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& Exhibit

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NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

Understanding Sewer Slope Transitions – Reduces Odor/Corrosion Impacts!

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Wastewater Historical Perspective

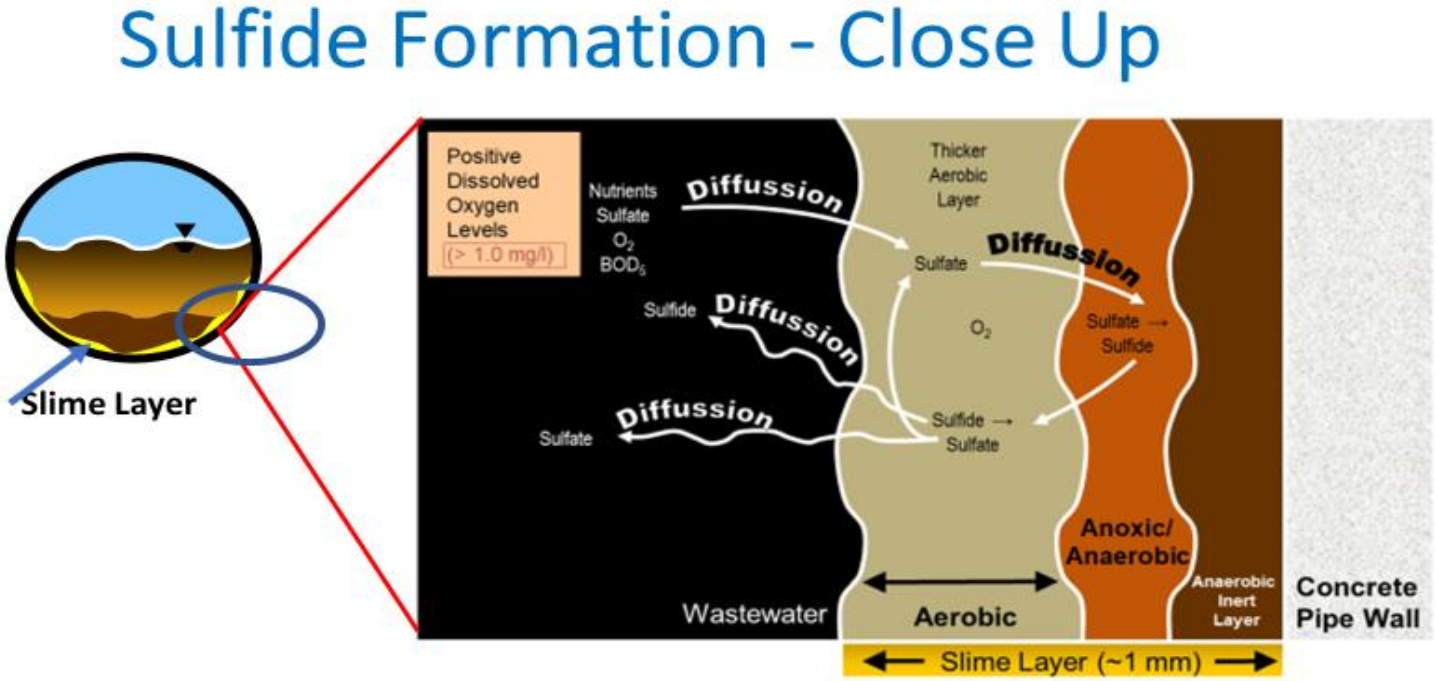
- **Focus on WWTPs/WRRFs**
  - Complaints accused
  - Visible
  - Community: Smell with their eyes
- **Collection System (CS)**
  - OOS/OOM
  - Not well understood
  - Largely ignored

Wastewater Historical Perspective

- **CS Design Intent**
  - Transport community ww
  - Long term
- **Poor Understanding:**
  - Supported odor formation
  - Created corrosive conditions
- **Trouble Underground!?**

Reality Kicks In!

