Odor and Corrosion Control System Study

Central Region, North Carolina

Sanitary Pump Station (SPS)

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Table of Contents

Background

Central NC Region Sanitary Pump Station (SPS)

In June 2025, this Central NC Region City and Source Technologies (Source) conducted a sulfide study of the sanitary sewer system from a SPS to two downstream air release valves (ARVs 107 and 108) and a Water Reclamation Facility, which are known hydrogen sulfide (H_2S) production zones. The force main conveys wastewater parallel to ∼∼ Road, where it eventually arrives at the WRF. ARV 108 is located outside of the ∼∼ neighborhood, 15 ft off of ∼∼ Road and the neighborhood sidewalk. ARV 107 is 1/3rd of a mile closer to the WRF, beside a sidewalk where ∼∼ Drive abuts ∼∼ Road. The close proximity of these air release valves (ARVs) to residential areas and public trails results in a high probability of nuisance complaints and introduces health and safety liabilities for the surrounding community.

Historically, this SPS has been the upstream dosing location for introducing odor abatement products. On average, the City uses roughly 9,125 gallons of Calcium Nitrate per year at an estimated annual cost of $30,000. Ideally, that investment would lower H_2S outgassing enough at ARV 108 so that odor complaints and corrosion would not occur, with the carbon scrubber attached to ARV 107 polishing off any remaining H_2S to protect the community. Unfortunately, odor remains a constant issue for this region, and corrosion is a major concern.

Beginning in February 2025, Source Technologies began collecting sulfide data from the ARVs and the WRF to profile the seasonal development of sulfide formation in this system while being actively treated with Calcium Nitrate. On June 18th, 2025, Source began testing multiple odor abatement solutions and dose rates, intending to determine what would provide the City with the most value while eliminating sulfide outgassing at the downstream control points, ARV 107 and 108.

Image 1: SPS

System Overview

Central NC Region SPS

The ~~ Water Reclamation Facility receives, on average, roughly 10 – 12 MGD of flow, with the SPS contributing ~1 MGD to that total. The SPS force main is a 20-inch diameter line that is approximately 17,730 ft. in length from the pump station to the headworks facility at the WRF. Based on an average daily flow of 977,000 gallons, the Hydraulic Retention Time (HRT) from the pump station to the WRF is ~7.1 hours. ARV 107 is an estimated 13,000 ft. downstream from the SPS, resulting in a roughly 5.2-hour HRT, with ARV 108 being approximately 11,500 ft. from the SPS, with an HRT of ~4.6 hours.

