Large Pump System Design

What's Different?

- Multi-tank design
- Multi-pump
- Multi-zone
  - Dispersal fields of varying sizes (non-symmetrical)
- Chemical feed
- Custom telemetry
- HMI screens

Tank Sizing:

- Emergency storage
  - Soffit to high level alarm
  - May be dictated by permit/local regs

Tank Sizing (cont):

- Retention time

Type 1, Residential quality waste[3] (includes apartments, condos, mobile home parks, municipal, planned communities, subdivisions, work camps)	n/a	2	2× design max. day flow (1P + 1A)	n/a
Type 2, Primarily black water waste [4,5] (includes airport facilities, campgrounds, fire departments, golf courses, marinas, offices, parks, public toilets, rest areas, RV parks[5], ski resorts, visitor centers)	3	3	3× design max. day flow (2P + 1A)	n/a

Tank Sizing (cont):

- Flow modulation

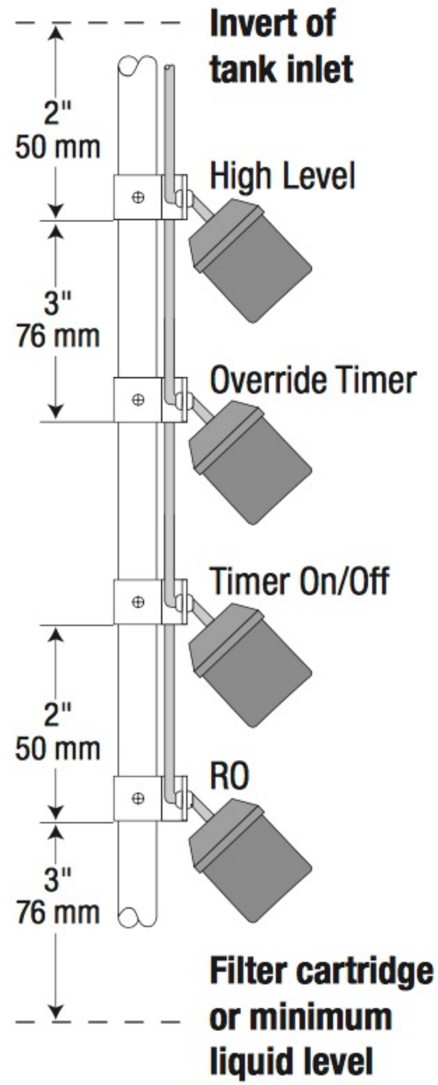
Type 3: *Primarily Black Water Waste with Surge Flows*	• Churches • Schools	• Waste streams are commercial in nature and primarily from black water sources • Flows and primary treated effluent quality are heavily dependent on the facilities (e.g., schools with cafeterias and shower facilities vary significantly from those without)	• *Due to variations in daily waste volumes, flow equalization tankage should be strongly considered in order to optimize the treatment process.* • *With appropriate primary treatment, primary-treated effluent typically ranges from:* – BOD_5 300-500 mg/L – TSS 80-250 mg/L – TKN 90-150 mg/L

PVU Selection:

- Dimensions – larger, multiple pump clusters
  - Inverts
  - MLL
  - 60-70%

Float Settings:

- HLA
- OVR
- Timer on/off
- Low level/RO



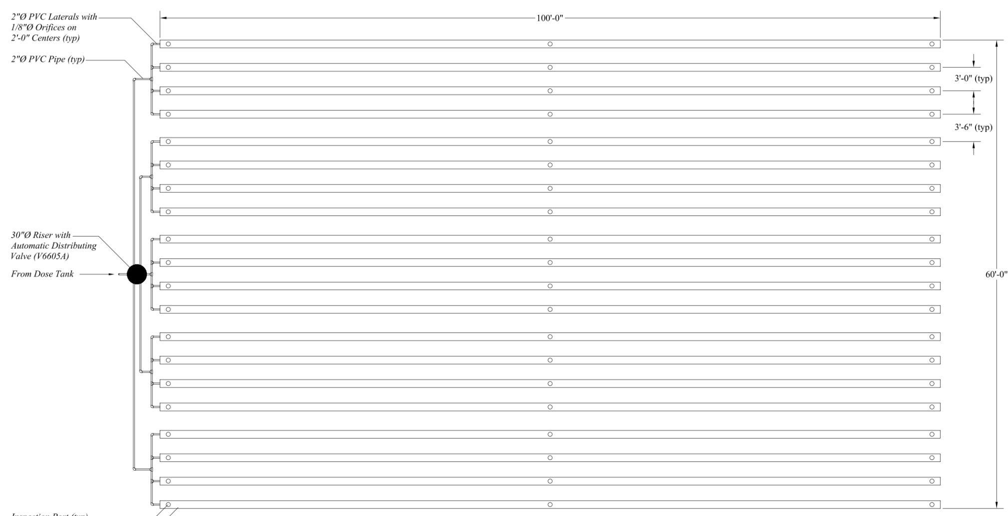
Timer Settings:

- What’s my design flow?
- What’s my peak flow?
- What’s my dose? (permitted)
- Pump GPM? (actual)

- How do we spread this flow out over a 24hr period?

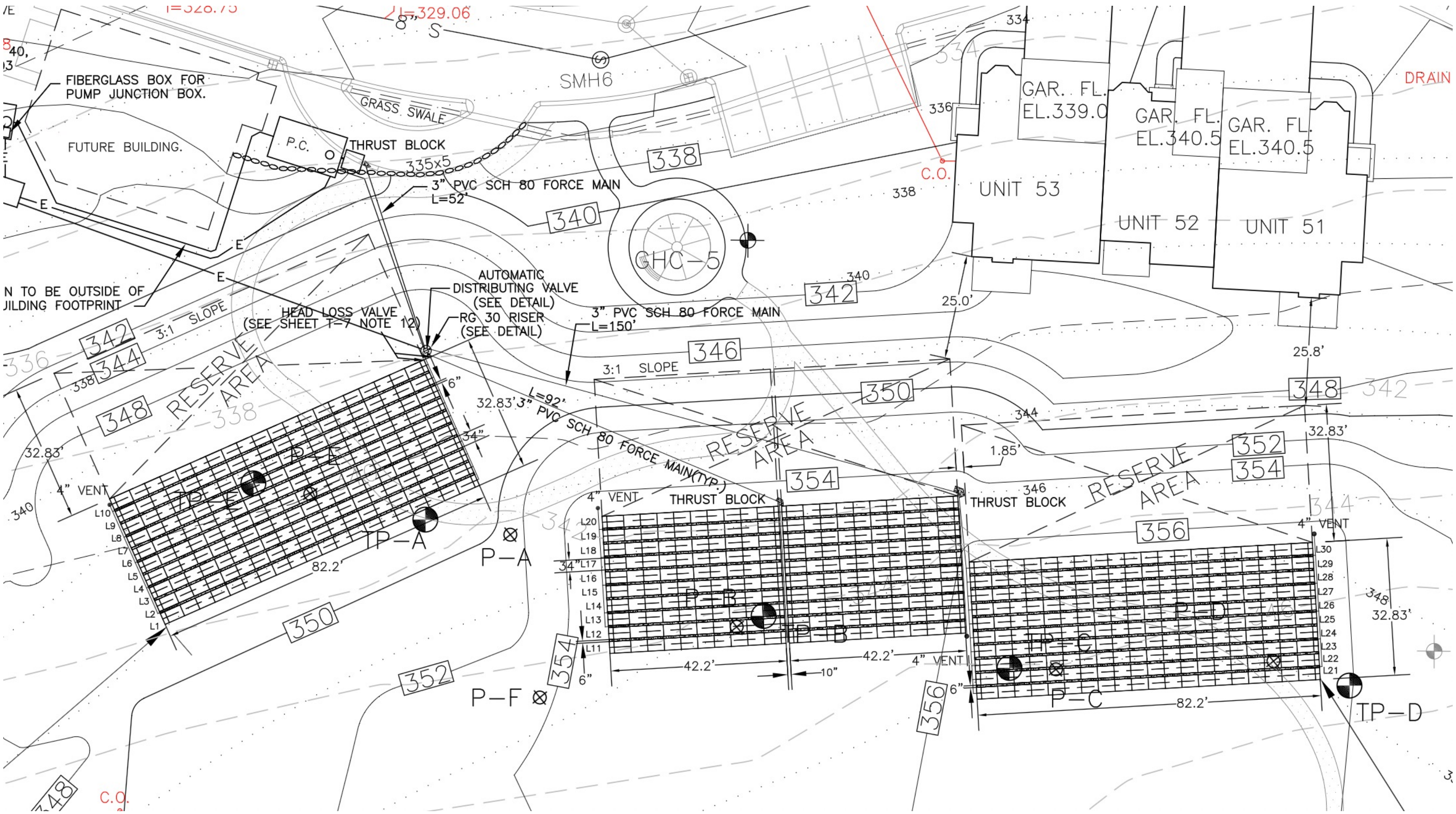
Dispersal Field:

