



Wastewater  
Treatment



TRANSFORMING  
WASTEWATER  
TO RESOURCES



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Water



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Production



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# Shore Acres Pump Station Forcemain Failure Analysis

Board of Directors Meeting  
March 12, 2025

# Shore Acres Pump Station Forcemain Failure Analysis

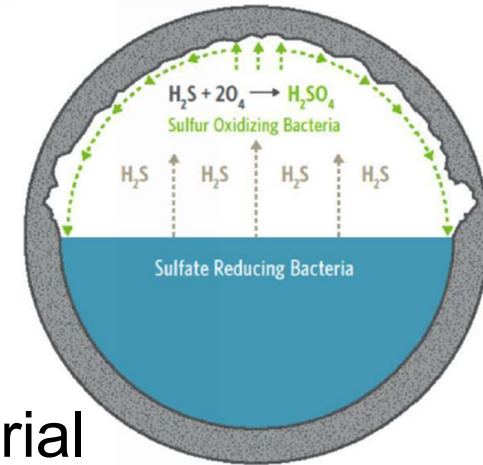
- Following identification of break (Dec 2024), District hired HDR to conduct technical forcemain failure analysis
  - Meets regulatory reporting requirements
  - Results submitted as part of 90-day Amended Spill Technical Report (submitted, March 4, 2025)
- HDR reviewed SAPS operating info, maintenance records, failed pipe materials, and prior studies/reports
  - Goal: Identify failure **root causes** and **contributing factors**
- Background Information
  - Installed in 1980, 4,700 feet in length, 16-inch diameter bar-wrapped concrete cylinder pipe with a 200-foot ductile iron pipe section
  - Little-to-no pipe slope with liquid oxygen feed system for odor control



# Failure Analysis

## Root Cause and Contributing Factors

- Root Cause: Internal corrosion of concrete lining and steel cylinder from hydrogen sulfide gas [ $\text{H}_2\text{S}(\text{g})$ ] caused failure
  - HDR ruled out vandalism, equipment malfunction, over-pressurization, operational conditions
- Contributing Factor No. 1: Existing Pipe Material
  - Existing bar-wrapped concrete cylinder pipe is susceptible to corrosion in wastewater applications—more modern, corrosion-resistant materials are now available (e.g., HDPE, PVC)

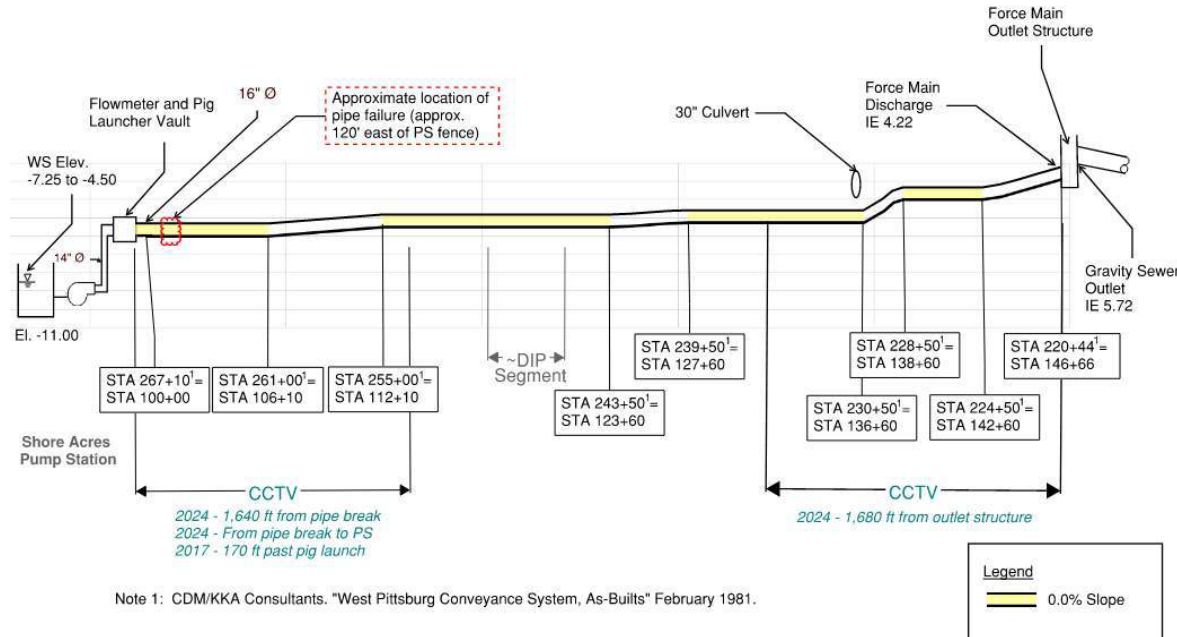


# Failure Analysis (cont'd)

## Root Cause and Contributing Factors

- Contributing Factor No. 2: Low Wastewater Flow Velocities**
  - Flow velocity is below recommended rate (due to wastewater flow rates, existing pipe diameter) to move air pockets and avoid suspended solids deposition (i.e., increased corrosion potential)
- Contributing Factor No. 3: Lack of Forcemain Slope**

