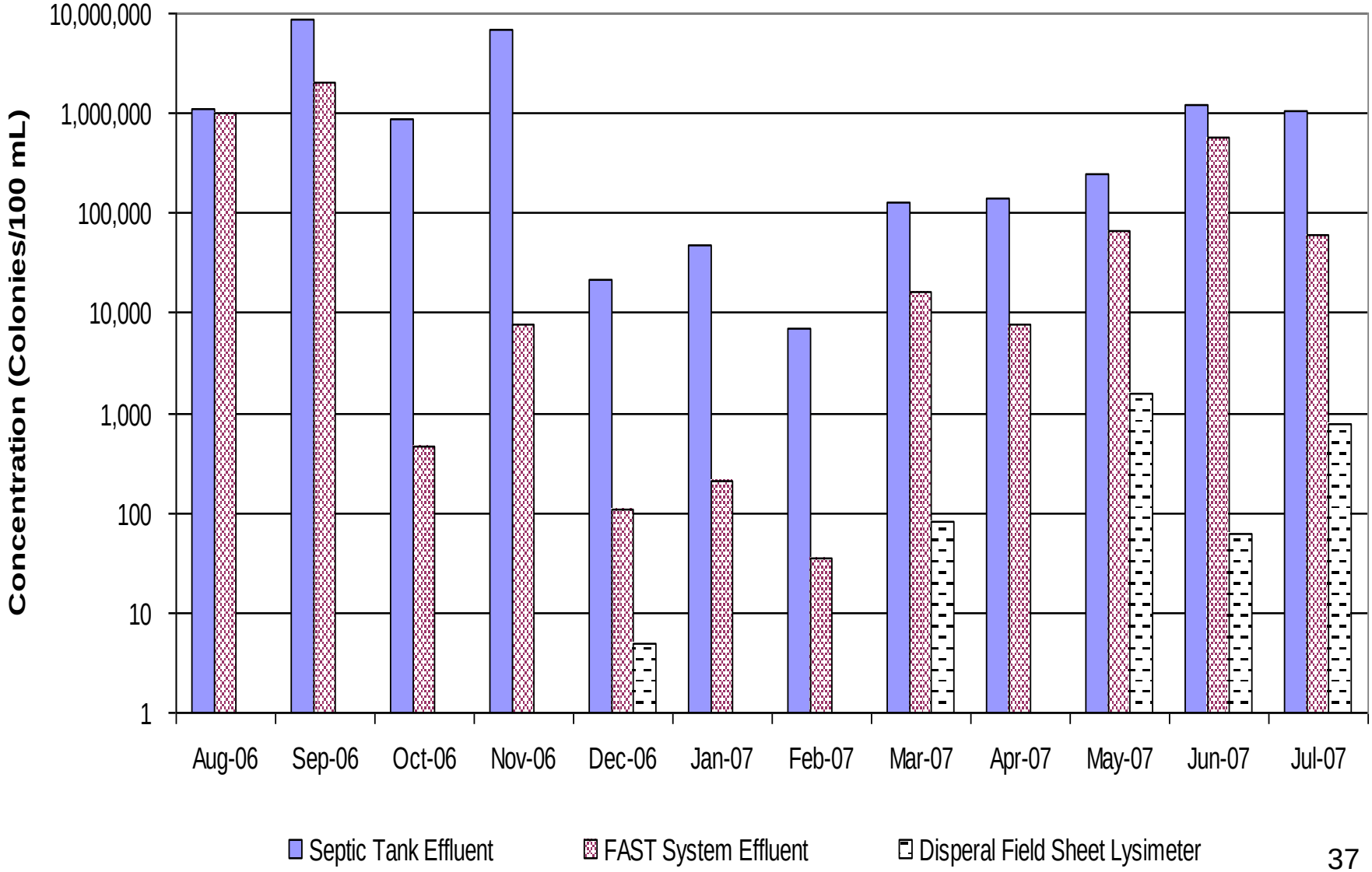
Median sample concentrations of dispersal field and control lysimeter

	Cape Fair Resort	Lampe Resort	Shell Knob Restaurant S.
	BOD5 (mg/L)		
Plastic sheet lysimeter			
Dispersal Field	3	----	3
Control	3	----	3
Half-pipe lysimeter			
Dispersal Field	11	3	4
Control	3	3	7
	Ammonia (mg/L)		
Plastic sheet lysimeter			
Dispersal Field	0.02	----	0.02
Control	0.02	----	1.28
Half-pipe lysimeter			
Dispersal Field	0.03	0.62	0.61
Control	0.02	0.14	0.44
	Phosphorus (mg/L)		
Plastic sheet lysimeter			
Dispersal Field	0.46	----	0.06
Control	0.14	----	0.25
Half-pipe lysimeter			
Dispersal Field	0.98	1.17	1.10
Control	0.15	0.19	0.16
	Fecal Coliform (colonies/100ml))		
Plastic sheet lysimeter			
Dispersal Field	81	----	23
Control	63	----	5
Half-pipe lysimeter			
Dispersal Field	45	186	153
Control	99	5	18

Cape Fair Resort Decrease in Total Phosphorus Concentrations: FAST System to Sheet Lysimeter



Cape Fair Resort - Fecal Coliform



Old Lagoon Lampe Resort

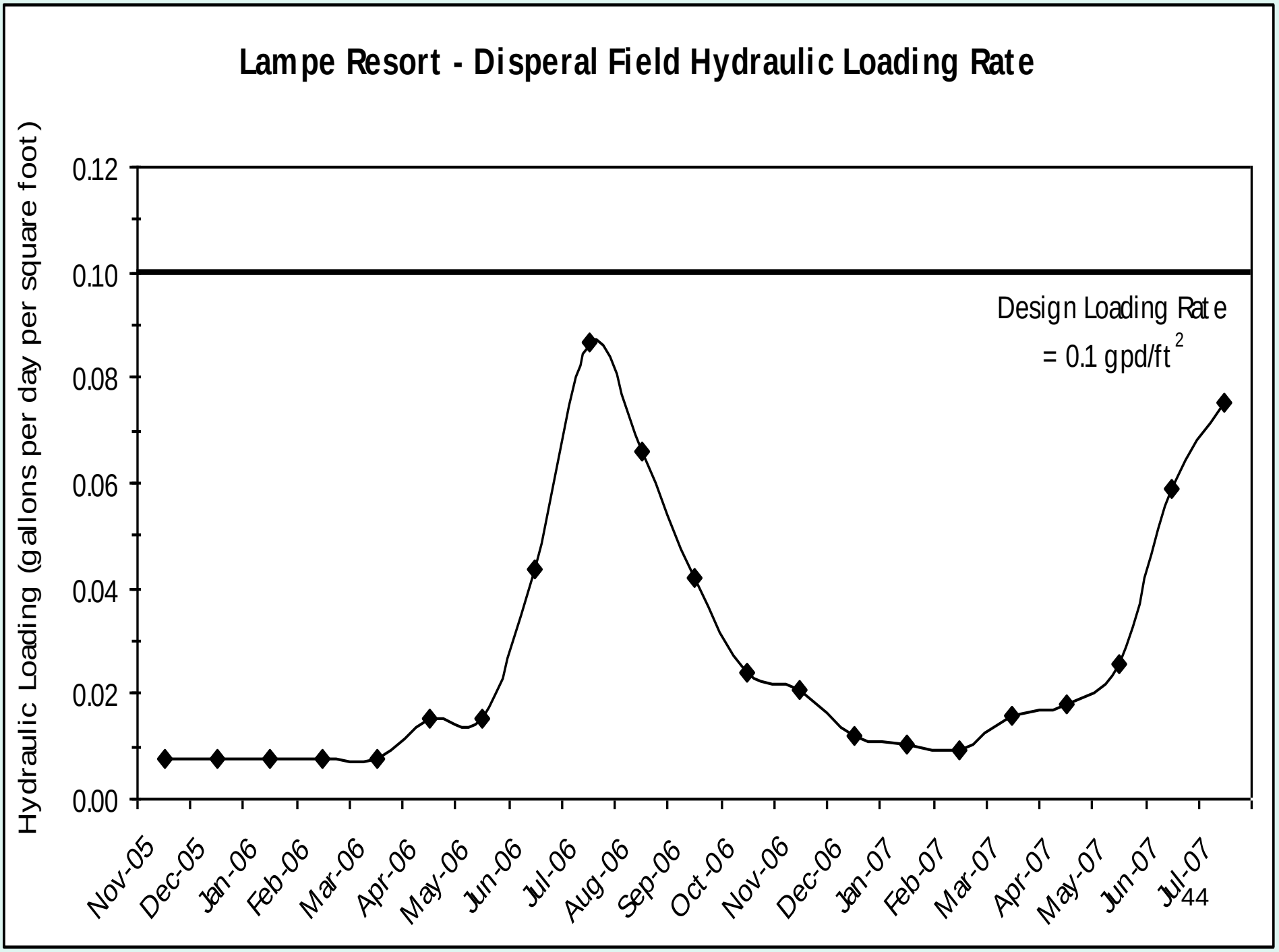
Chipping of Bedrock for Tanks: Lampe Resort

