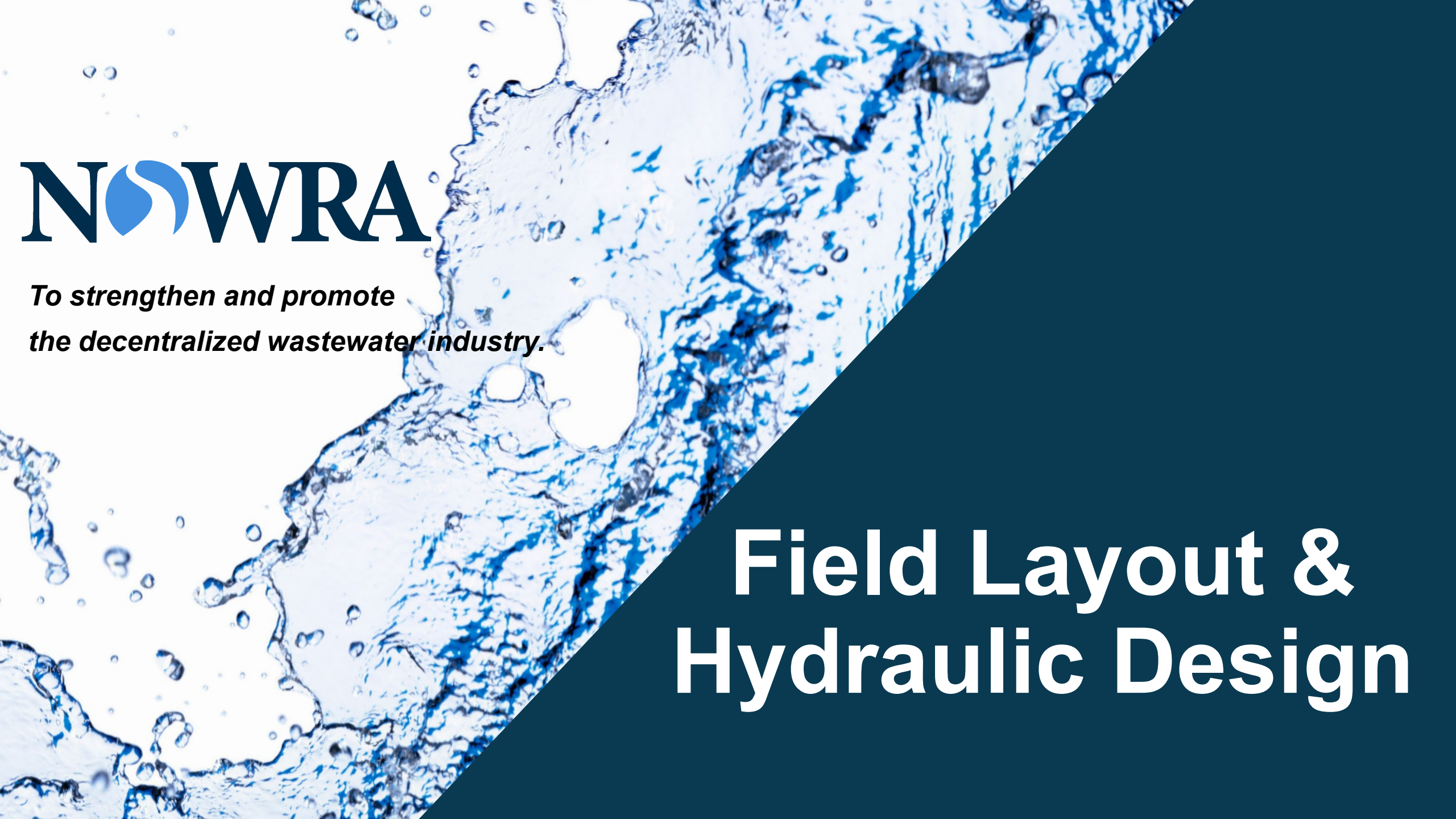
NOWRA

To strengthen and promote the decentralized wastewater industry.



Field Layout & Hydraulic Design

NOWRA

To strengthen and promote the decentralized wastewater industry.

Presented By:

Steven Berkowitz

NCDHHS (Retired); SERCAP

Presentation Overview

Terminology and Options Overview

Field/Zone Layout

- Considerations/Trade-offs

Hydraulic Design Factors

- Flow, Head, Pump Selection
- Dosing/Flushing Regimes

Hydraulic Measurements

- Start-up
- Ongoing for Performance Verificatio

Terminology

Fields

- **Separately Dosed Drainfield Areas**
- **Unique Supply and Return Lines**

Zones

- **Common Supply/Return Manifolds (Single control valve per zone)**
- **Dosed individually or in Multiples (e.g., 2 or 3); Flushed Individually**

Runs (on-contour); Laterals (one or more runs)

- **Lateral Between Supply and Return Manifold.**

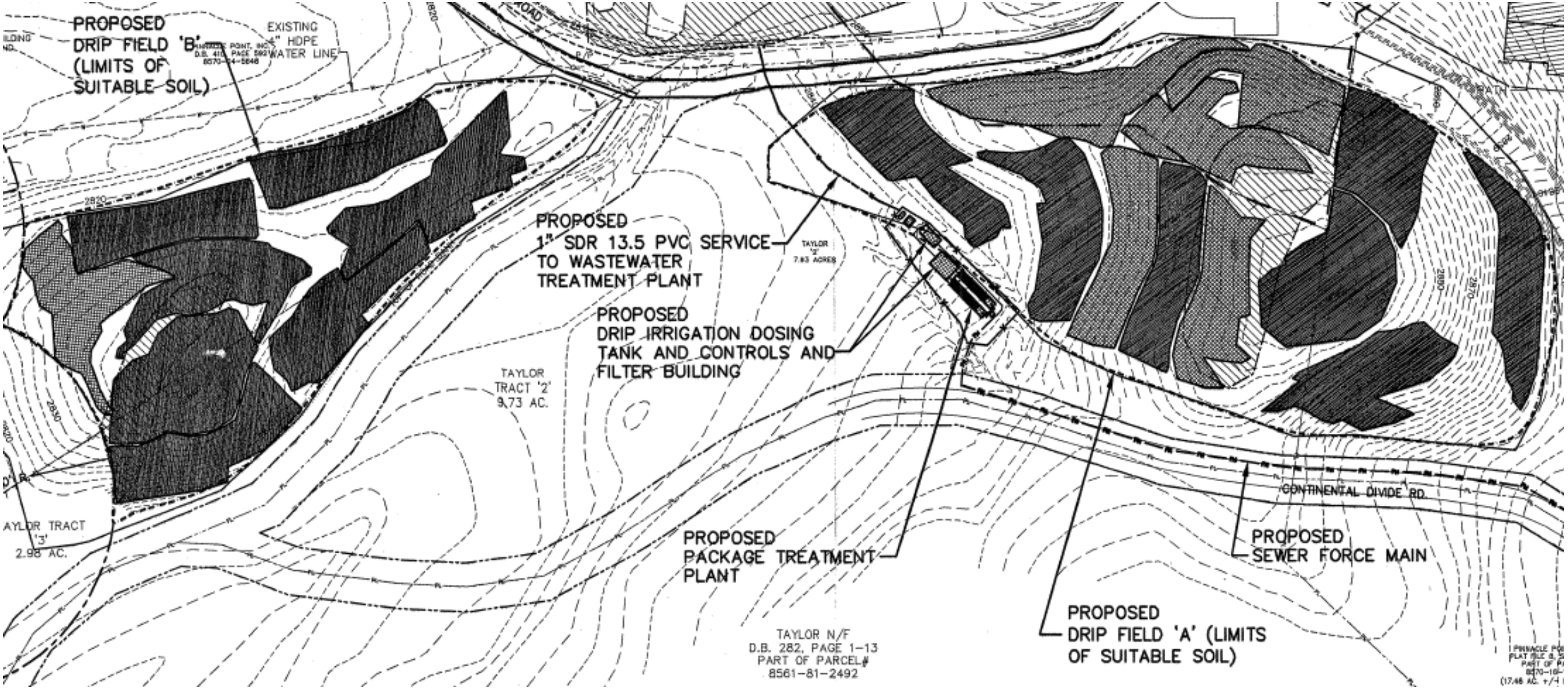
Manifold Options

- **Opposite Side or Same Side of Zone**
- **Side-Feeding or Top Feeding (lateral connection implications)**

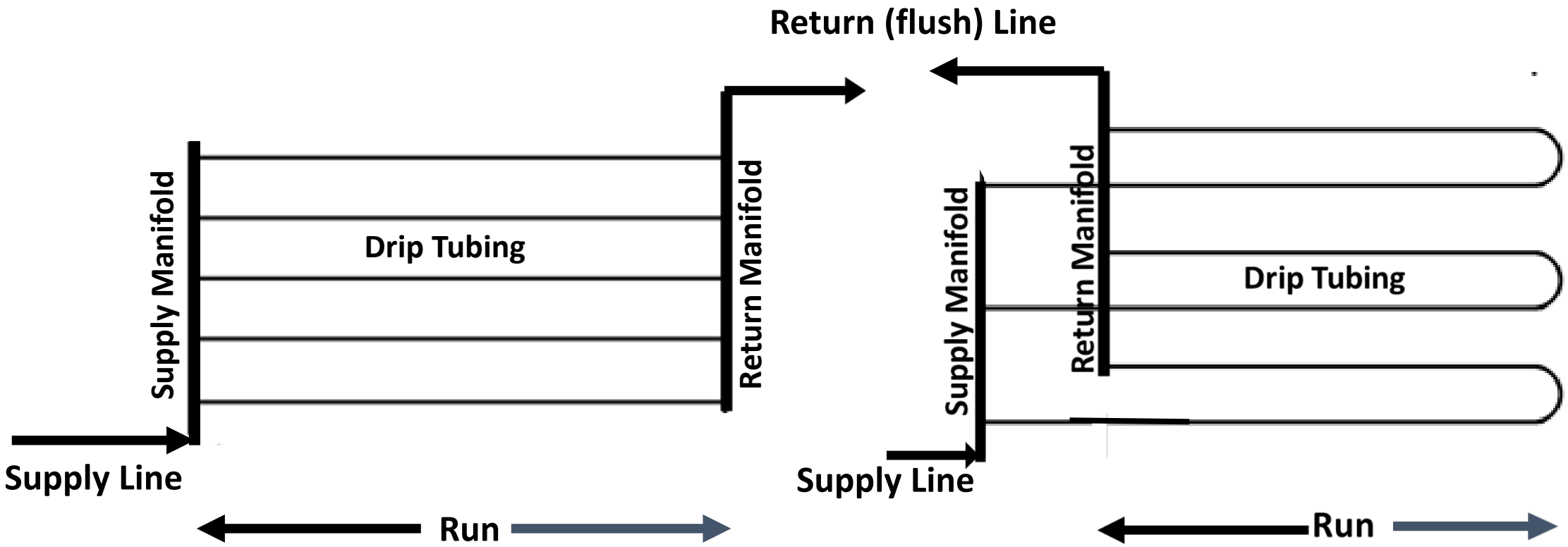
Dripline and Emitter Options

- **Size and Spacing**
- **Emitter (gallons per hour; spacing along dripline)**

Two Fields (Initial and Repair Areas Shown)