- Considerations:
  - Gravity (D-Box)
  - Pressurized & Shallow Subsurface
    - Uneven terrain making zones asymmetrical?
    - Zones at different elevations?
    - Is the system curve the same for all zones dosed?
  - Drip
    - Dosing & Flush Cycles
    - Emitter type



5 Zone Layout
Scale: 1" = 10'-0"

Zoning Options, Considerations & Pitfalls



Zoning Options, Considerations & Pitfalls

- Automatic distributing valve & how it operates
- Valve monitoring options

Automatic Distributing Valve

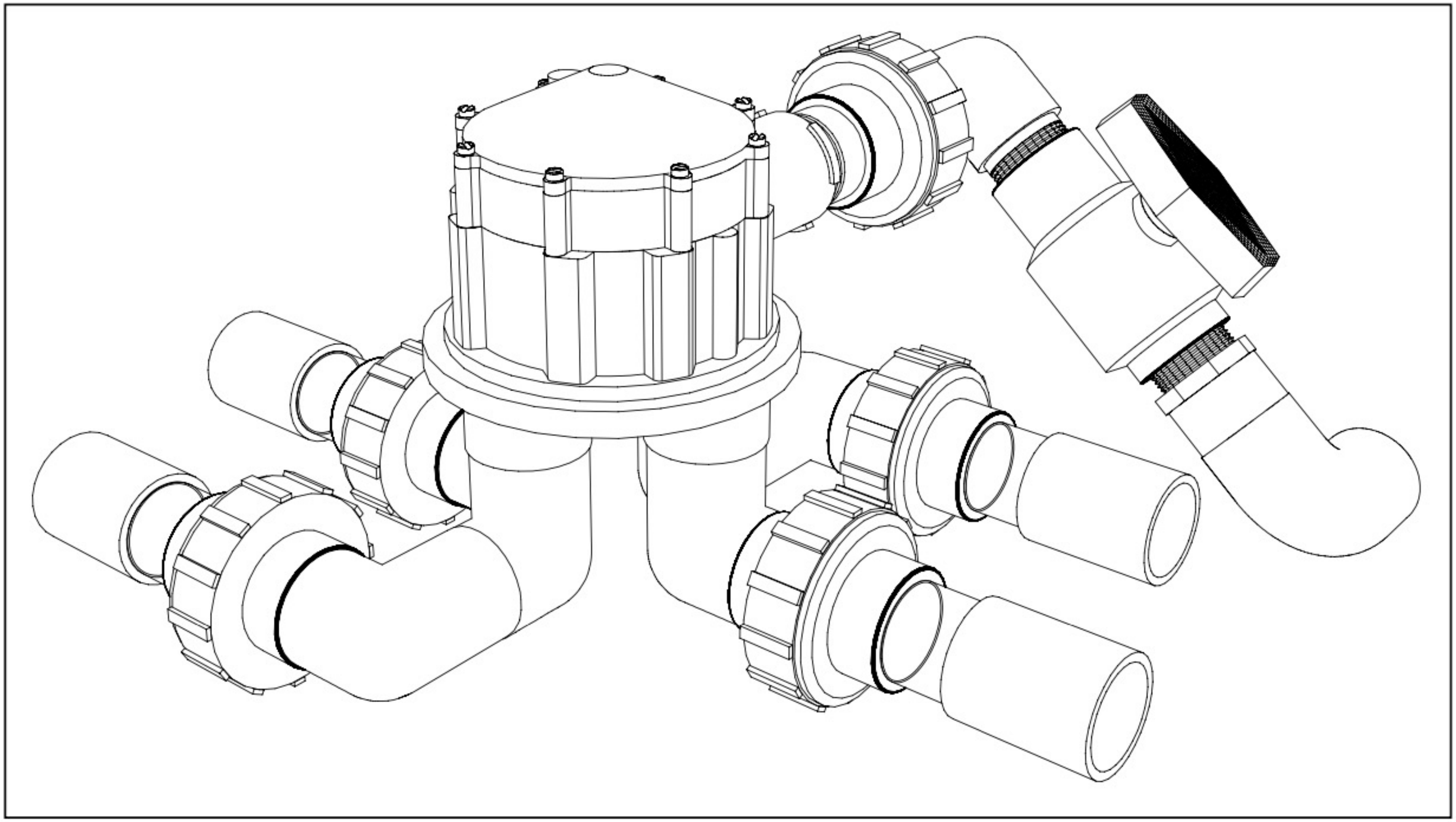


Figure 2:
Orenco Distributing Valve Assembly (6000 Series Valve)

Automatic Distributing Valve

- Liquid flowing through the valve assembly must pass through fairly small openings and make several changes in direction. Because of this, headlosses through the valve assembly are fairly high. Table 1 gives the headloss equations for several different assemblies and Figure 3 shows the graphical representations of these equations. Orenco recommends that high-head turbine pumps be used to pressurize the valve assemblies to ensure enough head is available for proper system operation. High-head turbine pumps are also recommended because the use of a distributing valve usually requires more frequent pump cycling. The high-head turbine pumps are designed for high cycling systems and will outlast conventional effluent pumps by a factor of 10 or more in a high cycling mode. Furthermore, the high-head turbine pump intake is 12 inches or more above the bottom of the pump and tends to prevent any settled solids from being pumped into the distribution valve and obstructing its operation. A minimum flow rate through the distributing valve is required to ensure proper seating of the rubber flap disk. Minimum flow rates for the various models are given in Table 1.