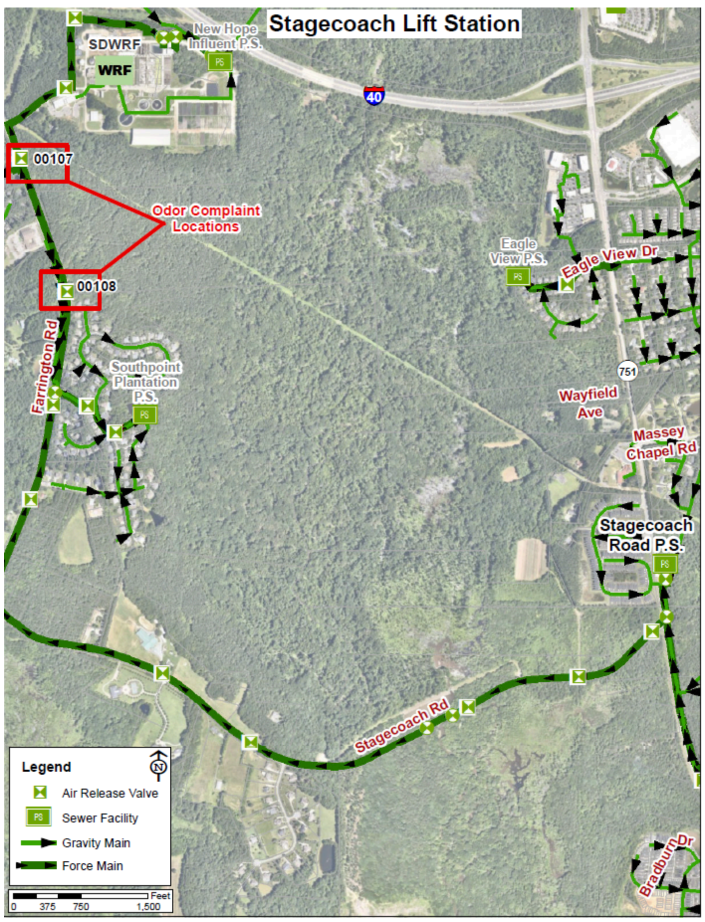


Image 2: SPS Force Main

Odor and corrosion abatement strategies are highly dependent on hydraulic retention time (HRT), pH, sulfide loading, and oxygen demand. Temperature and seasonal changes can also impact odor production. When evaluating the SPS force main, Source gathered data during the winter and summer months to observe these changes within the water composition. pH fluctuated between **6.5 – 7.5**, but ultimately remained consistent throughout the seasonal changes. Sulfide generation, however, was impacted significantly, with H_2S outgassing being multiple times higher in warmer conditions despite the use of Calcium Nitrate at the SPS.

Treated winter H_2S averages ranged from **40 PPM – 60 PPM**, with maximum spikes of H_2S reaching **200 PPM** (Figures 1 & 2). Summer H_2S averages ranged from **127 PPM – 245 PPM**, with a maximum level of nearly **2,400 PPM** recorded at the WRF (Figures 3 & 7). Water samples determining the mg/L of dissolved sulfide (S^{2-}) in solution were just as extreme, with a winter average of **0.48 mg/L S^{2-}** and peaks of **3.5 mg/L S^{2-}**, and a summer average of **0.83 mg/L S^{2-}** with an astounding **14.77 mg/L S^{2-}** peak, despite upstream treatment.