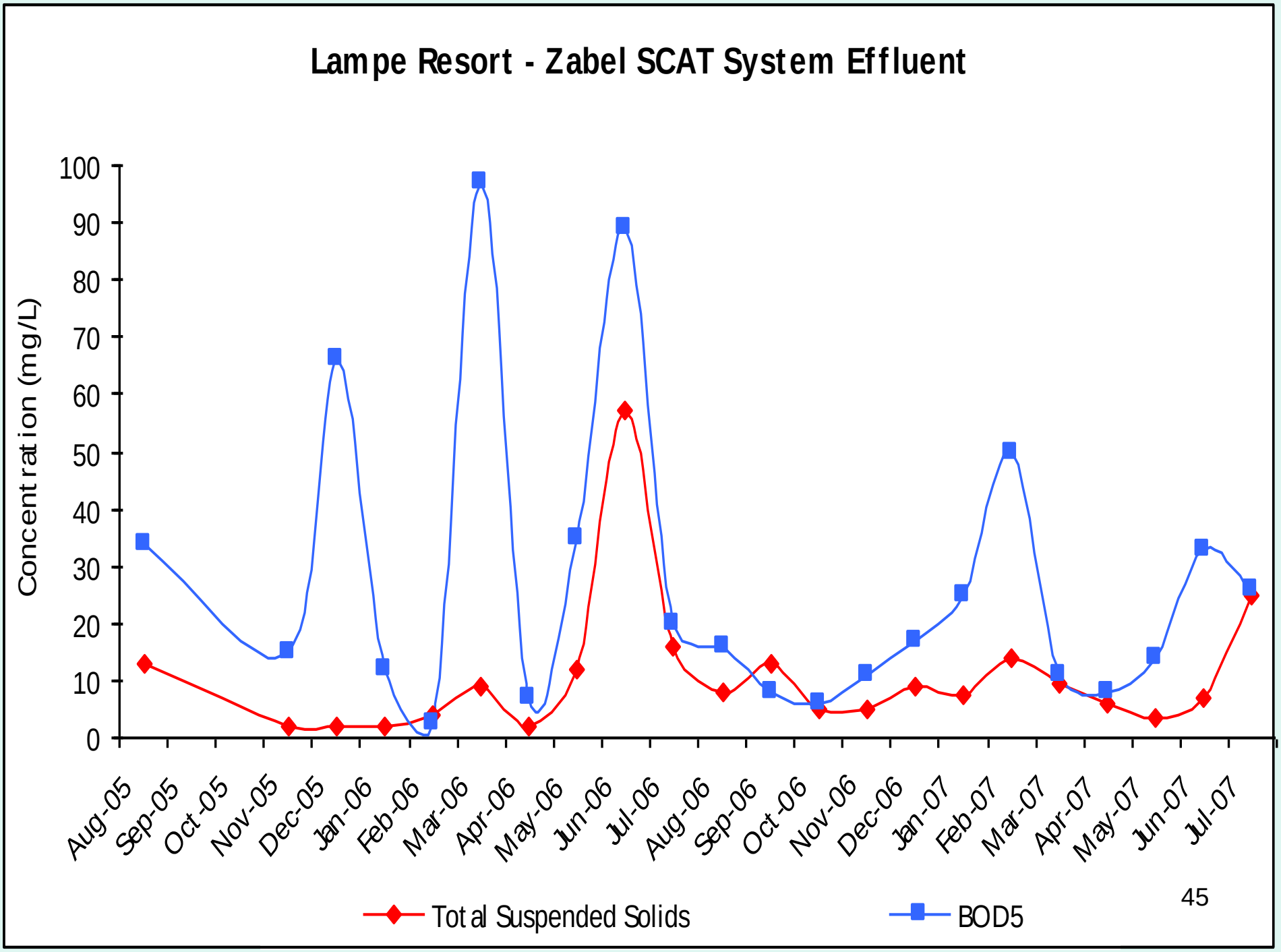
Zabel Scat System: Lampe Resort

Drip Dispersal Layout: Lampe Resort

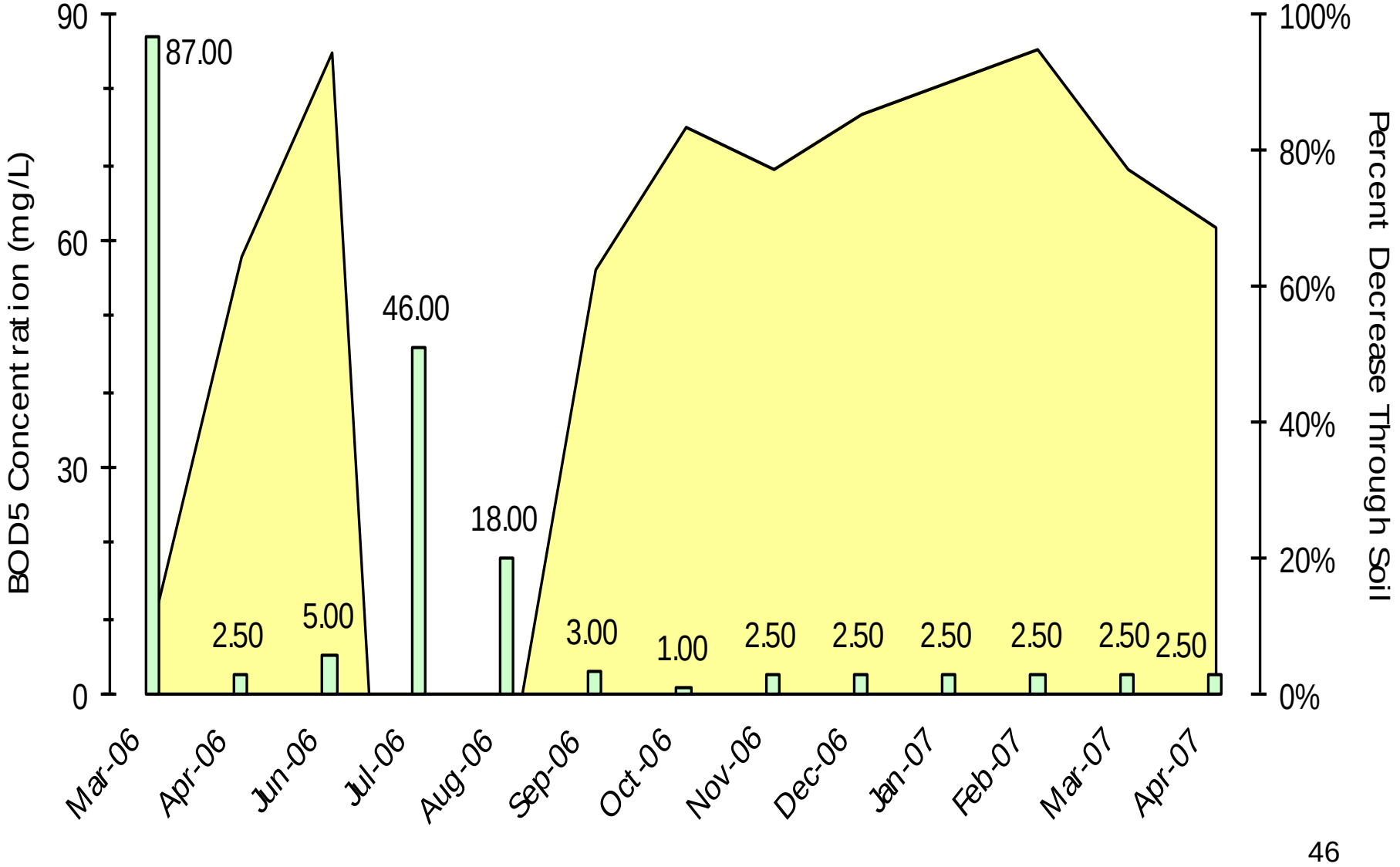
Drip Dispersal Layout: Lampe Resort

Placement of Imported Soil: Lampe Resort

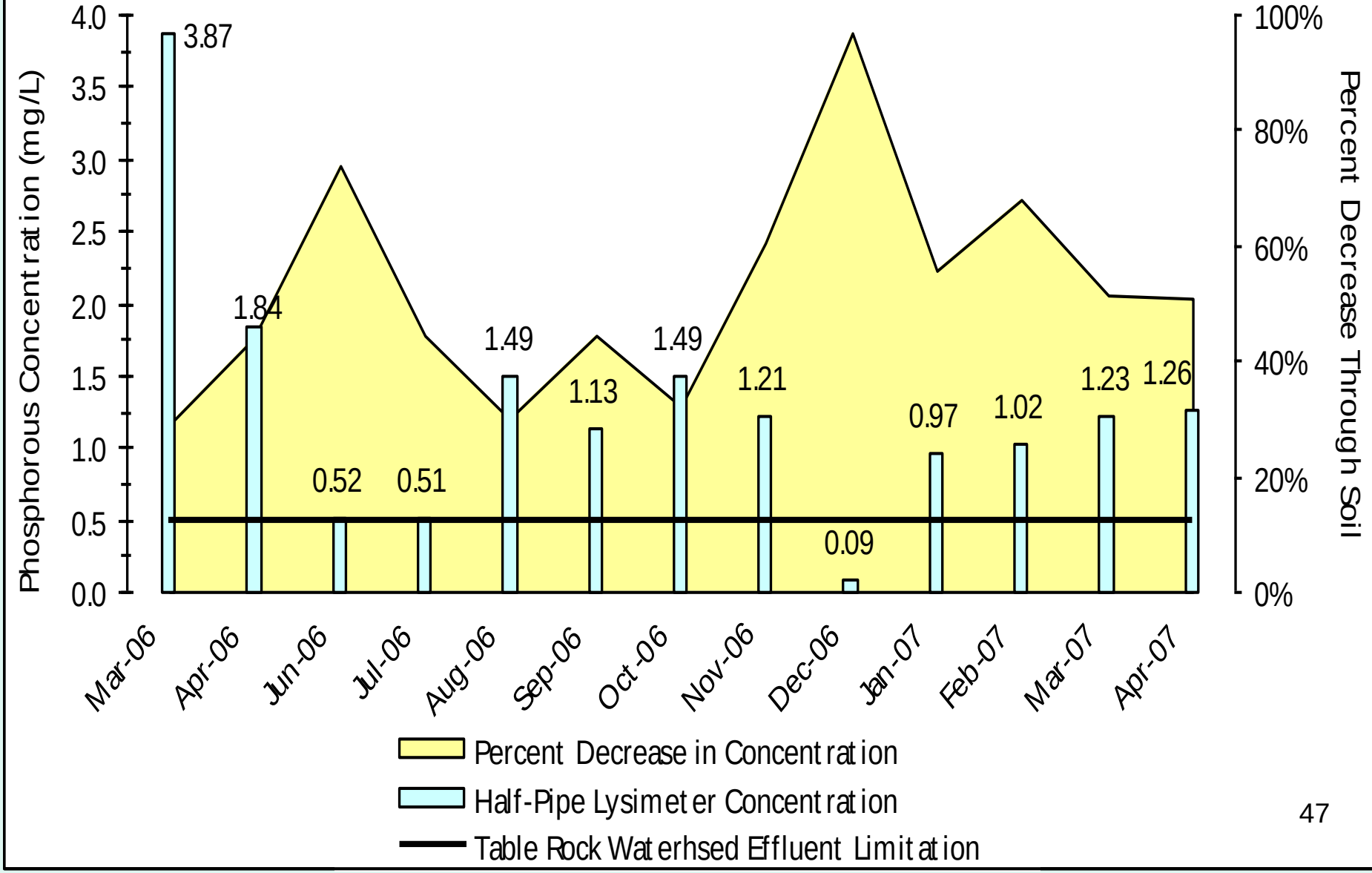

Lampe Resort - Disperal Field Hydraulic Loading Rate
Hydraulic Loading (gallons per day per square foot)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Design Loading Rate
= 0.1 gpd/ft 2
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07


Lampe Resort - Zabel SCAT System Effluent
Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Total Suspended Solids
BOD5