- Let’s examine some physical valves to better understand how they work. (hands on exercise)

Automatic Distributing Valve

Table 1. Automatic Distributing Valve Assembly Headloss Equations

Model Series	Equation	Operating Range (gpm)
V4400A	$H_L = 0.085 \times Q^{1.45}$	10 - 40
V4600A	$H_L = 0.085 \times Q^{1.58}$	10 - 25
V6400A	$H_L = 0.0045 \times Q^2 + 3.5 \times (1 - e^{-0.06Q})$	15 - 70
V6600A	$H_L = 0.0049 \times Q^2 + 5.5 \times (1 - e^{-0.1Q})$	15 - 70

Automatic Distributing Valve

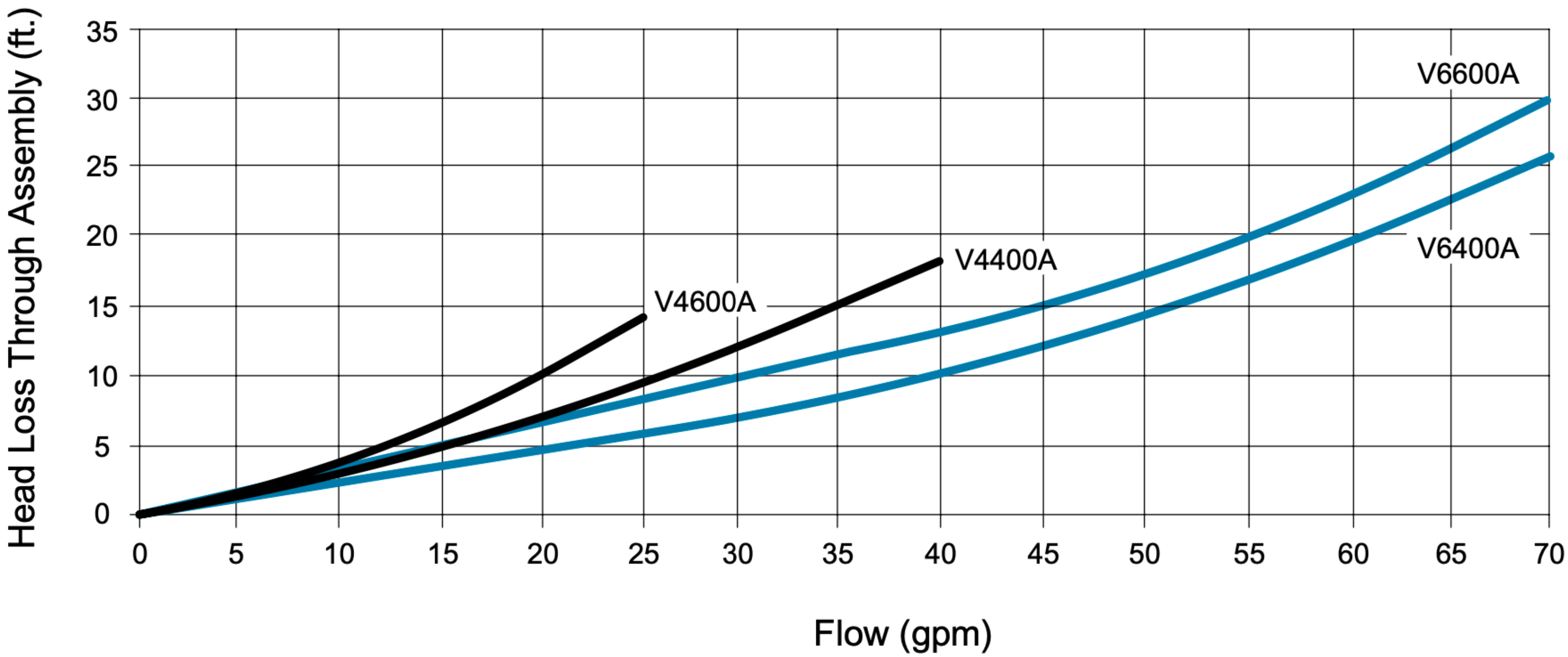
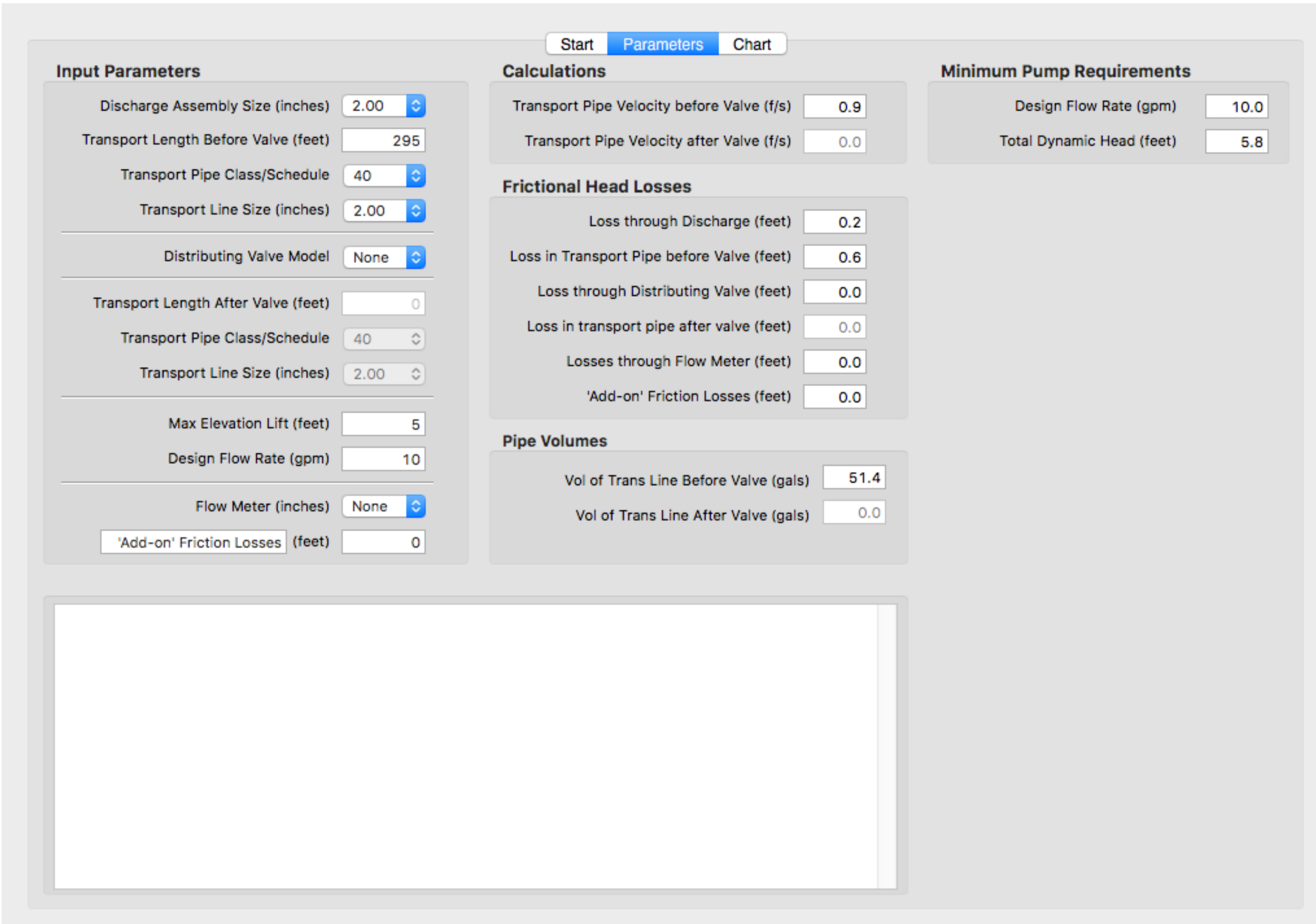