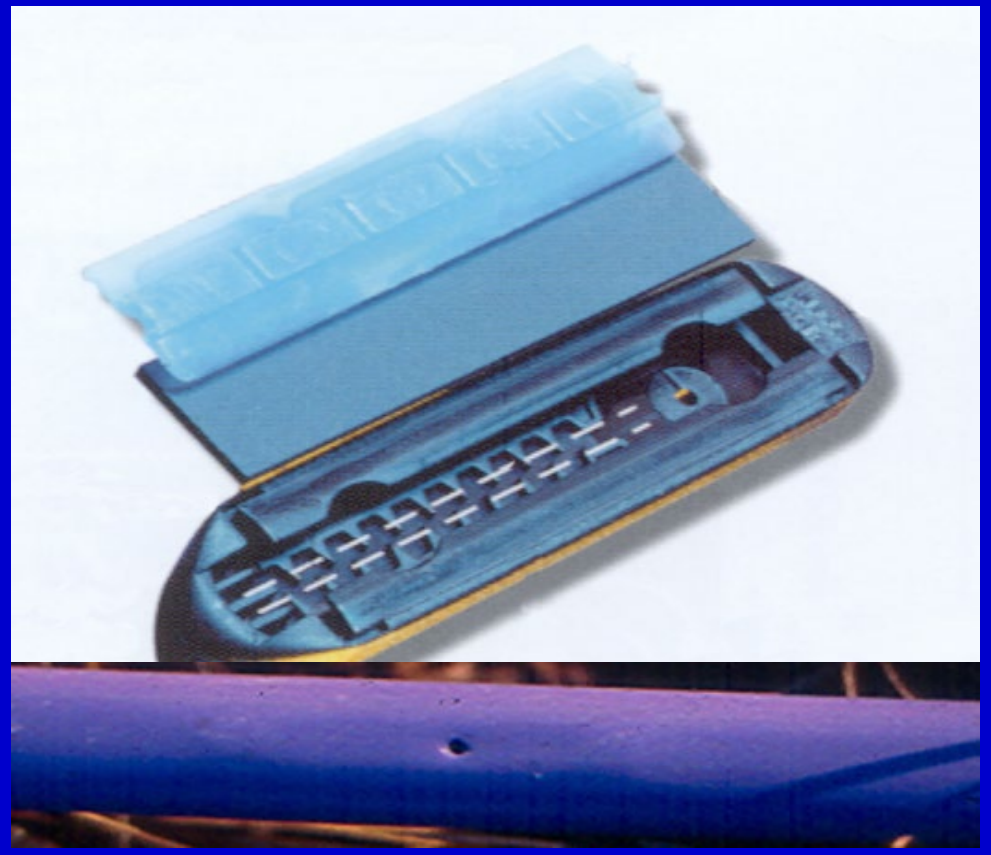
Zone Configuration/Options



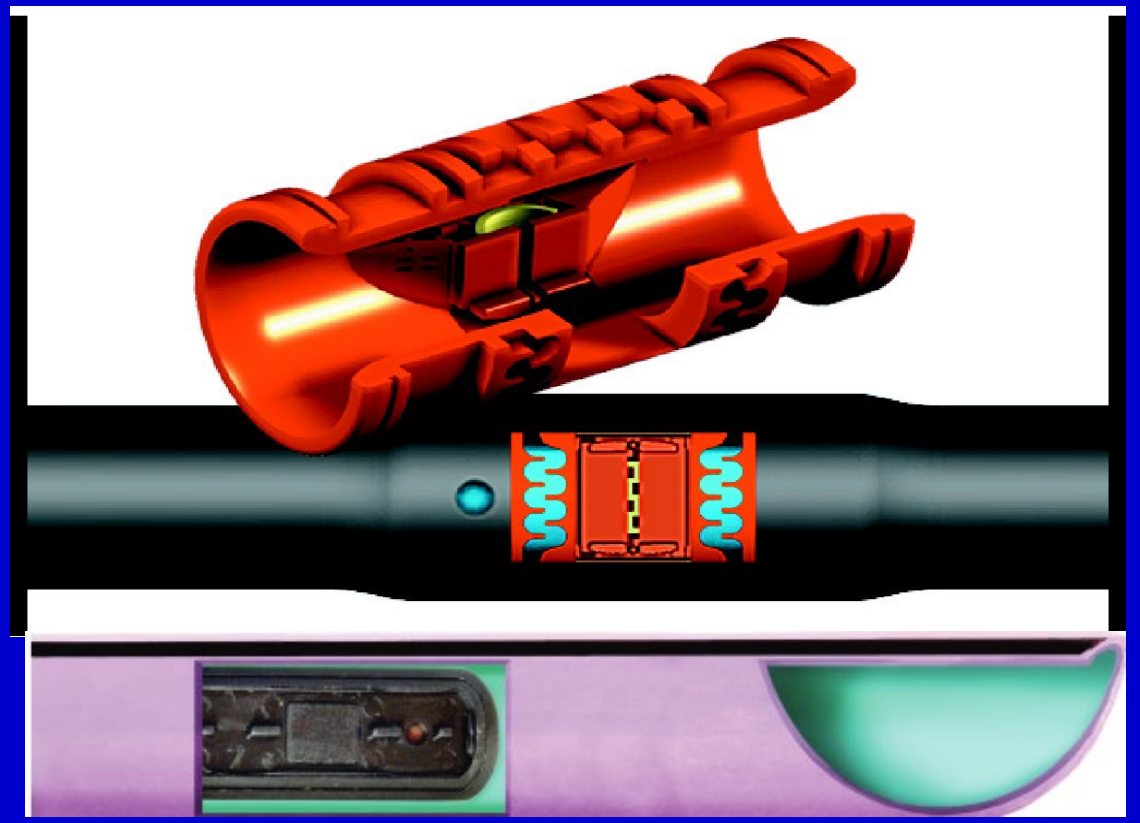
Single Run Per Lateral
(opposite side manifolds)

Two Runs Per Lateral
(same side manifolds)

Drip Emitters



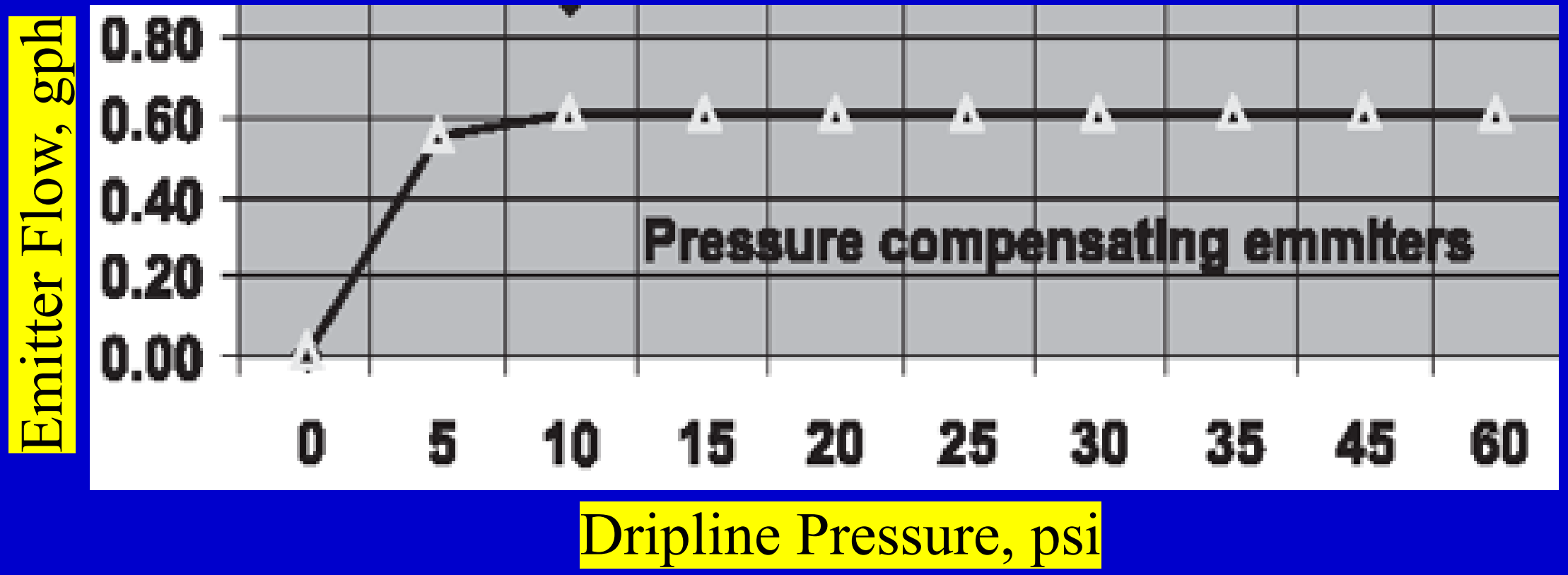
Emitter Options: 0.4; 0.6; 0.9 gph



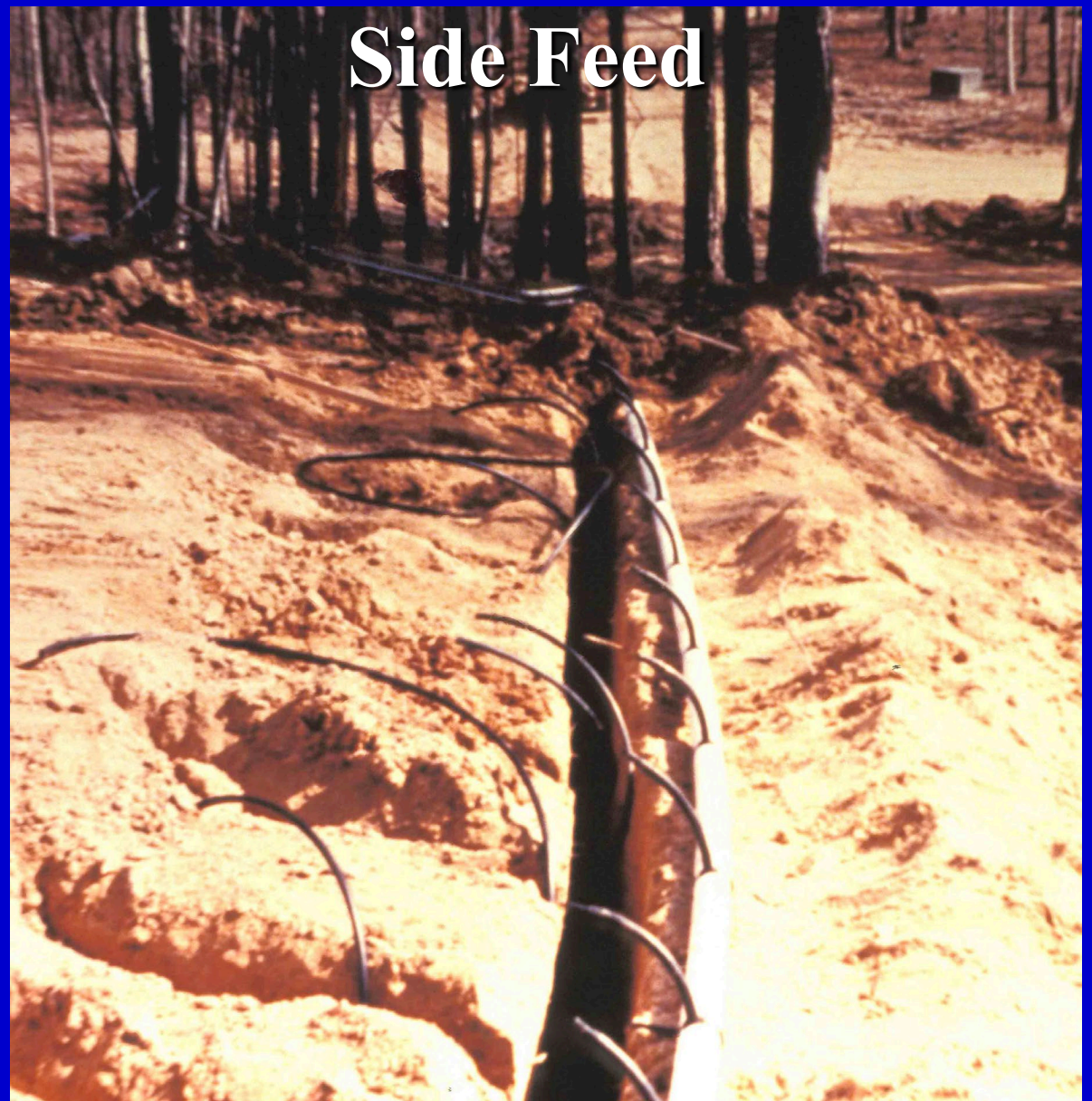
Emitter Options: 0.6; 0.9 gph

Emitter Options: 0.4; 0.6; 1.0 gph

Pressure-Compensating Emitters



Manifold-to-Lateral Connections



Layout Considerations

Objectives

- **Follow Contour**
- **“Paint” the Drainfield Area**
- **Optimize/Respect Site Conveyance Capacity**
- **Integrate Active/Repair Zones**

Trade-Offs

- **Long Laterals On-Contour**
- **Multiple Zones**
- **Opposite vs Same-Side Manifolds**

Mobile Home Park System (9000 gpd)

