Prevention of Fat, Oil, and Grease (FOG) Buildup in an Explosion-proof Pump Station Environment through Consistent Dosage of a Plant-based Formulation by Means of a Pump-less Liquid Dispensing System

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THE CITY OF LOWELL
THERE'S A LOT TO *like*

Protein Matrix

The First Problem: Fats, Oils, Grease (FOG)

- Clogs
- Overflows (SSO)
- Maintenance
  - Inefficiency
  - Wasted hours

How do we deal with FOG?

Time-consuming cleanouts

Dangerous chemicals

Ineffective bacteria and enzymes

FOG Problems Solved

- Food service establishments
- Collection systems
- Pump stations
- Pipes (jetting)
- In-plant "trouble spots"

Protein Matrix

What is Protein Matrix?

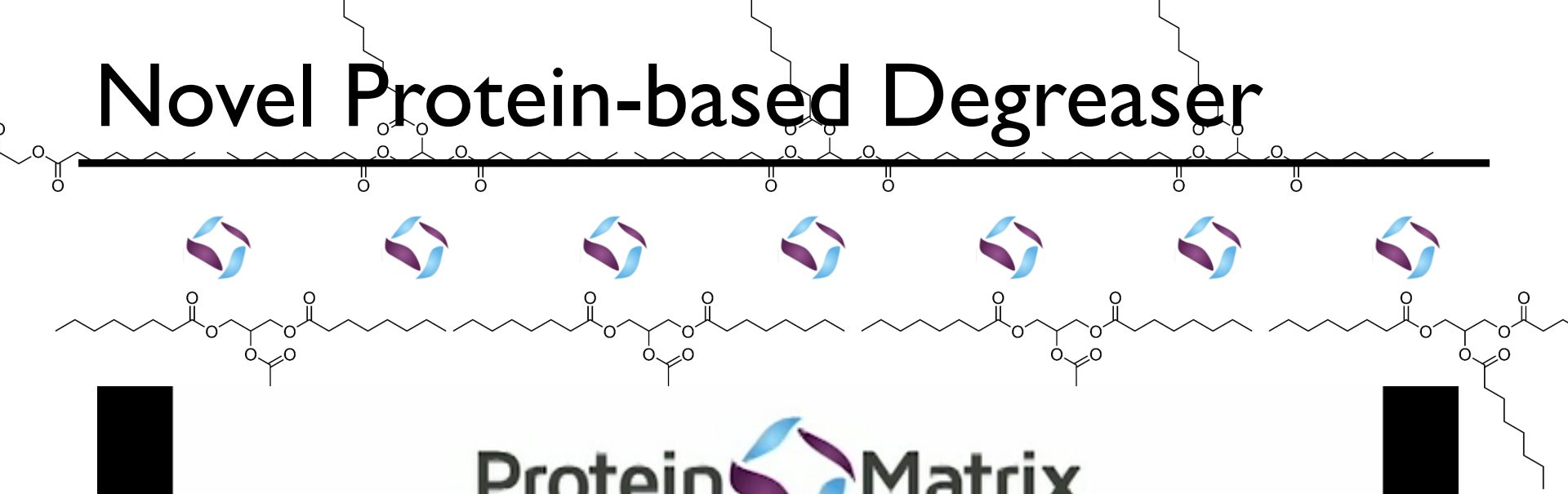
- No bacteria, no enzymes, no detergents

- A mixture of proteins and polypeptides extracted from plants
  - water-based
  - non-toxic
  - non-volatile
  - non-flammable
  - biodegradable
  - NSF/ANSI 60 Certified

What does Protein Matrix do?