Figure 3:
Automatic distributing valve assembly headloss curves

Pump/System Curve:

- Critical to system reliability
  - Orifice scouring velocity
  - Pump longevity of life
  - Even dispersal across all terrain (10% differential)
- Accurate curves give accurate doses
- Drain field can fail due to improper pressurization

Pump Select (Non-Pressurized)



Orenco WATER

Pump Select (Pressurized)

Start | Parameters | Chart

Input Parameters

Discharge Assembly Size (inches)	2.00
Transport Length Before Valve (feet)	50.0
Transport Pipe Class/Schedule	40
Transport Line Size (inches)	2.00
Distributing Valve Model	None
Transport Length After Valve (feet)	0
Transport Pipe Class/Schedule	40
Transport Line Size (inches)	2.00
Max Elevation Lift (feet)	5.0
Manifold Length (feet)	20
Manifold Pipe Class/Schedule	40
Manifold Line Size (inches)	1.00
Number of Laterals per Cell	24
Lateral Length (feet)	50
Lateral Pipe Class/Schedule	40
Lateral Line Size (inches)	1.00
Orifice Size (inches)	1/8
Orifice Spacing (feet)	4
Residual Head at Last Orifice (feet)	5
Flow Meter (inches)	None
'Add-on' Friction Losses (feet)	0

Calculations

Minimum Flow Rate per Orifice (gpm)	0.43
Number of Orifices per Zone	312
Total Flow Rate per Zone (gpm)	136.2
Number of Laterals per Zone	24
% Flow Differential 1st and Last Orifice	3.1
Transport Pipe Velocity before Valve (f/s)	13.1
Transport Pipe Velocity after Valve (f/s)	0.0

Frictional Head Losses

Loss through Discharge (feet)	37.1
Loss in Transport Pipe before Valve (feet)	12.7
Loss through Distributing Valve (feet)	0.0
Loss in transport pipe after valve (feet)	0.0
Loss in Manifold (feet)	38.3
Loss in Laterals (feet)	0.4
Losses through Flow Meter (feet)	0.0
'Add-on' Friction Losses (feet)	0.0

Static Heads

Max Elevation Lift (feet)	5.0
Residual Head at Last Orifice (feet)	5.0

Pipe Volumes

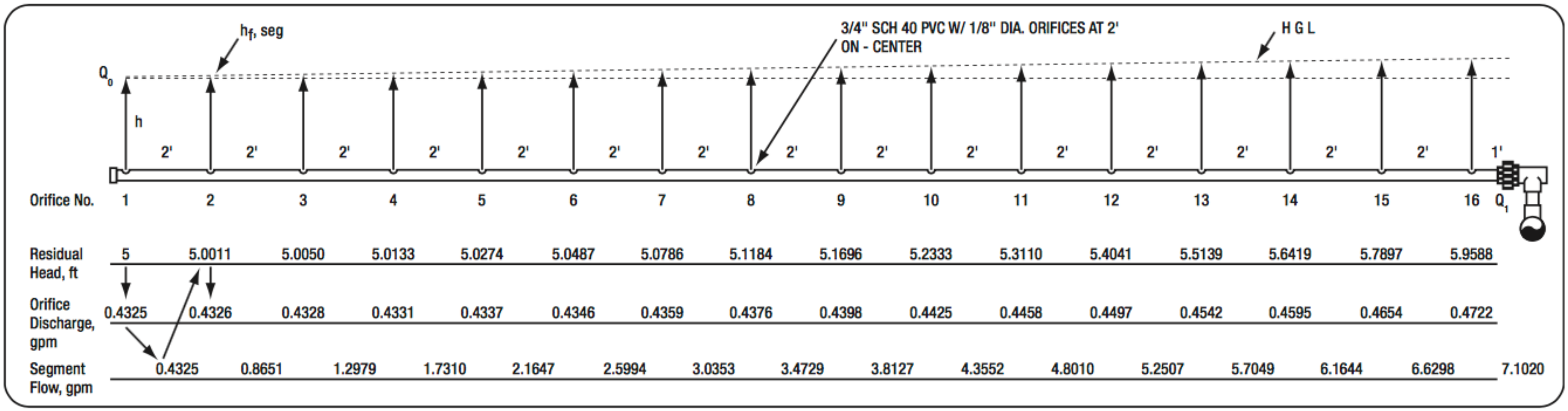
Vol of Trans Line Before Valve (gals)	8.7
Vol of Trans Line After Valve (gals)	0.0
Volume of Manifold (gals)	0.9
Volume of Laterals per zone (gals)	53.9
Total volume before valve (gals)	8.7
Total volume after valve (gals)	54.8

