People Caring About Water

2019 Northeast Onsite Wastewater Short Course

April 2-4, 2019
Mystic Marriott Hotel
Groton, Connecticut

A to Z
Gravity & Pressure Distribution

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April 2-4, 2019

NOWRA
National Onsite Wastewater Recycling Association

Types of Distribution

- Gravity
- Pressure manifold
  - Combination of pressure and gravity
- Pressure distribution
- Drip distribution

Why Distribution?

- To manage hydraulic flow
- To manage BOD/TSS
- To control/manage the organic mat
- To provide for unsaturated flow

How Does Unsaturated Flow Happen?

- Unsaturated flow is the key for treatment
- Biomat formation
  - BOD
  - Oxygen relationship
  - TSS
- Pressure distribution and drip distribution

Biomat

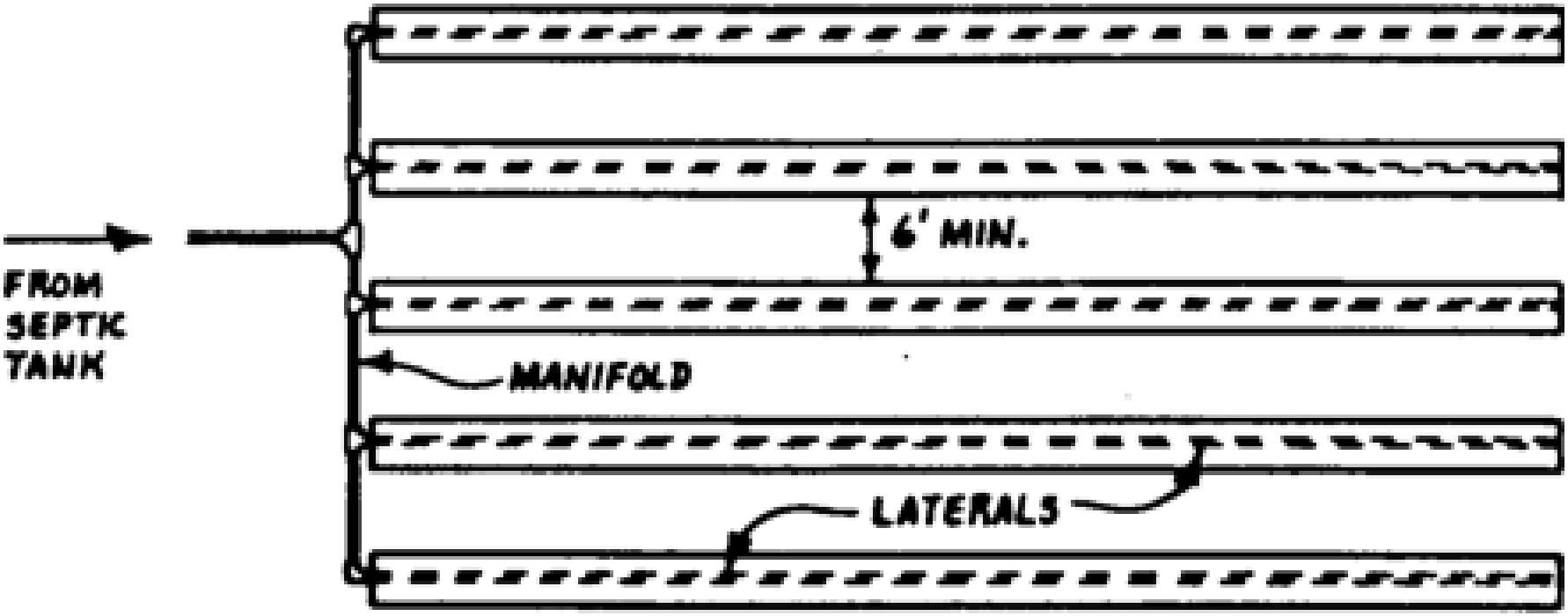
- Provides excellent treatment
- Reduces hydraulic capacity
- Must be managed
  - to provide excellent treatment
  - at acceptable hydraulic capacity

Biomat formation –

Caused by organic loading
with the soil system.
Thus, the system goes anaerobic,
producing slimes and other
byproducts.

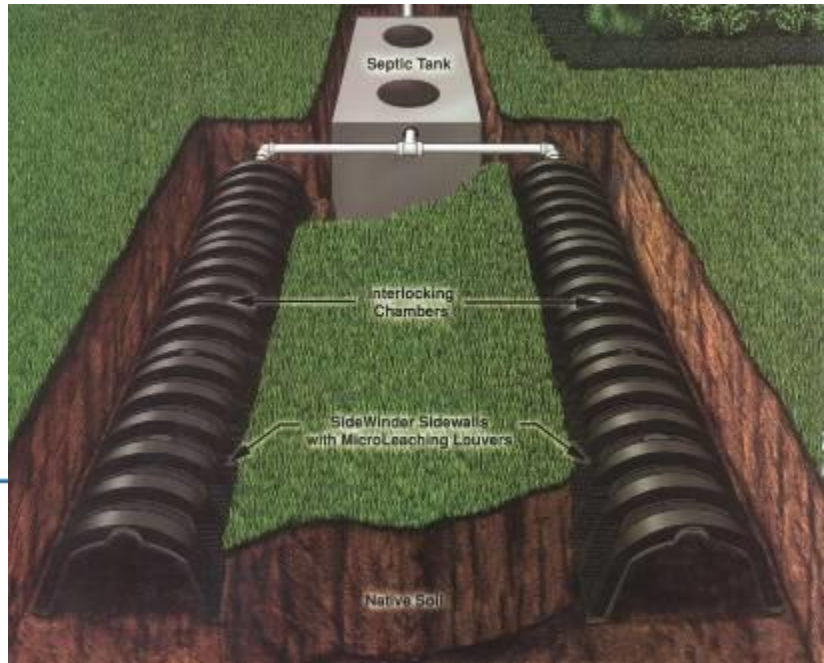
Gravity-Flow Distribution

- Appropriate for deep, well-drained sites
- Most widely used
- Least expensive
- Typically 4” Pipe
- Does not distribute effluent uniformly regardless of media type
  - Drops effluent in one or two locations

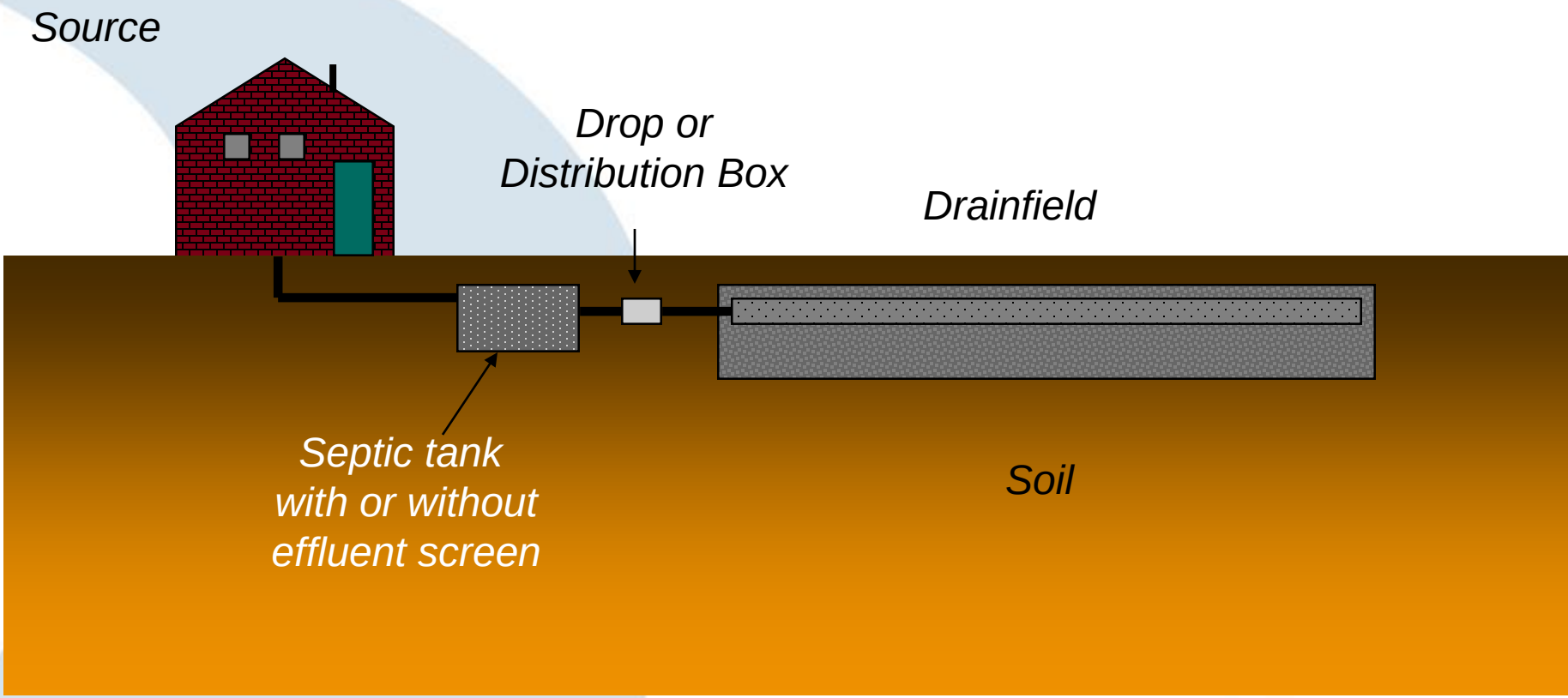


Manifold distribution

Effluent flows to all trenches,
no opportunity to rest one.

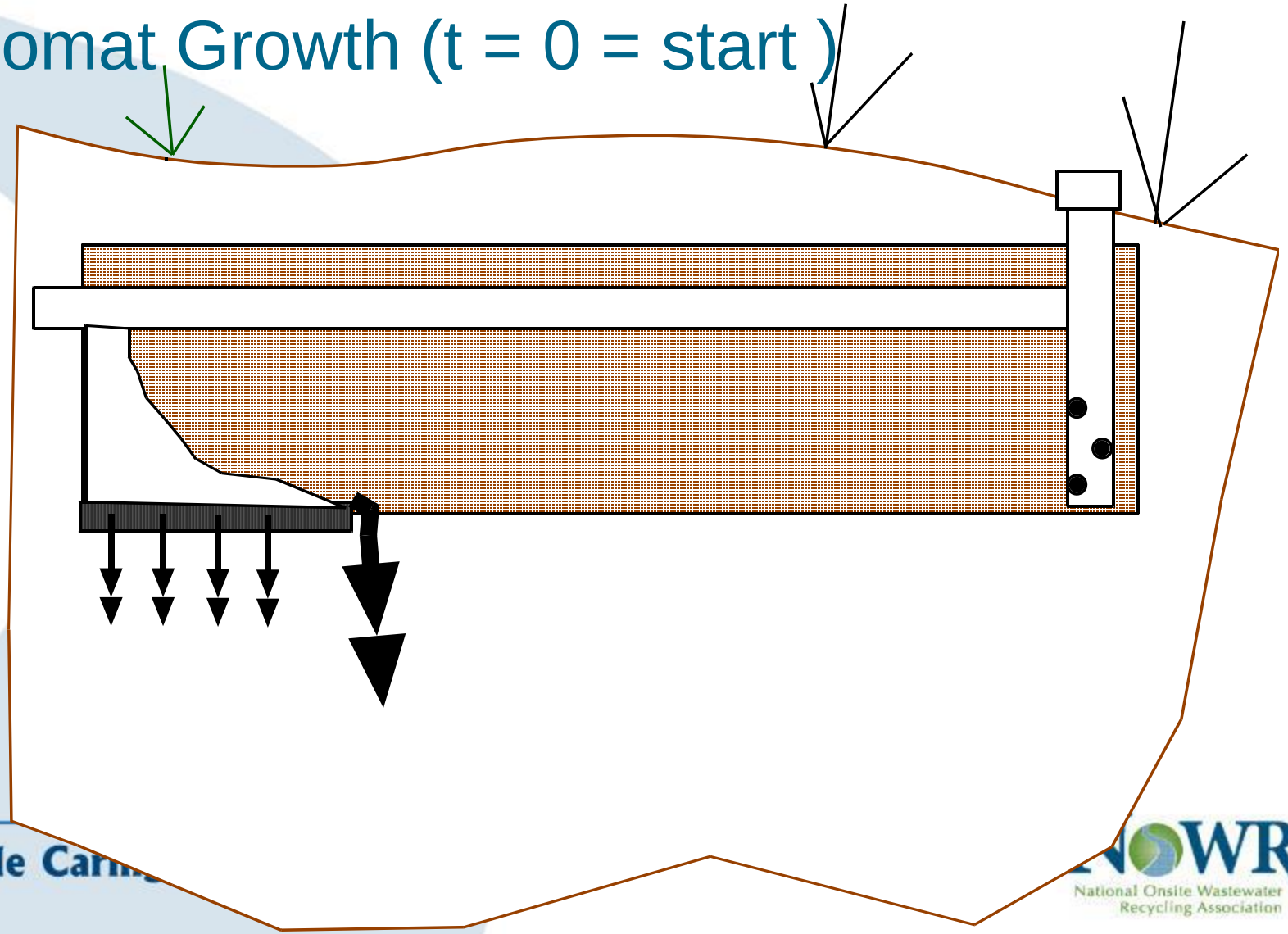


Basic Gravity System Components



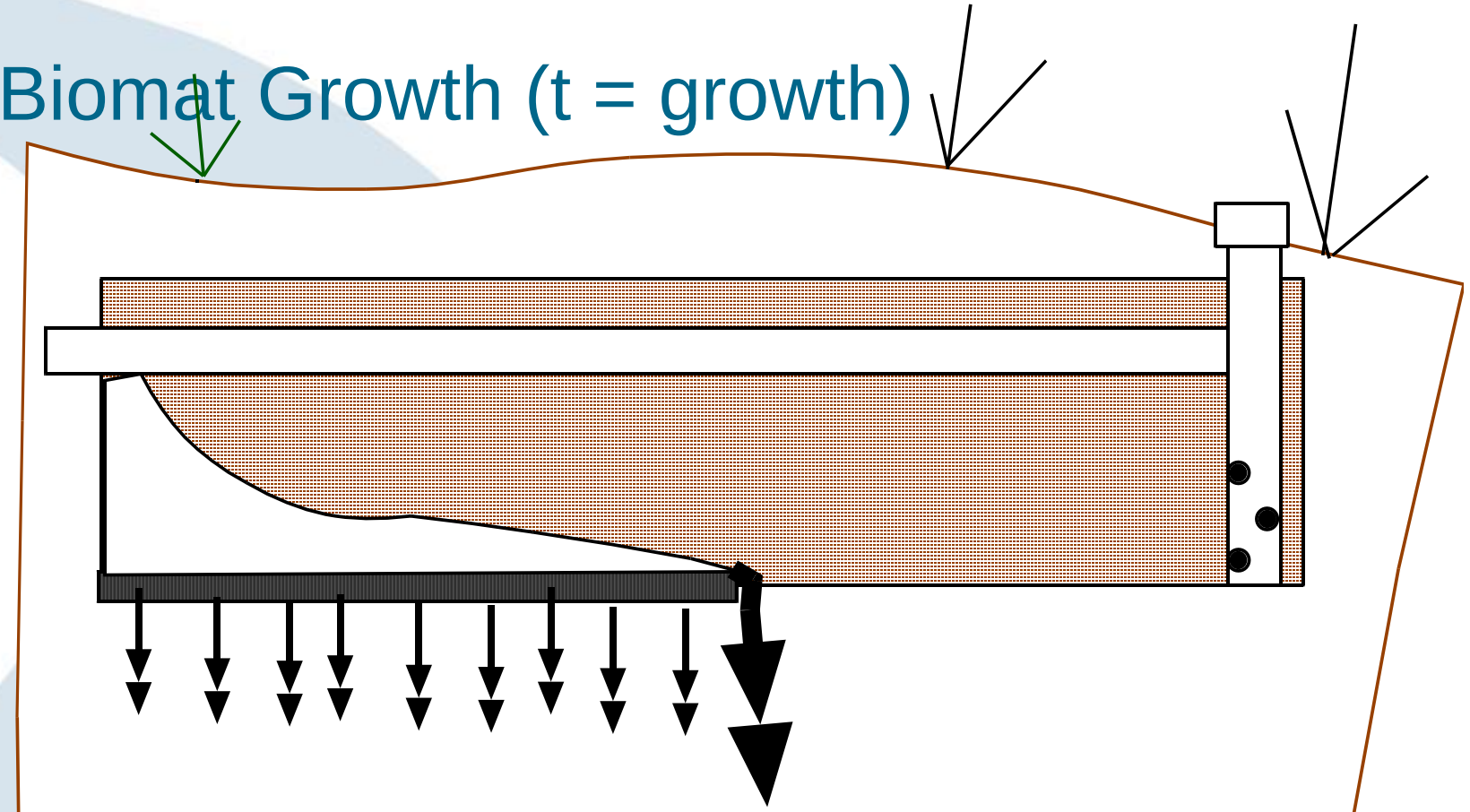
Flow Pattern in a Gravity Trench

- Biomat Growth (t = 0 = start)