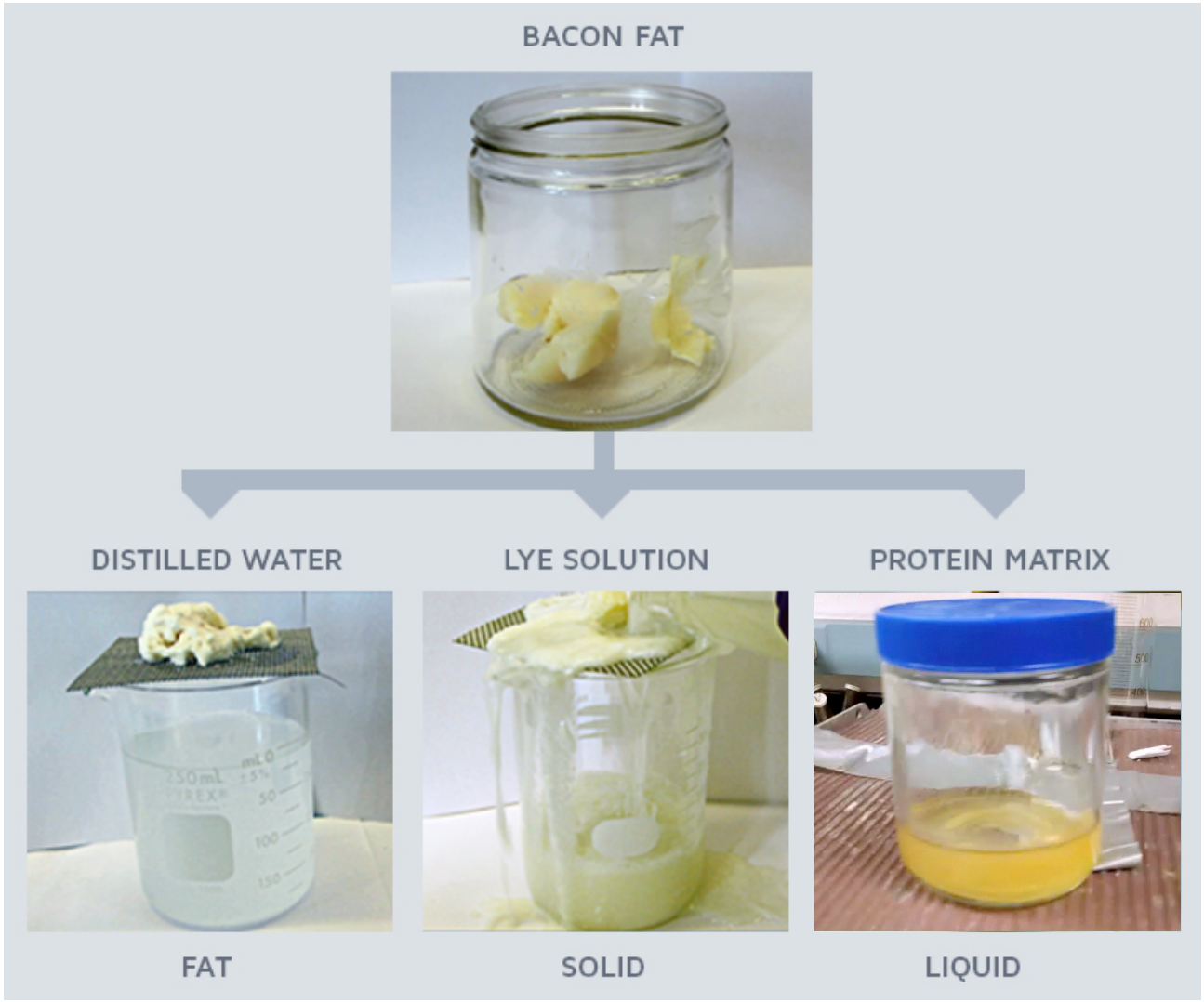
- Prevents FOG buildup in pipes, interceptors, and lift stations
- Reduces FOG-related cleaning and maintenance
- Does not harm downstream plant processes

Novel Protein-based Degreaser



Protein Matrix

Byproduct does not re-solidify

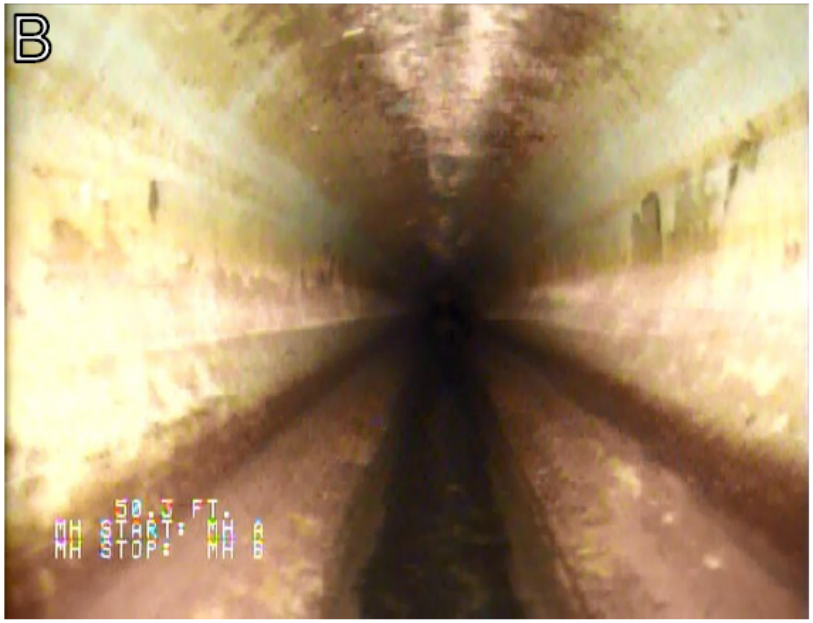


Protein Matrix Usage

Normal grease buildup	Protein Matrix
	

- Proactive vs. Reactive
- Protein Matrix dosed at ppm levels into wastewater systems to prevent buildup

No buildup downstream

Before (grease buildup)	**After** (four months of Protein Matrix treatment)
	

Keep Lift Stations Clean

Protein Matrix

www.proteinmatrix.com

Keep Lift Stations Clean

One week of buildup	Two months of Protein Matrix
	

The Second Problem - Dosing

- Protein Matrix dosed at ppm levels into wastewater systems to prevent buildup
- FSE's can use interval dosing pump, WWT uses continuous duty pumps
  - Peristaltic
  - Extremely low-flow (<2 mL/min)
- Remote locations
  - Unpowered
  - Unsecured
- NEMA 7-10 rated environments
  - i.e. "explosion proof"

Appleton Mills

- $64 Million Renovation of Appleton Mills Complex in Lowell, MA into 130 Apartments and Work Spaces