- **Asset Management**
  - Inspections revealed issues
- **Odor formation documented**
- **Supporting conditions understood**
- **Impacts are REAL:**
  - Nuisance odors
  - Community Complaints
  - System corrosion
  - Infrastructure compromised!



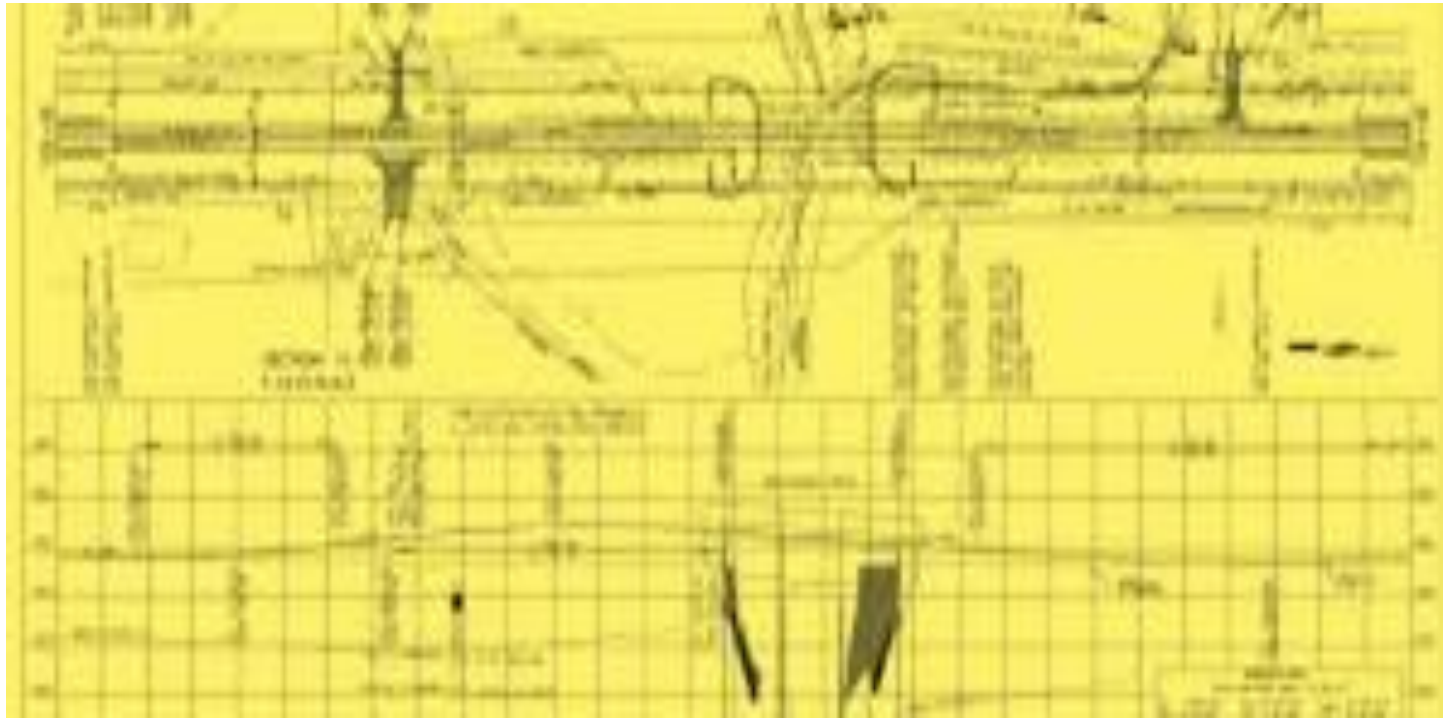
Solutions

- Identify Hot Spots
- Housekeeping Steps
- Protect Surfaces
- Add Chemical
- Extract & Treat

All steps designed to mitigate odors and corrosion!