Minimum Pump Requirements

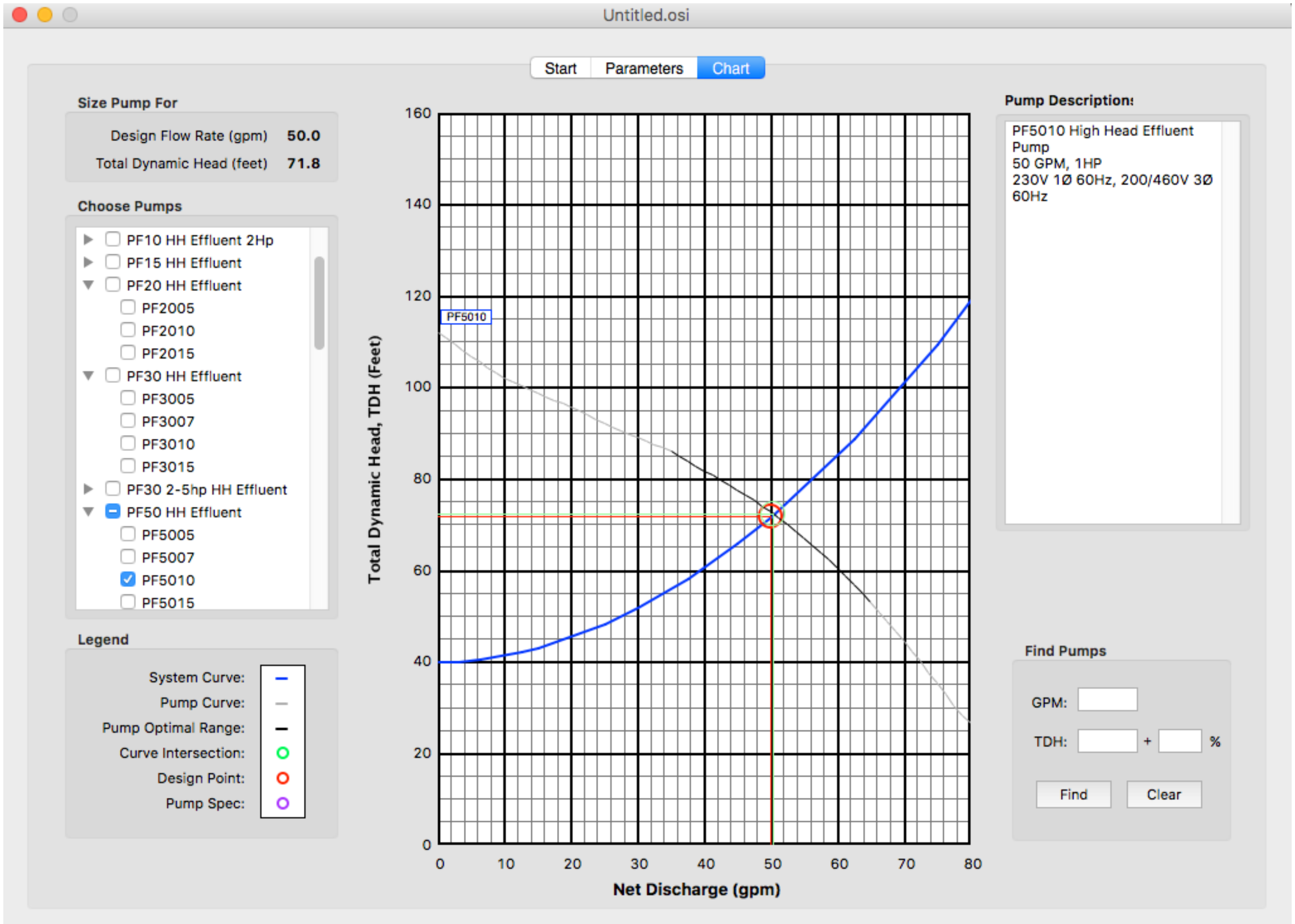
Design Flow Rate (gpm)	136.2
Total Dynamic Head (feet)	98.6

Orifice Equations

- Built into Pump Select



Good Curve


Untitled.osi
Start
Parameters
Chart
Size Pump For
Design Flow Rate (gpm) 50.0
Total Dynamic Head (feet) 71.8
Choose Pumps
PF10 HH Effluent 2Hp
PF15 HH Effluent
PF20 HH Effluent
PF2005
PF2010
PF2015
PF30 HH Effluent
PF3005
PF3007
PF3010
PF3015
PF30 2-5hp HH Effluent
PF50 HH Effluent
PF5005
PF5007
PF5010
PF5015
Legend
System Curve:
Pump Curve:
Pump Optimal Range:
Curve Intersection:
Design Point:
Pump Spec:
PF5010
Total Dynamic Head, TDH (Feet)
Net Discharge (gpm)
Pump Description:
PF5010 High Head Effluent Pump
50 GPM, 1HP
230V 1Ø 60Hz, 200/460V 3Ø 60Hz
Find Pumps
GPM:
TDH:
%
Find
Clear

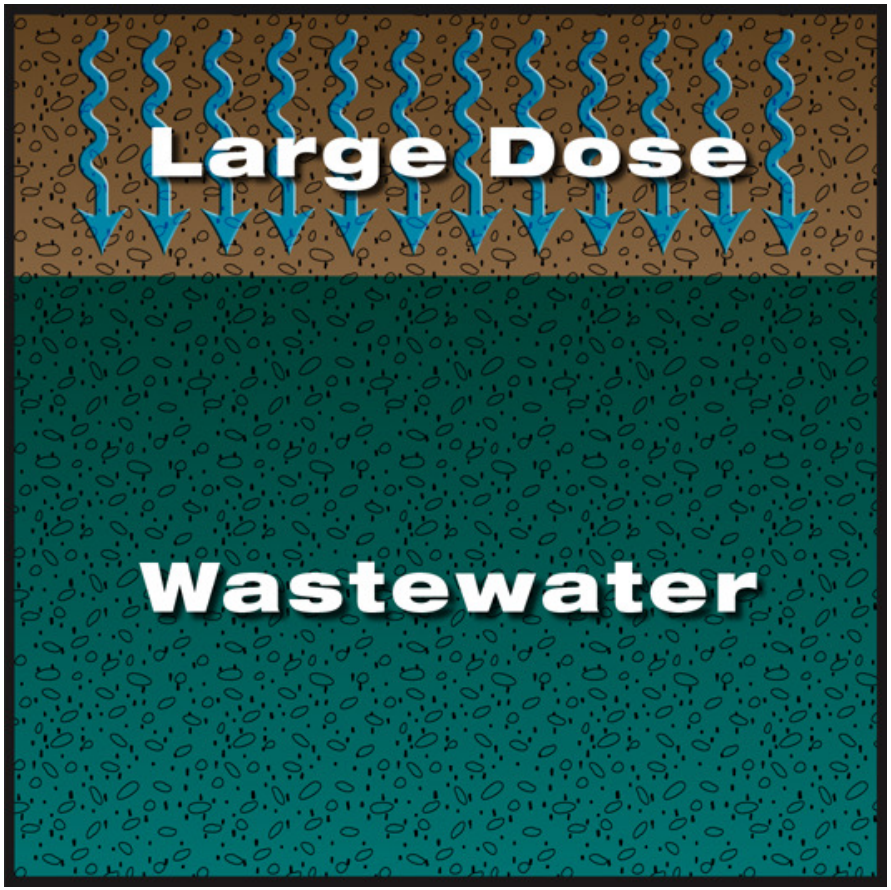
Hydraulic Modeling Examples

- Let's use our modeling tool Pump Select to work through the following examples.
  - Large gravity (D-Box) example
  - Large hydrosplitter example
  - Zoning with multiple pumps
  - Zoning a large system using indexing valves