Appleton Mills

- Adjacent to UMass - Lowell Innovation Hub

Appleton Mills

- Central collection station in courtyard; unsecured

Appleton Mills

- Grease buildup along with rags, canvases
- Monthy or Bi-Monthly vacuum truck pumpouts required

Appleton Mills

- Explosion Risk; Confined Space

The Competition

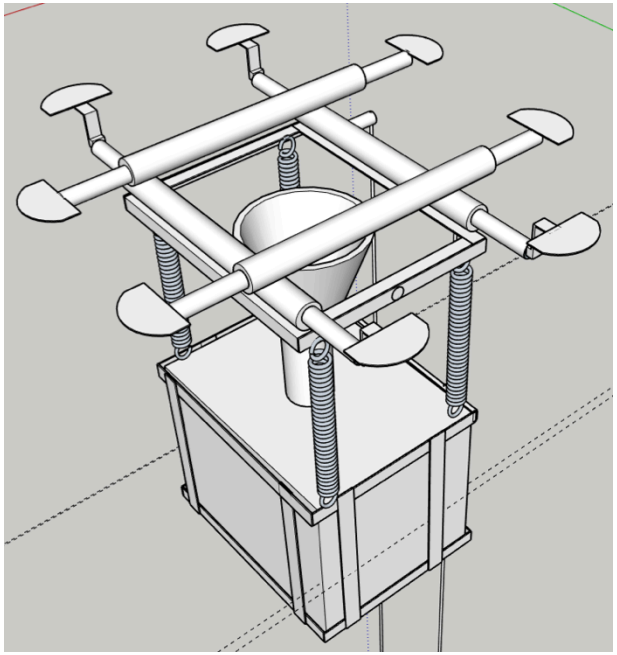
- Explosion Proof Dosing Pumps
  - Require proper electrical installation (NEMA) or battery
  - Batteries require replacement
  - Pump requires mounting
  - Chemical requires placement; mounting

- Confined space entry for chemical/battery replacement
- Removal of pump during maintenance
- Peristaltic Tube maintenance and monitoring
- Security and safety; environmental exposure
- High capital cost

The Protein Matrix D.R.I.P.™ System

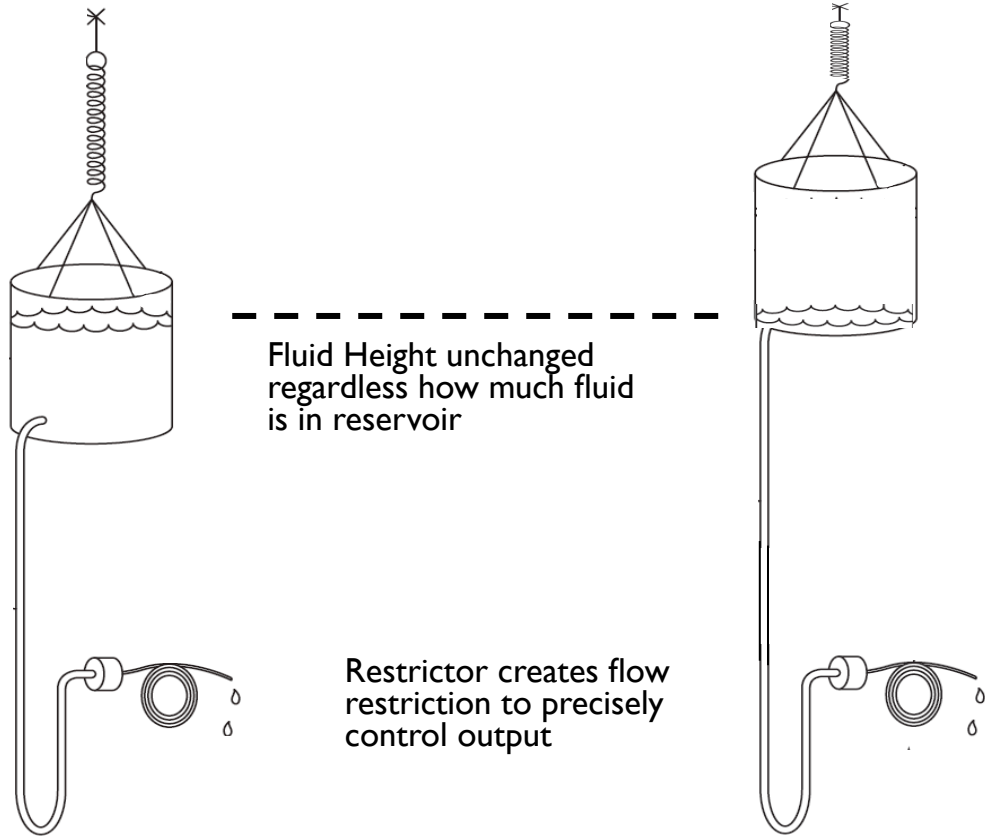
- **D**evice for **R**egular **I**ntroduction of **P**roduct

- No batteries, no motors, no power
- Device *and* chemical container both mounted within manhole
  - Custom mount created for Appleton Mills by Lowell WWT
- Uninterrupted product delivery
- Corrosion resistant construction