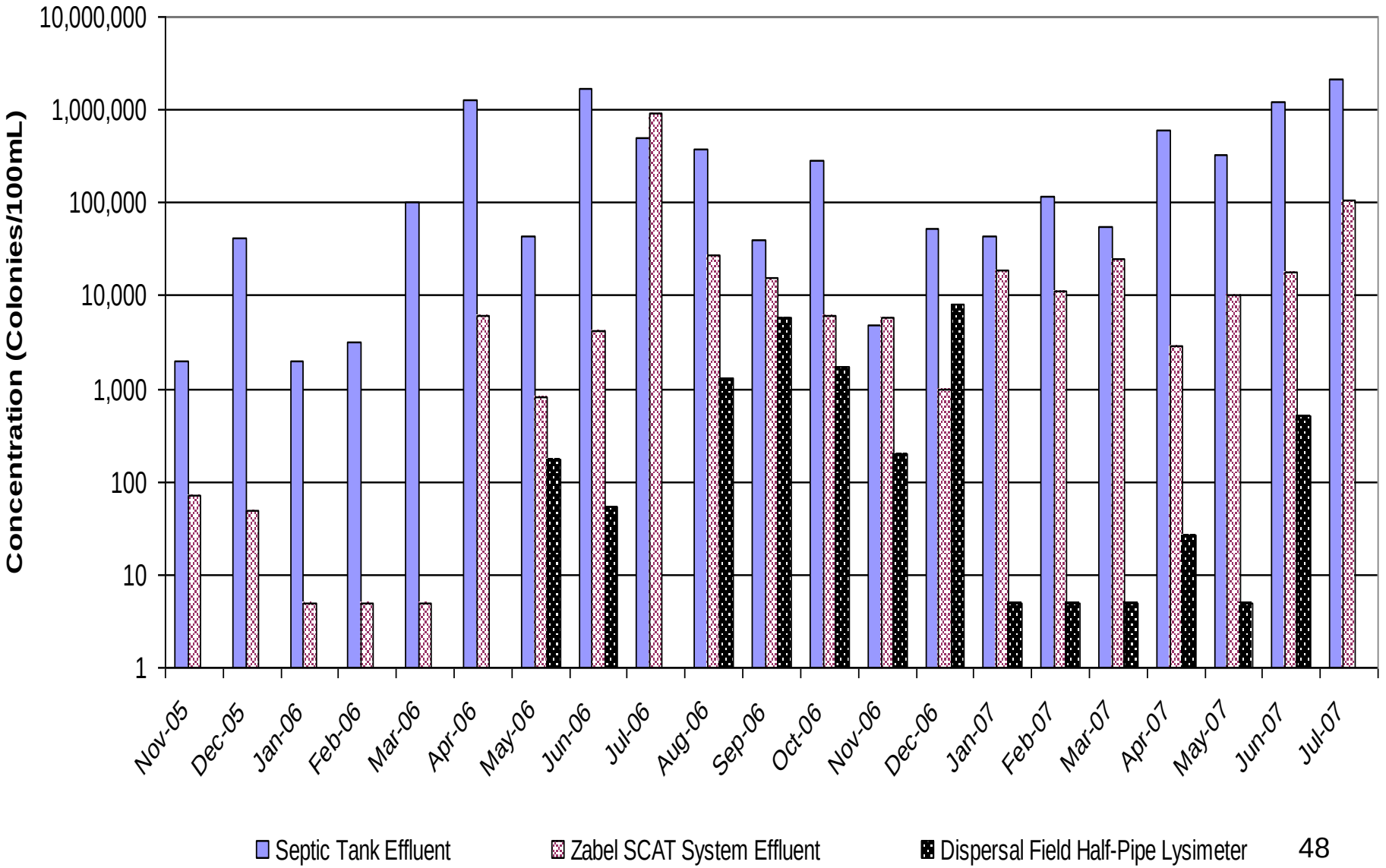
Lampe Resort - Decrease in BOD5 Concentrations: Zabel SCAT System to Half-Pipe Lysimeter



Lampe Resort - Decrease in Phosphorus Concentration: Zabel SCAT System to Half-Pipe Lysimeter