Historical Sewer Design

- Sewer Designs
  - Connect **A** with **B**
  - Follow grades/streets
  - Insert LS/PS where needed
  - Install siphons when can't go over or around
- Did Engineers anticipate
  - Design impacts
- How Physical layouts:
  - Can exacerbate
    - Odor Formation
    - Odor Stripping
    - Release to Atmosphere

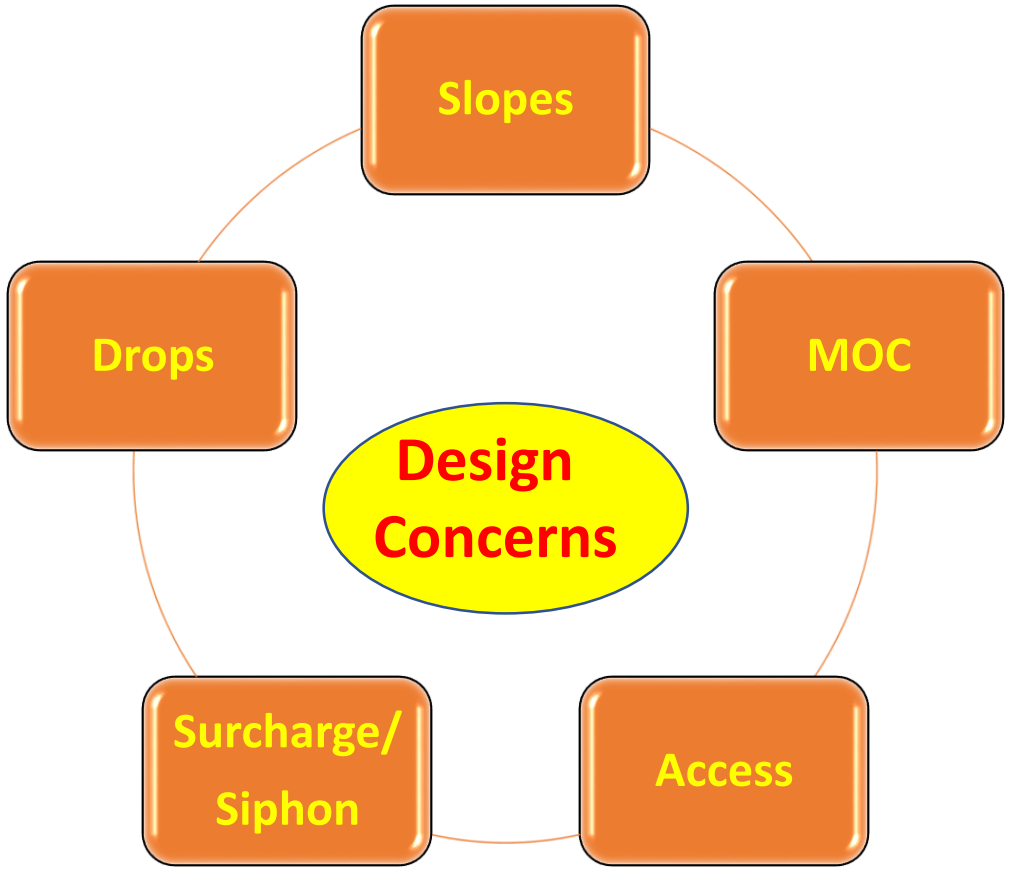


Moving Forward

- Review and enhance sewer designs
  - Consider Materials of Construction
  - Understand odor formation & release
  - Reduce turbulence
  - Build in controls