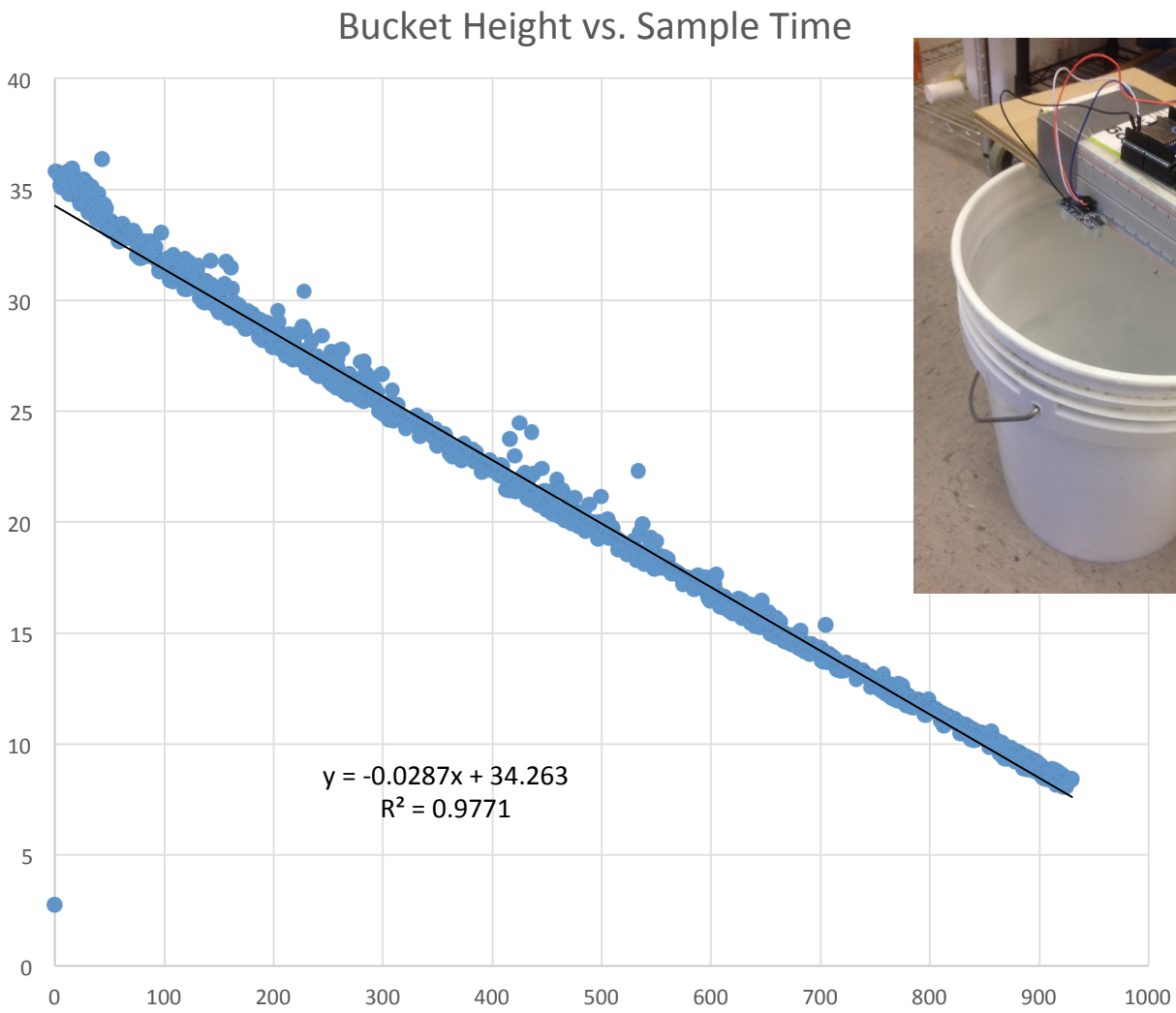
- ***Approximately 60% less expensive than an explosion-proof, battery-powered dosing pump ($5k vs. $2k)***

How the D.R.I.P.™ System works



- Two key functional parts:
  - Springs
  - Restrictor

Early System Data



How the D.R.I.P.™ System works

Spring Theory

$$dm/dz = df/dx$$

m = mass of the fluid
z = height of the reservoir
f = force of the spring
x = length (extension) of spring

Restrictor Theory

$$H_P + Z_1 - Z_2 + \frac{P_1 - P_2}{S} + \frac{V_1^2 - V_2^2}{2g} = h_f + h_m \quad \text{where:}$$

$$h_m = K_m \frac{V^2}{2g} \qquad \mathrm{Re} = \frac{VD}{\nu} \qquad Q = VA \qquad A = \frac{\pi}{4} D^2$$

$$\text{Darcy–Weisbach Equation: } h_f = f \frac{L}{D} \frac{V^2}{2g} \quad \text{where:}$$