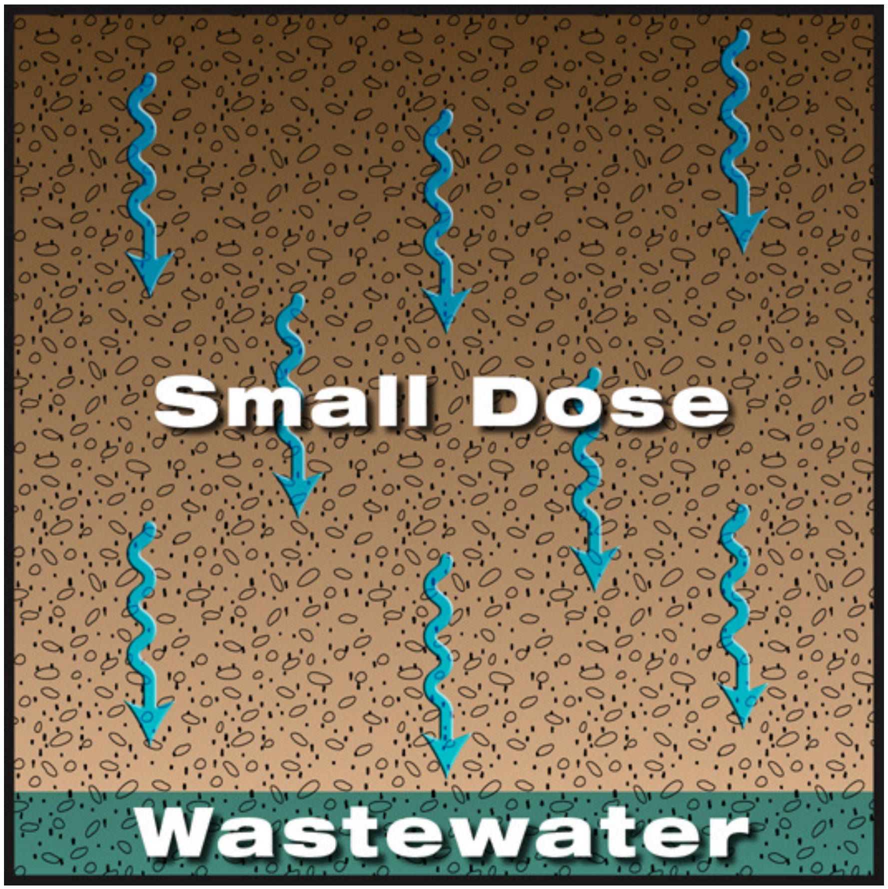
Troubleshooting

- Let’s examine common issues
  - Uneven dosing
  - Erratic cycling & tracking issues
  - Lateral servicing
  - Valve operation & maintanence

Effect of a Large Dose In The Drainfield



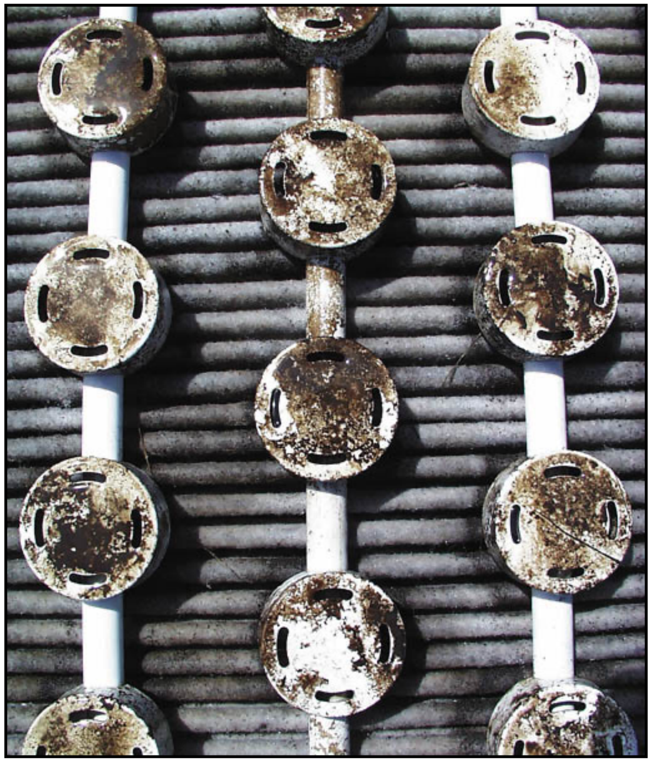
Large dose fills all of the voids in the trench, eventually clogging and surfacing



Small dose spreads over the bottom of the trench, allowing the wastewater to infiltrate into the soil before the next dose is applied

Packed Bed Filter – Media Health Indicators

- Color — Light to dark brown, not yellow
- Texture — Gelatinous, not lard-like
- Odor — Musty, not pungent
- Moisture — Moist, not ponding*



Lateral Cleaning

- Use pump or jet hose
- Use a bottle brush

Cleaning by running pump

Cleaning with bottle brush

Residual Pressure & Pump Run Time

% BLOCKAGE	RUN TIME				PRESSURE			
	Boss 300		300SI05		Boss 300		300SI05	
	t	$\left(\frac{t-t_o}{t_o}\right) \times 100\%$	t	$\left(\frac{t-t_o}{t_o}\right) \times 100\%$	p	$\left(\frac{p-p_o}{p_o}\right) \times 100\%$	p	$\left(\frac{p-p_o}{p_o}\right) \times 100\%$
0%	50.8	0%	49.9	0%	58	0%	60.75	0%
15%	52.5	3%	50	0%	75	29%	77.75	28%
25%	54.3	7%	50.7	2%	91.5	58%	106.25	75%
50%	63.0	24%	51.5	3%	160.8	177%	260.6	329%

t = Run time in seconds
t_o = Initial run time (0% blockage)

p = Residual pressure in inches of H_2O
p_o = Initial residual pressure (0% blockage)