- A vertical alignment with little-to-no slope inhibited movement of  $H_2S(g)$  pockets and precluded use of air release valves at high points



# Failure Analysis (cont'd)

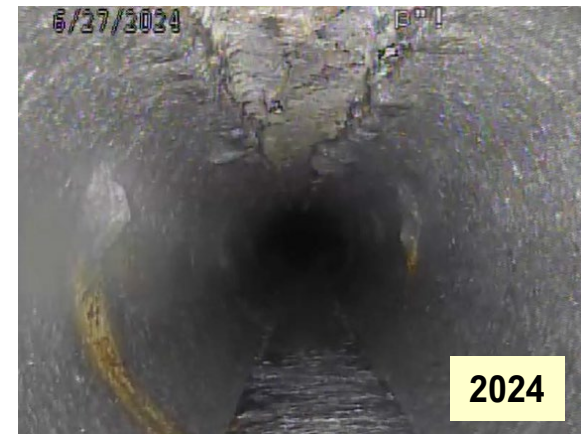
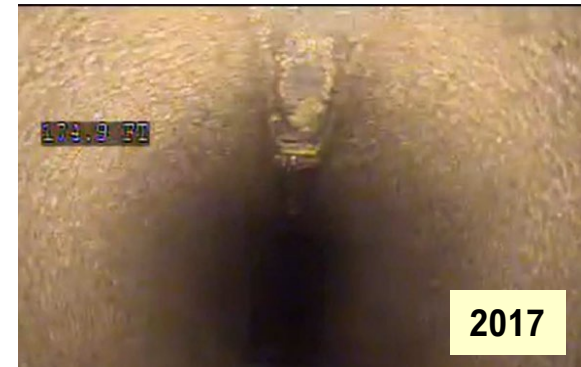
## Root Cause and Contributing Factors

- Contributing Factor No. 4: Challenging Site Conditions
  - Geotechnical investigations identified presence of Bay Mud with potential for 0.5-1.5 feet of settlement if pipe was constructed on uncompacted backfill
  - Original as-built construction records indicate pipe was constructed on compacted bedding and backfill
  - However, constructing a pipe with no slope in these soil conditions is challenging; local high points that trap  $H_2S(g)$  may be present due to construction irregularities or localized settlement in multiple locations



# SAPS Forcemain Inspection and Condition Assessment

- 3,200 feet of CCTV footage recorded during emergency repairs
  - Five locations with severe corrosion, minor corrosion over half of length
- 240 feet of CCTV footage (2017) identified minor-to-moderate cement lining defects—formal review not conducted in 2017
- “Facility Condition Assessment Project Report” (July 2020)
  - Engineering consultant estimated 15 to 30 years of remaining service life based on “desktop analysis” (age, material, service conditions)



# Existing SAPS Corrosion Prevention Systems

## Liquid Oxygen Feed System



- Intended to achieve H<sub>2</sub>S at or near 0 mg/L and dissolved oxygen >1.0 mg/L for downstream **odor control**
- System was out-of-service from 2018-2022 due to leak in liquid oxygen storage tank
  - Construction conflict with Pump Station Facilities Repair Project
  - Extended procurement period related to site conditions (i.e., oxygen delivery truck access, seismic anchorage requirements)
- HDR inferred liquid oxygen feed system was not sufficient to prevent hydrogen sulfide corrosion in SAPS forcemain (based primarily on 2017 CCTV footage)

# Existing SAPS Corrosion Prevention Systems

## Cathodic Protection System



- Intended to prevent external pipe corrosion
- In 2019, an assessment found no issues and recommended bonding to protect 200-ft ductile iron pipe section (~1,400 feet downstream of failure location)
- Lab analysis of failed pipe materials found low pH, high chloride-to-hydroxide ratio that **supports internal corrosion was most likely failure cause**



# Future Design Considerations

- Select modern pipeline materials (e.g., HDPE, PVC are more corrosion resistant)
- Consider a smaller diameter pipeline (e.g., 14-inch instead of 16-inch diameter) to increase flow velocity and construct new pipeline with appropriate slope
- Provide pipe inspection and maintenance access features
- Evaluate chemical addition alternatives to protect against corrosion in entire wastewater conveyance system