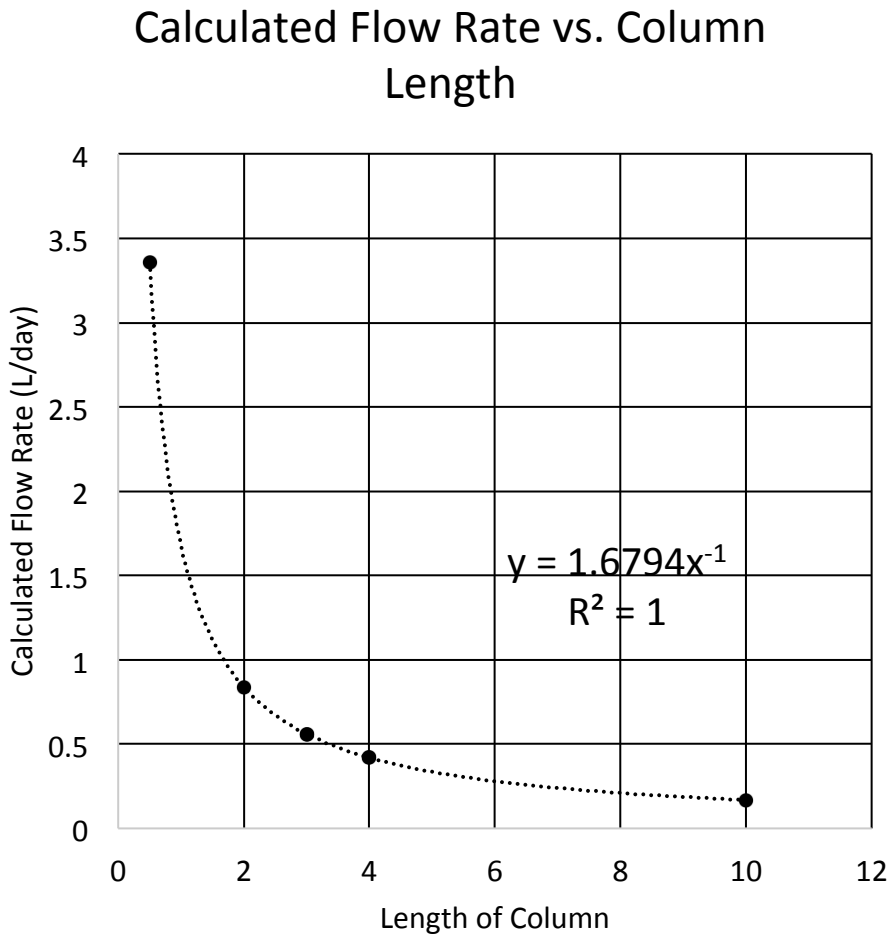
$$\text{If laminar flow } \left(\mathrm{Re} < 4000 \text{ and any } \frac{e}{D}\right), \quad f = \frac{64}{\mathrm{Re}}$$

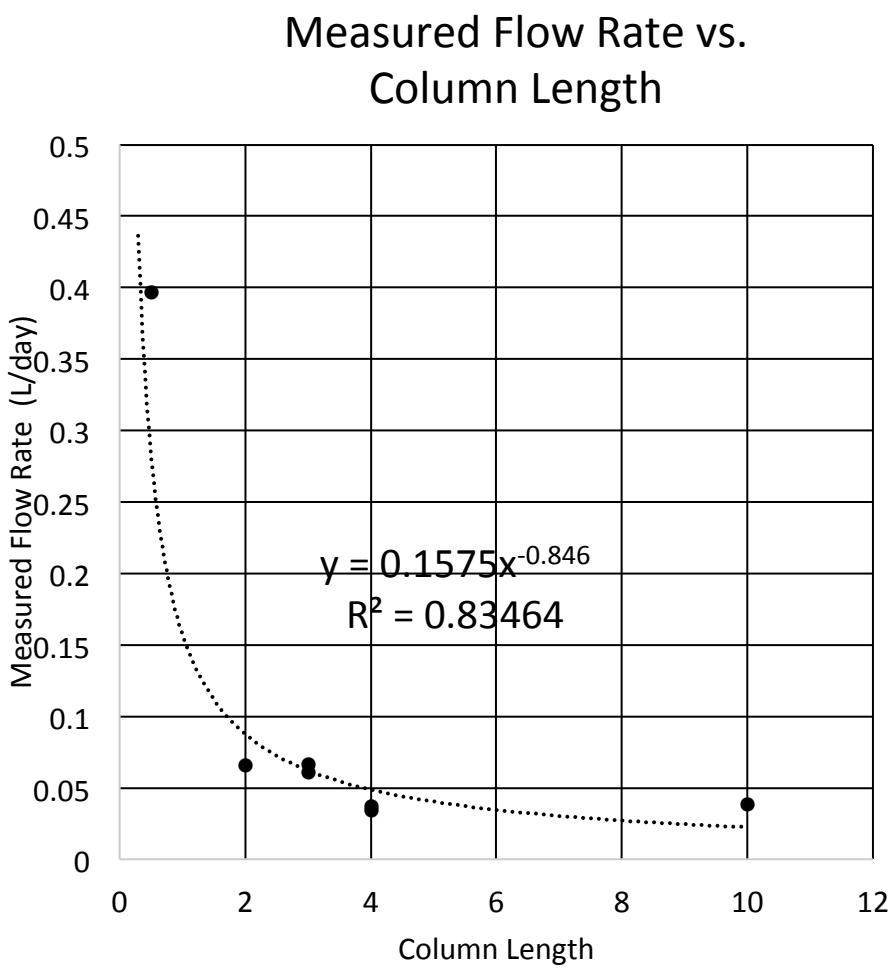
A = Pipe cross-sectional area, ft^2 or m^2.
D = Pipe diameter, ft or m.
Driving Head (DH) = left side of the first equation (or right side of the equation), ft or m. This is not total dynamic head.
e = Pipe surface roughness, ft or m. Select from the drop-down menu in our calculation. Additional values.
f = Moody friction factor, unit-less. Do not confuse the Moody f with the Fanning friction factor. $f = 4 f_{Fanning}$.
g = acceleration due to gravity = 32.174 ft/s^2 = 9.8066 m/s^2.
h_f = Major (friction) losses, ft or m.