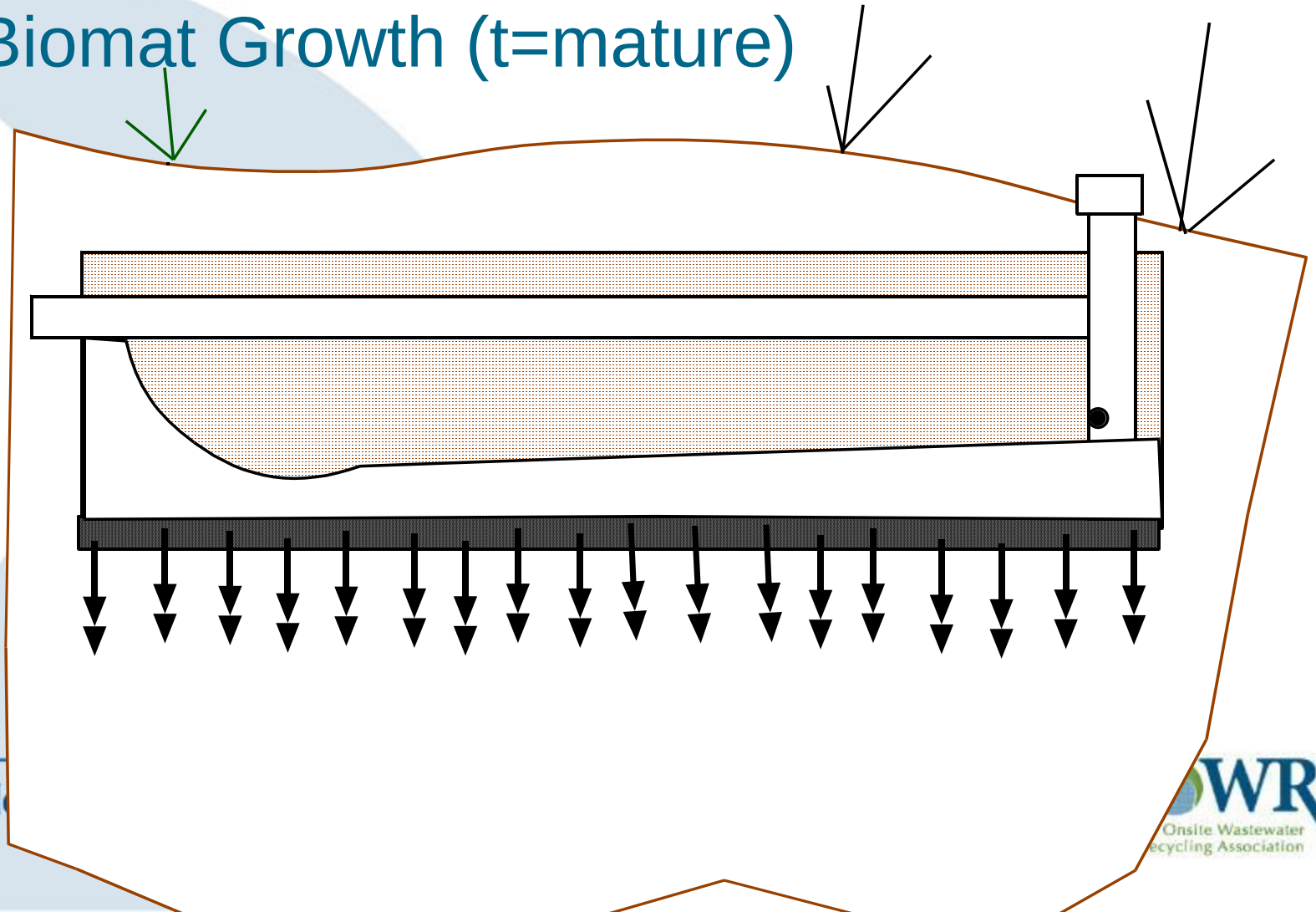
Flow Pattern in a Gravity Trench

- Biomat Growth (t = growth)



Flow Pattern in a Gravity Trench

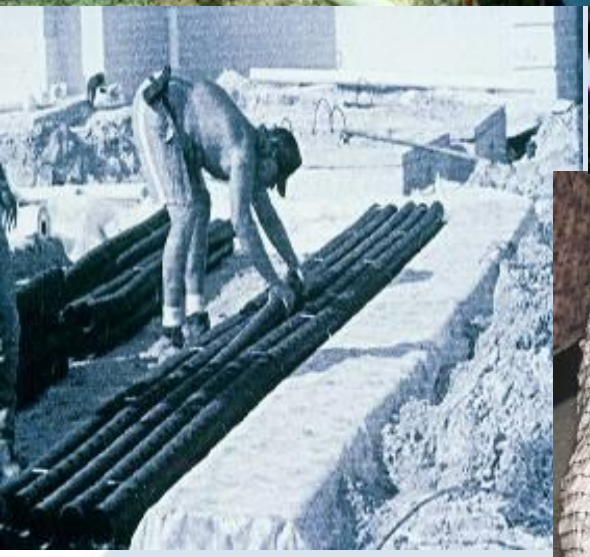
- Biomat Growth (t=mature)



Gravity Distribution

- 4" perforated pipe
  - Gravel
  - Tire chips
  - Polywrapped perforated pipe
  - Pipe bundles
- Chamber
- Large diameter fabric perforated pipe

Types of Media



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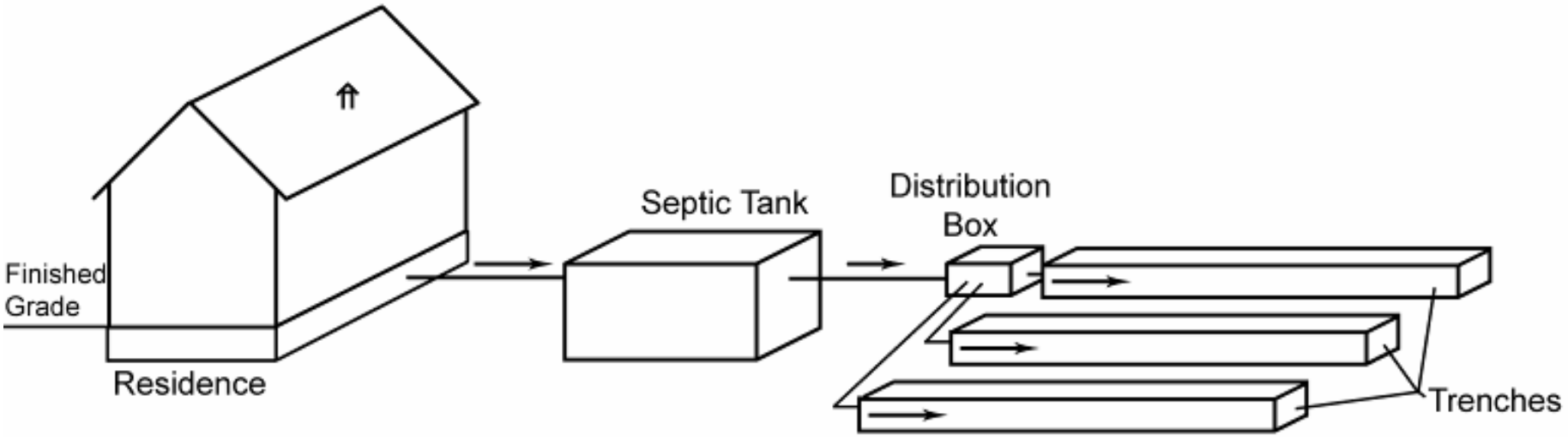
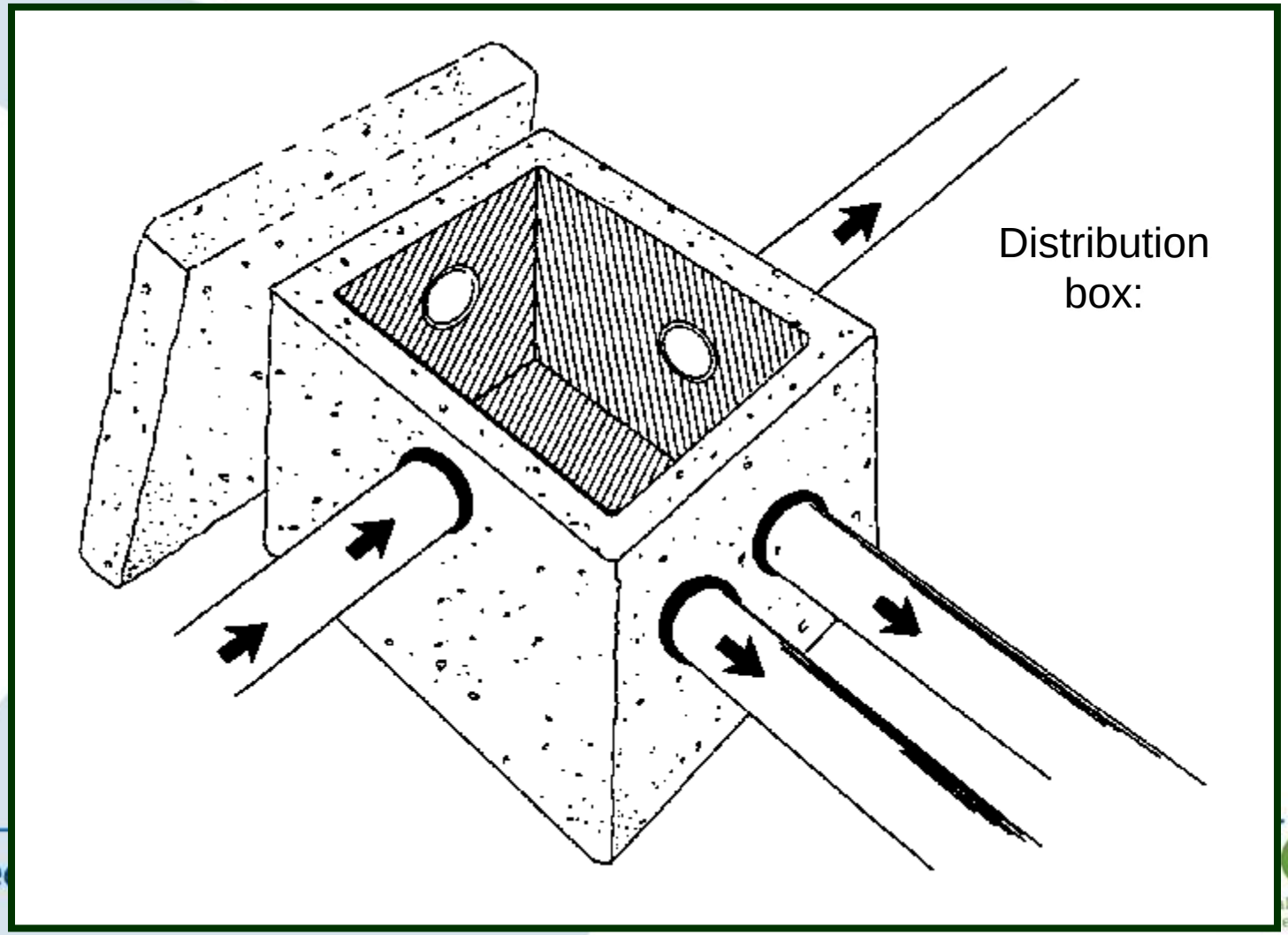
Gravity-Flow Distribution

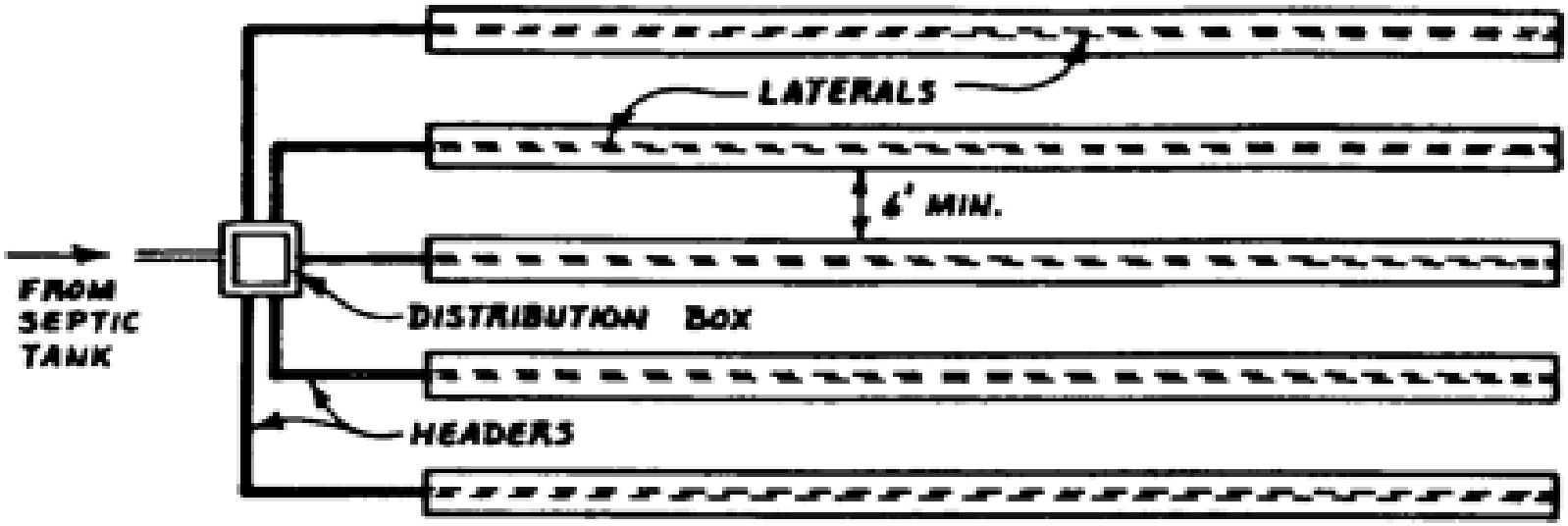
- Field configurations
  - Parallel (Distribution box, manifold)
  - Sequential (Drop box)
  - Serial
- Each lateral should be parallel to a contour
- Bottom of each lateral should be level