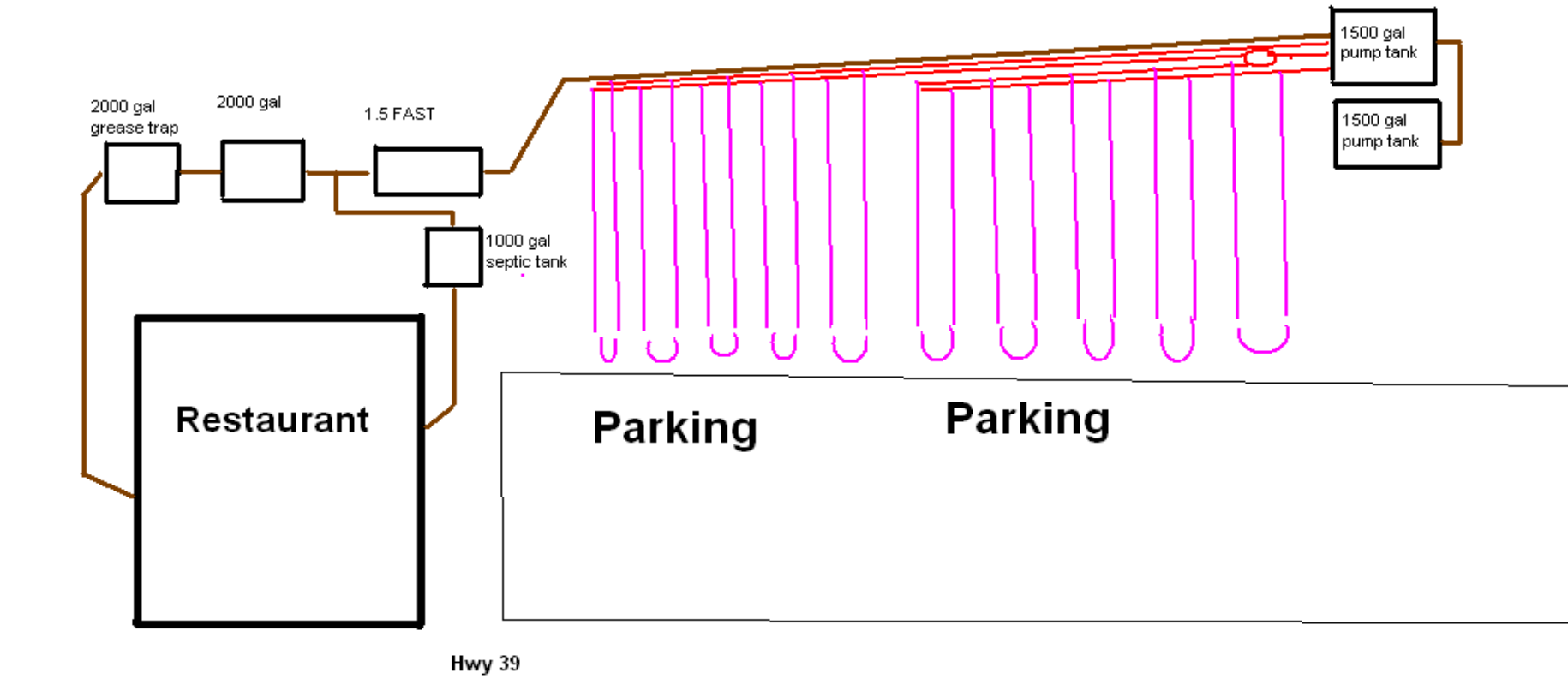


Lampe Resort - Fecal Coliform



Old System: Shell Knob South

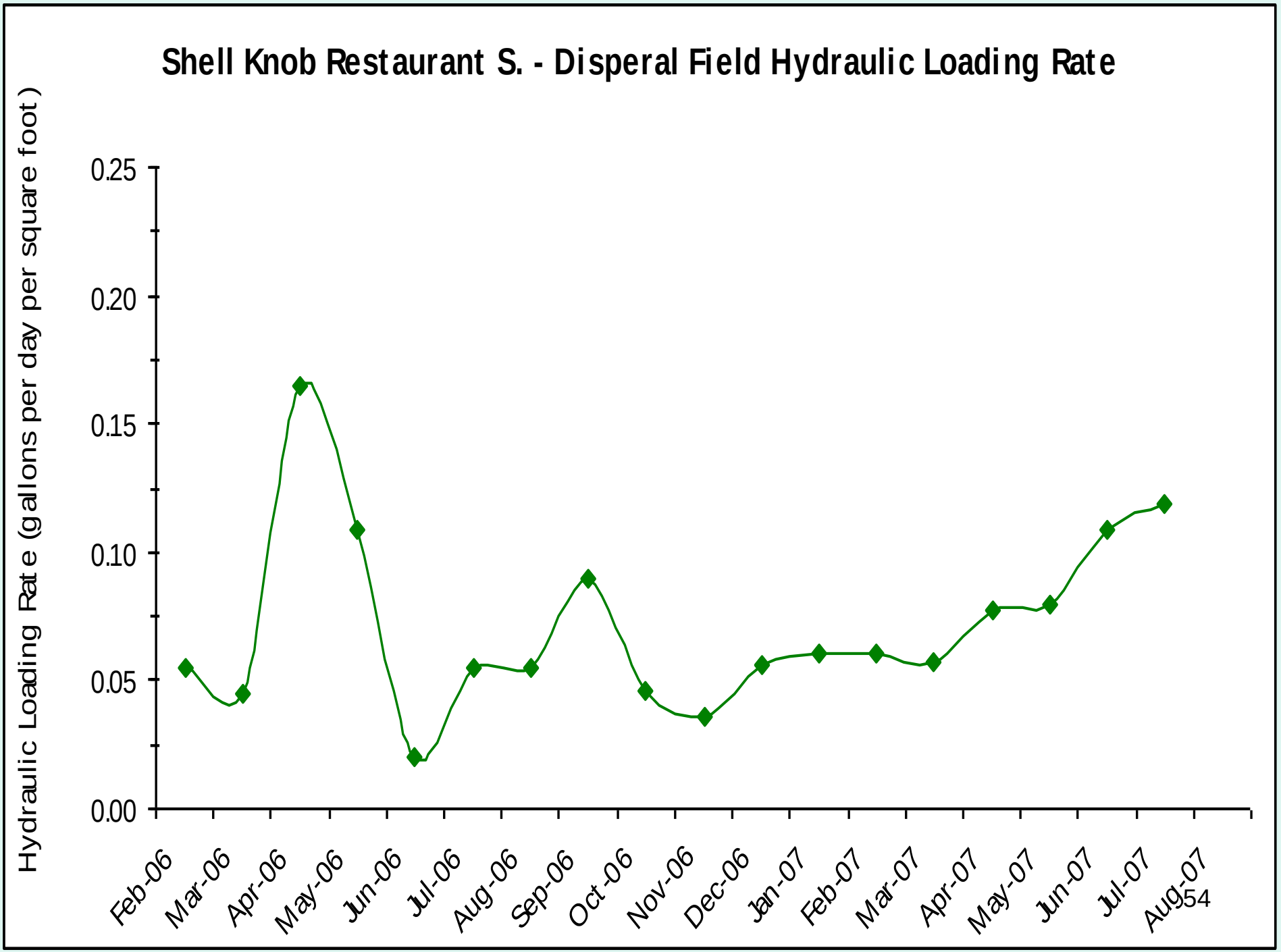
Shell Knob South Restaurant

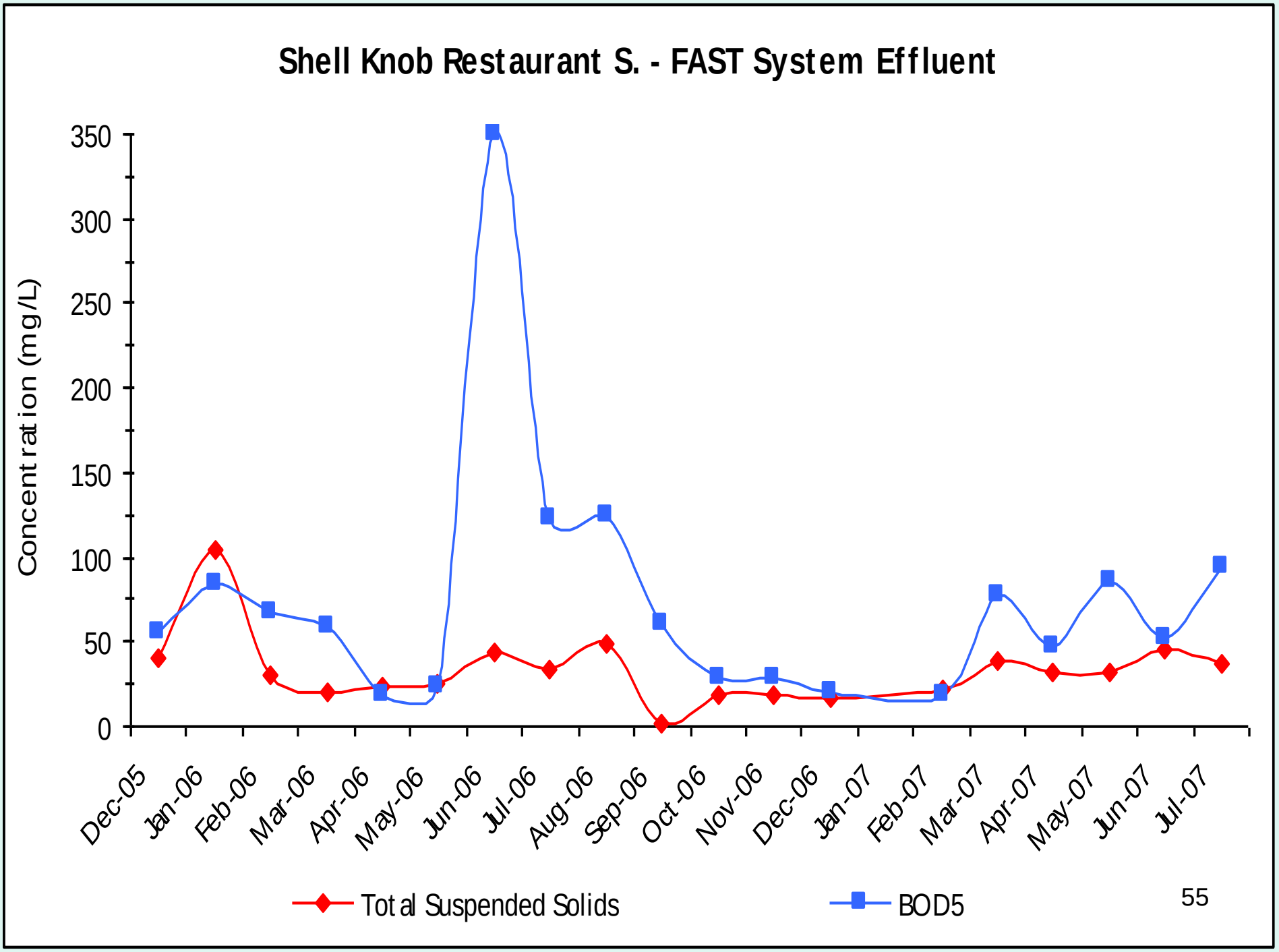


FAST System: Shell Knob South

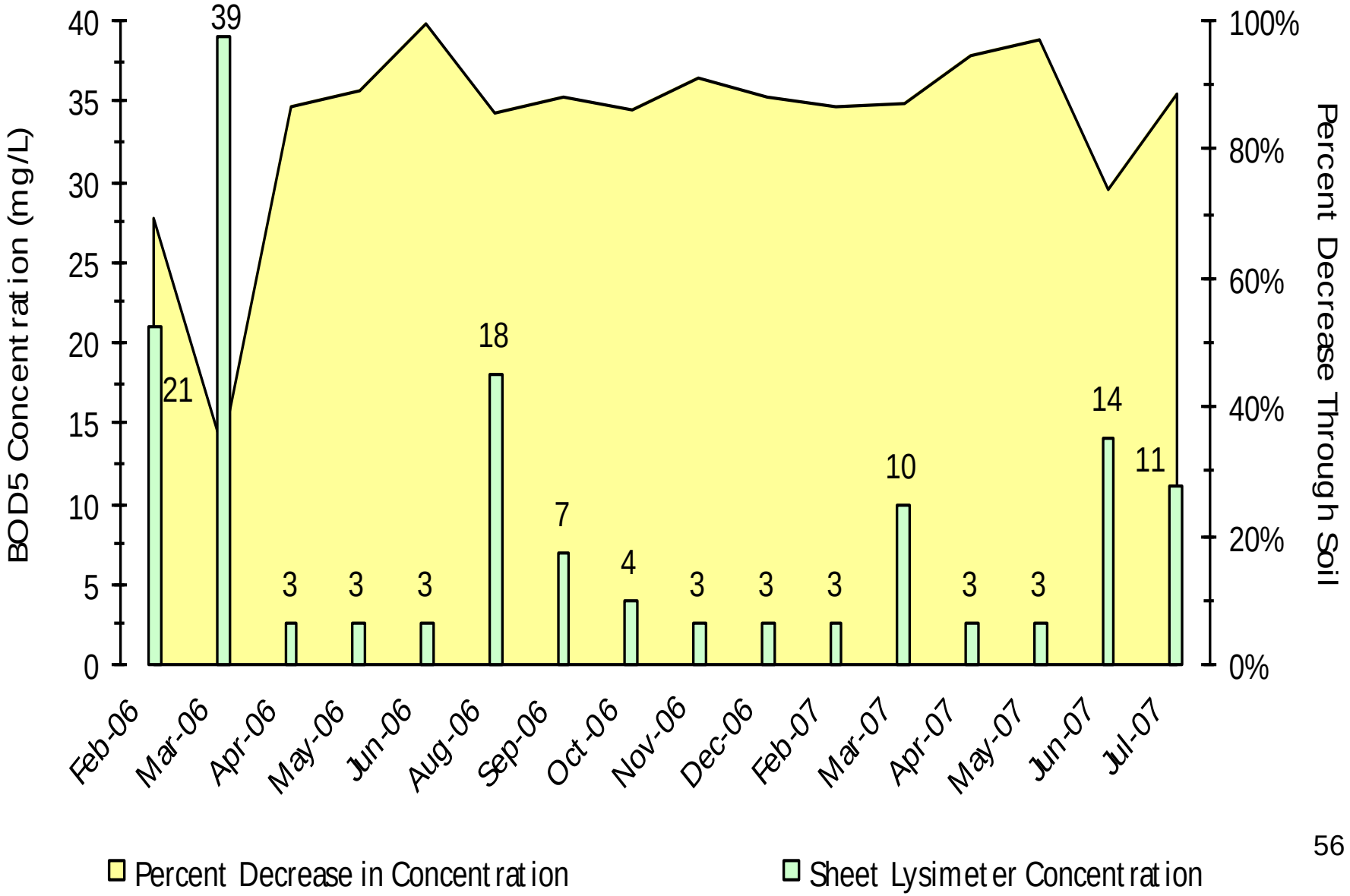
Placement of Imported Soil: Shell Knob South

Half-pipe lysimeter: Shell Knob South

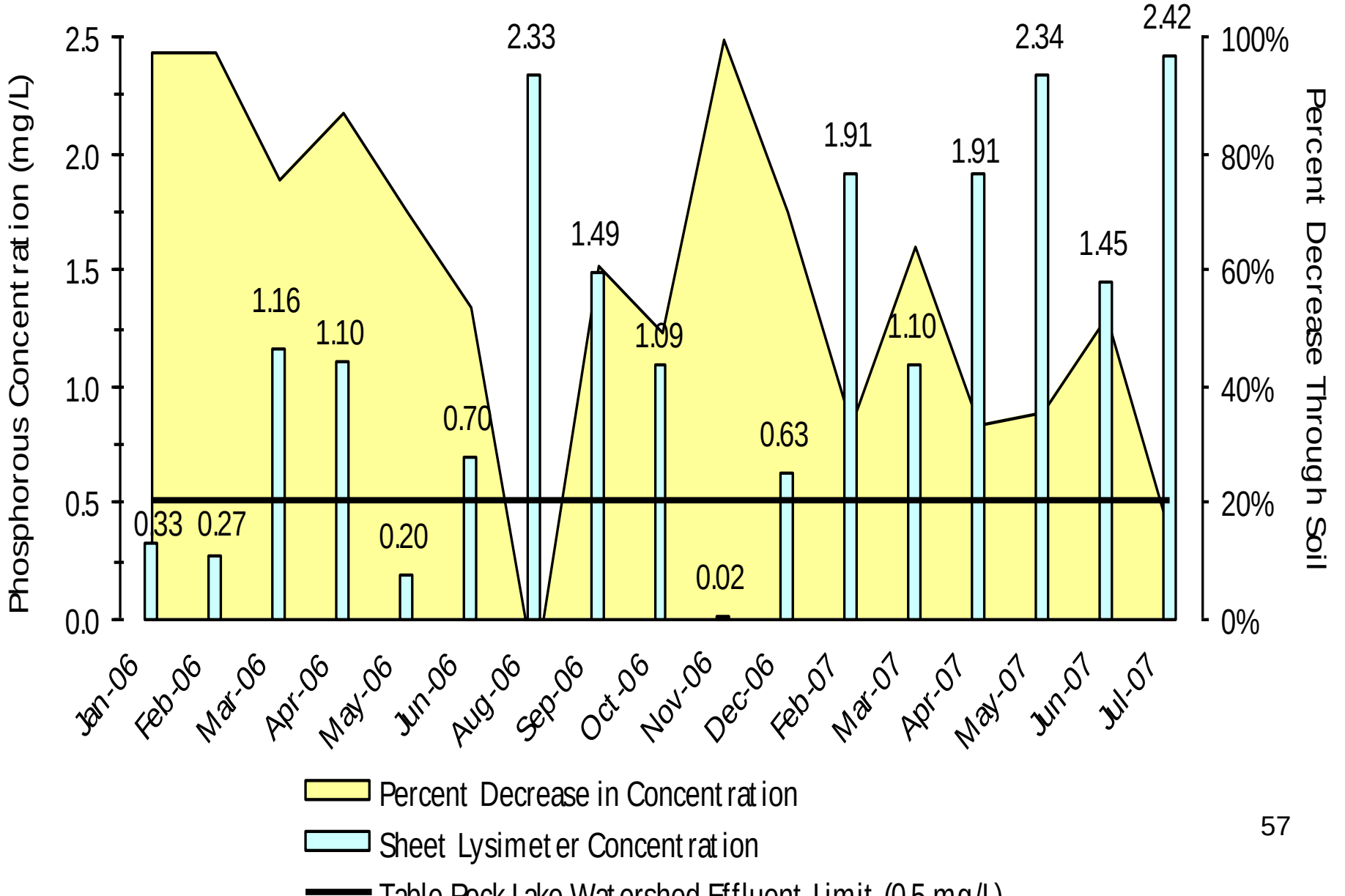

Shell Knob Restaurant S. - Disperal Field Hydraulic Loading Rate
Hydraulic Loading Rate (gallons per day per square foot)
0.25
0.20
0.15
0.10
0.05
0.00
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07


Shell Knob Restaurant S. - FAST System Effluent
Concentration (mg/L)
350
300
250
200
150
100
50
0
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Total Suspended Solids
BOD5