- Theory ≠ Collection Systems!

ProteinMatrix

Calculated vs. Measured





“Real Life”

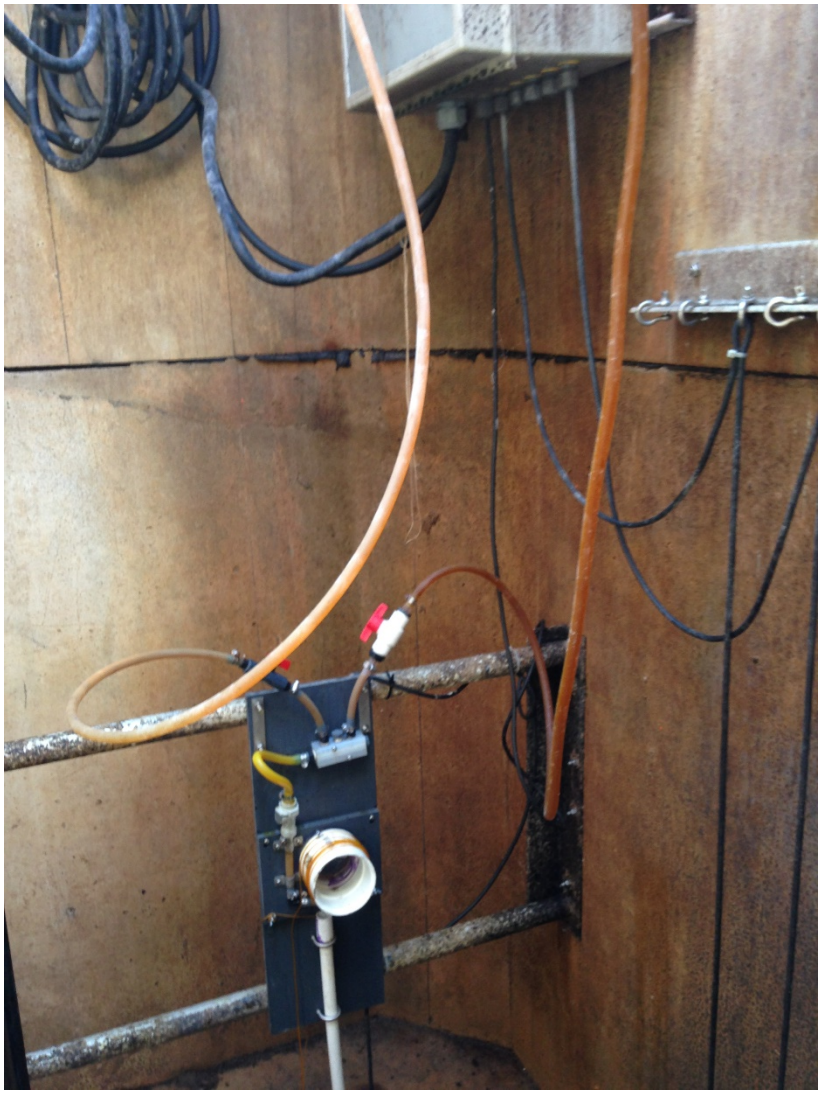
Protein Matrix

Prototype Lessons Learned

- Springs
  - Custom made, stainless steel, precise *k* rating
  - Easy but secure connect/disconnect
- Restrictor
  - Valves, pinches, packed columns cause clogs
  - Tubing needs to be extremely thin, yet durable
    - Flexelene 1/32”
  - Curvature matters
    - Standardized shape of restrictor
- Plumbing
  - “hot swap”