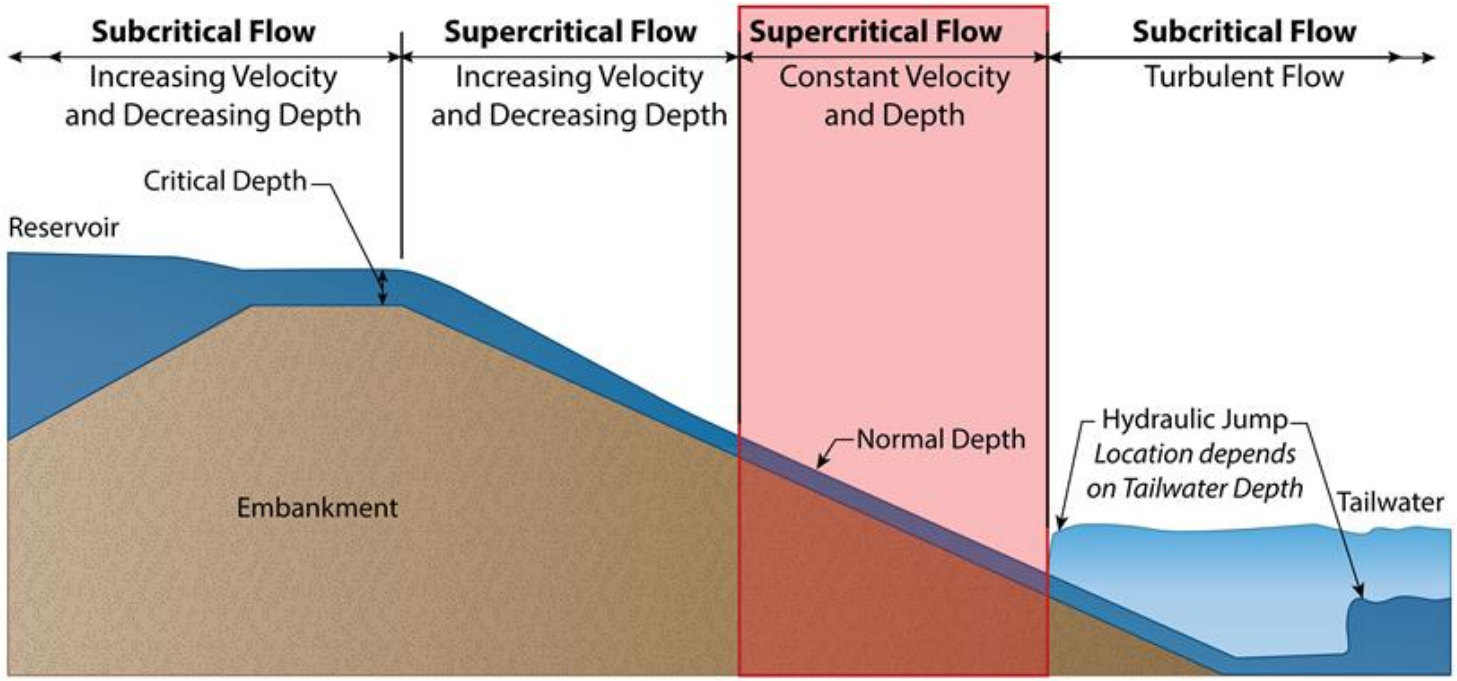
Working With What We Have

- **Replacing is not an Option**
- **Understanding Existing Conditions**
- **Create Workable/Viable Solutions**
  - KISS Approach
- **Set Criteria for Future Designs**



Example: Physical Layout Implications

- Condition Statement
  - Steep to Flat/Mild Slope Intersection
- Common Location
  - FM break to gravity
- Cannot/Difficult to Avoid
- Awareness
  - Recognize conditions
  - Protect infrastructure
  - Mitigate odors