Parallel Gravity Distribution



Parallel Configurations

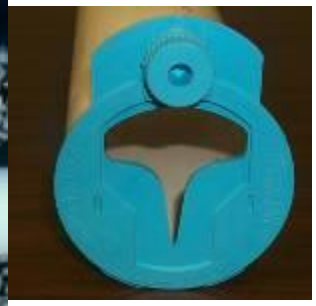




Distribution Box

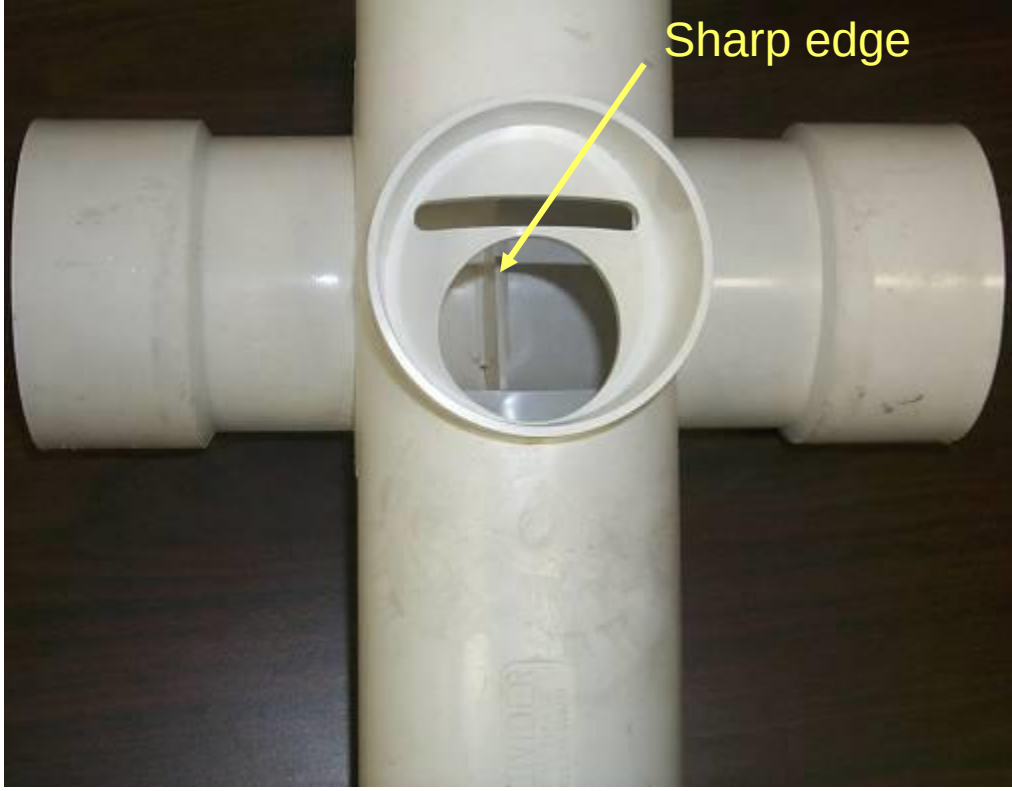
- *For level or slightly sloping sites.*
- *Flow will go to all trenches evenly.*
- *Easy to direct flow to desired trench and take one out of service to rest.*

Distribution Boxes

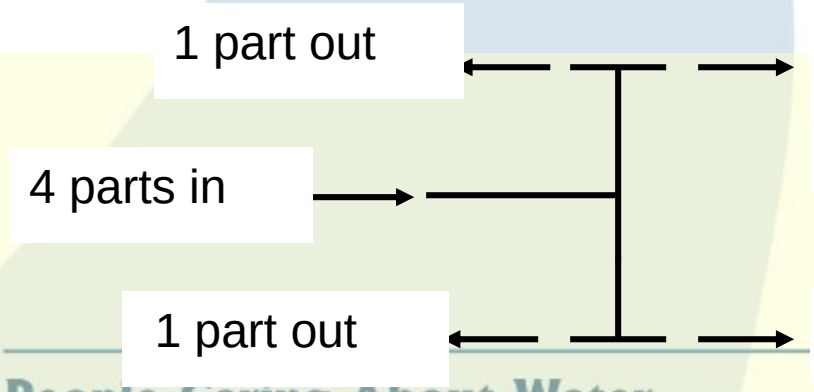


Manage systems by installing elbows or flow adjusters to direct flow to a given trench. Later divert flow and let trench rest.

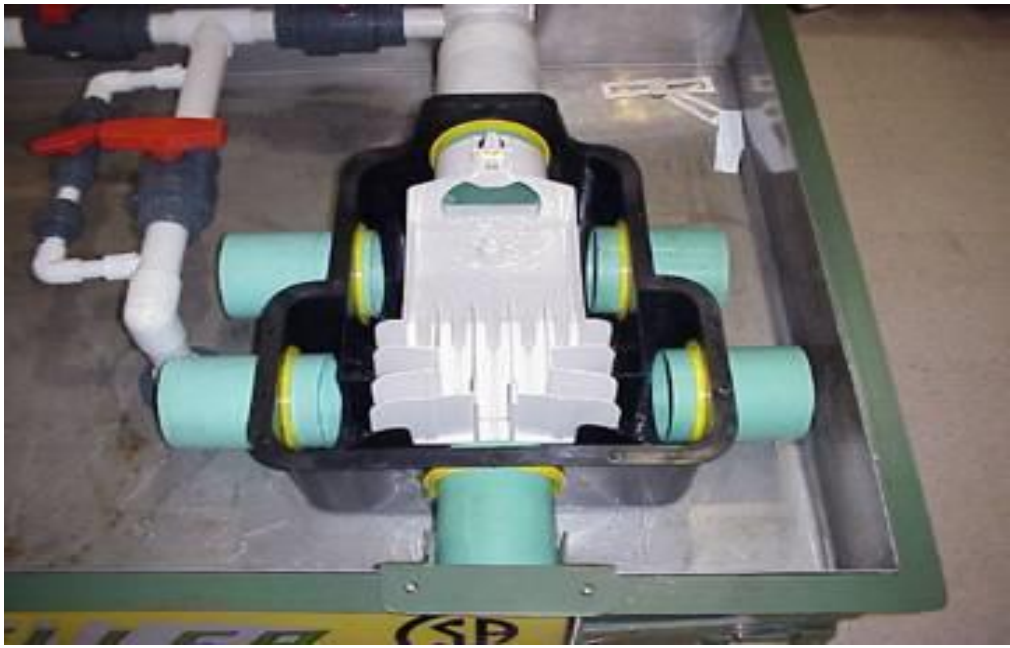
Flow splitter device.
Two equal flows.



Sharp edge splits the flow.

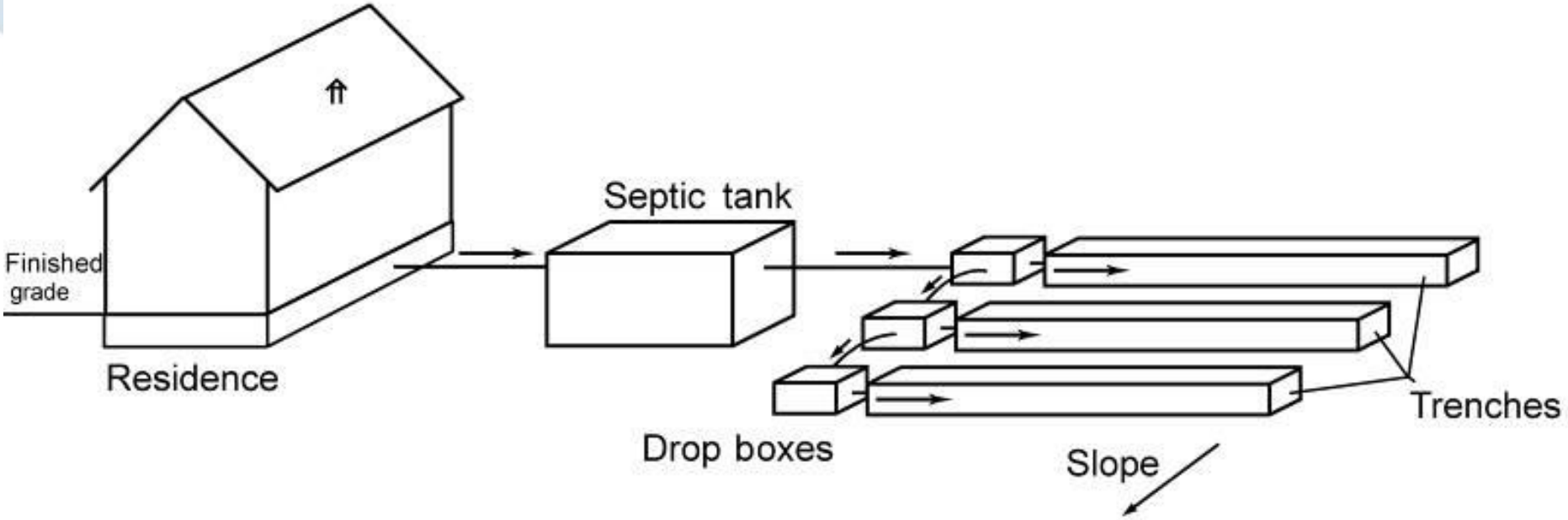


Three units together split into 1/4ths

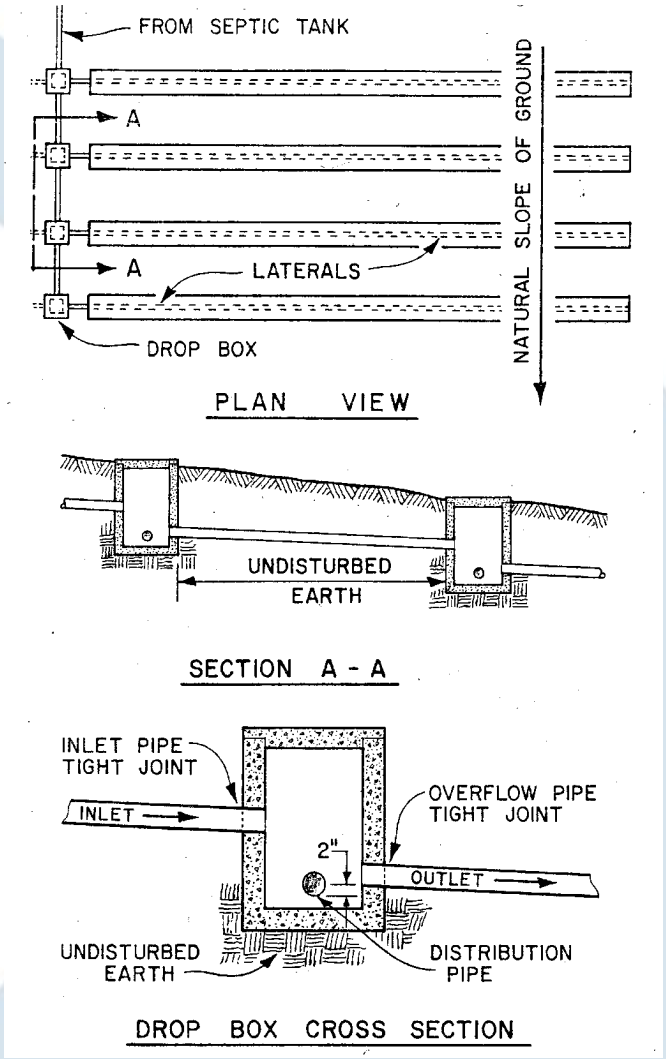


Distribution box to distribute effluent uniformly to each trench

Sequential with Drop Boxes

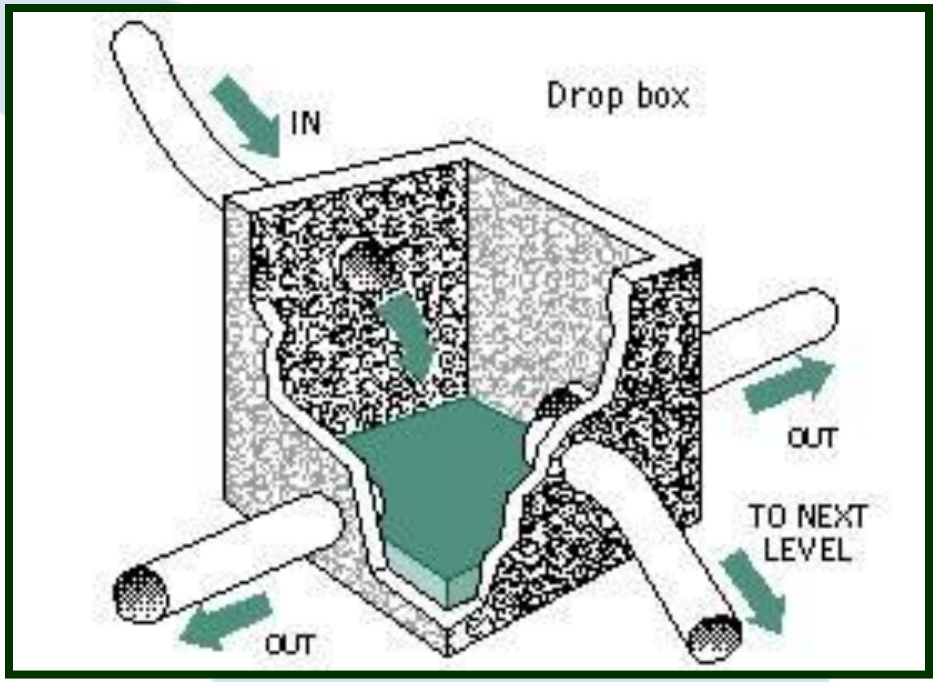


Drop Box Distribution



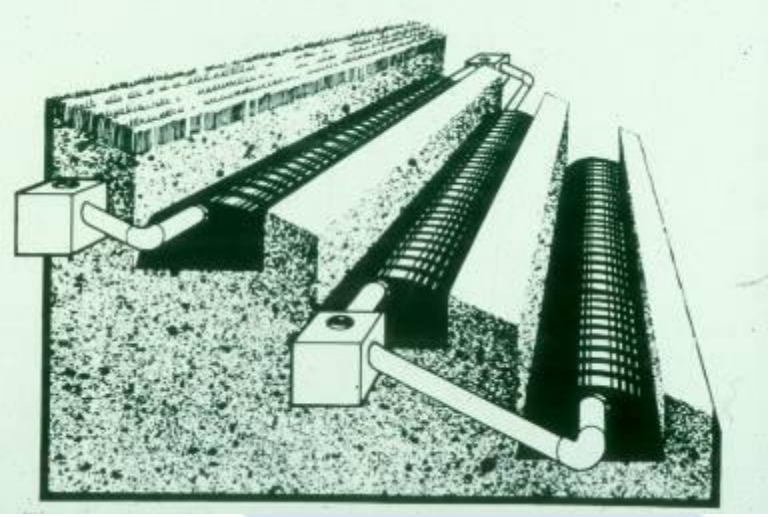
- Effluent leaves ST and flows into first drop box. All effluent flows to first trench. When it is full, effluent flows to second drop box & into second trench, then to third drop box & trench, etc.
- Can take a trench out of service
  - plug inlet pipe to trench or
  - place an upturned elbow on it.