Table 1. Run Time vs. Pressure

Residual Pressure & Pump Run Time

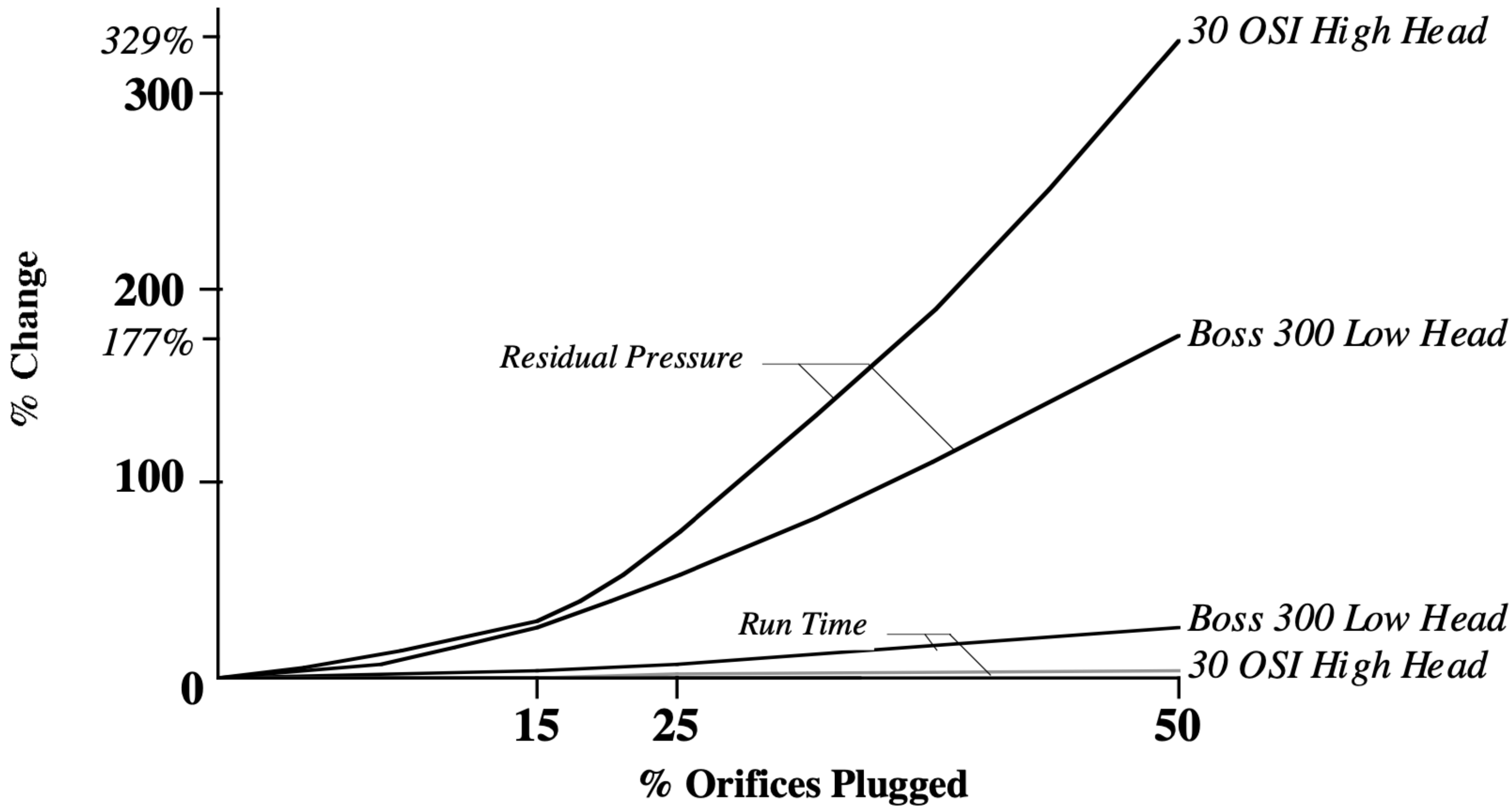
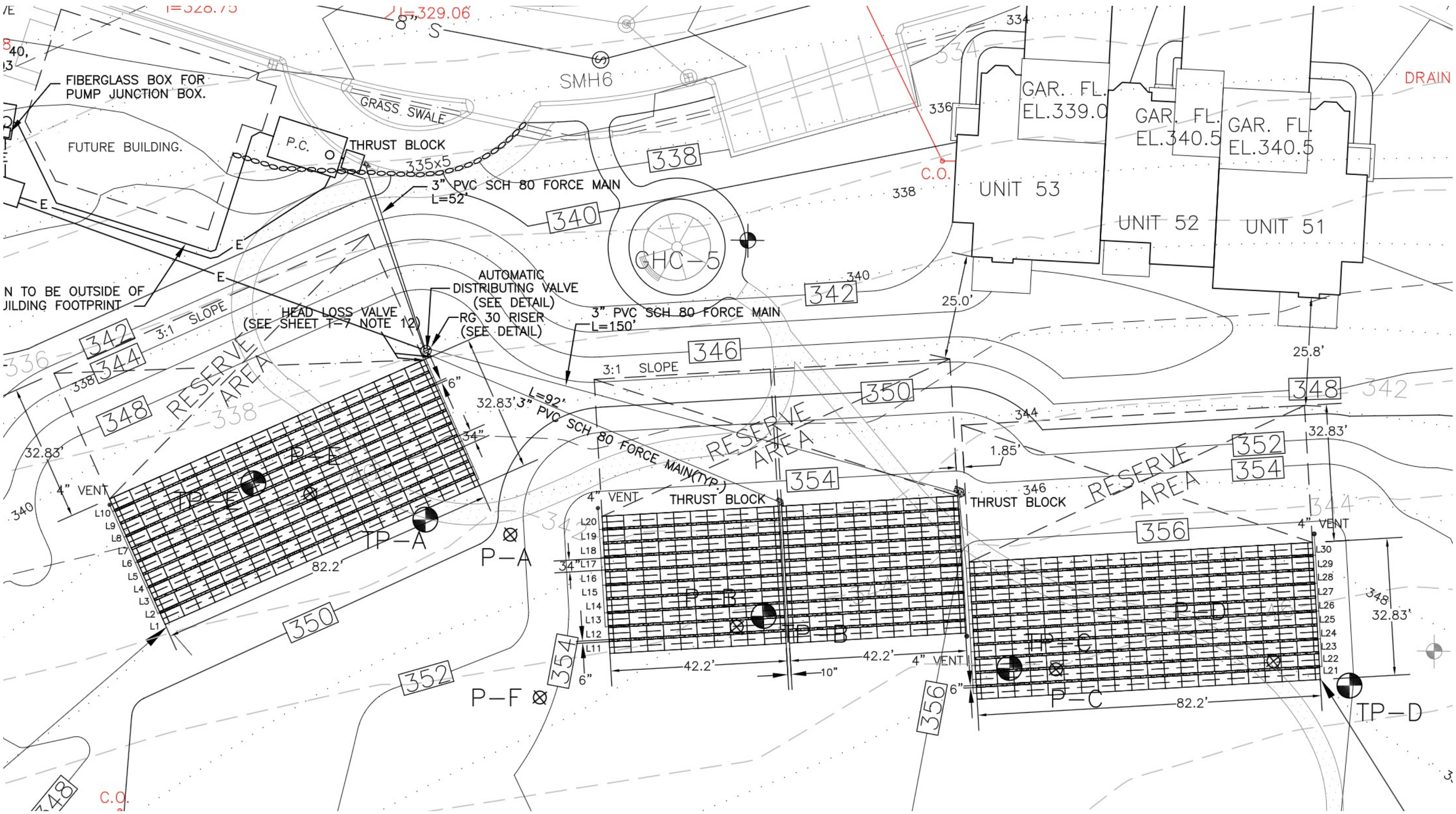


Figure 1. System Sensitivity (residual pressure and dose time)