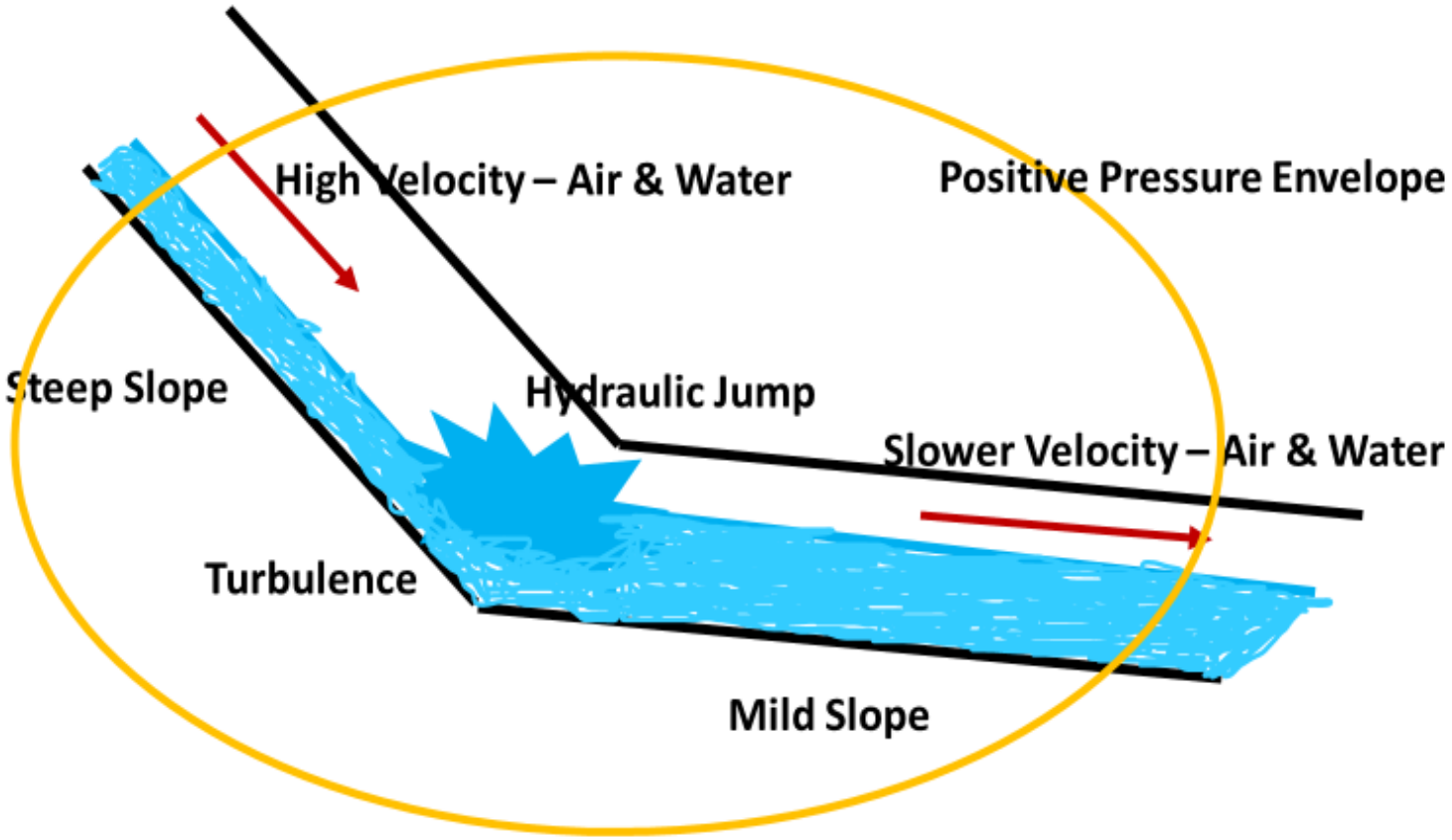
As part of DESIGN!

Steep to Flat/Mild Slope Conditions

- High velocity
  - Air
  - Water

MEETING

- Lower velocity
  - Air
  - Water



Result

Hydraulic Jump: Creating

- Turbulence
  - Stripping
- Positive air pressure envelope
  - Up & Downstream
  - Looking for a way out!

Case Histories

- **Three Different Scenarios**
- 1.) Northern Kentucky (KY)
- 2.) Westchester County (NY)
- 3.) Northern Kentucky (KY)

CASE HISTORY #1: NORTHEN KENTUCKY

Northern Kentucky (KY)

Background

- PS -- FM
  - 3 mile FM
- Break to gravity
  - Top of ravine
- Connects to Interceptor
  - Bottom of ravine

Northern Kentucky FM (KY)

Background

- Gravity connector
  - Steep slope

- Shortly before & at Interceptor
  - Mild to flat slope
- Connection
  - 90° “T” connection

Northern Kentucky FM (KY)