7 Zones

9000 gpd/0.3 LTAR

15-20% Slope

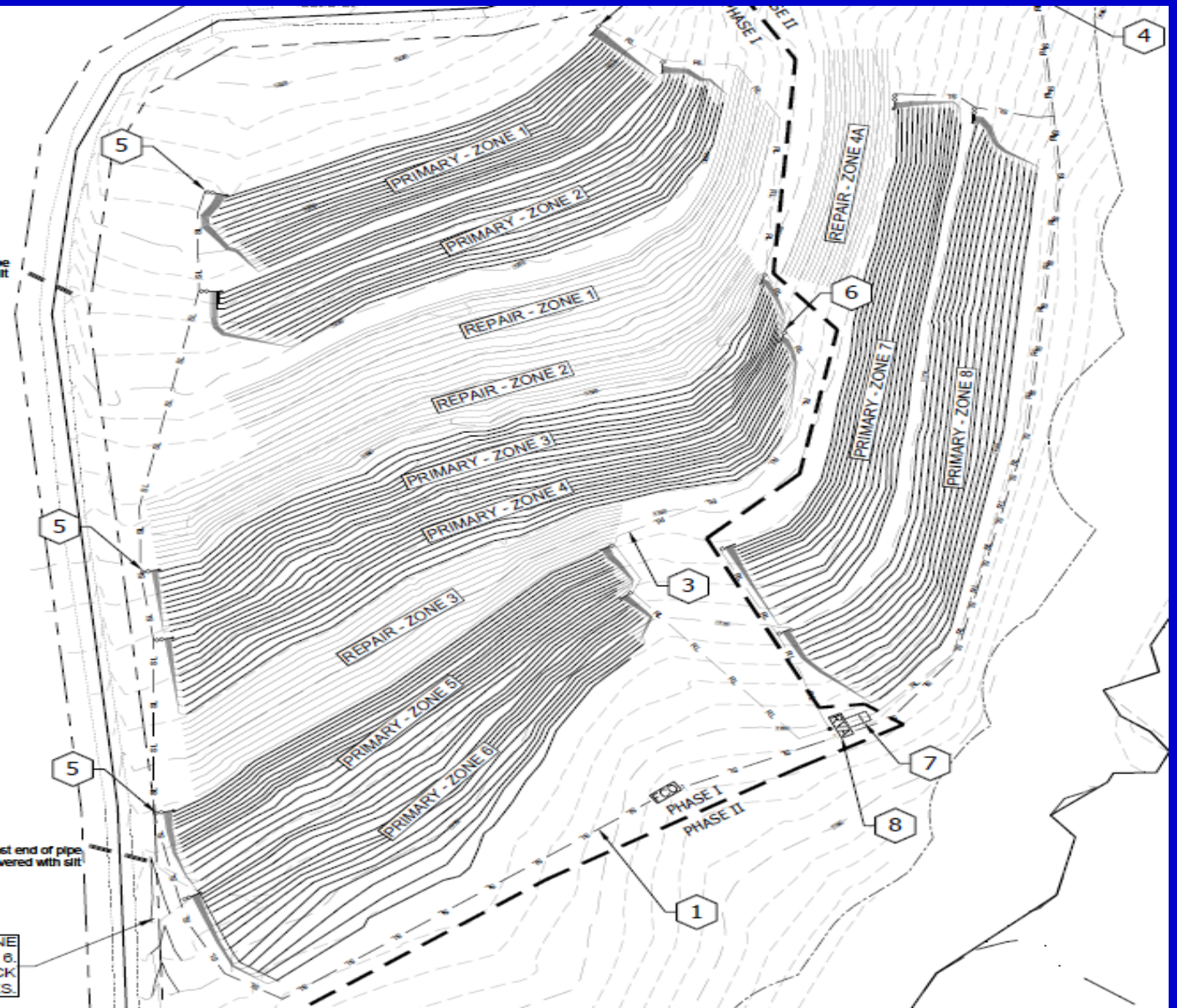
Top-Feed/Same Side Manifolds

2384 LF/Zone

8 Laterals/16 Runs/Lat

Laterals 298’ Each (1 Loop)

RV Park System (Phase I 5845 gpd)



6 Zones

5845 gpd/0.3 LTAR

15% Slope

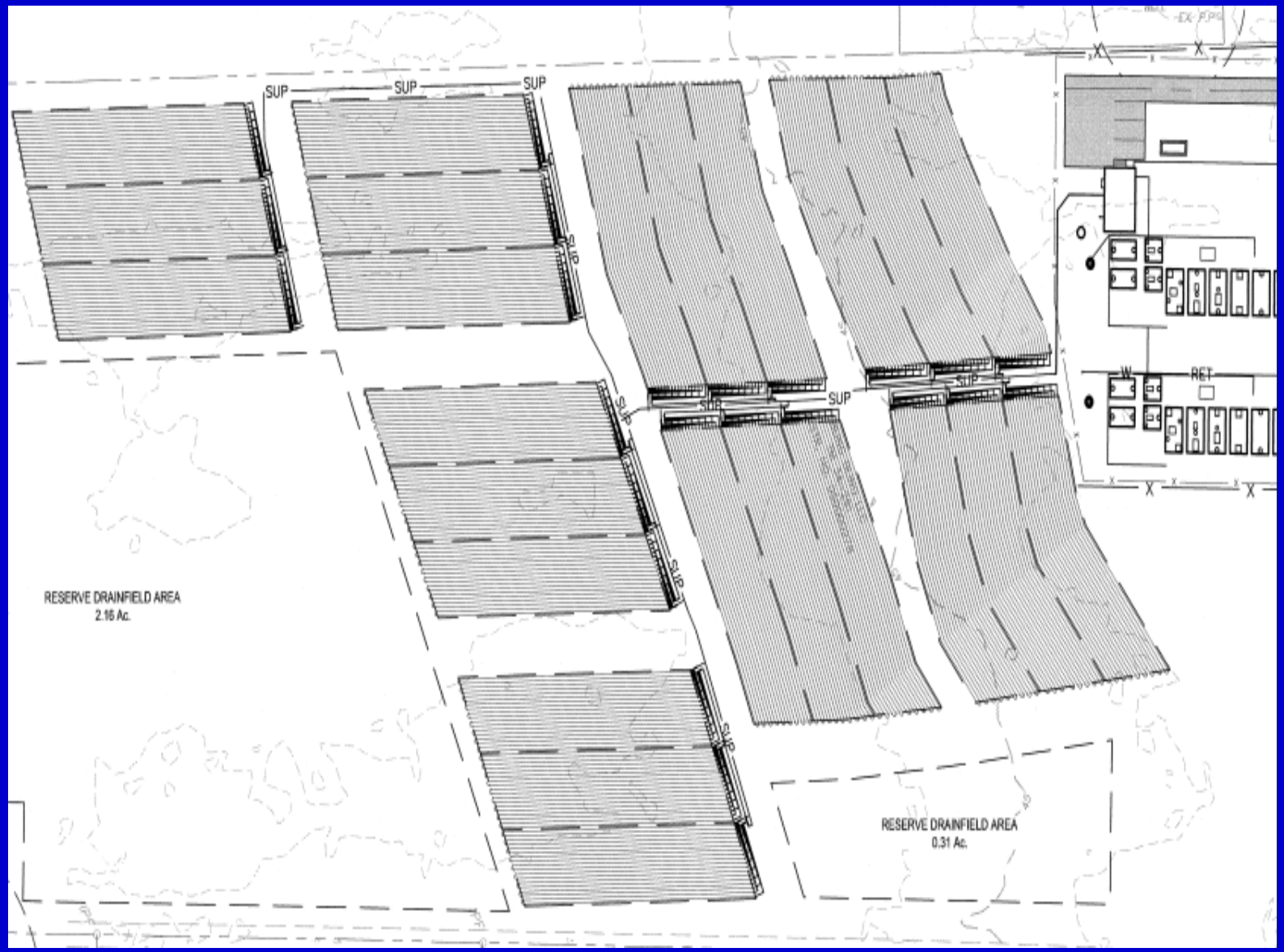
Top-Feed/Opposite Side

3208-3500 LF/Zone

11-17 Laterals/Zone

Laterals 188-312 LF

White Stone, VA (40,000 gpd Drip Field)



8 Zones

0.3 LTAR

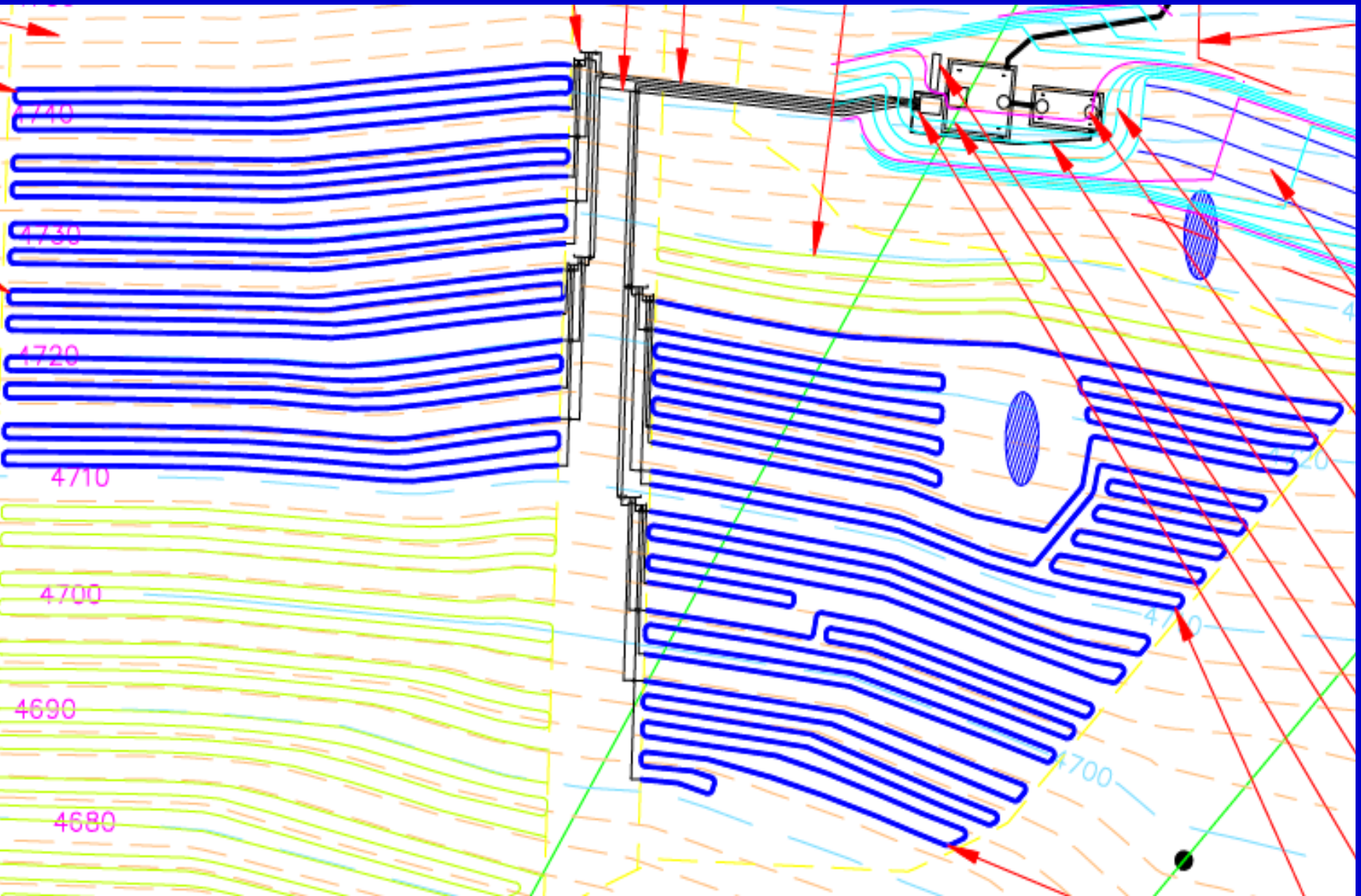
Top-Feed/Same Side

3 SubZones/Zone

9 Laterals/SubZone

Laterals 300 LF

Mountain Townhome System (2880 gpd)



4 Zones

0.4 LTAR

45-50% Slope

Top-Feed/Same Side

3 Laterals/Zone

Multiple Loops

All Laterals 300 LF

Hydraulic Design Steps

- Field Network Layout
  - Number/location of Zones
  - Number/size/length of Laterals, Supply, Return
  - Number/specifications for Emitters
- Compute/Select Flow Parameters
- Compute TDH/Pump Selection
- Specify Pumping/Operating Regime

Hydraulic Design Considerations

General

- Flow Requirements (Dosing/Flushing/Filter Backwash)
- Total Dynamic Head (TDH) Requirements
- Pump Selection
- Pump Operating Regime (“Normal”; “Peak”; Flushing)

Dosing

- Flow = # emitters/zone x # zones dosed (1 or more) x gph/emitter
- TDH = HWL + EH+ SL + Longest Lat FH + PH