Sequential or Serial Configurations



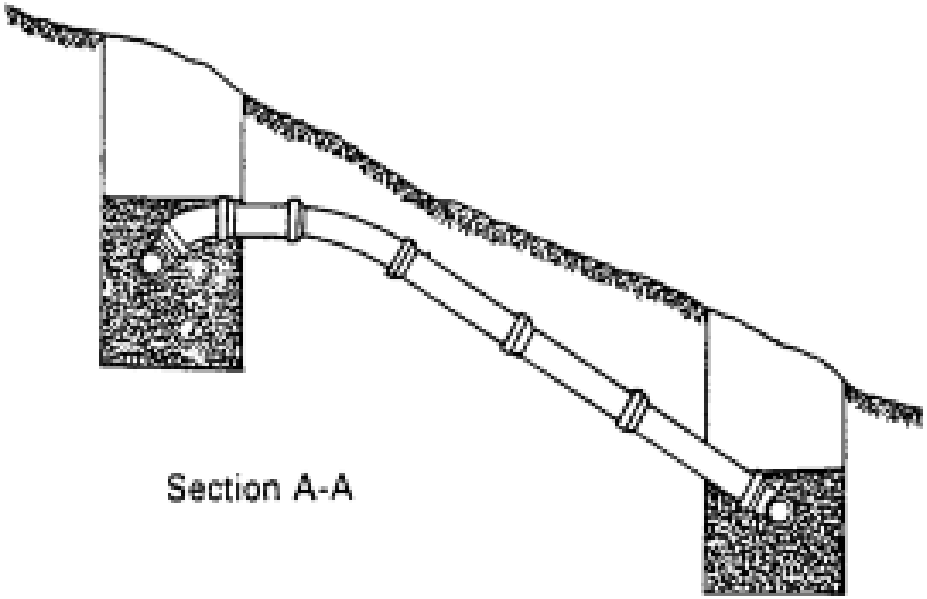
Drop box configuration

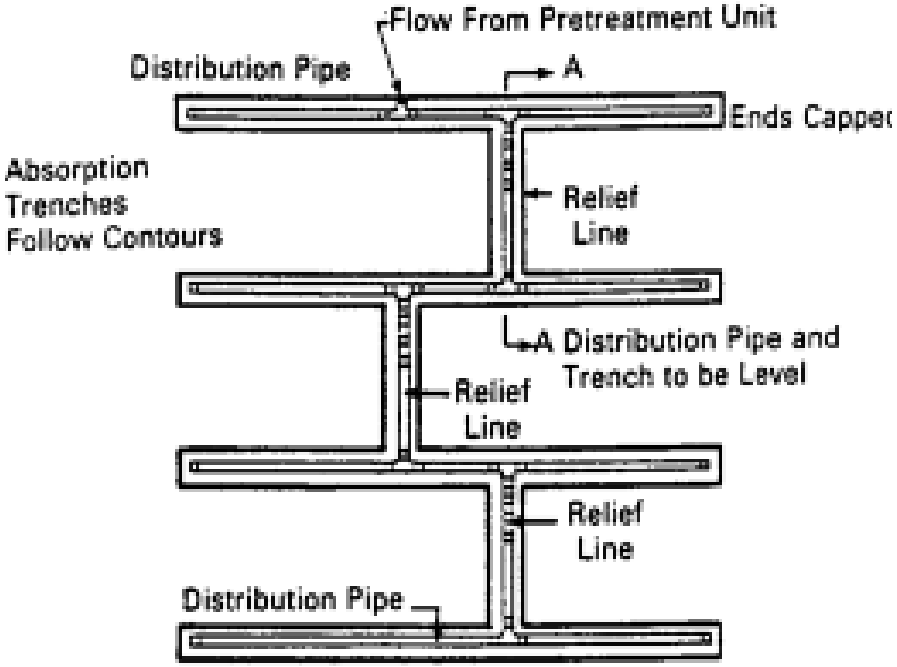
Serial Distribution



- For sloping sites - first chamber will collect solid
- Can’t rest any trenches

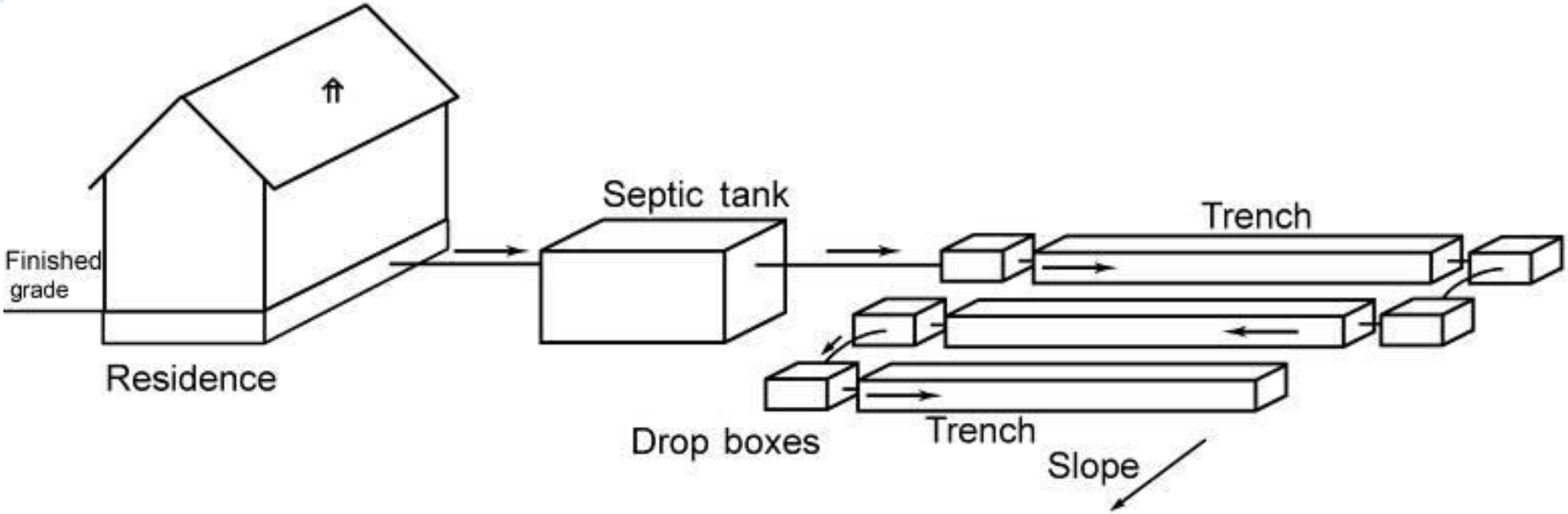
Serial distribution with liquid level control (drop) boxes.



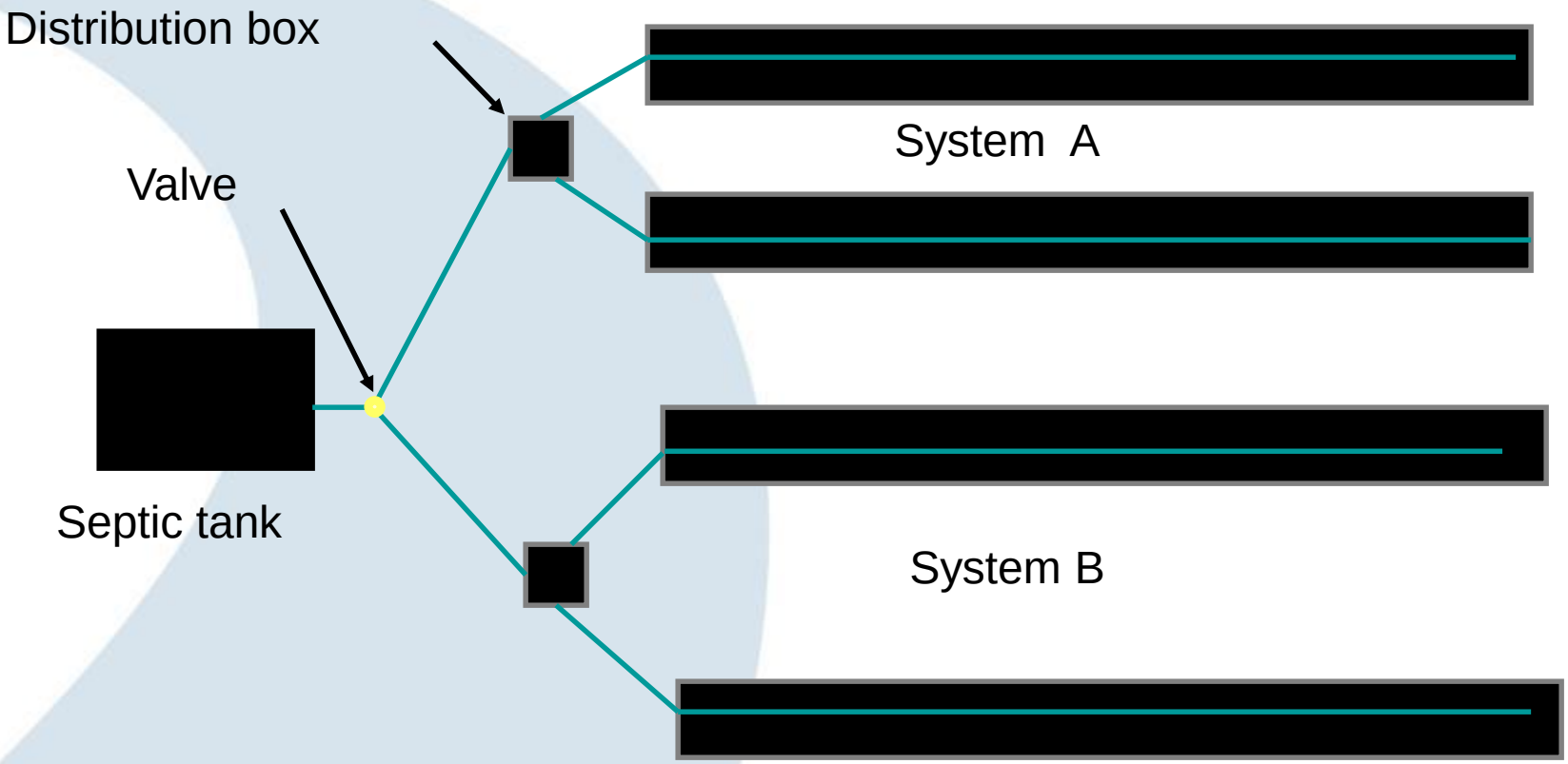


Serial distribution with pipe. Relief lines could be at ends.

Serial Distribution with Drop Boxes



Alternating Systems



Alternate between two full size systems annually using valve.

Goal: Manage Biomat by Resting

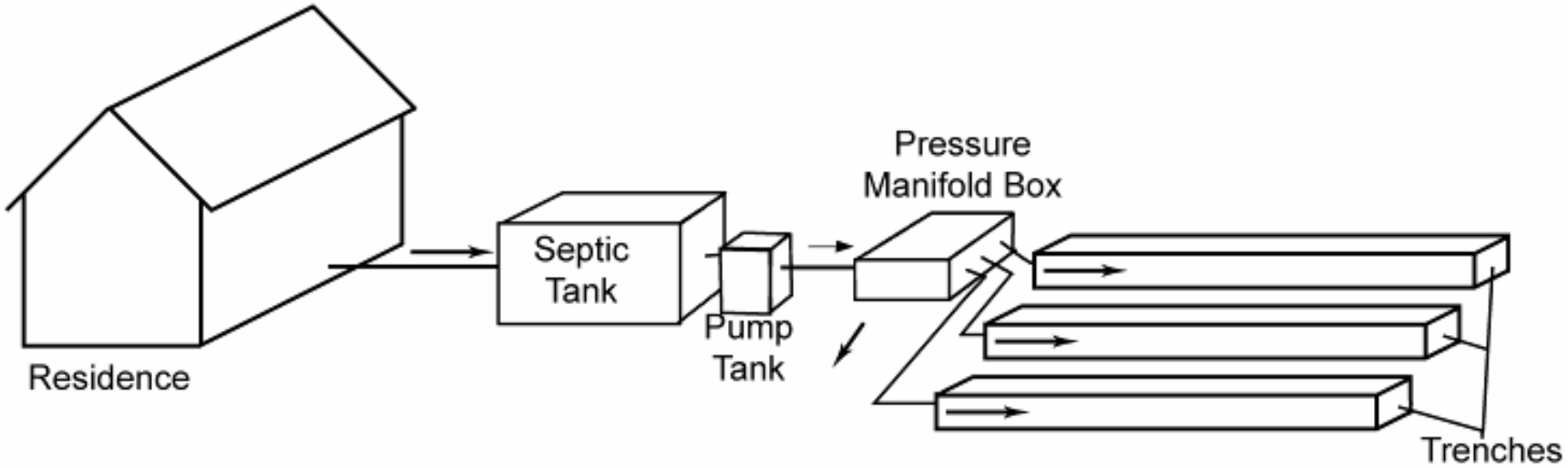
- Must be able to divert flow and rest cell
- Allows aerobic bacteria to decompose biomat
  - Improves the hydraulic conductivity
  - Takes time for aerobic bacteria to decompose biomat
- Need to be able to
  - manage the clogging mat by resting
  - divert flow from one area to another easily

Summary of Gravity Flow - Design for Management

- Design and install so system can be managed
- Design so absorption areas can be rested
- Bring all distribution and drop boxes to ground surface for ease of maintenance
- Use a method that allows for resting part of system
  - Drop boxes – all sites
  - Distribution boxes – only for level or slightly sloping sites

Dosing Options

- Method for dosing
  - Gravity to gravity
  - Pump to gravity
  - Siphon to gravity
  - Pressure



Provides equal distribution to each trench with gravity in trench

What is Pressure Distribution?