Problems

- Turbulence
  - High velocity of steep slope
  - Hydraulic jump at intersection
  - Abrupt stop @ “T” connection
  - High H_2S released
- Positive DP
  - Hydraulic jump
  - Dead end “T” connection

FM Stats:

- Length – 3 miles
- Diameter – 30”
- Q= 8 mgd
- Slope – 20%
- H_2S
  - Avg. 250 ppm
  - Max. >500 ppm

Northern Kentucky FM (KY)

Problems

- Positive DP plume spread out
  - Wide zone of influence (ZOI)
  - Up/Downstream of interceptor
- Upstream
  - Lateral connections
  - New expensive Townhomes
    - Odor complaints
- Downstream undeveloped
  - Open & undeveloped land

Northern Kentucky FM (KY)

Solutions

- Reconnect to interceptor
  - Wye connection
  - Smoother transition
  - Reduce (not eliminate) turbulence & DP plume
- Initial Plan
  - Vapor phase odor control
  - Select biofilter
  - Cost estimate: $1-2M

Northern Kentucky FM (KY)

Additional Option

- Open land to Plant

Propose

- Contain odors/Push downstream
- Close up sewer vents
  - Protected surfaces
- Flaps on laterals
- Solid MH covers
- Vent to atmosphere

Simple Solutions are Always Best!

CASE HISTORY #2: WESTCHESTER COUNTY

Westchester County (NY)

- Background
- PS – FM (4-5 miles)
- FM break to gravity
  - Top of hill
- Steep slope
  - Length: ~ ½ mile
- Bottom
  - Flattens out
- Runs into Inverted siphon (short)

Westchester County

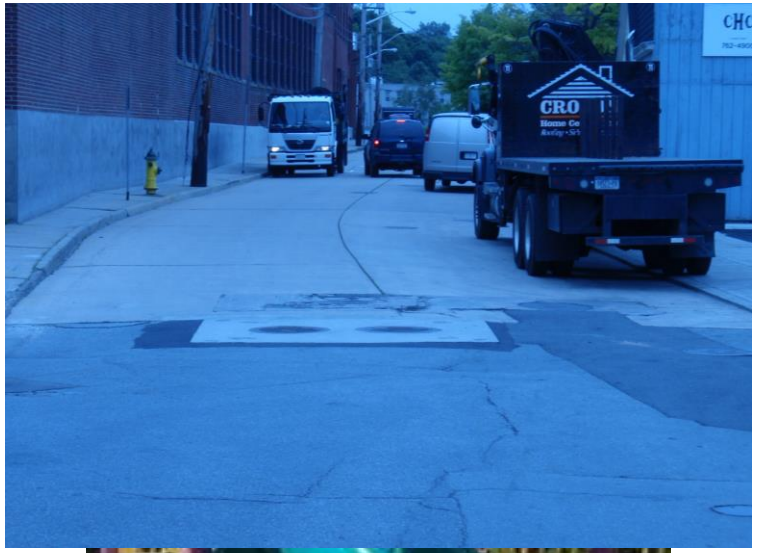
Two separate sewer lines on steep slope

- Village
  - Fresh wastewater
  - Low odors
- County
  - FM discharge
  - Septic
  - “No” flow when FM off
  - High odors

Connect Downstream (at toe of slope)

Westchester County

- Before combine – along steep slope
  - Neighborhood Park
  - Residences
- After combine – along mild slope
  - Inverted Siphon – short length
  - Industrial area



Conditions of Concern

Problems

- Turbulence
  - Along length
  - Hydraulic Jump
  - Transition (steep to mild)
- Negative Differential Pressure (DP)
  - Upper length
    - Wastewater drag
- Positive DP plume
  - Lower length
    - Jump
    - Siphon
- Backing up line

  To Park and Homes

Alternative Options

Solutions

- Physical
  - Too costly
- Recommended
  - Vapor phase control
    - Carbon
    - Near Park & siphon
  - Chemical addition at PS
    - Magnesium Hydroxide
    - Very effective
- Complaints way down!