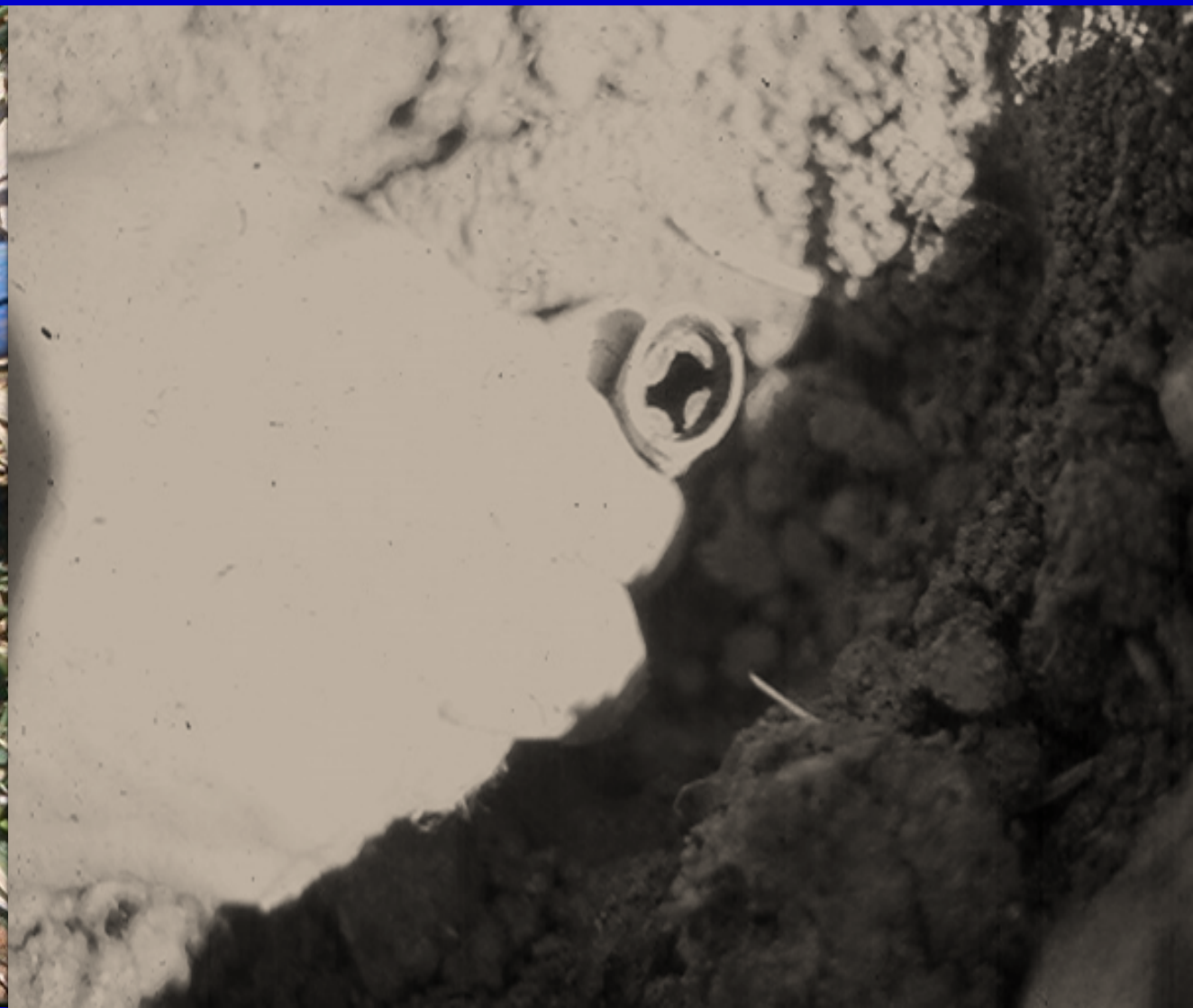
Flushing

- Flow/lateral function of design min Scour Velocity (1-3 fps), Lateral Dia.
- Flow = Dosing Flow + SVF x # Laterals/Zone
  - Increment to achieve min SV when Lateral Lengths are variable
- TDH = HWL + EH+ SL + Network HL + PH
  - Add RL if net loss (EH + Friction) > 10 psi

Compute/Select Flows

- Dosing Flow
  - Number of emitters/zone x gph/emitter
  - Dose single or multiple zones?
- Flushing Flow (rec. 1.5 – 3 fps/lateral, min)
  - Scour velocity flow x number of laterals **plus dosing flow**
  - Use DRIPNET (esp. for non-uniform layouts)
- Filter Backwash Flow
  - Filter-Dependent
- Use Manufacturer's Worksheets

Too Low Flushing Velocity (Anaerobic Drip)

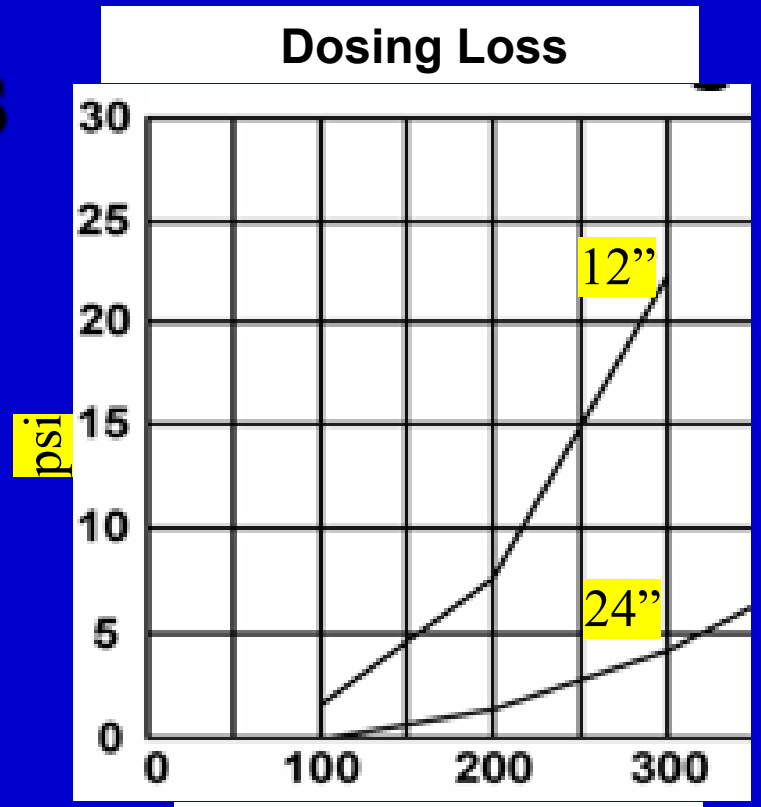


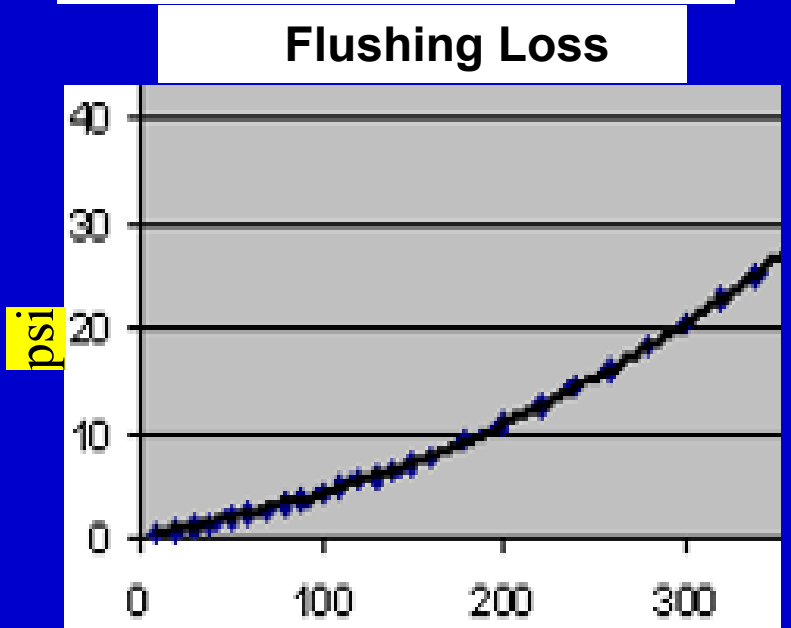
Determine Total Dynamic Head (TDH)

- Dosing (at dosing flow rate)
  - HWL + EH + SL + Longest Lat FH + PH
  - Is Max-Field Pressure ≤ emitter man. recs?
- Flushing (at flushing flow rate)
  - HWL + EH + SL + Network HL + PH
  - Check Return Net HL (add only if > 10 psi)
  - Use DRIPNET for Network Loss
- Filter Backwash (at design flow rate)
  - Filter-Dependent