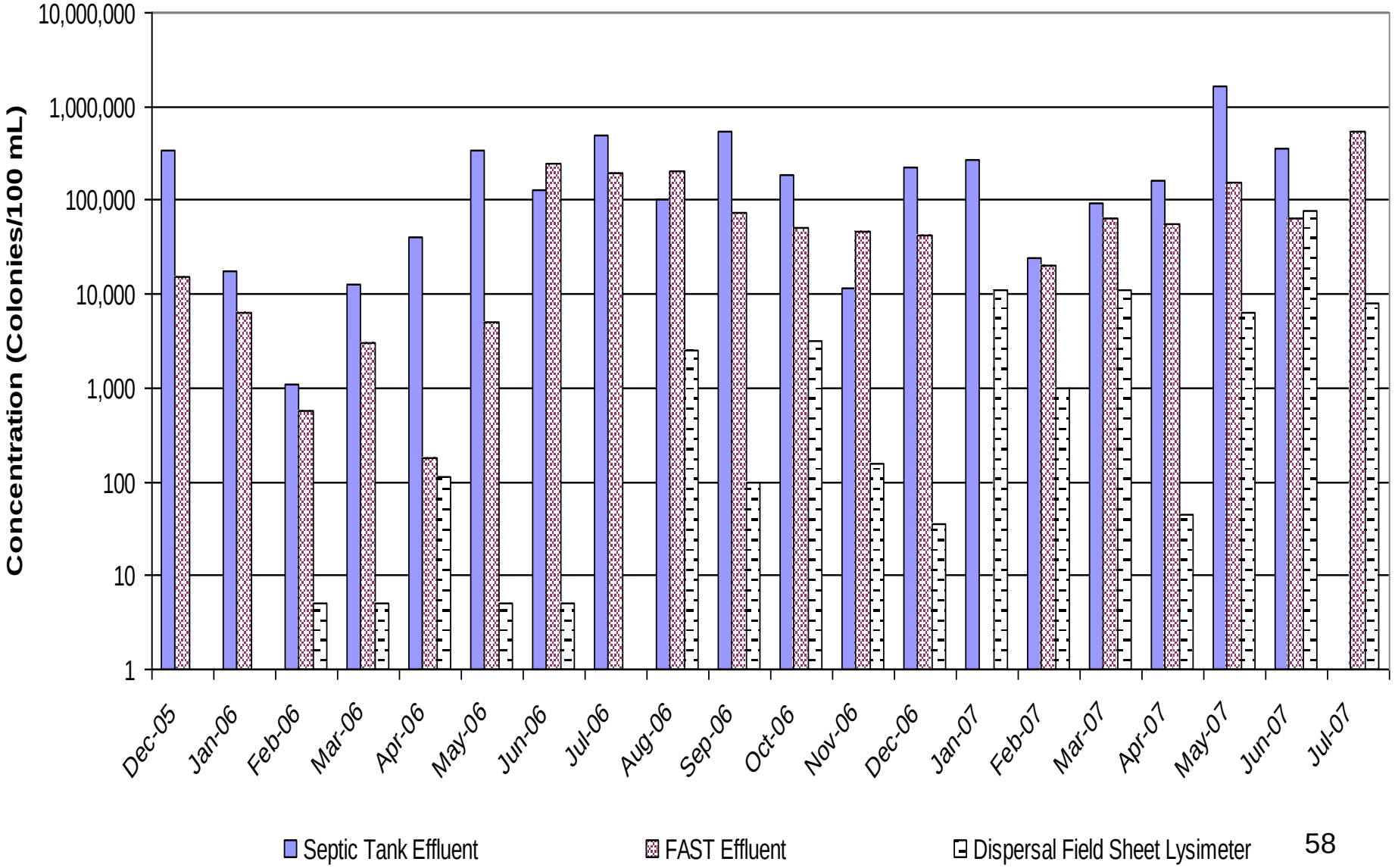
Shell Knob Restaurant S. Decrease in BOD5 Concentration: FAST System to Sheet Lysimeter



Shell Knob Restaurant S. Decrease in Phosphorus Concentration: FAST System to Sheet Lysimeter



Shell Knob Restaurant S. - Fecal Coliform



Septic Tank Effluent, Treated Effluent, and Subsurface Median Concentrations

	Cape Fair Resort	Lampe Resort	Shell Knob Restaurant S.
BOD5 (mg/L)			
Septic Tank Effluent	108	36	343
Treatment System Effluent	12	17	59
Subsurface Samples	3	3	4
TSS (mg/L)			
Septic Tank Effluent	46	29	64
Treatment System Effluent	12	7.8	32
Ammonia (mg/L)			
Septic Tank Effluent	6.1	5.6	5.3
Treatment System Effluent	4.8	5.2	5.7
Subsurface Samples	0.02	0.62	0.61
Phosphorus(mg/L)			
Septic Tank Effluent	2.6	3.0	3.5
Treatment System Effluent	2.1	2.8	3.0
Subsurface Samples	0.5	1.2	1.1
Fecal Coliform (colonies/100 mL)			
Septic Tank Effluent	551,000	103,000	160,000
Treatment System Effluent	12,060	8,290	50,000
Subsurface Samples	81	186	153

Summary of Results for the Soil Receiving Environment

- Effluent BOD_5 and TSS concentrations for the advanced system units were consistently below 20 mg/L (ppm).
- Plastic sheet and half-pipe gravity lysimeters were effective in collecting subsurface samples.
- Plastic sheet lysimeters preferred if lysimeters are installed in concert with the system installation.
- Piezometers were not effective in collecting subsurface drip dispersal field samples
- Piezometers are a point source measurement versus an integration of the soil treatment field through the use of half-pipe or sheet lysimeters.

Summary of Results for the Soil Receiving Environment (continued)

- Dispersal field subsurface sample concentrations were consistently smaller for all water quality parameters measured.
- For all three systems with gravity lysimeters median BOD_5, ammonia and fecal coliform concentrations were below effluent discharge limits for a mechanical surface discharging systems possessing nitrification and disinfection units processes.

Application of the Findings of the Study

- Advanced treatment combined with the unsaturated flow from time-dosed drip dispersal technology in concert with imported soil provides a reasonably high degree of success (while lowering risk) on marginal soil sites.
- Provided impetus for adaptation in other marginal Missouri soil /site receiving environments. Has been adapted in other states.

Use of Imported Soil in Marginal Sites:

- Not a “Magic Bullet” as there is a narrow range of tolerances.
- Rigid standards for imported soil material.
- Rigid standards for preparation of the soil treatment receiving site.
- Rigid standards for harvest, transport, and placement of imported soil material. (Steer away from compaction and platy structure!)
- Aerobic pre-treatment of effluent a must.
- Dispersal as unsaturated flow is critical.

Use of Imported Soil in Marginal Sites:

- Not an easy or low cost alternative.
- Specifications are not to discourage the installation but:

If you want a job that is easy, sell shoes; practically everyone needs to wear shoes

One of the Bigger Questions Relative to Performance and Regulatory Considerations