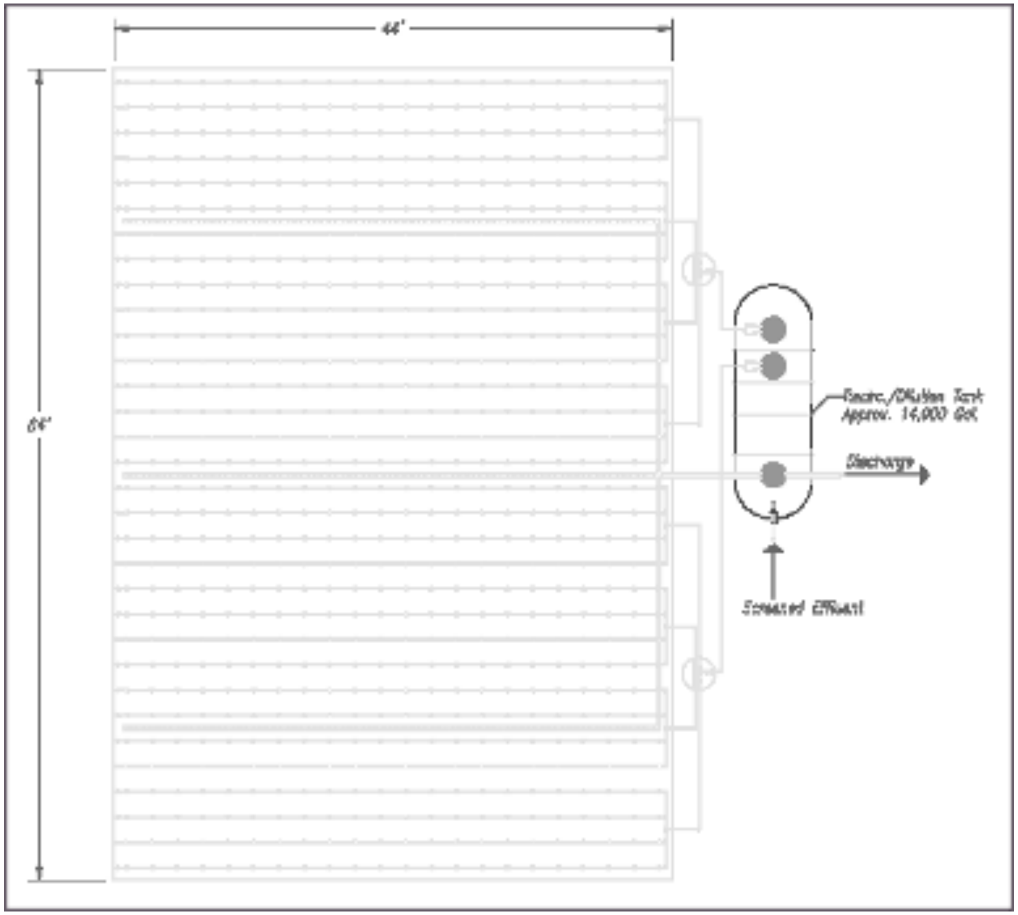
Valve Troubleshooting

- Erratic cycling or skipped cycles
- Stuck & doesn't cycle
- Capabilities of monitors

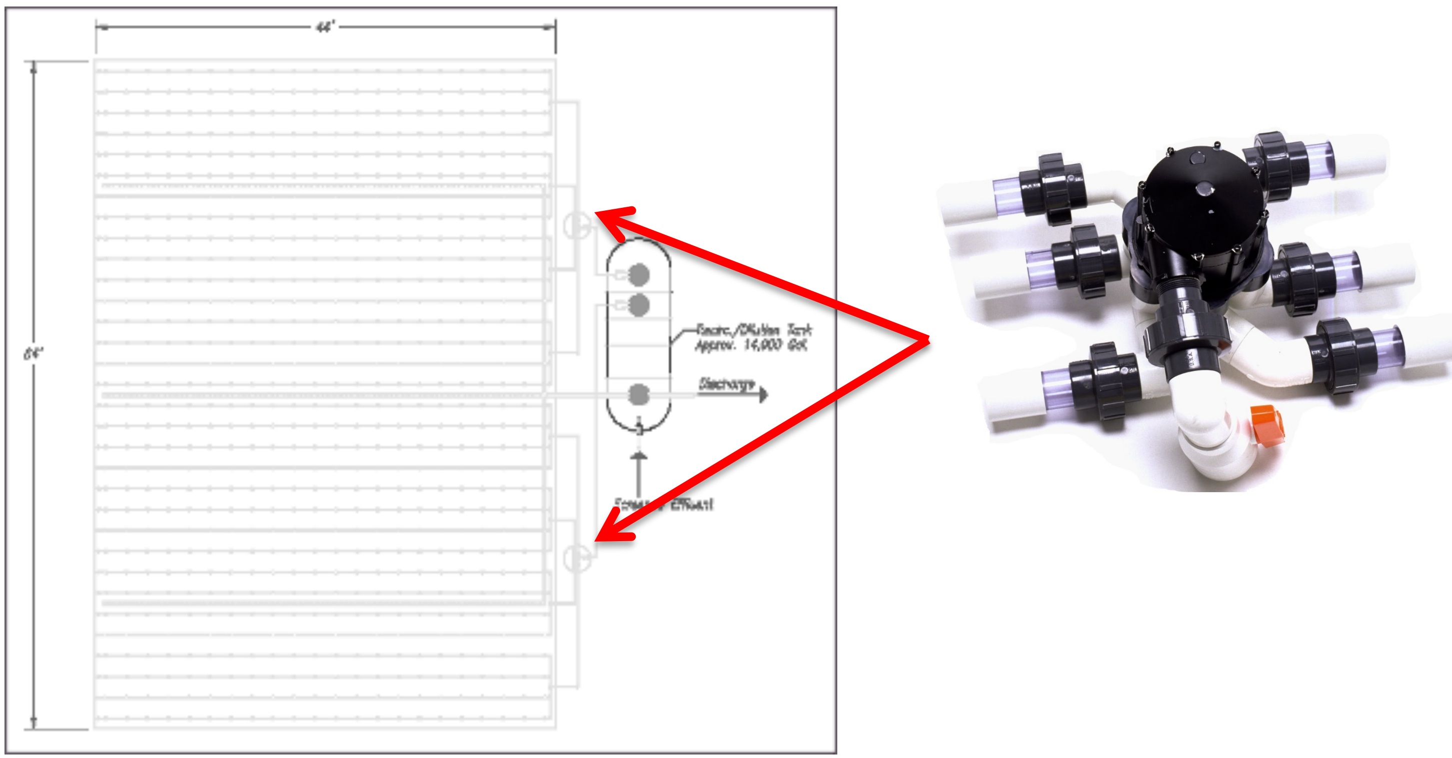
Zoning Options, Considerations & Pitfalls



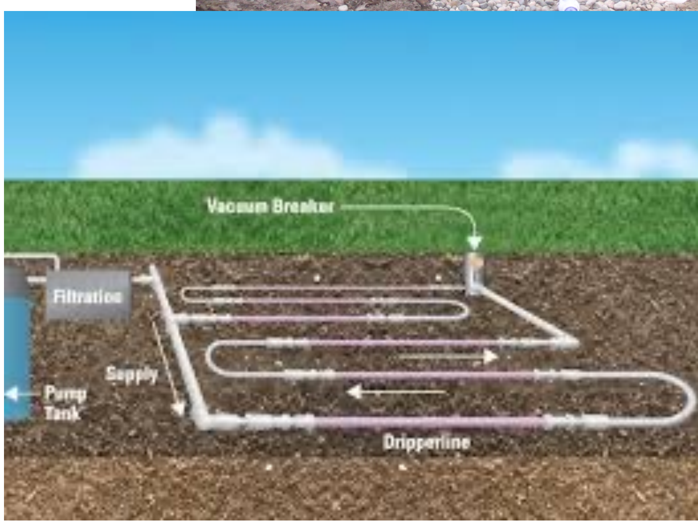
Larger Sand Filter System Example



Distribution Valve Operation Example



Dispersal in Unconventional Soil



References

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- *Soil Acceptance of Onsite Wastewater as Affected by Soil Morphology and Wastewater Quality*, in Proceedings of the Seventh International Symposium on Individual and Small Community Sewage Systems, Atlanta, Georgia. American Society of Agricultural Engineers (ASAE). – Jerry Tyler

Large Pump System Design

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