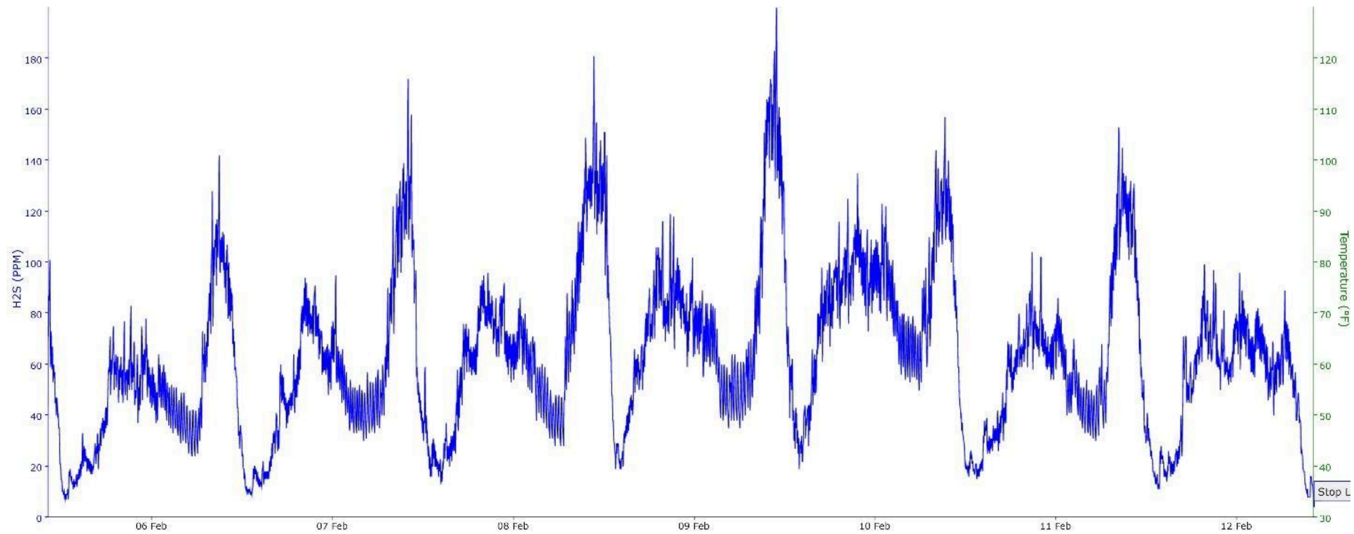


Figure 1: ARV 107, February 2025: H_2S Average: 63 PPM; Maximum: 202 PPM

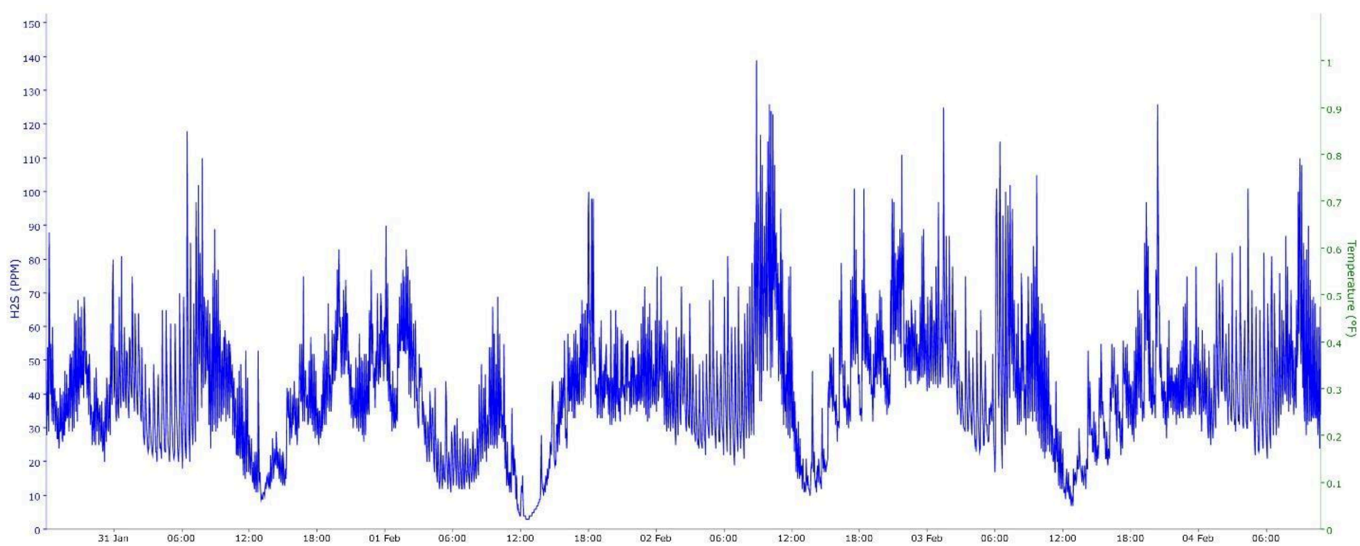


Figure 2: WRF, February 2025: H_2S Average: 40.88 PPM; Maximum 139 PPM

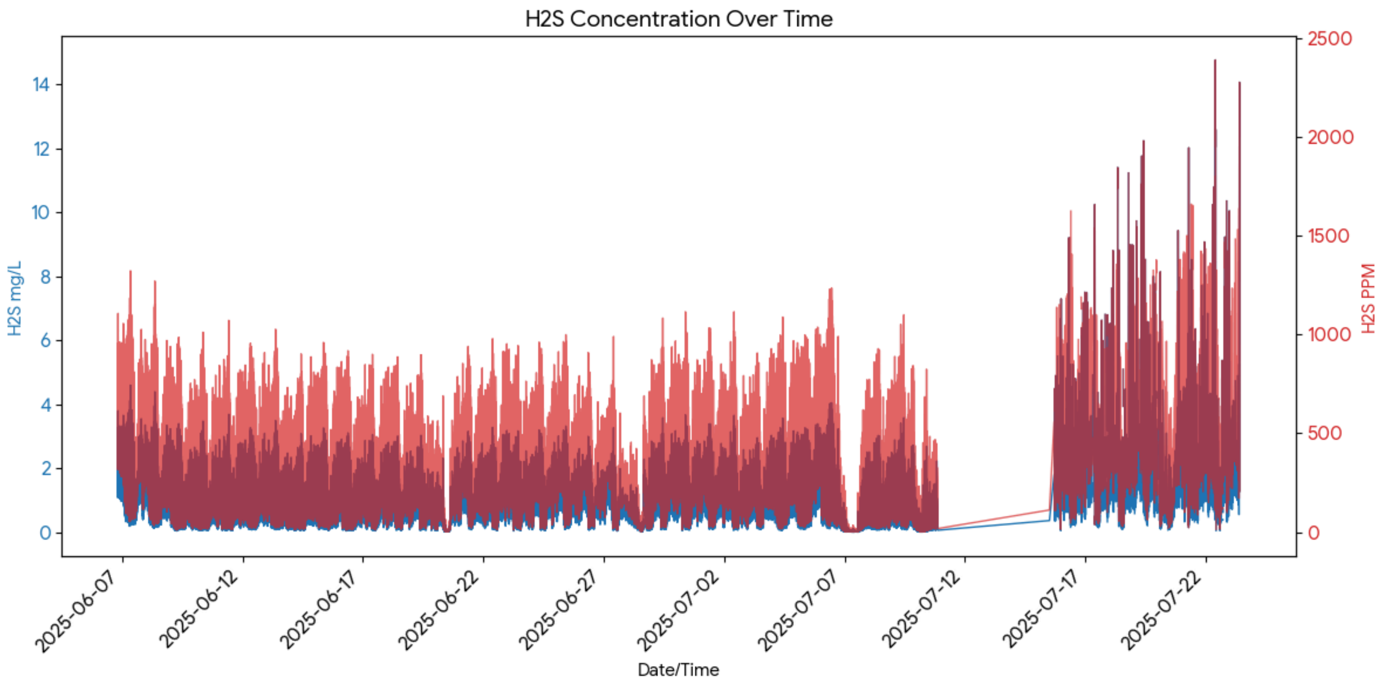


Figure 3: WRF, June – July, 2025: H_2S Average: 244 PPM; Maximum: 2,392 PPM

WRF Combined Total Statistics: (June through July, 2025)

- Average H_2S mg/L: 0.83 mg/L
- Maximum H_2S mg/L: **14.77 mg/L**
- Average H_2S PPM: 244.26 PPM
- Maximum H_2S PPM: **2,392.40 PPM**

Health and Safety Risks

Hydrogen sulfide is a fast-acting, highly toxic poison. At low levels, it causes nausea, headaches, and eye irritation. As concentrations increase, it deadens the sense of smell (olfactory fatigue), giving workers a false sense of safety just as the gas reaches its most dangerous levels.

At 100 parts per million (PPM), H_2S is classified by OSHA as **"Immediately Dangerous to Life or Health" (IDLH)**. H_2S can cause unconsciousness and death in minutes (See Appendix B for H_2S Exposure Chart). Levels seen throughout this study (See Figures 1 - 8) consistently demonstrated the ability to outgas H_2S at or above the OSHA IDLH classification, often multiple times higher. This presents an extreme risk to employee and public safety.

Corrosion and Infrastructure Costs

The most significant long-term financial drain from H_2S is **Microbial-Induced Corrosion (MIC)** (See Appendix B for EPA Infrastructure Life Expectancy Chart). This is not a slow process; it is an aggressive chemical attack that actively dissolves the concrete pipes, manholes, and lift stations that form the backbone of wastewater infrastructure.