- Pressure delivery TO and **WITHIN** the soil treatment area
- Facilitates more uniform application over space and time
- Spreads small volume over large area
- Maximizes soil contact time
- Spreads along length of system

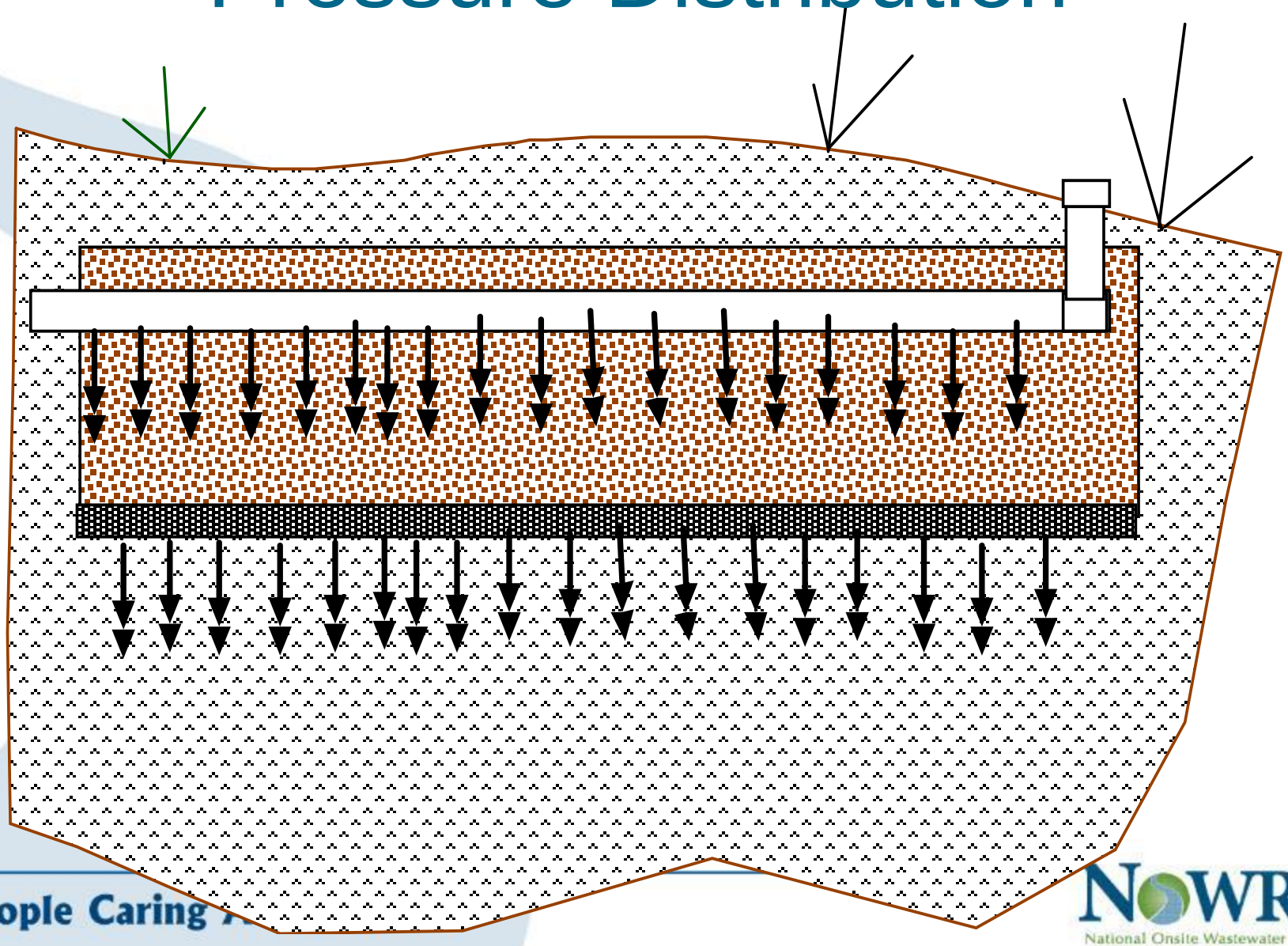
Why Use Pressure Distribution?

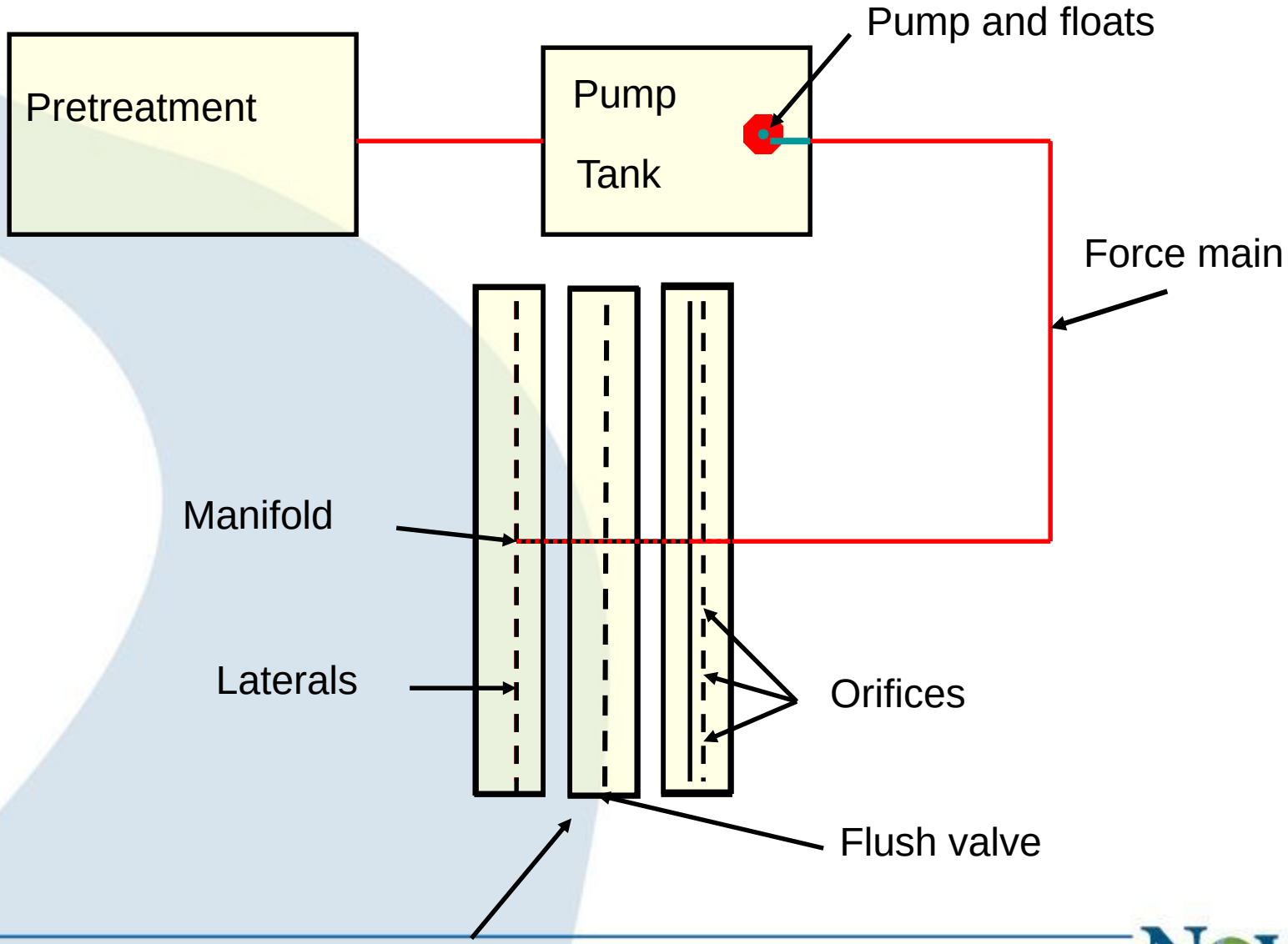
- To spread effluent out over the contour
- Above ground systems
- Sandy soils
- Low BOD Distribution / area
- Elevation differences – need to lift effluent
  - *I have a pump anyway*

Pressure Distribution

- Used in:
  - In-ground trenches
  - LPP systems
  - At-grade
  - Mounds and modified mounds
- Distribution of:
  - Septic tank effluent
  - Aerobically treated effluent

Pressure Distribution

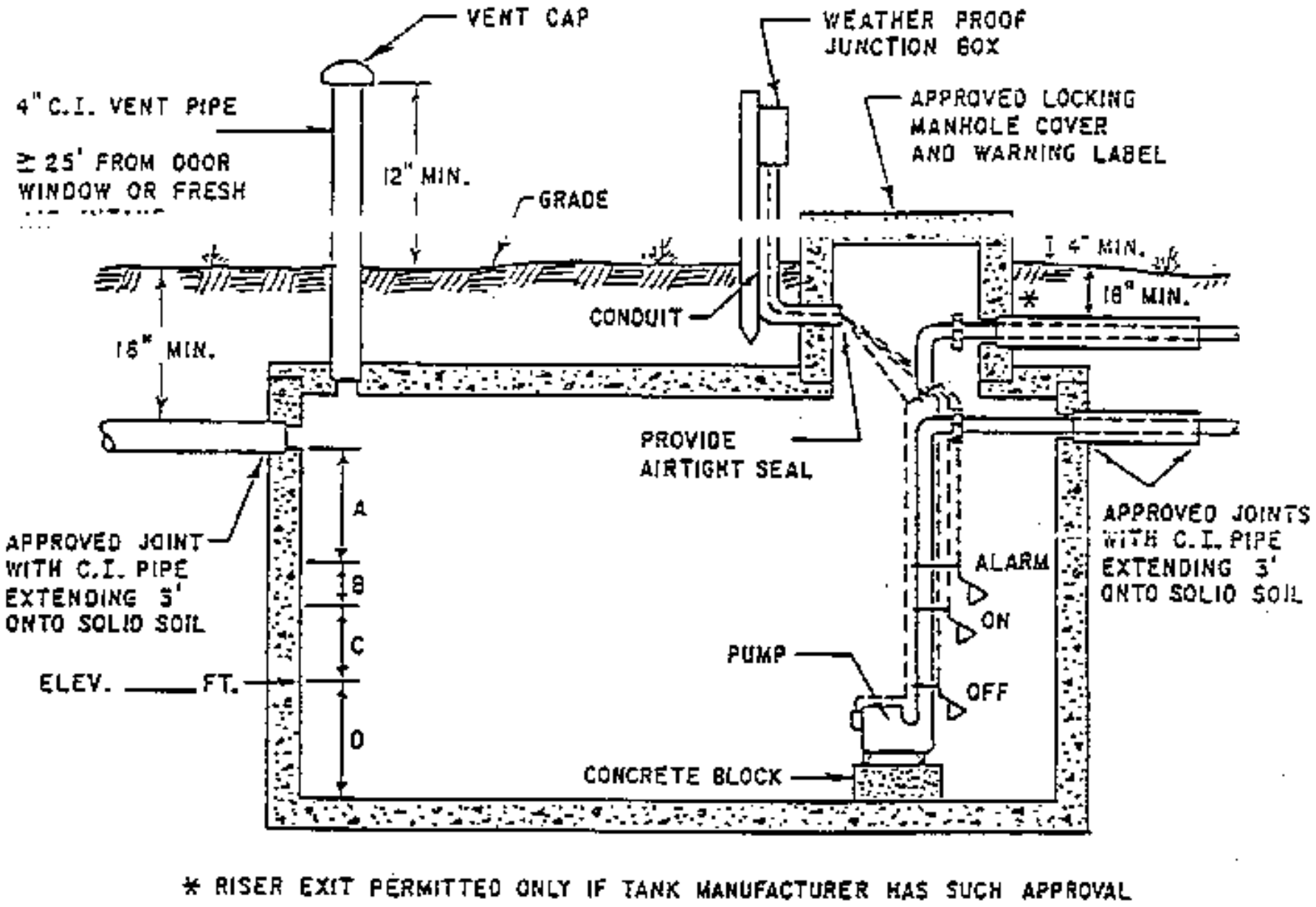



Pump and floats
Pretreatment
Pump
Tank
Force main
Manifold
Laterals
Orifices
Flush valve
Soil Treatment Unit

Dosing Chamber Sizing

- Dependent upon
  - Dose volume
  - Emergency storage
  - Pump height/pedestal
  - Pump controls
  - Regulations

Cross section of pump chamber with pump & floats



* RISER EXIT PERMITTED ONLY IF TANK MANUFACTURER HAS SUCH APPROVAL

Dosing Controls

- **Demand dosing**
  - Pump is activated when enough wastewater is available for a dose
- **Timed dosing**
  - Provides more uniform application throughout day
  - Provides better treatment
  - Maintains more aerobic conditions
  - Adds cost

Design of Distribution Network

- Must match pump performance curve with distribution network
  - Determine flow rate
  - Determine total dynamic head
- There are computer programs and manual programs that assist in design of pressure distribution

Orifice Flow Rate

Estimate the flow rate per hole
Orifice discharge equation:

$$q = 11.79 d^2 h_d^{1/2}$$

This formula was used to determine numbers in table

where:

- q = orifice flow rate (gpm)
- d = orifice diameter (in)
- h_d= distal in-line pressure (ft)

Pressure Design

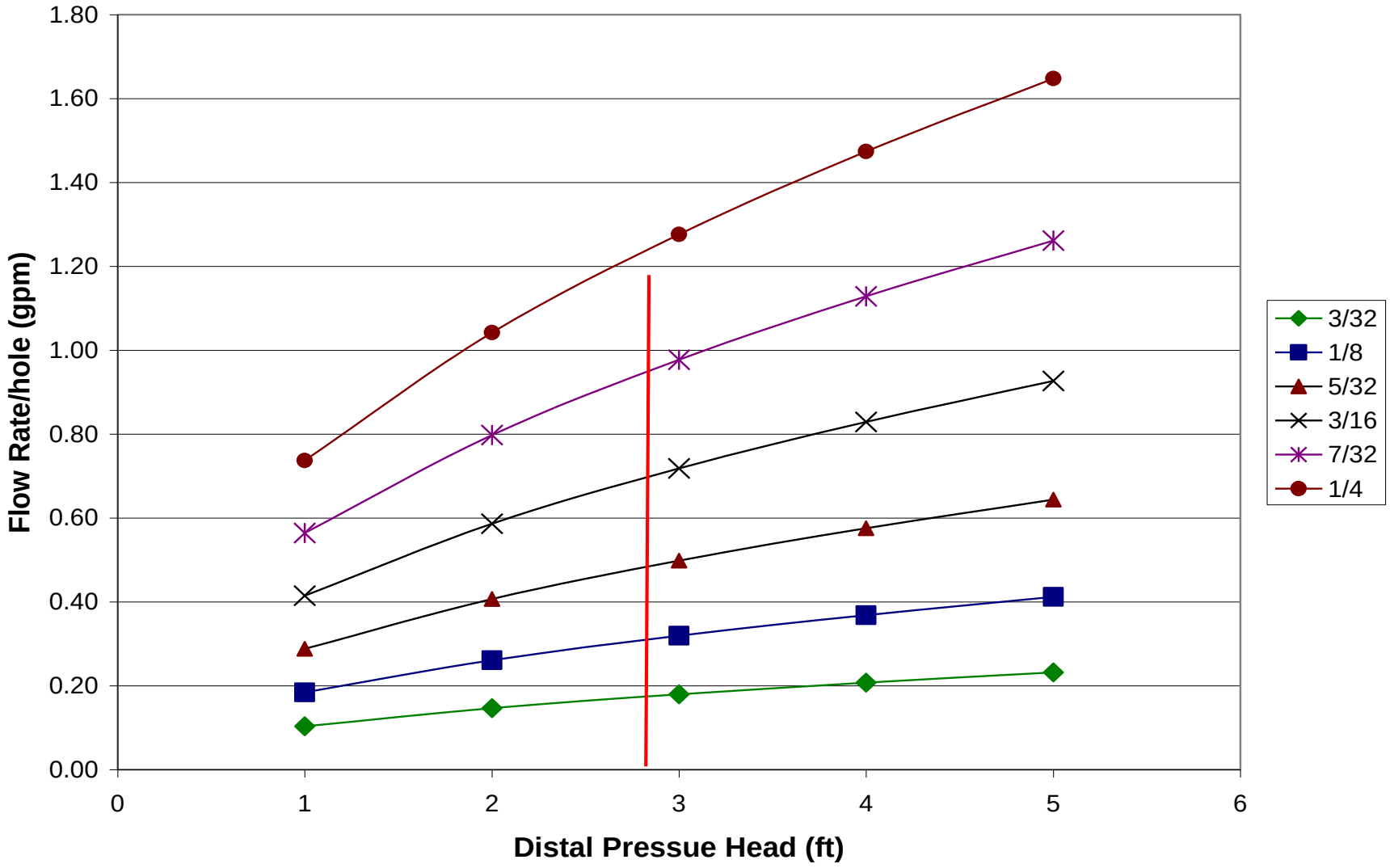
- Use number of perforations to determine required GPM
- Choose perf diameter (1/4" most common)