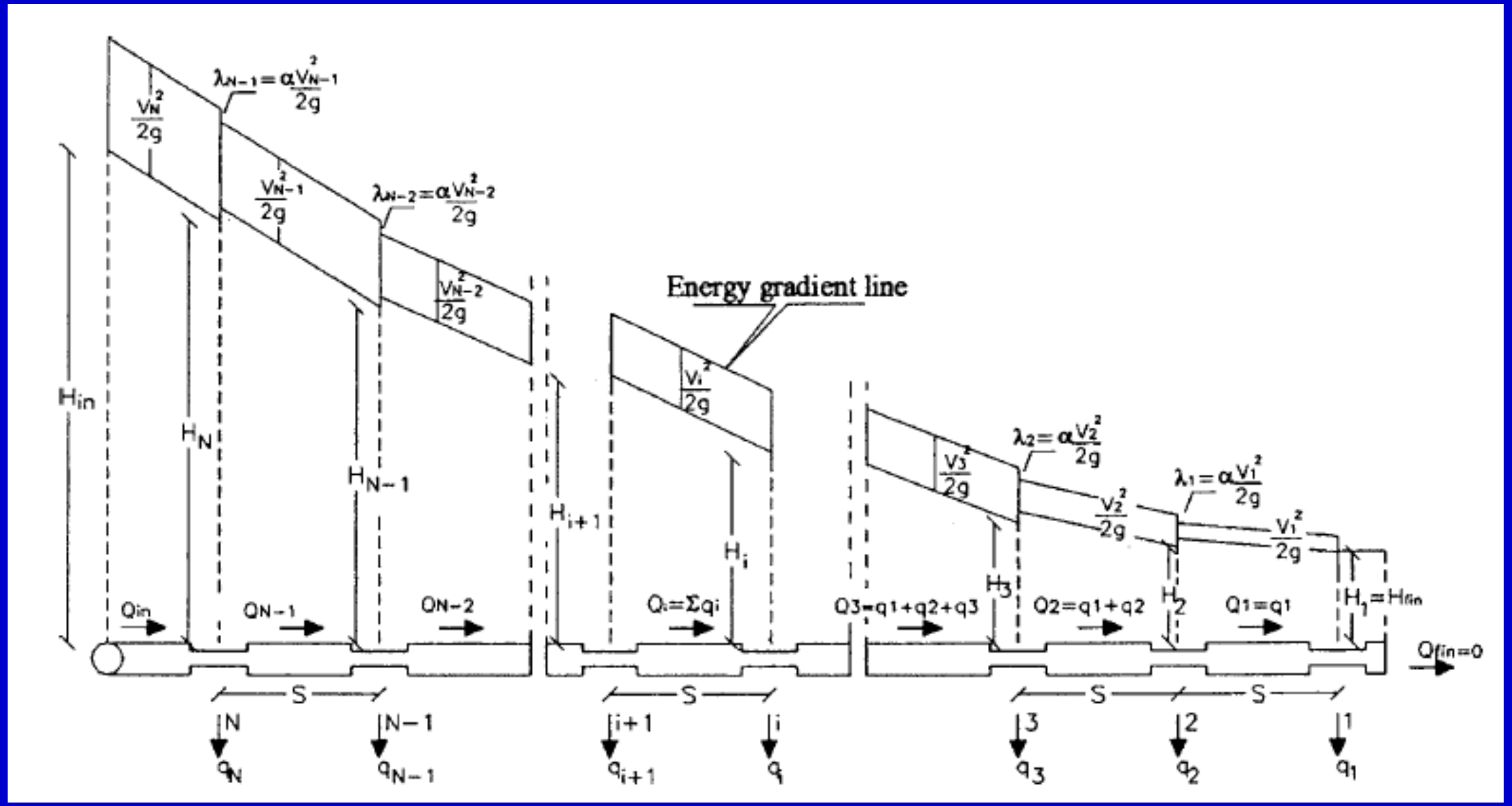
Compute Lateral Head Loss

- Drip line diameter
- Emitter spacing
- Dosing Head loss
- Flushing Head loss

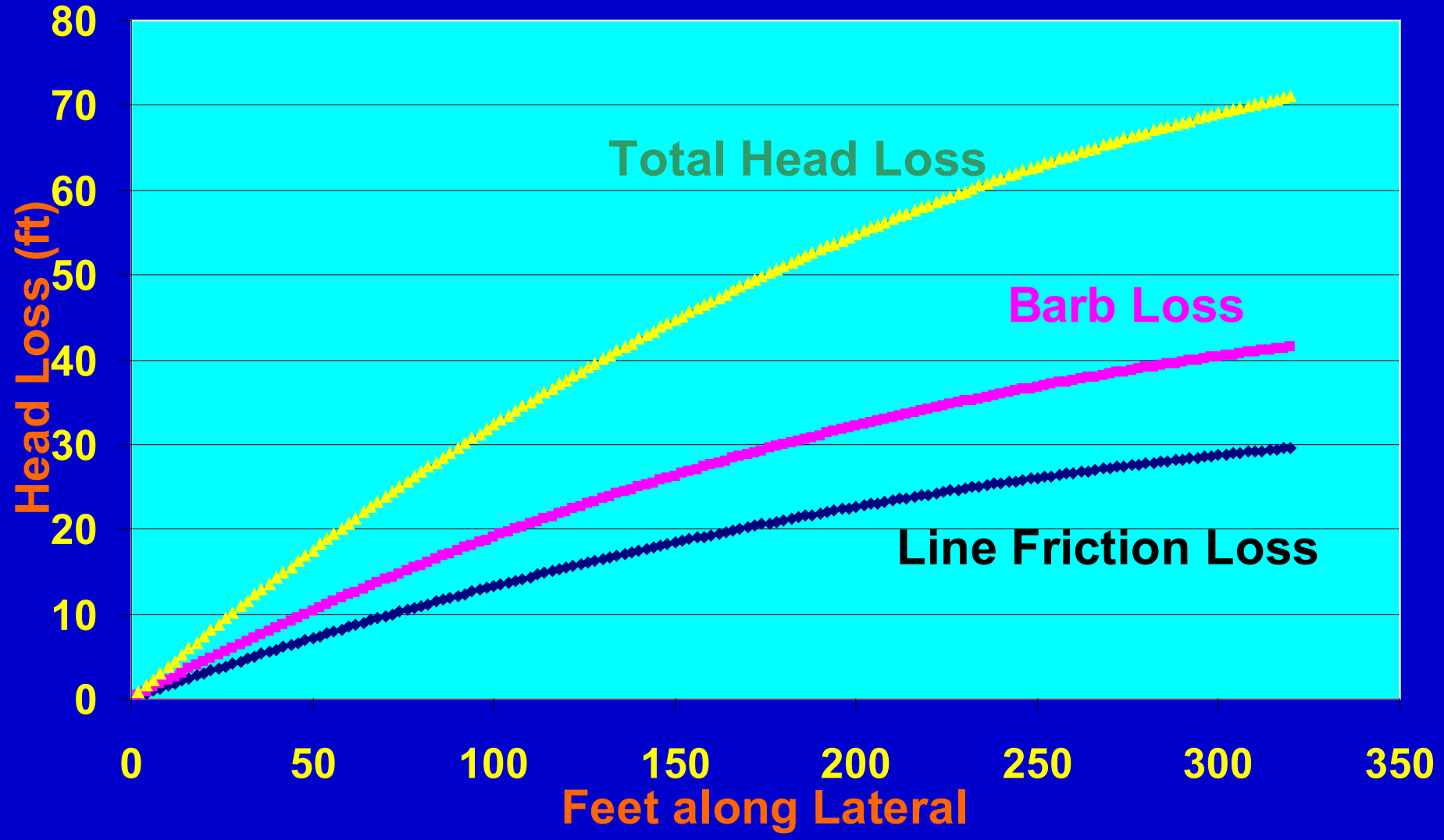




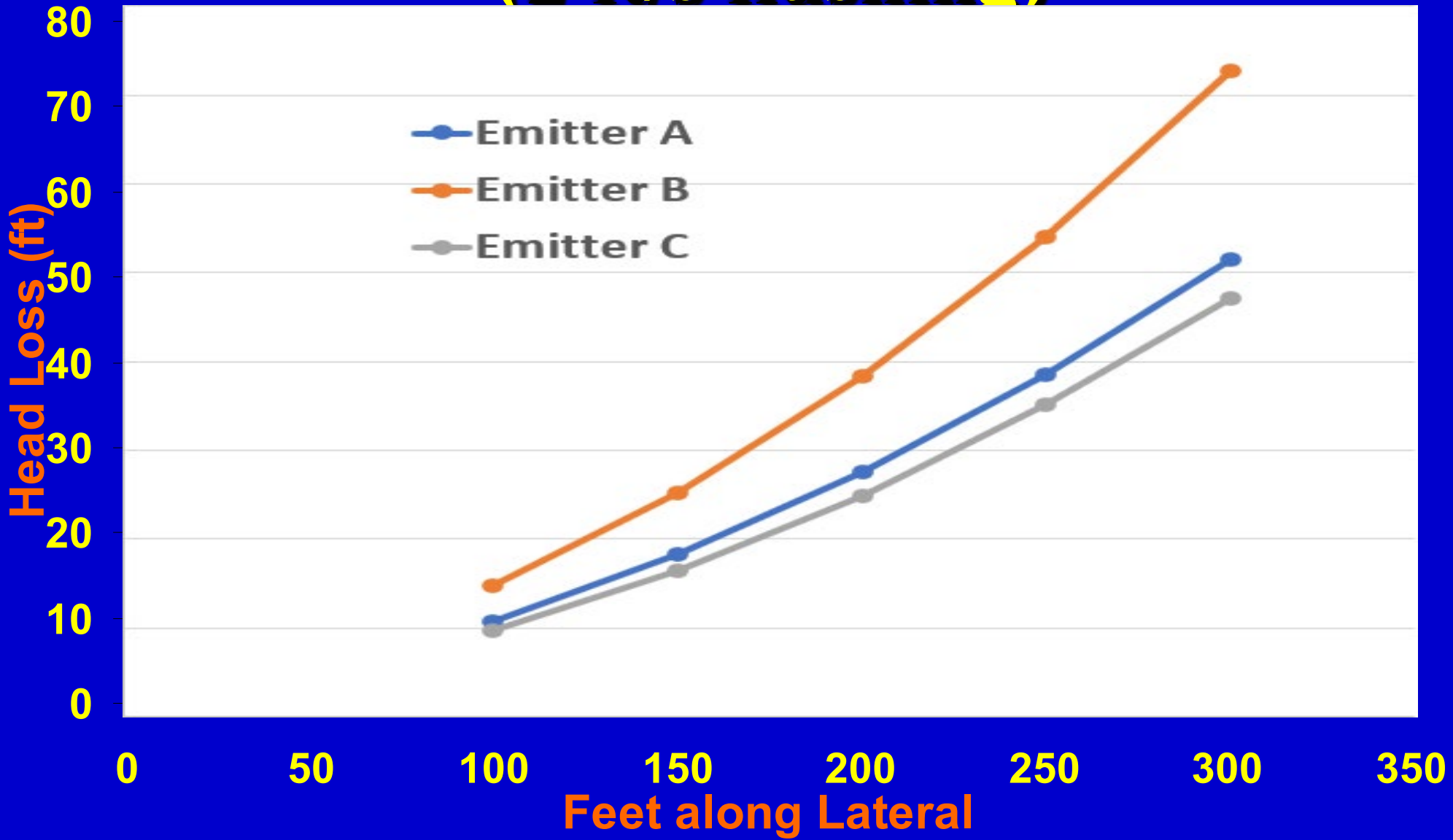
Head Loss Along Drip Lateral



Friction Loss Along Lateral (2 ft/s flushing)

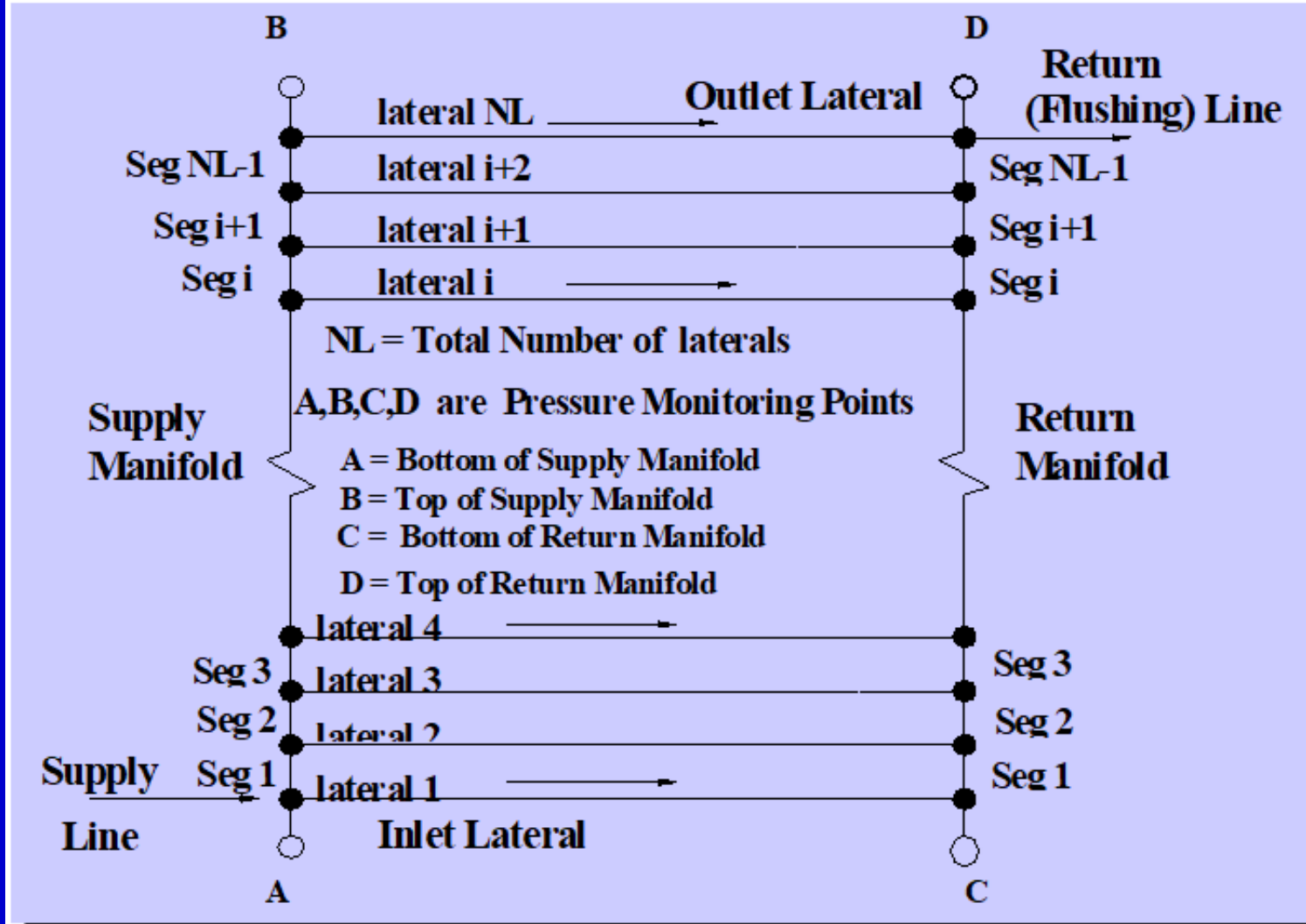


Friction Loss Along Lateral (2 ft/s flushing)

