A to Z
Gravity & Pressure Distribution
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April 5 & 6, 2016
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.

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Basic Gravity System Components

Source

Septic tank with or without effluent screen

Drop or Distribution Box

Drainfield

Soil

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National Onsite Wastewater Recycling Association
Flow Pattern in a Gravity Trench

- Biomat Growth ($t = 0 = \text{start}$)
Flow Pattern in a Gravity Trench

- Biomat Growth ($t = \text{growth}$)
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
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:
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.

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

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Flow splitter device. Two equal flows.

1 part out

4 parts in

1 part out

Sharp edge splits the flow.

1 part out

1 part out

1 part out

Three units together split into 1/4ths

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NOWRA
National Onsite Wastewater Recycling Association
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 solids
- 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
Alternate between two full size systems annually using valve.

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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
Dosing Chamber Sizing

• Dependent upon
  – Dose volume
  – Emergency storage
  – Pump height/pedestal
  – Pump controls
  – Regulations
Cross section of pump chamber with pump & floats

Vent Cap

Weather Proof Junction Box

Approved Locking Manhole Cover and Warning Label

4" C.I. Vent Pipe

≥ 25' from door window or fresh air intake

Grade

Conduit

Provide Airtight Seal

Approved Joint with C.I. Pipe extending 3' onto solid soil

Elev. __ FT.

Concrete Block

* 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 the 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:

\[ q = 11.79d^2 h_d^{1/2} \]

where:

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

This formula was used to determine numbers in table.
Pressure Design

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

<table>
<thead>
<tr>
<th>Head (feet)</th>
<th>Perforation diameter (inches)</th>
<th>3/16&quot;</th>
<th>7/32&quot;</th>
<th>1/4&quot;</th>
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<tr>
<td>1</td>
<td>0.42</td>
<td>0.56</td>
<td>0.74</td>
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</tr>
<tr>
<td>2</td>
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<td>0.80</td>
<td>1.04</td>
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<tr>
<td>5</td>
<td>0.94</td>
<td>1.26</td>
<td>1.65</td>
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</tr>
</tbody>
</table>

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

Distal Pressure Head (ft)
Flow Rate/hole (gpm)

- 3/32
- 1/8
- 5/32
- 3/16
- 7/32
- 1/4

Flow Rate/hole (gpm) vs Distal Pressure Head (ft) graph
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 -
Manifold pressure = 1.3 \times \text{distal pressure}

Elevation head

Force main head

Distal pressure (2-5 ft)

Pretreatment

Pump Tank

Total Dynamic Head – Level Site
Pump Selection

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

### Effluent Pump Curve

- **½ HP High Head Turbine**
- **½ HP Conventional Low Head**

<table>
<thead>
<tr>
<th>Discharge (GPM)</th>
<th>Total Dynamic Head (Feet)</th>
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<tbody>
<tr>
<td>0</td>
<td>200</td>
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<tr>
<td>5</td>
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</tr>
<tr>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

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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

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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

Wrong 90
Orifice Shields and Turn Ups

Flush the lines with turn ups. Orifice shields protect the orifices.
Flush laterals and measure pressure annually.
Valve Boxes

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

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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
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

Wastewater treatment system

Filtration

Supply

Pump tank

Drip emitter

Vacuum breaker
Zones must be flushed and filters must be backflushed for all drip units.
Pressure Compensating

Non-pressure compensating
System Using Side Manifolds

- **Slope Supply Header to Drain Back to Wetwell**
- **Supply Main**
- **2"Ø Sch 40 PVC**
- **Gate Valve**
- **Drain-Back Valve**
- **Irrigation Pump**
- **Valve Box (Typical)** (Place at Highest Point)
- **Air/Vacuum Relief Valve (Typical)**
- **2"Ø Sch 40 PVC Return Header**
- **Drip Tubing**
- **Slope Return Header to Drain Back to Wetwell**
- **Drip Tubing Should be Level on Contour. Avoid Sags Which Trap Water After Drain-Back.**

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[Logo: National Onsite Wastewater Recycling Association]
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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