Perforation Discharge in GPM			
Head (feet)	Perforation diameter (inches)		
	3/16"	7/32"	1/4"
1	0.42	0.56	0.74
2	0.59	0.80	1.04
5	0.94	1.26	1.65
Distal pressure typically 2 – 5 ft of head (1-2 psi)			

Flow Rate

- What is flow rate for the following network?
  - 50 orifices at ¼" diameter with 2.5 ft of head.
  - Go to chart or table and pick off number?
  - 1.2 gpm/orifice x 50 orifices = 60 gpm pump flow

Estimate Dosing Flow Rate



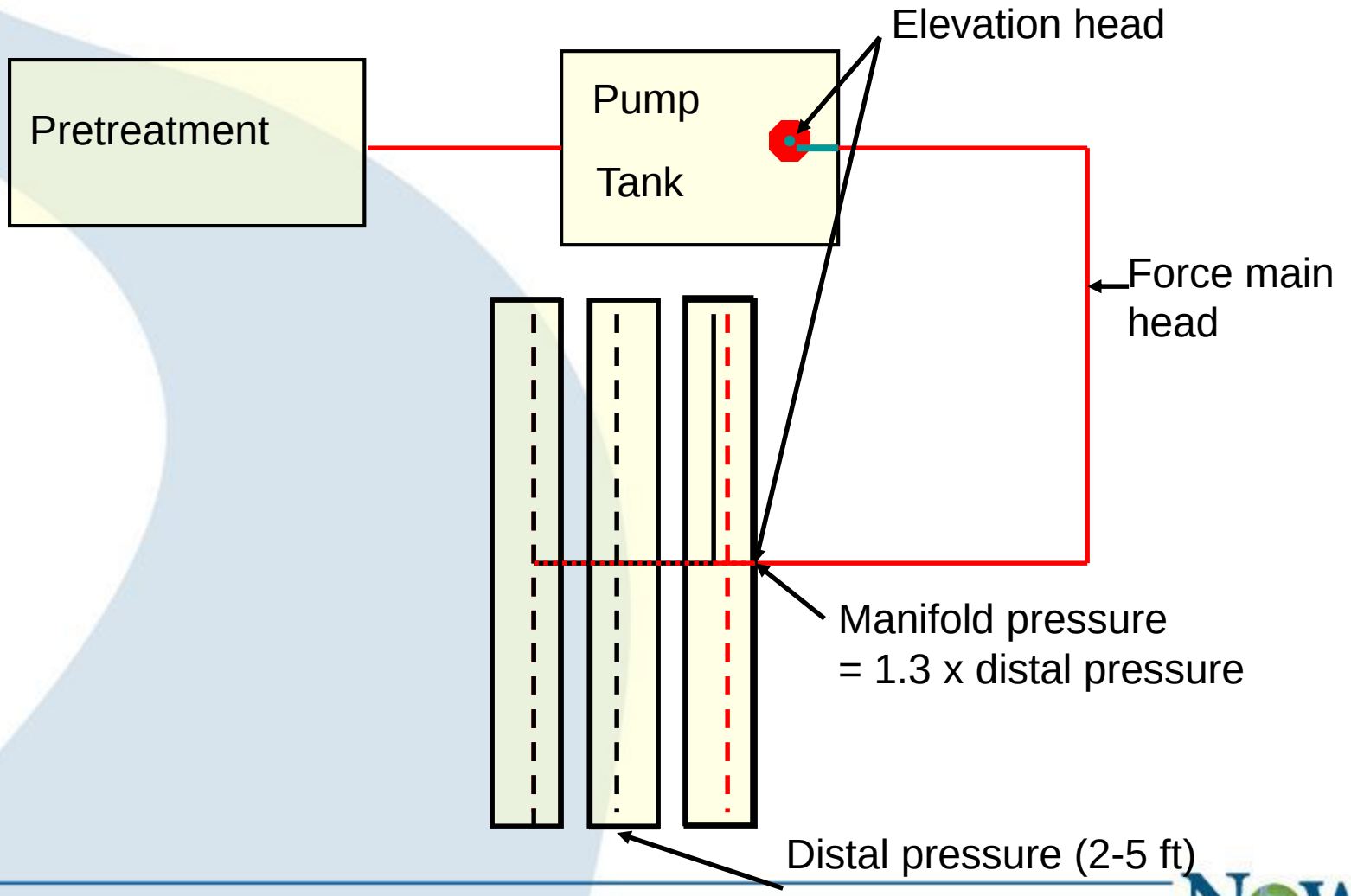
LPP Flow Dangers

- Compare typical system with 70 orifices and 4’ of operating head or squirt
- 5/32” holes = 41.5 GPM
- 3/16” holes = 60.2 GPM

Distribution Network Design

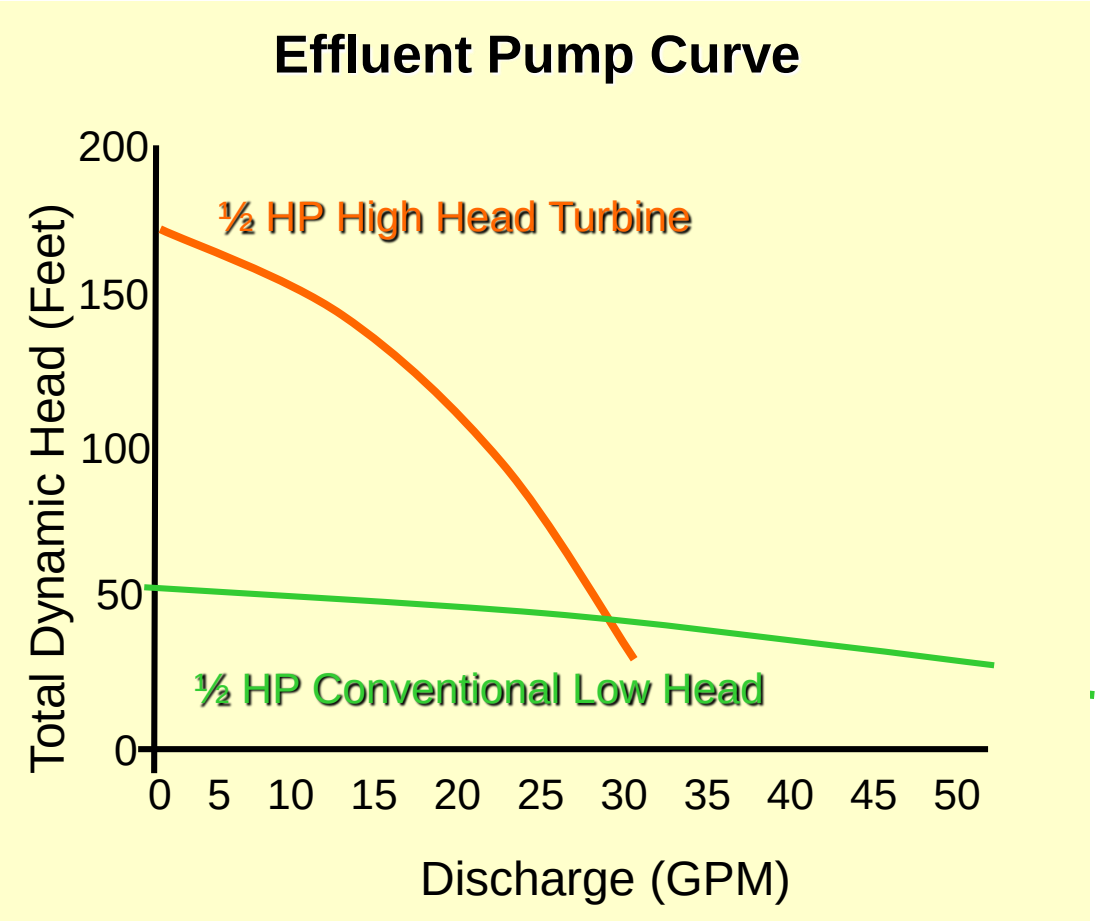
- Determine total dynamic head
  - Network pressure –
  - Force main head loss
  - Elevation difference -

Total Dynamic Head – Level Site

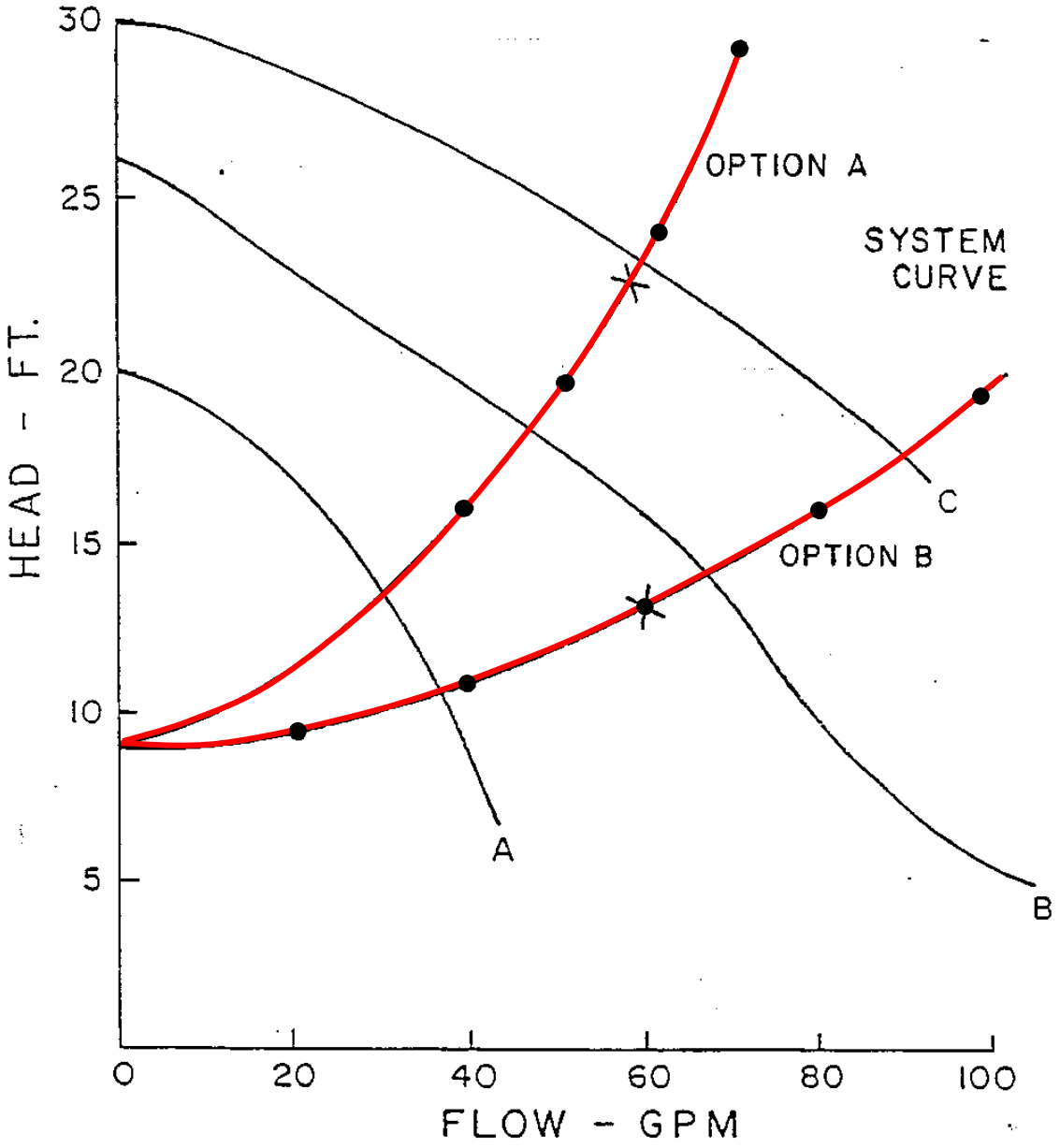


Pump Selection

- A pump operates on its performance curve
  - Flow rate
  - Head



Two System Performance and Three Pump Performance Curves

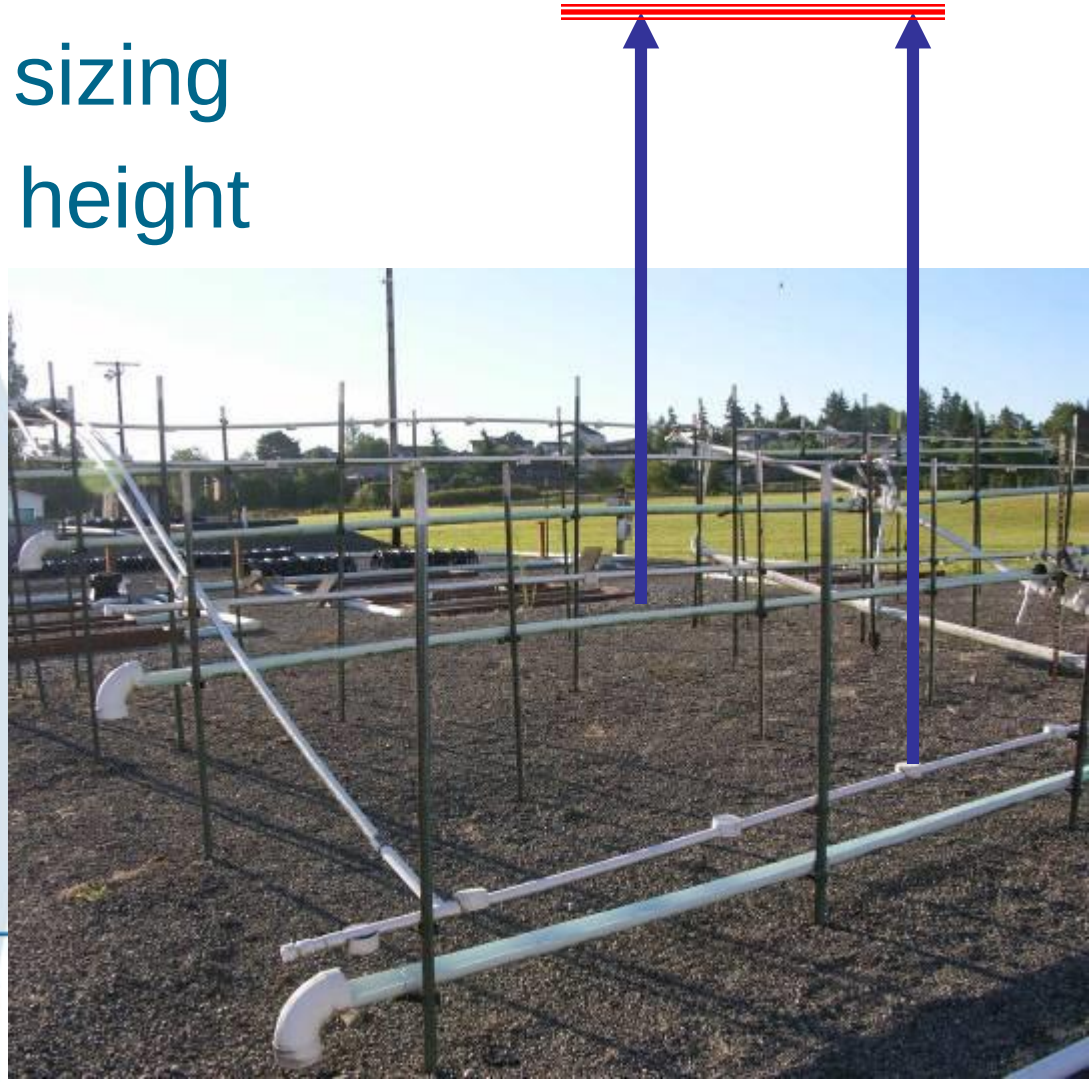


Construction

- Drill orifices with sharp bit
  - Best to drill holes in shop on drill press
- Make them perpendicular with lateral
- Remove burrs
- Remove filings
- Consider using orifice shields
- Place orifices up or down
  - Freezing considerations
- Place laterals level