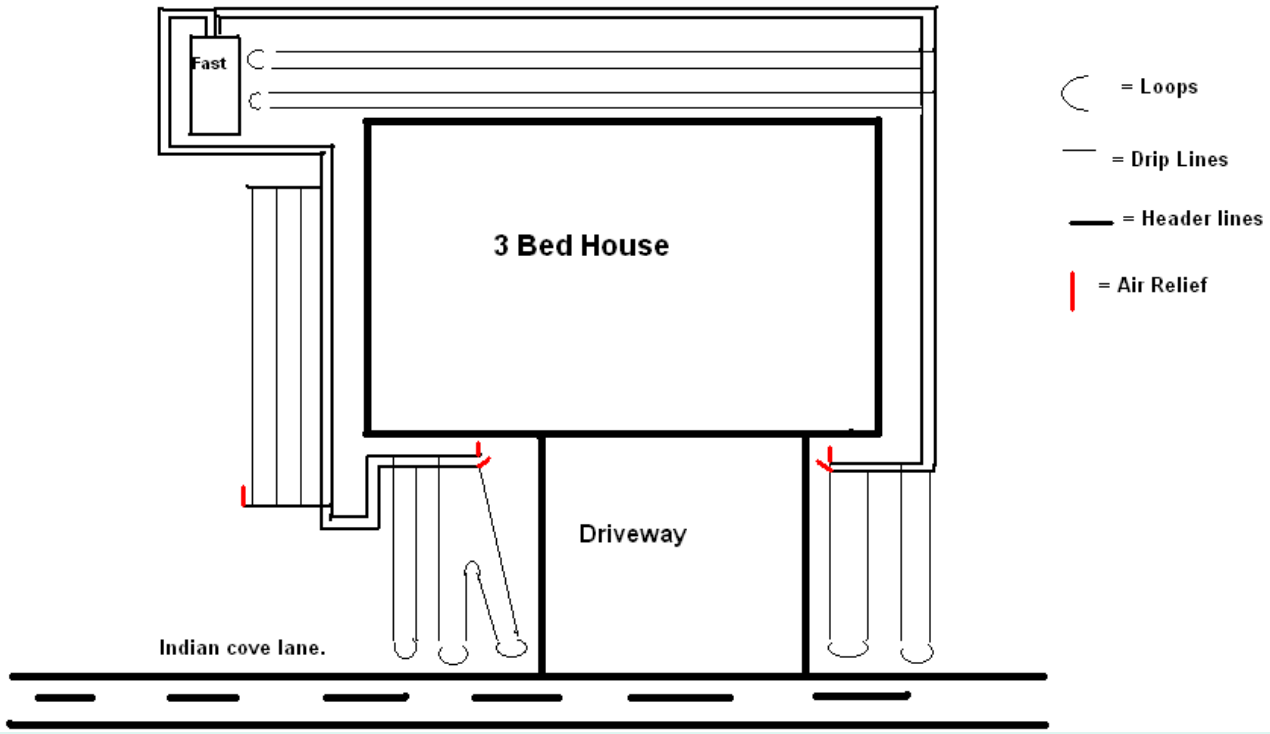
- Use of unsaturated flow can be useful but..
- What do the MPN or FC Colonies per gram of dry soil mean?
- Can we relate the dry soil fecal coliform (or any other organism) numbers to reasonable assurances of treatment and human health and safety?

Case Studies of Onsite Wastewater Systems Utilizing Imported Soil

A Resort and An Individual Residential System

Gevers Residence

Ed Gevers
Briar Cliff rd. H hwy,Lampe
417-779-1913
950' drip tubing
.5 Fast, 500 gal pump tank
single zone
24" of topsoil hauled in
sod on finish grade



Gevers Residence

Gevers Residence

Gevers Residence

Gevers Residence: Preparation in Backyard

Gevers Residence: Drip Tubing Installed in Backyard

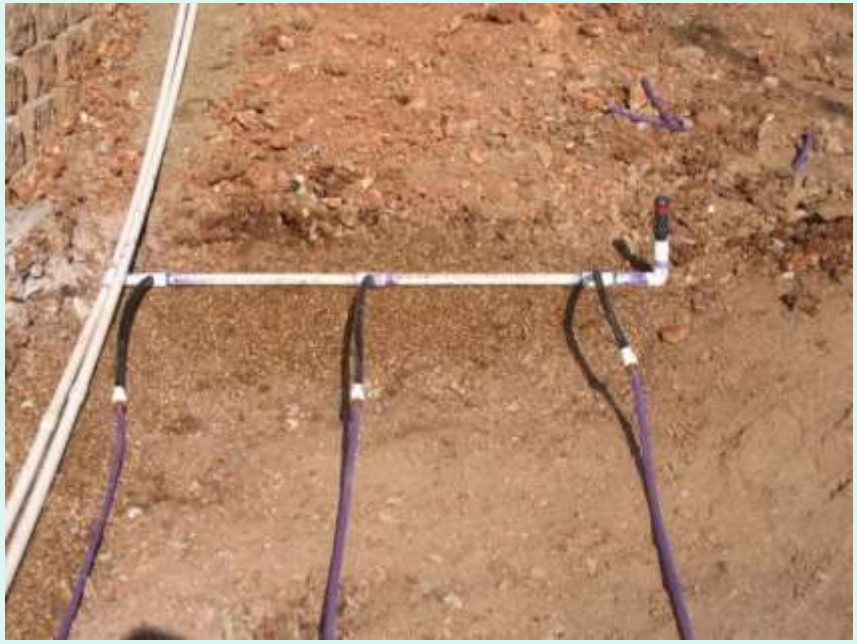
Gevers Residence: Placing Imported Soil on Drip Tubing

Gevers Residence: Right Side of House

Gevers Residence: Right Side of House

Gevers Residence: Front Yard

Gevers Residence: Left Side of House



Gevers Residence:
Tight Working Conditions

Gevers Residence: Finishing the Sodding

Gevers Residence: Present

Gevers Residence Present

Gevers Resident: Present

Gevers Residence: Present

Boulder Point Resort

Boulder Point Resort

Boulder Point Resort

Boulder Point Resort

Boulder Point Resort: Pour for Concrete Tank

Boulder Point Resort: Blown In Tank with Pump Tank

Boulder Point Resort: Drip Irrigation Tube Set in Treatment Field

Boulder Point Resort: Drip Tubing Set up to Property Line

Boulder Point Resort: Drip Tubing Set Using All Available Area

Placing Imported Soil as Cap At Boulder Point Resort

Placing Imported Soil As Cap At Boulder Point Resort

Imported Soil Used for Manicuring Lawn

Soil Treatment Field Mulched with Surface Diversion: Boulder Point Resort

Boulder Point Resort: SCAT Unit Set on Tank

Boulder Point Resort: Soil Treatment Field Mulched

Boulder Point Resort: SCAT Unit Set on Tank

Boulder Point Resort: Soil Treatment Field

Application of the Findings of the Study

- Advanced treatment combined with the unsaturated flow from time-dosed drip dispersal technology in concert with imported soil provides a reasonably high degree of success (while lowering risk) on marginal soil sites.
- Provided impetus for adaptation in other parts of Missouri soil receiving environments.

FILL SOIL MATERIALS FOR ONSITE WASTEWATER DISPERSAL FIELDS HAS MANY PROBLEMS AND CHALLENGES

- Fill must be a specific textural class range
- Lack of uniformity of fill material- laterally and vertically
  - Variable in texture and structure
  - Structure is easy to destroy or degrade
- Easy to compact in the harvest and placement process (Stay away from compaction and platy structure!)
- Subsidence can be a long term problem
- Plant residue in the placement area as well as the harvest area Influences Water Movement

PROBLEMS WITH USE OF FILL FOR ONSITE WASTEWATER SYSTEMS

- Poor quality soil material is specified or used
- Diversity of soil texture is used
- Soil structure is destroyed or obliterated
- Soil material is compacted
- Placement is not uniform, allowing preferential by-pass flow
- **The loading rate for imported soil is about half of what it was under native conditions**

PROBLEMS WITH USE OF FILL FOR ONSITE WASTEWATER SYSTEMS
(CONTINUED)

- Takes a long time to stabilize and not subside
- Plant residue and roots are not removed thus providing channels for by-pass flow
- Use of on demand or gravity distribution
  - Uneven soil trench depth, thus not providing proper distribution
  - leads to localized overloading
- Incomplete treatment

Fundamental Guidelines and Suggestions That Assist in Providing More Efficient Performance of The Fill Soil for Onsite Wastewater Systems

- It is better to err on using the sandier material within the specified range
- It is better to err on harvesting, transport, and placement under drier conditions rather than moist
- If in doubt remove the few remaining roots and organic debris
- Divert all surface and subsurface water
- Place in small layer increments, not one thick layer
- No matter how “uniform” you believe the fill is placed, consider timed, pressure dosing (DRIP DISPERSAL). This provides unsaturated flow!!!!!!!!!!!!!
- You cannot go wrong with highly treated effluent
- Use fill as a “cap” not the absorption area