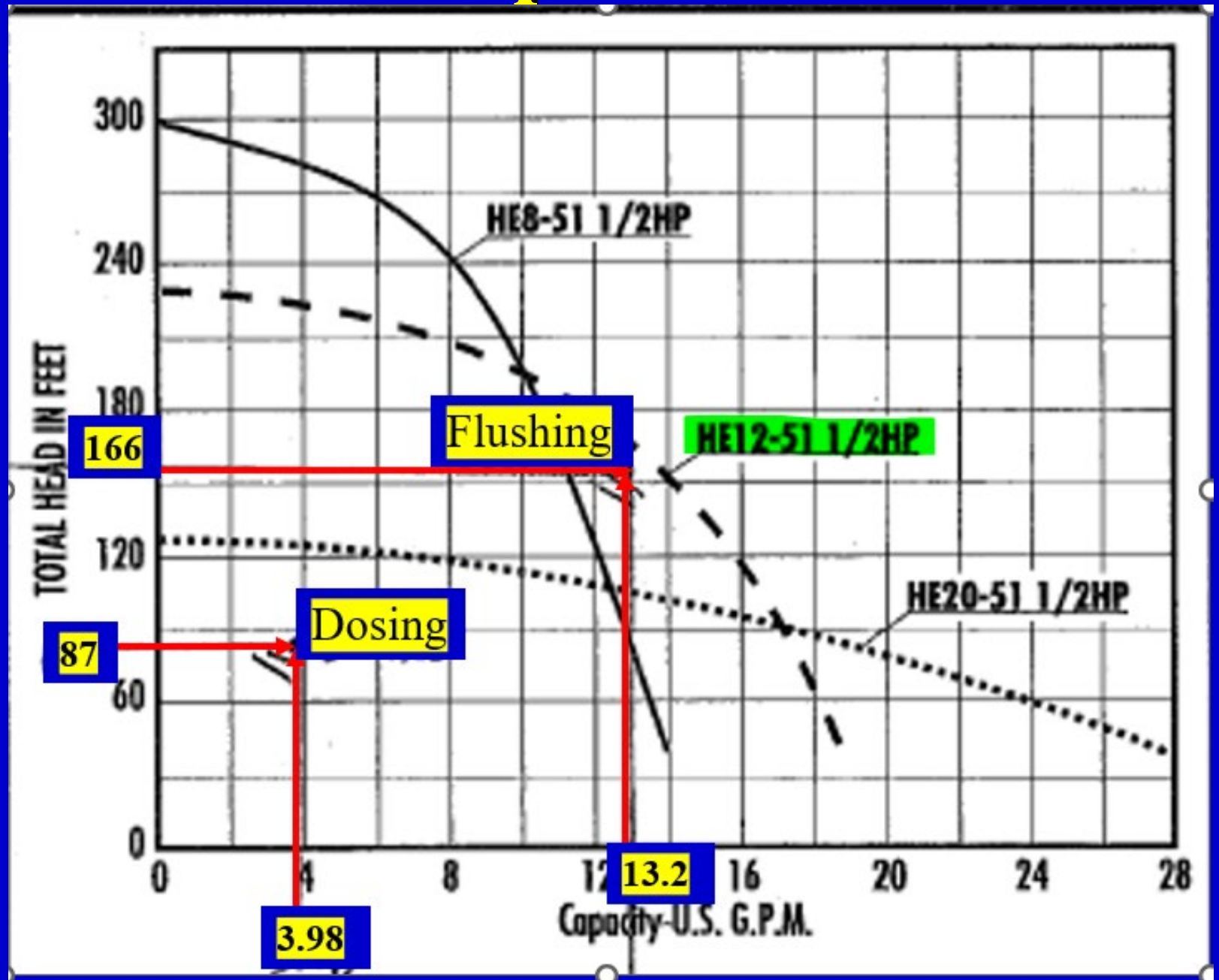


Increment Flushing Flows When Lateral Lengths Vary to Achieve Desired Minimum

Computer Program DRIPNET



Pump Selection

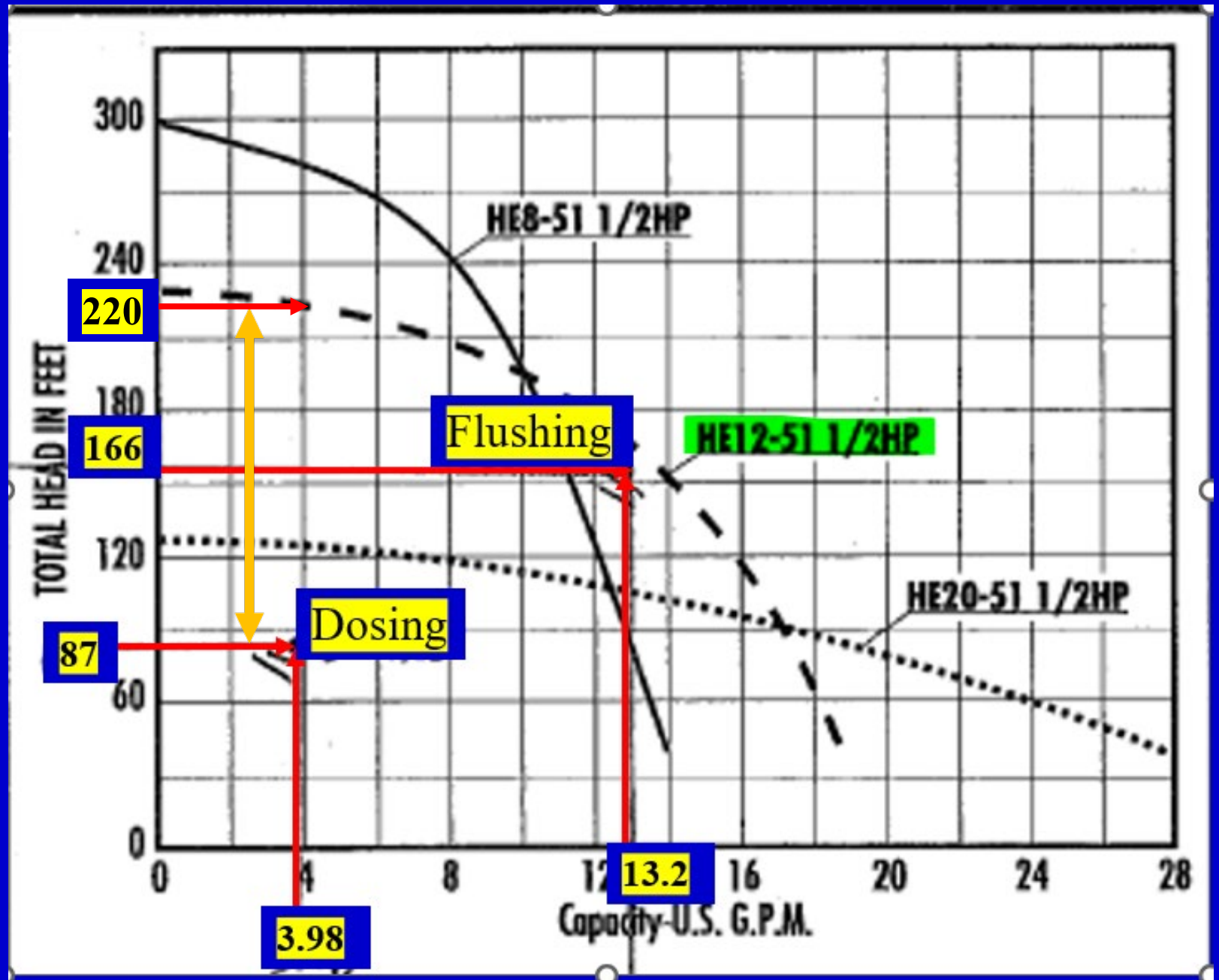


Check Maximum Field Operating Pressure

- Start with Pump Pressure at Dosing Flow
  - Determine from Pump Curve
  - Subtract Dosing TDH
  - Add net field EH (top of Zone to lowest lateral)

- Is it> Emitter Man. Recommendations (e.g., 50-60 psi)?
  - If “Yes”, use Pressure Sustaining Valve (inlet to Zone)
  - Recheck if min. Flushing Flow Rate Sustainable

Peak Pressure Calculation



- Peak Pressure =
  - Pump Operating Head (dosing)
    (minus)
  - Dosing TDH
    (plus)
  - Field Elevation Drop (FED)
- Peak Pressure =
  - 220 – 87 = 133 Ft + FED
  - **= 58 psi (+ FED)**

Pump Operating Regimes

General

- "Normal" Dosing
- "Peak" Dosing
- Field Flushing
- Filter Backwash

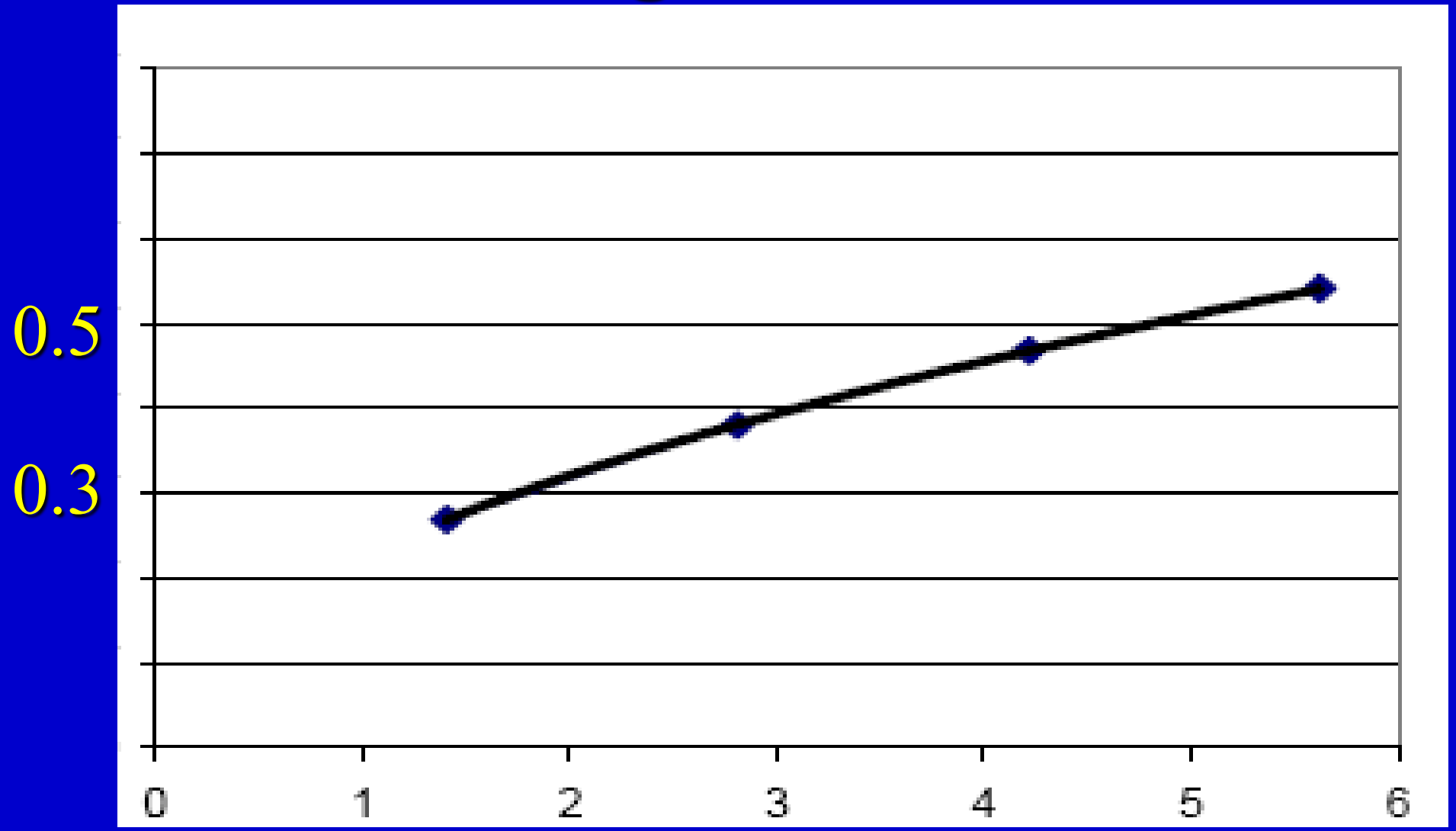
Dosing Parameters

- Equalize over 24-hours (a given)
- Trade-Offs:
  - "Micro" Dosing (many small doses throughout day, short run times)
  - Min. Volume needed for Distribution Uniformity
- Dose Control Options: Time vs Volume
- Coordinate Dose Control with Level Sensor Indicators