A lift station that should last 30-50 years can be completely destroyed by sulfuric acid in less than a decade. The cost to replace a single collapsed sewer main or rebuild a corroded lift station can easily exceed **$1-2 million**. These failures are not a matter of "if," but "when," with sulfide loading levels observed during this study. Proactive chemical treatment, by comparison, can cost only a fraction of a single emergency repair and prolong the life expectancy of infrastructure to meet the designed lifespan.

Image 3: The above image is from ~~ Wastewater Treatment Plant. This location averaged 7.9 mg/L Total Sulfide, with peaks for 12.9 mg/L. At the time of this photo, the corroded facility seen above was only 7 years old, reduced to a barely functional state from H_2S Corrosion.

Odor & Corrosion Study

Central NC Region SPS

June 18th, 2025: at 12:45 PM, Source turned off the calcium nitrate system and initiated the first stage of the pilot study. Based on the HRT and the sulfide loading data gathered up to this point, the advanced oxidation REDOX method known as the STX Process was initiated to test the value of rapid oxidation for abating H_2S off-gassing as far as ARV 107. Chemical dose rates were established based on the estimated pounds of sulfide generated within the force main. As of the initiation of this stage, Source had not seen sulfide loading levels above 3.5 mg/L S^{2-}. With an estimated **28.52 lbs**. of sulfide being generated per day, **2 gallons** of STX and **10 gallons** of 50% H_2O_2 were calculated to be the required volume for treatment. This matched the current annual cost for treatment with calcium nitrate.