CASE HISTORY #3: NORTHERN KENTUCKY

Northern Kentucky (KY)

Background

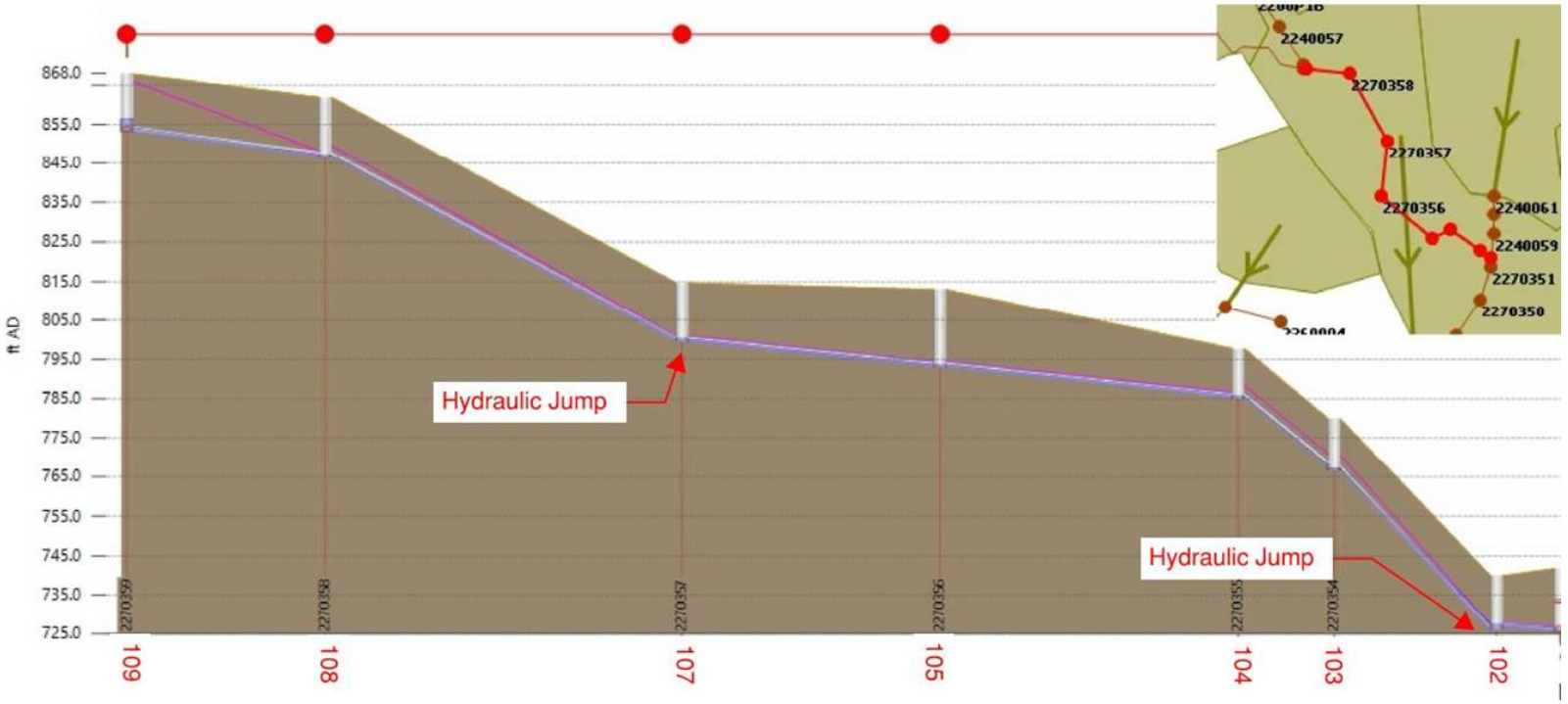
- FM
  - Break to gravity
  - Steep slope
  - Less steep slope

- Community along steep slope
  - Odor complaints
  - Odor in homes

Northern Kentucky (KY)

Background

- PS operations
  - 1 Pump start/hour
  - Average run time: 3.3 minutes
  - FM – 18” Ø
- Gravity slopes
  - Range: 0.95% to 18%
  - Velocities: 6 to 15 fps
  - Hydraulic jumps