Field Implementation

Field Implementation

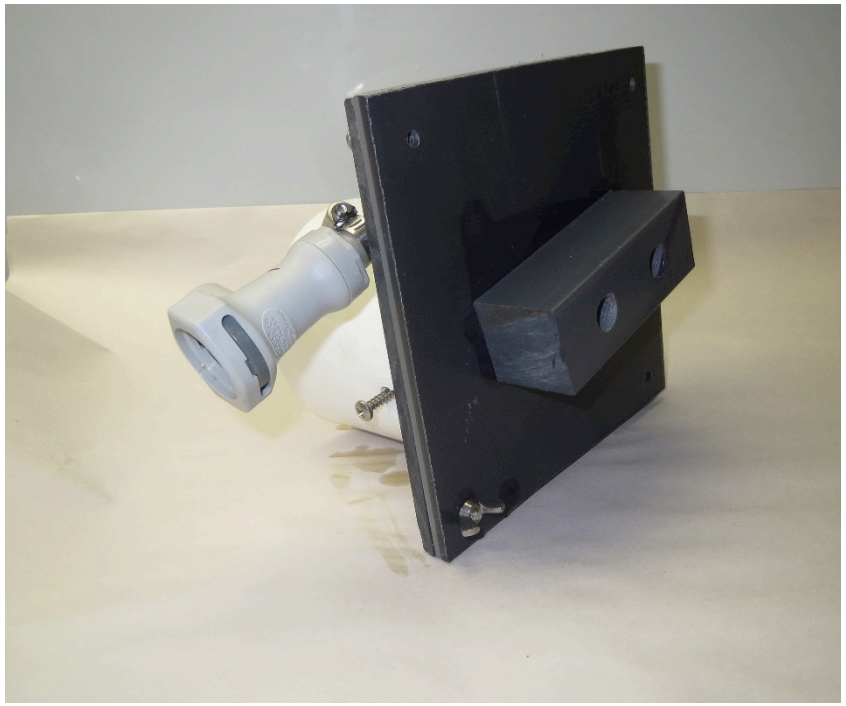


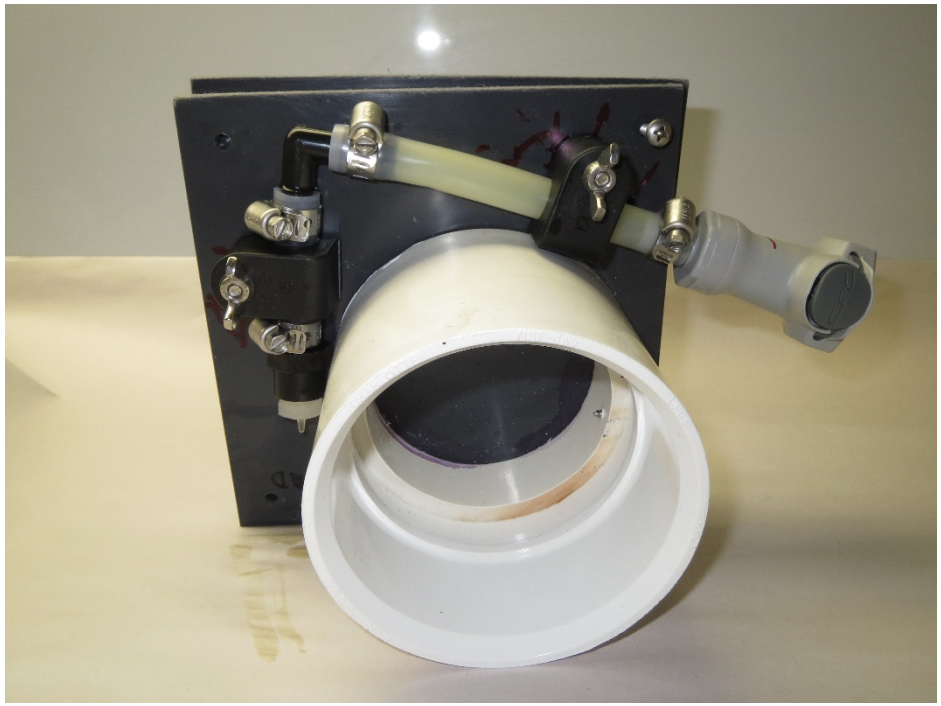
Field Implementation

Field Implemented Lessons Learned

- Delivery near input stream
  - Circulator Pump
  - Clogging/Splash

Field Implemented Lessons Learned





- "Hot swap"

Field Implemented Lessons Learned

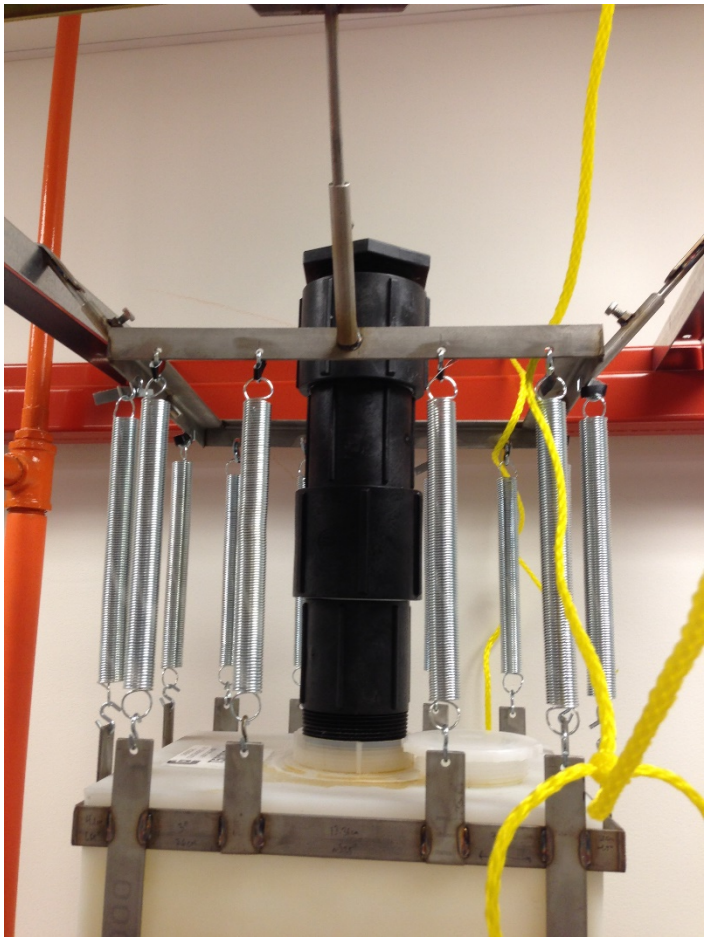
ACCESSIBILITY

- Railing
- Valves
- "Clothesline"