Peroxide residual tests and water samples obtained the following morning, as well as Acrulog H_2S data, quickly demonstrated that oxidation processes were likely to not add value nor be effective without utilizing extreme volumes. Dose rates were doubled at 7:30 pm the previous evening after H_2S data remained consistent with what we see while treating with calcium nitrate, but that adjustment made no noticeable impact on H_2S.

June 19th, 2025: at 9 am, the STX process was turned off and dosing was switched to the ETX process. ETX provides the value of rapid oxidation for destroying existing reduced sulfur compounds, with the ability to prevent Sulfate Reducing Bacteria (SRBs) from converting sulfate to sulfide, similar to the mechanism used by calcium nitrate. The switch to the ETX process made a noticeable impact on H_2S production at both ARV 107 and the headworks of the WRF. Sulfide readings were cut by ~50% with the typical mid-day spike reduced from over 200 ppm to below 10 ppm (See Figure 4; data to the left of the labels within the graph is treated with ETX, to the right of the labels is treated with 25 gpd calcium nitrate).

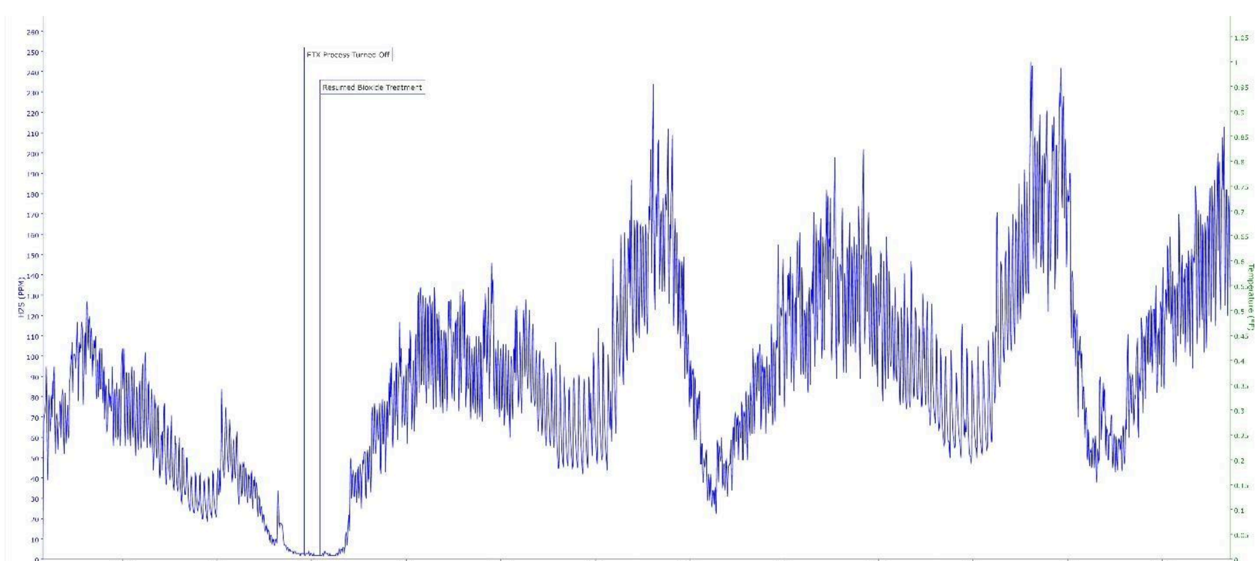


Figure 4: ARV 107, Week 1: Treated H_2S Average: 45 PPM; Treated Maximum: 127 PPM

Sulfide Data: June 19th to June 20th

Statistic	H_2S mg/L	H_2S PPM
Average	0.39 mg/L	45 PPM
Maximum	2.31 mg/L	127 PPM

June 20th, 2025: With the initial value seen from ETX, calcium nitrate was switched back on, but utilizing a comparable volume of NO_3^- to that being used by the ETX process. With a daily average of **122.5 lbs. of NO_3^-**, calcium nitrate treated from June 20th to June 23rd. Unfortunately, despite the changes, calcium nitrate made no noticeable impact on H_2S, averaging 108 PPM with a maximum reading of 257 PPM over the three days (see Figure 5). On June 24th, feed rates were returned to the standard application of **87.5 lbs. of NO_3^-** until June 27th. Very little difference was recorded between the two dose rates, with the only noticeable change being a slightly higher maximum H_2S reading of 297 PPM, which occurred at 9:20 am on the 24th.