Design Modifications

- Orifice spacing and sizing
- Sprays to the same height
- Lower laterals
  - Higher pressure
  - Smaller holes
  - Larger spacing



Using Valves

- Balancing the pressure
  - Most popular approach

Types of Lateral End Clean-outs

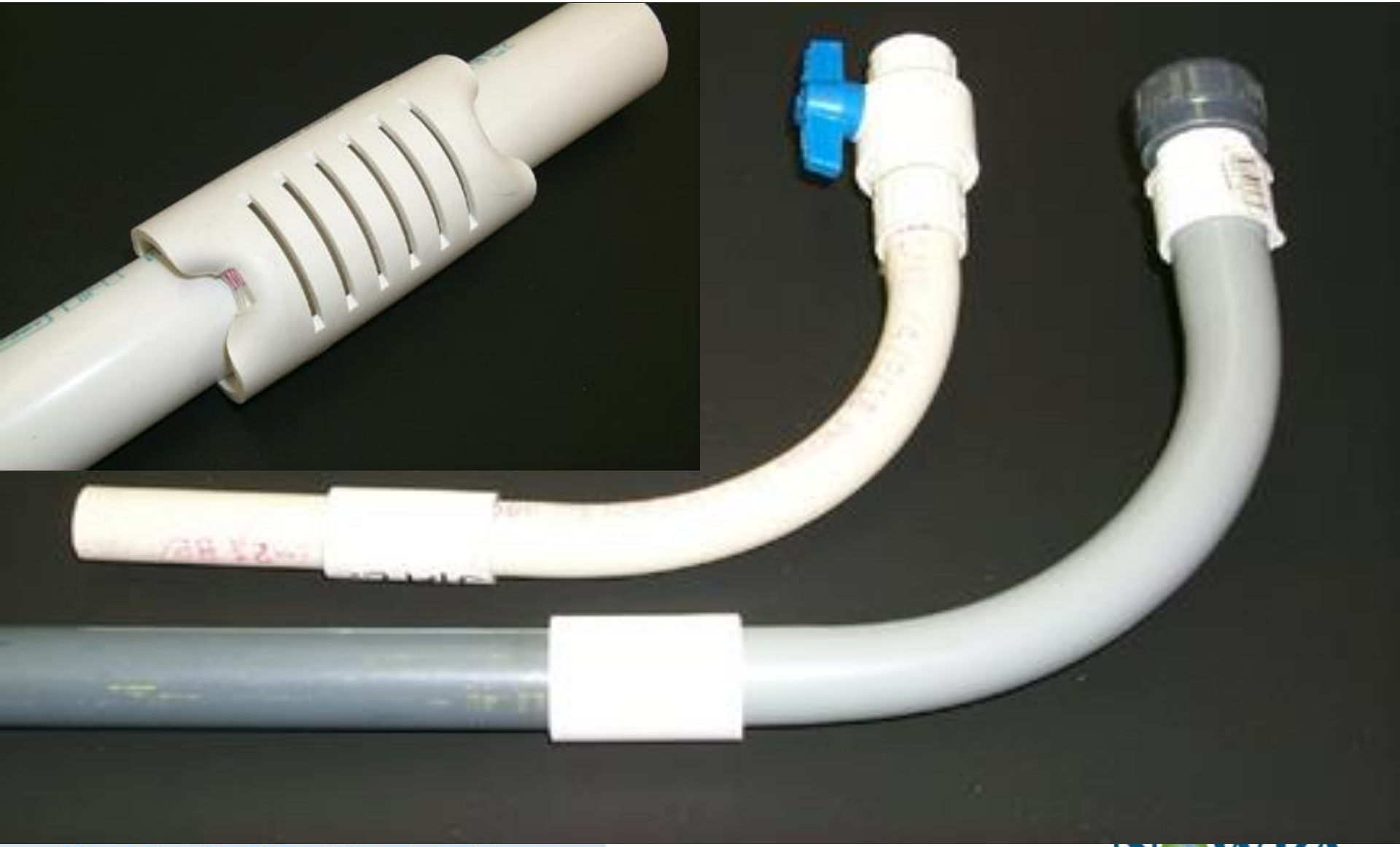
- Straight ends
  - Threaded caps
  - Ball valves
- Sweep 90-degree elbows (electrical sweeps are pressure rated)
- 45-degree elbows

Optional Lateral/Flushing Valve Connections

Sweep 2 - 45°

Lateral Turn-Up Showing Gravelless Option – Sleeved Line Shown at Rear

Orifice Shields and Turn Ups



Flush the lines with turn ups. Orifice shields protect the orifices.

Flush laterals
and measure
pressure annually

ut Water

Valve Boxes

Turn ups for flushing are in the valve boxes.
Pipes are observation/inspection ports

Drip Distribution Principles

- A method to distribute wastewater
  - Shallowly, in root zone
  - Over a large area as uniformly as possible
- Similar to drip irrigation for plants but need to disperse effluent all the time.
- Most uniform method of distribution

Drip Emitters in Action

Emitters – range of
0.5 to 1 gph/emitter

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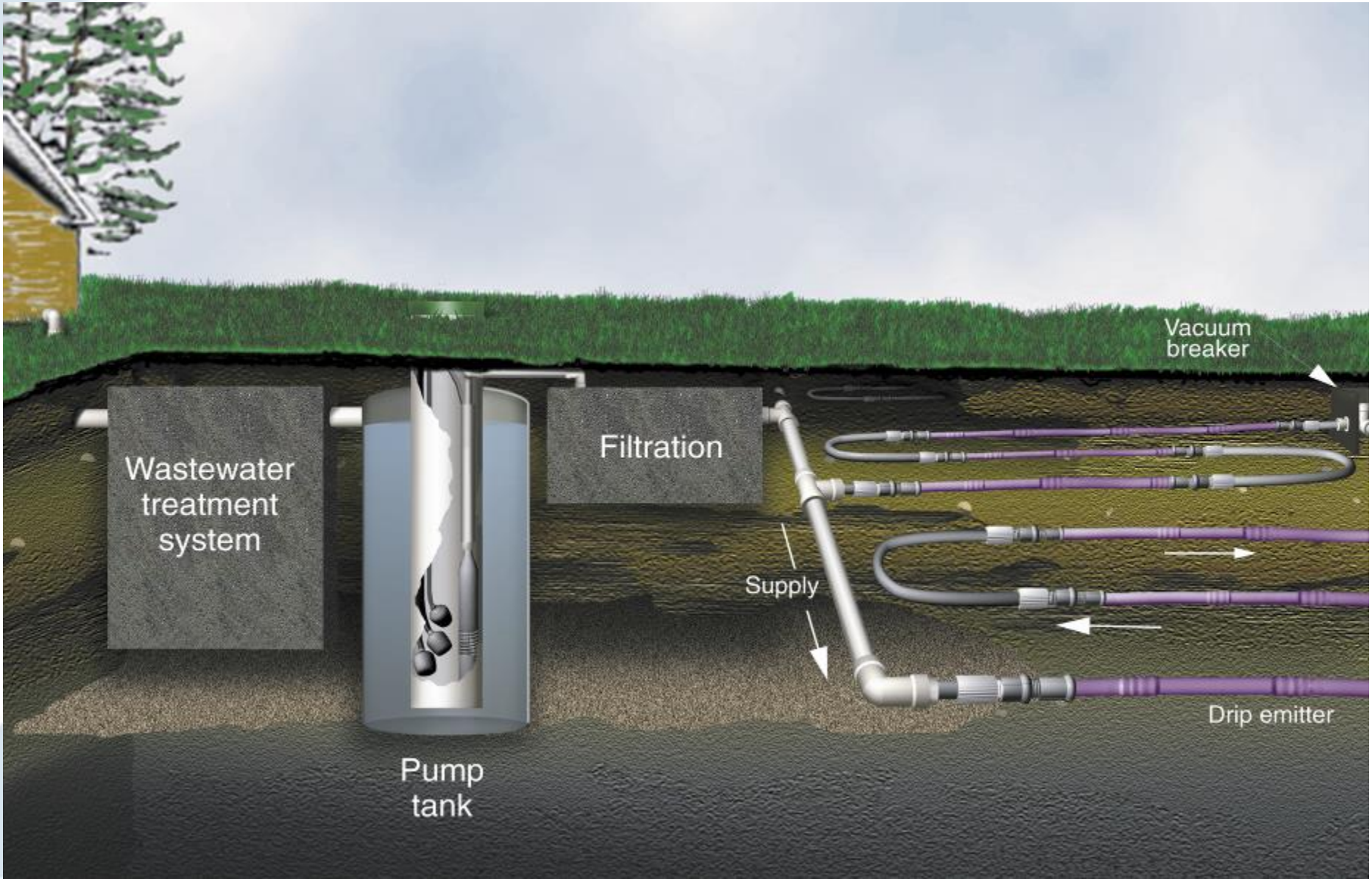
Components of Drip Distribution

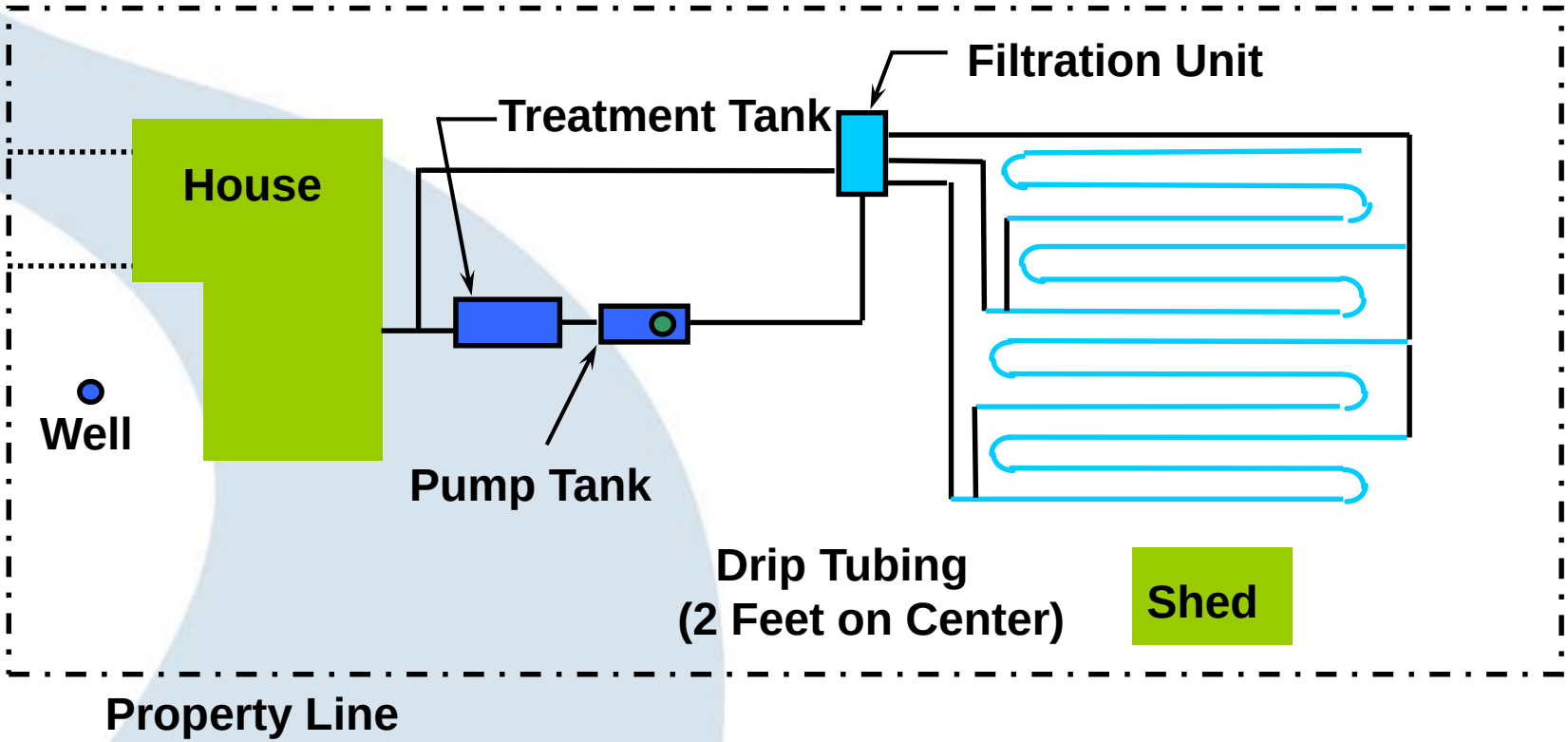
- Source
- Treatment
  - Aerobic
  - Septic effluent
- Control Panel
- Pump chamber/Pump
- Filters
  - Disk filters
  - Vortex filters

- Dispersal unit
  - Supply & return lines
  - Supply & return manifolds
  - Drip lines
  - Emitters
    - Pressure compensating
    - Non-pressure compensating
  - Air relief valve