Northern Kentucky (KY)

Field Monitoring

- Sewer smoke testing
  - Nearly all roof vents smoked
  - No smoke in homes
- Manhole smoke testing – steep slope
  - PS - OFF
    - Slow pull into sewer
  - PS - ON : 2 scenarios
    - 1. Significant force blowing out -- Before flow reaches location
    - 2. Considerable force pulling in -- As flow passes location

Unusual condition, but makes sense

Northern Kentucky (KY)

Field Monitoring

- Differential Pressure
  - Near “0” - Pump off
  - Positive - Pump on - no flow observed
  - Negative - Pump on - flow observed
    - High wastewater velocity
    - Drags air
    - Creates vacuum

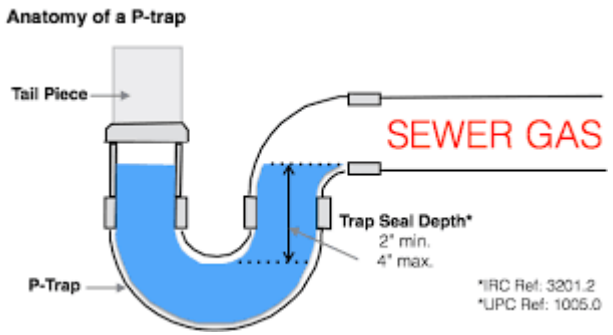
Drained house plumbing traps!!!

Northern Kentucky (KY)

Problem

- One pump cycle
  - Drain house trap

- Subsequent pump cycles
  - Odor into homes



Northern Kentucky (KY)

- Solutions
- Observed can reduce “ -/+” DP
  - MH lids removed
- Replace with vented lids
  - Require odor control
  - Carbon inserts
- Positive & Negative mitigation
  - Air admittance valves
  - Cleanouts with vents outside homes
  - Inline check/flap lateral valves

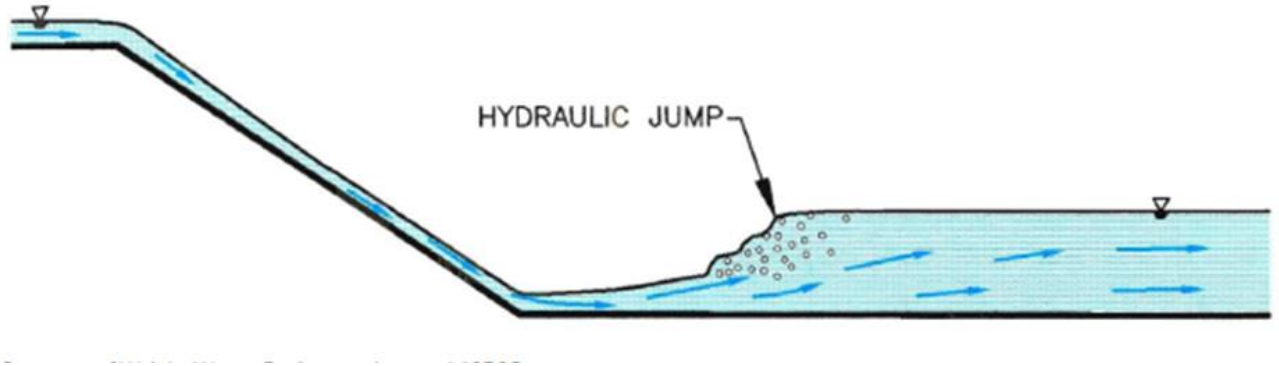
Northern Kentucky (KY)

Utility Approach

- New chemical feed pumps
- Add grated lids
- Carbon inserts

Conclusions – Collection Systems

- Physical layouts can create problems
- Answers not always system modification
  - Chemical addition
  - Use downstream release
  - Adjust pump cycles
  - Reduce pressure
- Moral of Story



Observe -- Monitor -- Review -- KIS

Find Your Path to Being a "Good Neighbor"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&
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