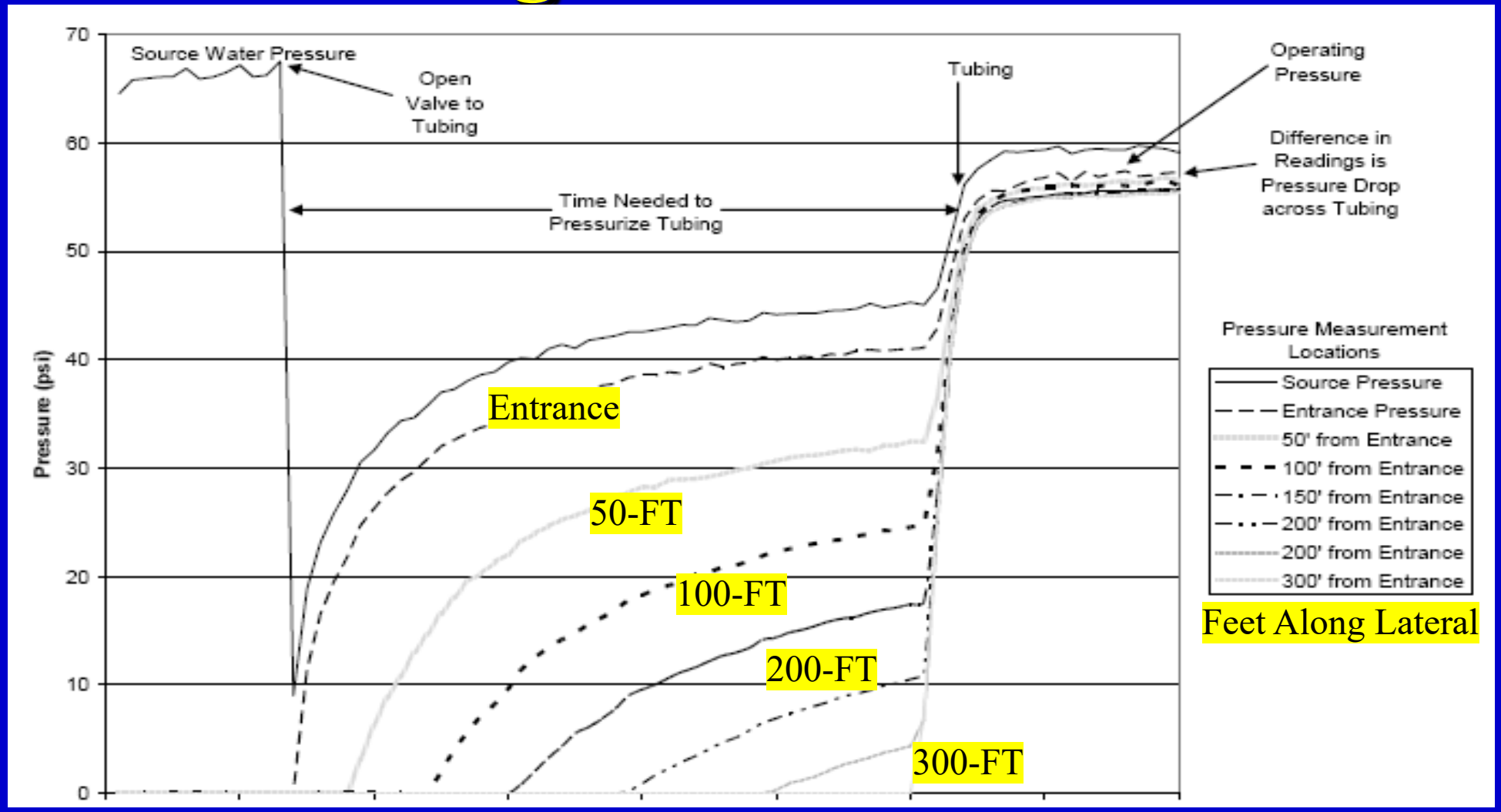
Dosing a Drip Field Zone

- Four stages of Dosing
  - Pressurization flow
  - Pressurized (uniform) flow
  - Depressurizing (draindown) flow
  - Resting

PC Emitter Flow During Pressurization

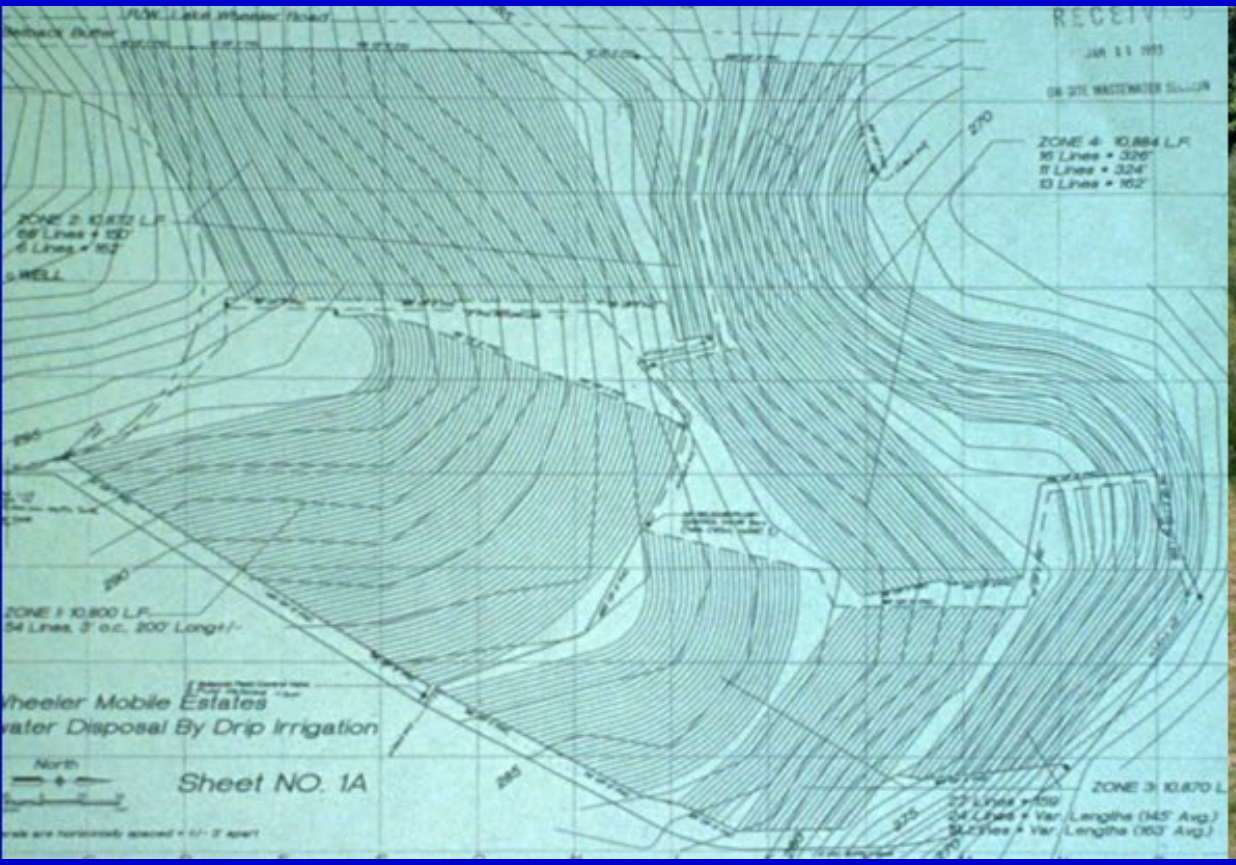


Buchanan, 2006: Non-Uniformity During Pressurization



Drainback: Volume Draining Non-Uniformly in Drip Laterals and Supply Manifolds at End of Dose

NC Example:



Drainback: Volume Draining Non-Uniformaly in Drip Laterals and Supply Manifolds at End of Dose

NC Example:

Field Zone	Laterals	Supply Manifold	Total Network Pipe
	(gallons)		
-			
1	143	67	210
2	144	138	282
3	144	237	381
4	144	117	260

Minimum Equalized Dose Volume to Meet 80% Delivery Criteria to Each Zone: 1100

Average Doses per Zone Per Day, at Design Daily Flow Rate: 3

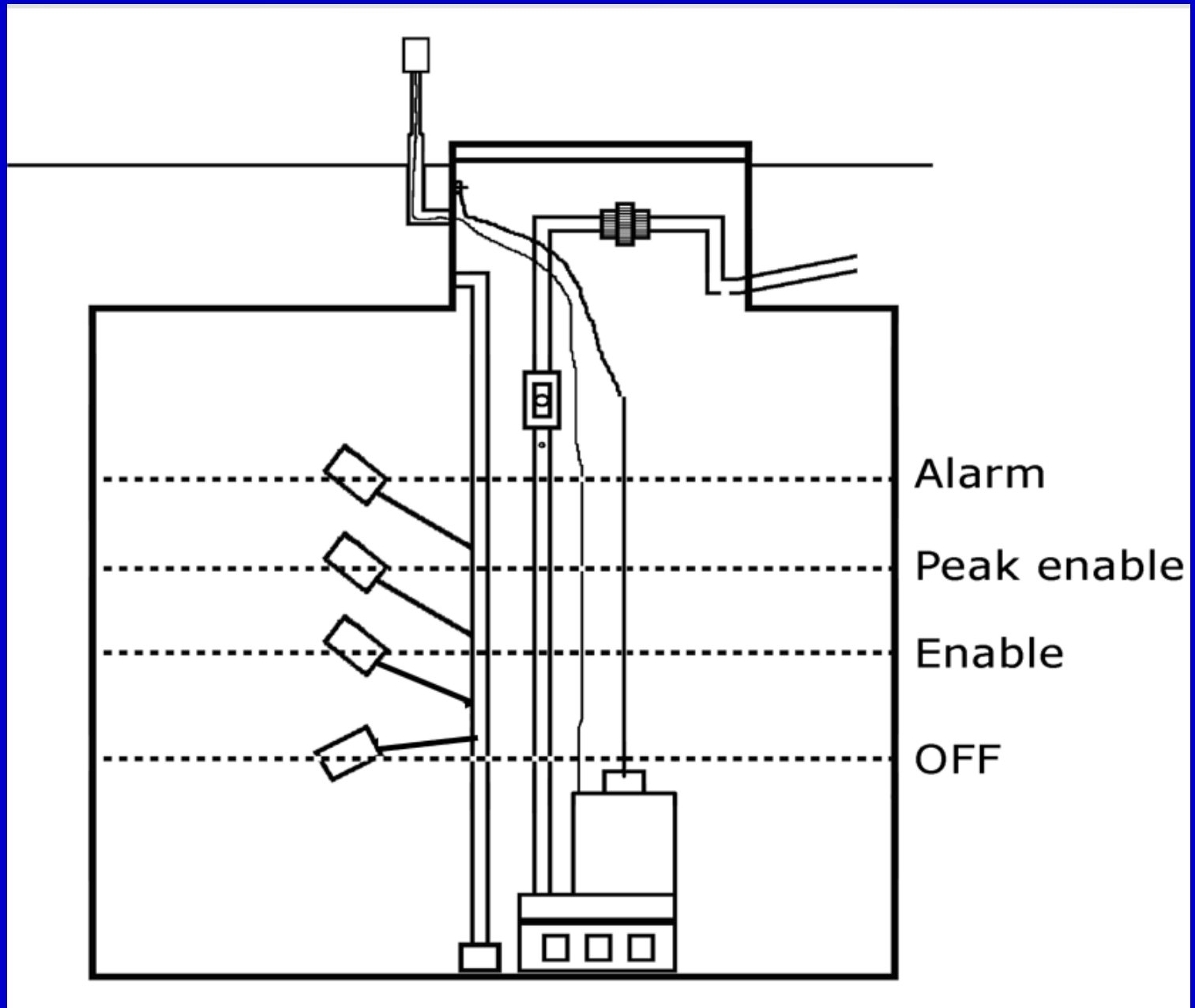
Minimum Dose Time and Volume Measurement

- Goal: >80% of Dose When Pressurized
  - With system “dry”, turn on, measure Time (PTi) and Volume (FGi) till pressurized
    (>10 psi at top of return)
  - Calculate Minimum Pressurized Dose Time
    = (4xFGi)/(Steady-State Dosing Flow Rate)= STi
  - Adjusted Minimum Dose Time = PTi + STi
  - Minimum Dose Volume = 5 x FGi

Option to Reduce Dose Time and Still Meet Minimum Dose Volume Criteria

- Use 18-inch vs 24-inch emitter spacing
  - Same Dose Volume Delivered over 25% shorter run-time
  - Also Reduces per/emitter application rate
    (a plus for clayee soils).
- Requires Higher Dose and Flushing Flow Rates
  - Results in higher lateral friction loss (e.g., during flushing)

Coordinate Controls With Level Sensors



Flushing Operating Parameters

General

- Scour Velocity Selected (controls flow and TDH)
- Aerobic vs Anaerobic
- Automated Controls (by activating normally closed flush valve on return line).
- Return directed to pretreatment system

Frequency

- Once per (X) dose cycles (e.g., 15-30?).
- Once per (X) days (e.g., 14-28?)