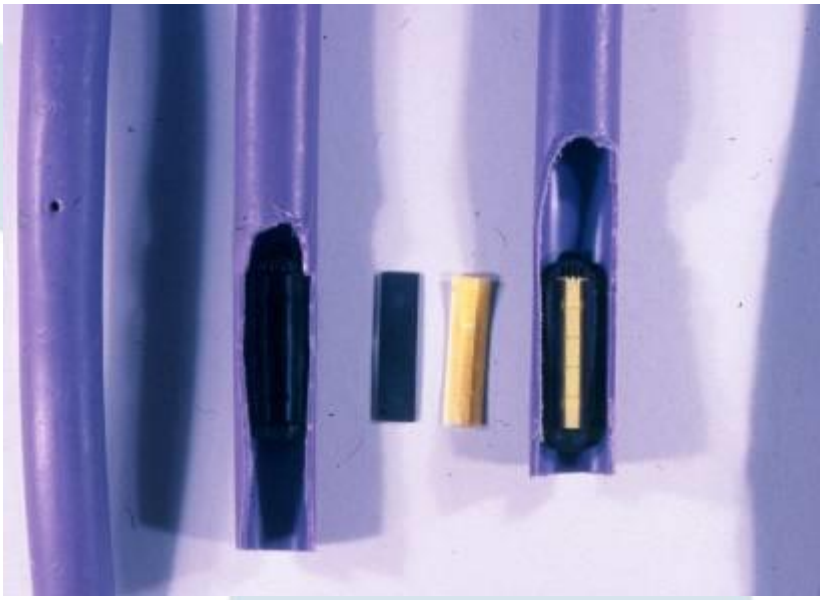
Drip Distribution System



Drip Dispersal with Two Zones



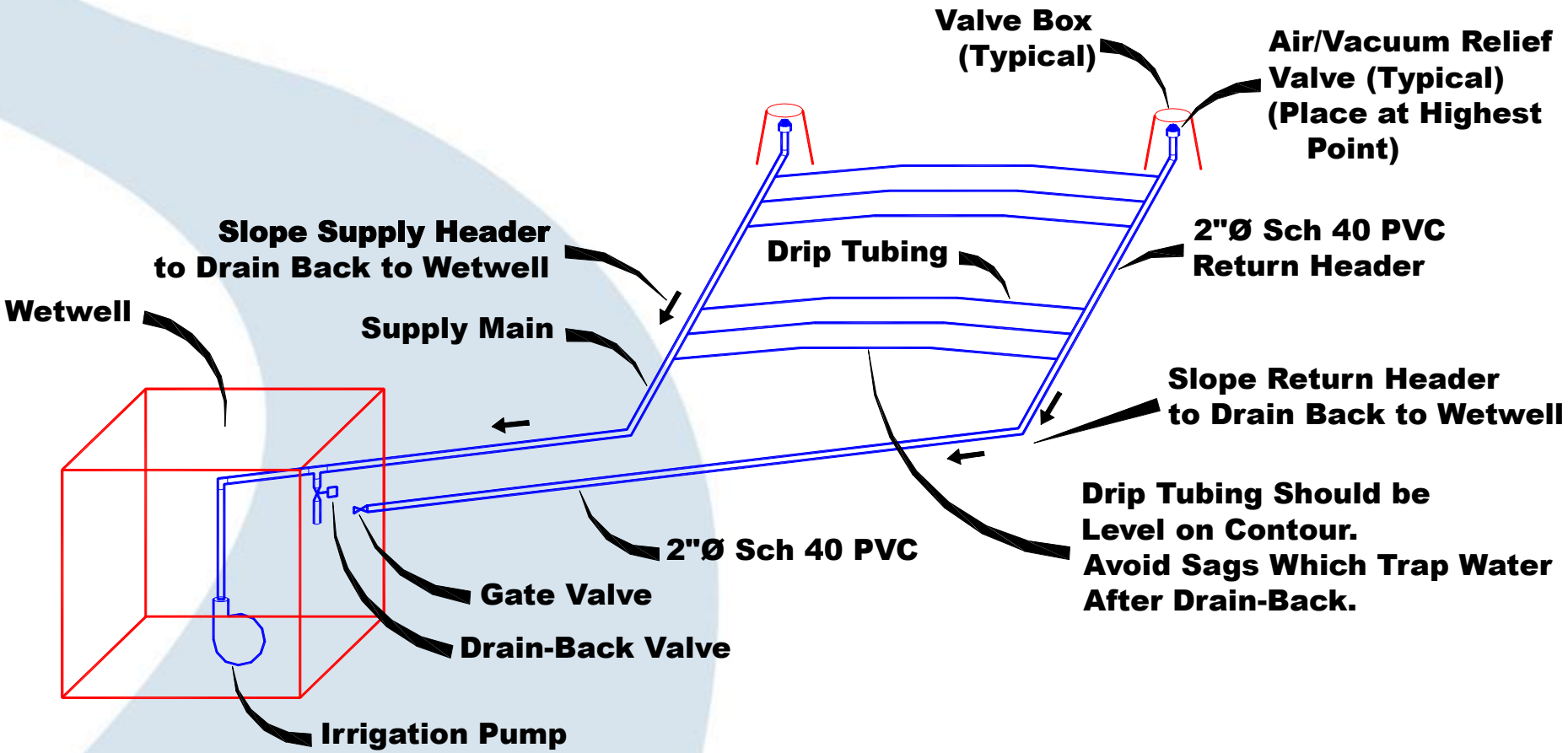
Zones must be flushed and filters must be backflushed for all drip units.



Two Types of Emitters:

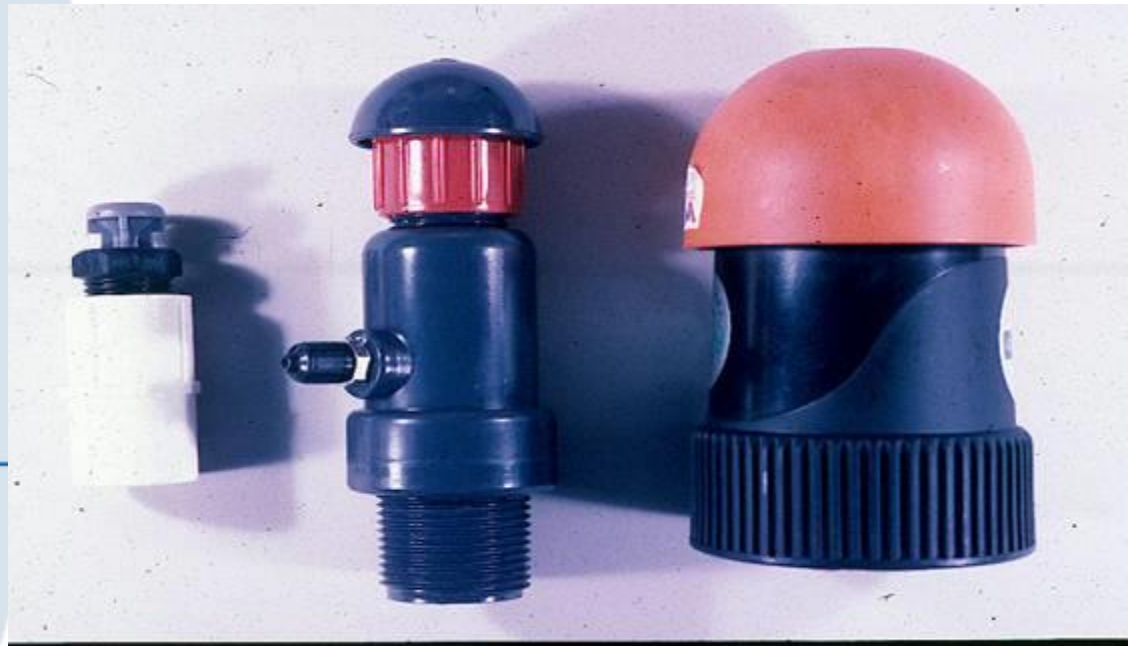
- Non-Pressure Compensating
- Pressure Compensating

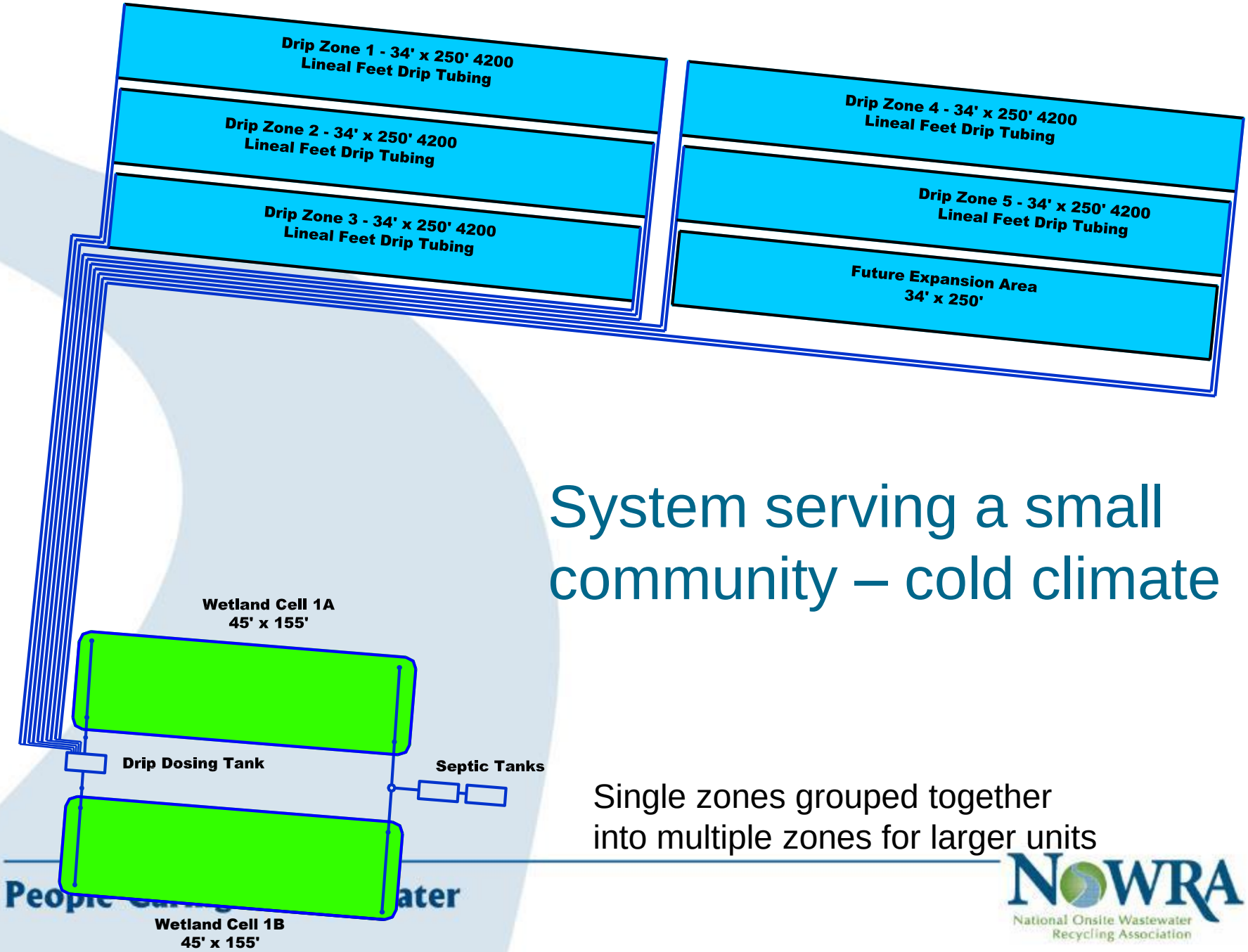
System Using Side Manifolds



Vacuum Release/Air Relief

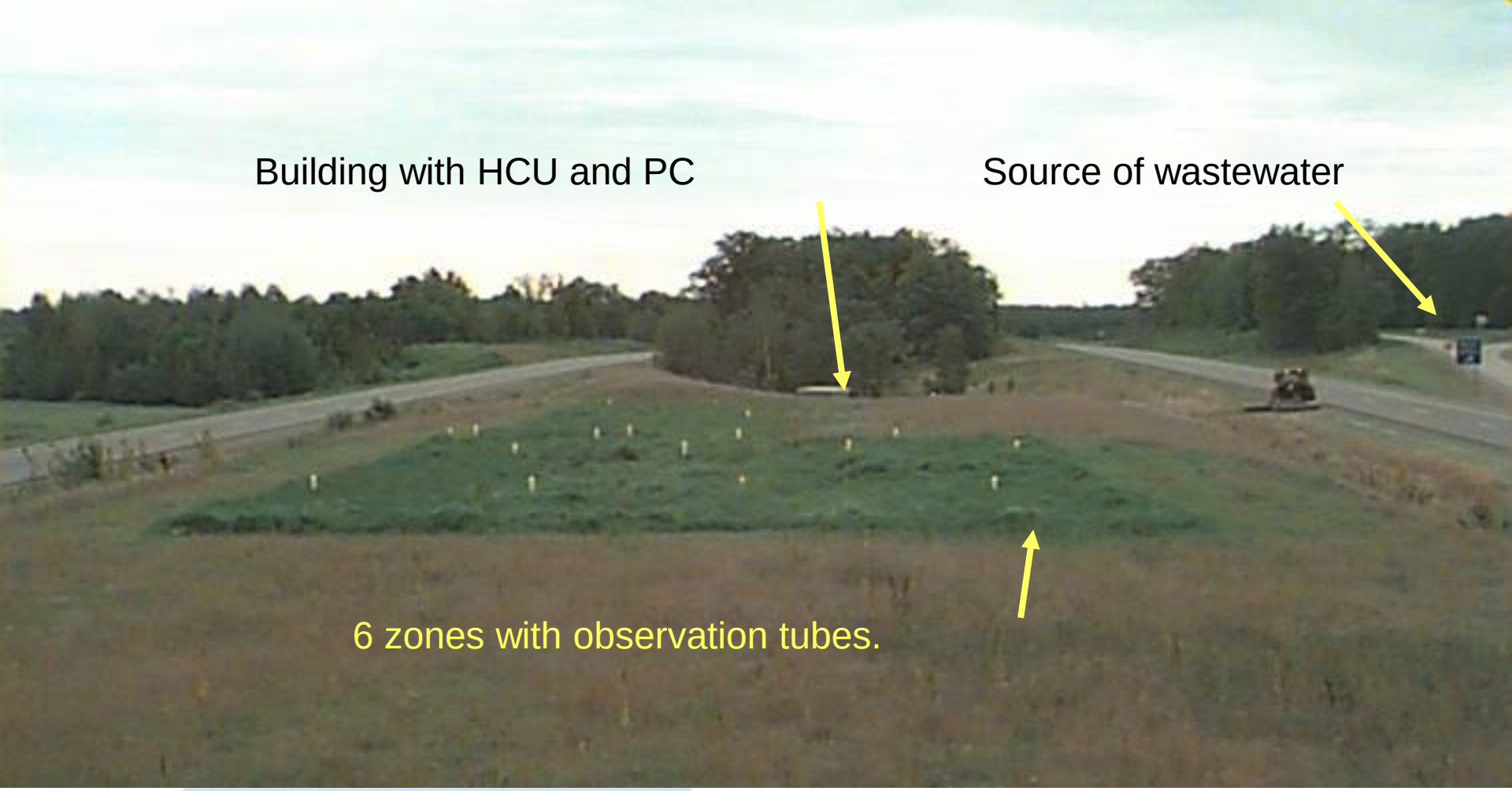
- Reduces sucking of soil particles into emitters
- Reduces vacuum on system when water moves around after dose cycle
- Located at high point in system- Manifold





System serving a small community – cold climate

Single zones grouped together into multiple zones for larger units



6-zone drip unit serves a rest stop. Septic tank effluent is pumped from across the road to a pump chamber (PC) with hydraulic control unit (HCU) in building. Effluent is dosed to the zones alternately.

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QUESTIONS ?