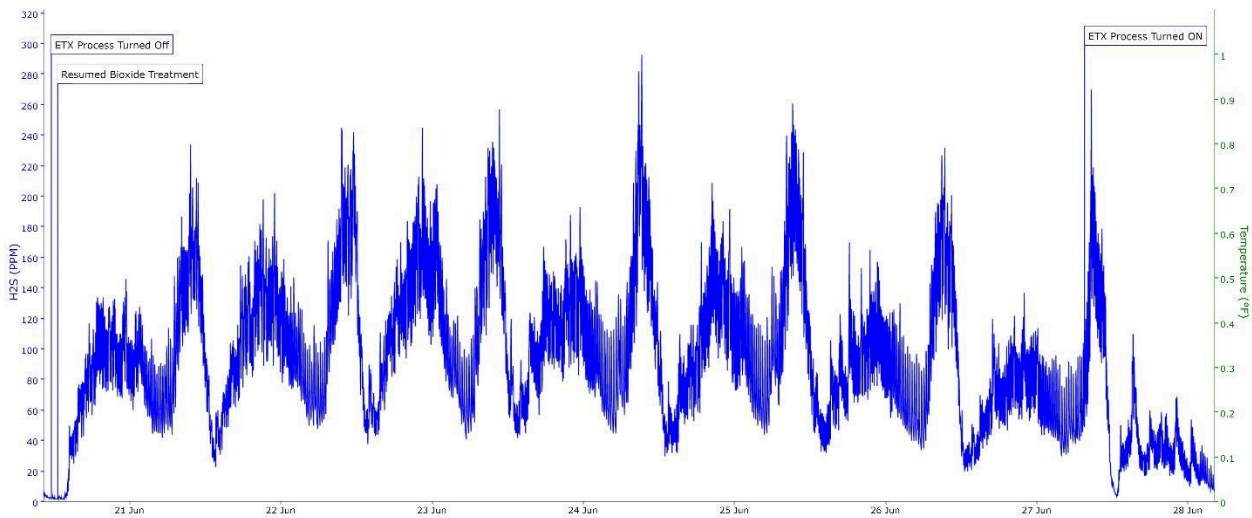


Figure 5: ARV 107, Week 1 & 2: 122.5 lbs. of NO_3^- Treated H_2S Average: 108 PPM; Treated Maximum: 257 PPM

June 27th, 2025: With the only noticeable impact from chemical intervention on the system coming from the ETX process, dose rates were increased based on updated water samples gathered from the WRF. Results from treatment showed an **80% reduction** in sulfide averages and a **60% reduction** in peak sulfide measurements (See Figure 6).