Field Implemented Lessons Learned

- Temperature
  - Insulate in winter, summertime flow increases

Field Implemented Lessons Learned

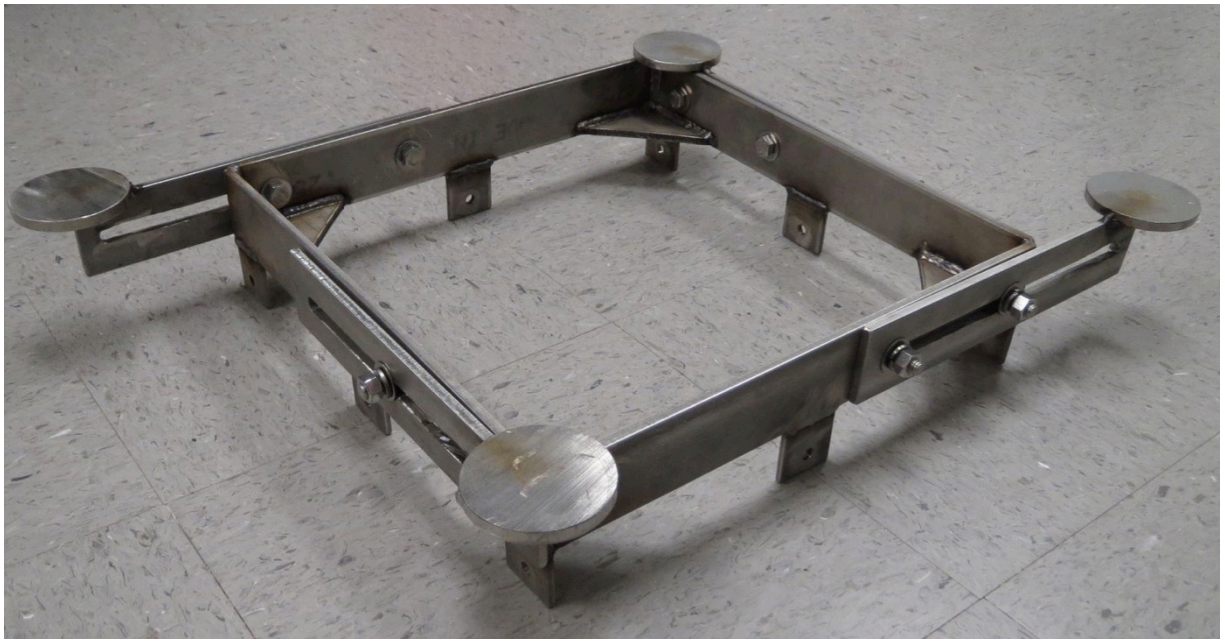


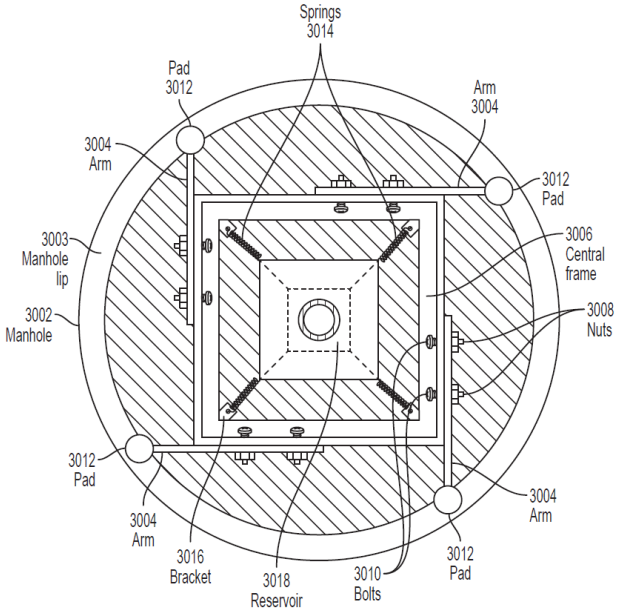
- Funnel for refilling

Field Implemented Lessons Learned

- Dried material
- Maintenance tools
  - Syringe fitting
- Restrictor Barb is "pinch point"
  - Use 1/16" barb with flexible tubing
- "Snorkel"

Manhole D.R.I.P.™ System





- Heavy Duty stainless steel frame
- Fits manholes 18-28” in diameter
- Feed pads only add ¼” of height

Manhole D.R.I.P.™ System

- 12 gal polypropylene tank and fittings
  - Decreases refill frequency
- Pre-plumbed
  - Snorkel, restrictor, manifold, valves
  - Tripod for installation helpful
- Multiple pre-calibrated flow tubes
  - Protein Matrix products

Protein Matrix

Appleton Mills D.R.I.P.™ System - Results

Before (1 month of buildup)

After (6 weeks)

Appleton Mills D.R.I.P.™ System - Results

- No pumpouts required
- No downstream negative effects observed
- Refills every 10 – 14 days
- Scum pit testing in progress at main plant

After (18 months!)