Duration

- Network Pressurization + 2 x longest lateral detention time

Hydraulic Performance Issues

- Change in Emitter Flow Rate
  - Reduction or Increase with Time?
- Reduction in Emitter Flow Uniformity
- Increase in Field Head Loss
  - Especially during flushing
- Valve “Issues”

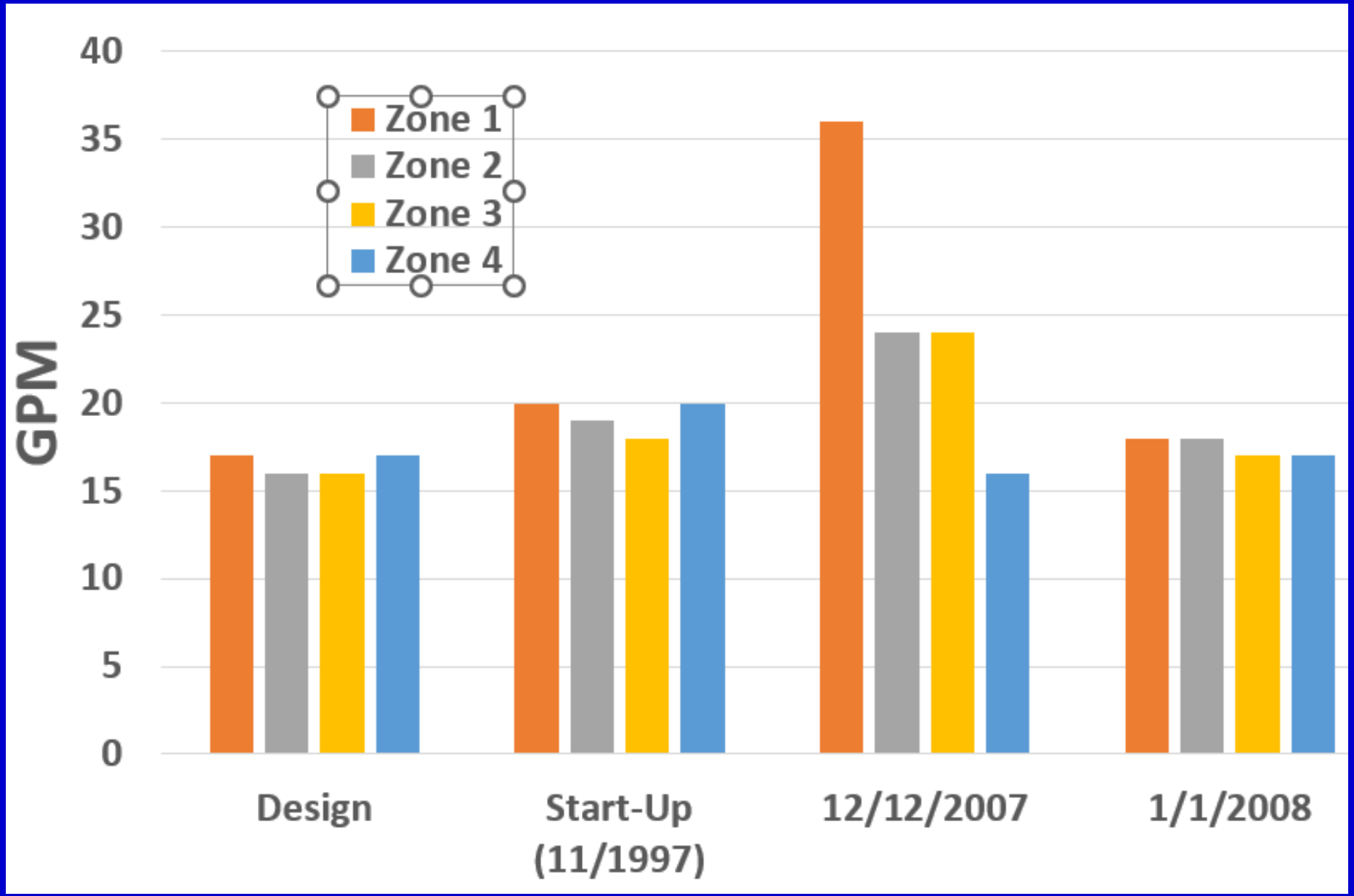
Field Measurements

- Dosing Flow Rate
- Flushing Flow Rate
- Flushing Head Loss
  (Outlet - Inlet Pressure)

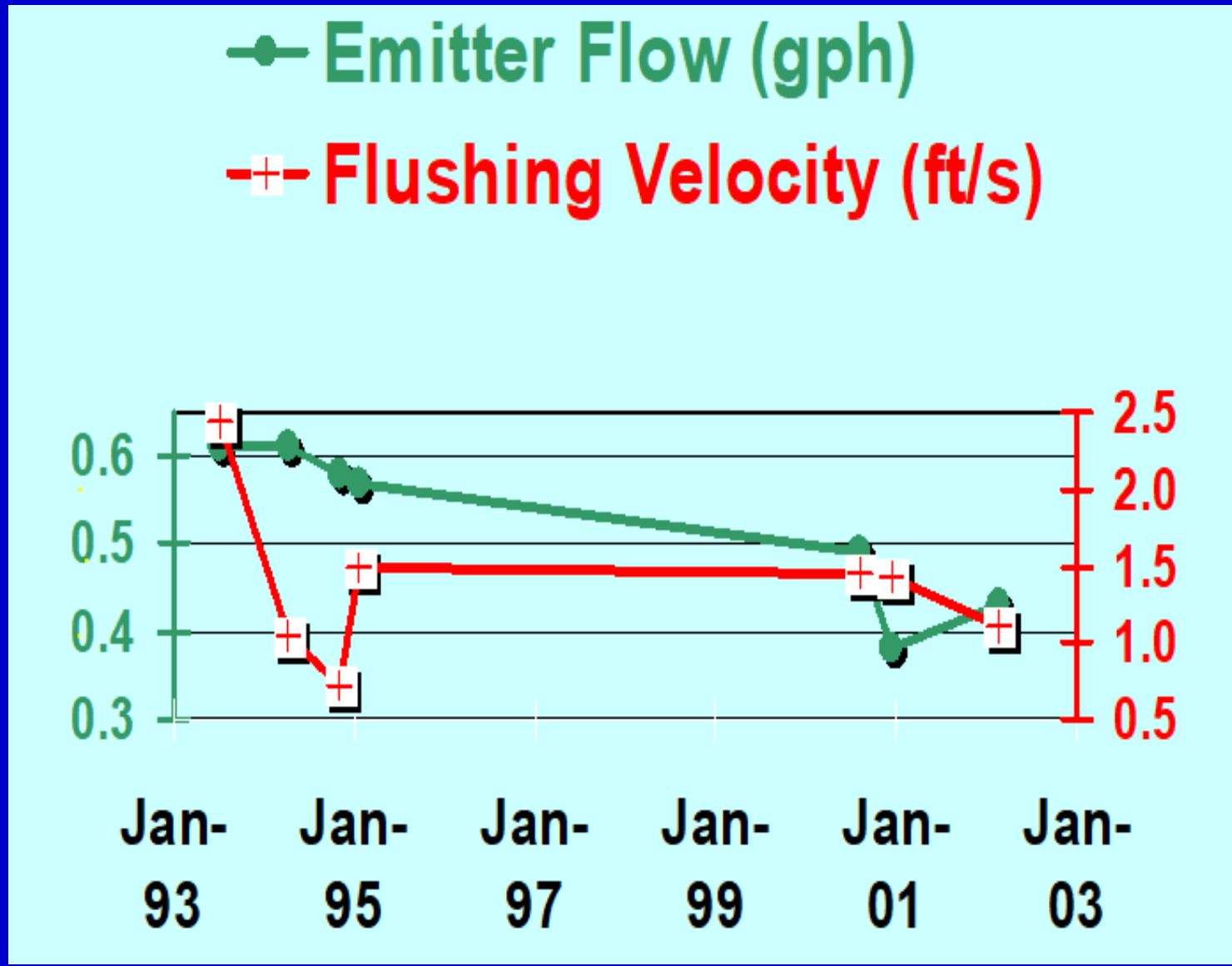
Start-Up Measurements

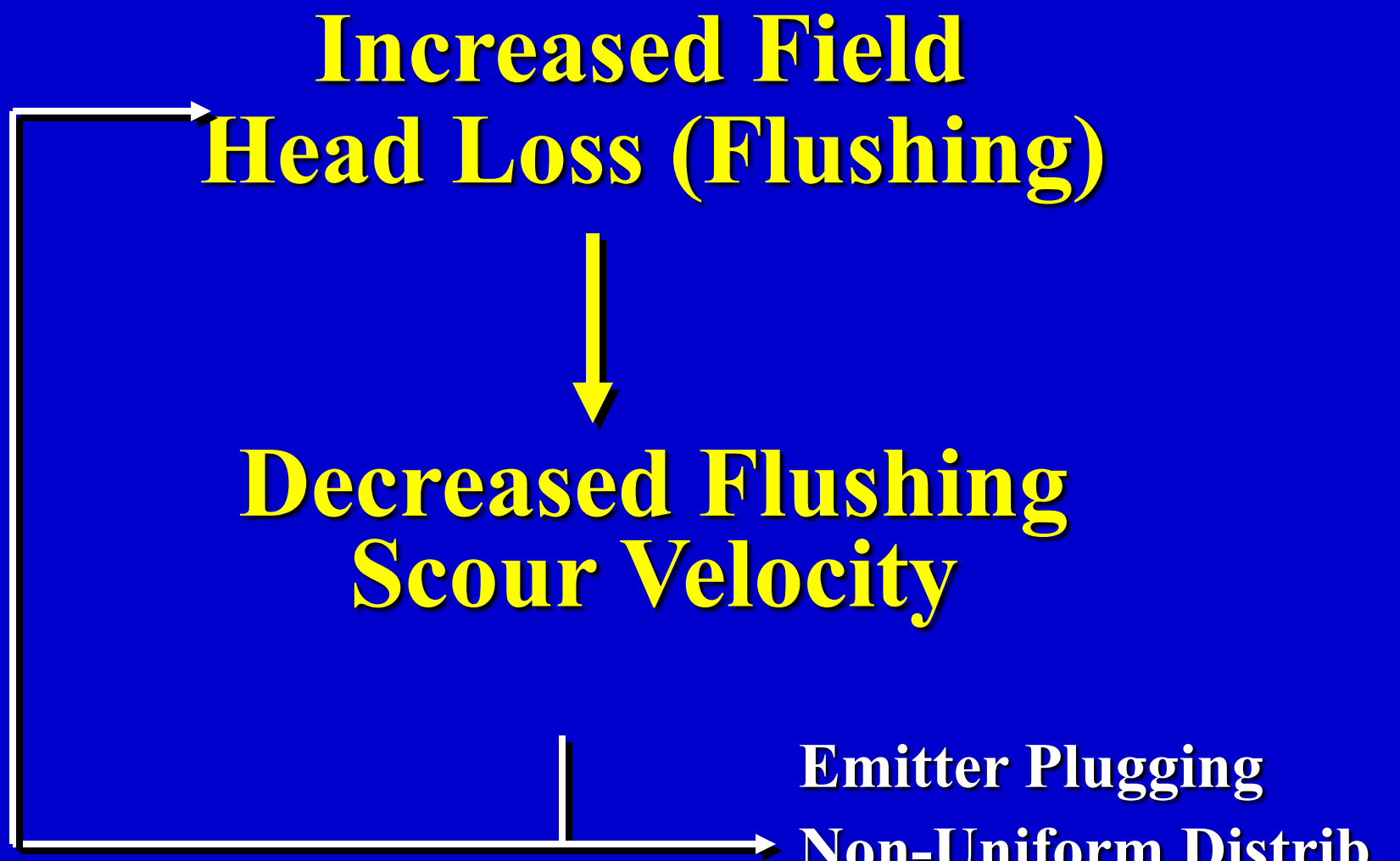
Queens Grant Start-up Measurements and DRIPNET Prediction Comparisons, 06/25/12											
Zone	Dosing			Flushing			Emitter Flow (0.90 gph design)		Min Flush Scour Vel. (ft/sec)**	Predicted vs Measured Head Loss (psi)	
	Flow (gpm)*	Pressures (psi)		Flow (gpm)*	Pressures (psi)		Meas. (gph)	% Design		Pred. ***	Mea.(mea. vs.pred.%)
		Supply	Return		Supply	Return					
5	16	47	41	33	36	9	.83	92%	2.5	42	27 (65%)
6	17	48	43	33	36	9	.88	98%	2.4	42	27 (65%)
7	17	47	42	31	30	8	.88	98%	2.1	36	22 (62%)
8	17	45	42	31	31.5	8.5	.88	98%	2.1	23	22 (65%)

Measured Zone Dosing Rate (Troubleshooting)



Anaerobic Drip (Performance Reduction)




Increased Field
Head Loss (Flushing)
Decreased Flushing
Scour Velocity
Emitter Plugging
Non-Uniform Distrib.

Reduction in Emitter Flow Rate

Reduced Distribution Uniformity

Key Take-Aways

- Optimize Drip's Unique Landscape Effluent Dispersal Advantages
- Respect Soil/Site Limitations
- Integrate Active/Repair Zones
- K.I.S.S. Maximizes Operability and Performance Assessment
  - Even # of Zones
  - Equal Lateral Length/Zone
- Iterative Design Decisions
  - Layout Options/Zone Number/Size
  - Resultant Dosing/Flushing Operating Regimes
- Maximize Steady-State portion of dose volume
- Monitor Hydraulic Parameters to assure long-term performance

NOWRA

To strengthen and promote the decentralized wastewater industry.

Questions

For More Information

Steven Berkowitz

sberkowitz@sercap.org

NOWRA Contact Information:

Thomas W. Groves (Tom), Executive Director
P.O. Box 982
Westford, MA 01886

(phone) 978.496.1800
(fax) 703.997.5609
www.nowra.org
executivedirector@nowra.org
info@nowra.org