Sulfide Date: June 27th to June 28th

Statistic	H_2S mg/L	H_2S PPM
Average	0.55 mg/L	22 PPM
Maximum	1.98 mg/L	110 PPM

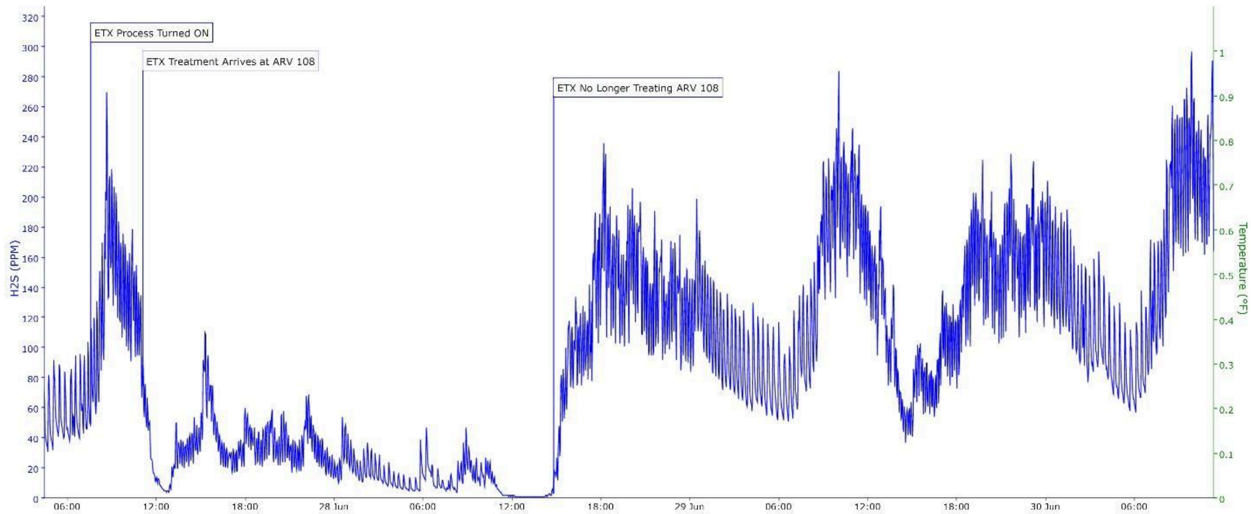


Figure 6: ARV 107, Week 2: Treated H_2S Average: 22 PPM; Treated Maximum: 110 PPM

June 28th, 2025: With the successful reduction of control point H_2S by 80% on average and a 60% reduction to peak H_2S, but utilizing a dose rate 7.2 times higher than the annual average, it was determined that liquid intervention, while effective, was likely beyond the current budget capabilities of the City to treat one location. The successful results came from deploying nearly **400 lbs of oxyanions** to abate downstream sulfide generation. While the value was able to be carried beyond the ARVs and reach the headworks of the WRF (see Figure 8: June 27th – June 28th), it would require a larger budget than the current $30,000/yr to maintain control over sulfide production. With the Winter months offering a decent reprieve from sulfide off-gassing, annual chemical allocation for this facility would likely be significantly less during those months. Further testing would be required to verify that claim, but initial test results were promising.

From Saturday, June 28th, to Wednesday, July 2nd, no chemical abatement products were injected into the SPS. This was to test the value of the current calcium nitrate feed rate. The system was turned back on using the standard calcium nitrate feed rate after the test concluded, and continued through the holiday weekend before graphs were downloaded the following week. Based on those results, it was concluded that calcium nitrate provided no value for odor or corrosion prevention during the summer months and likely little during winter using the existing dosing strategy.

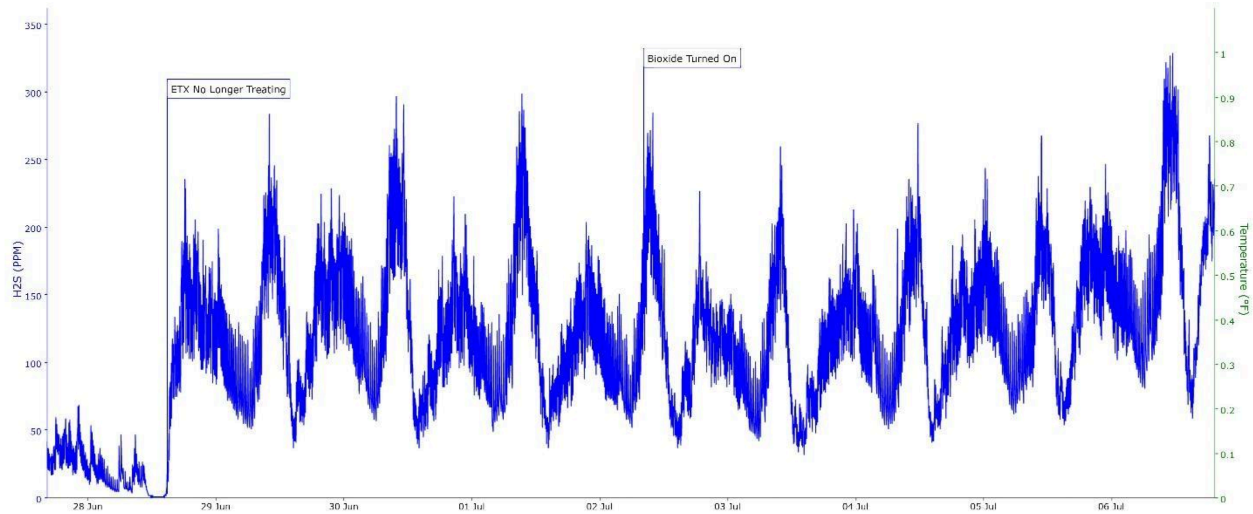


Figure 7: ARV 107, Week 3: Bioxide Treated H_2S Average: 127 PPM; Bioxide Treated Maximum: 329 PPM

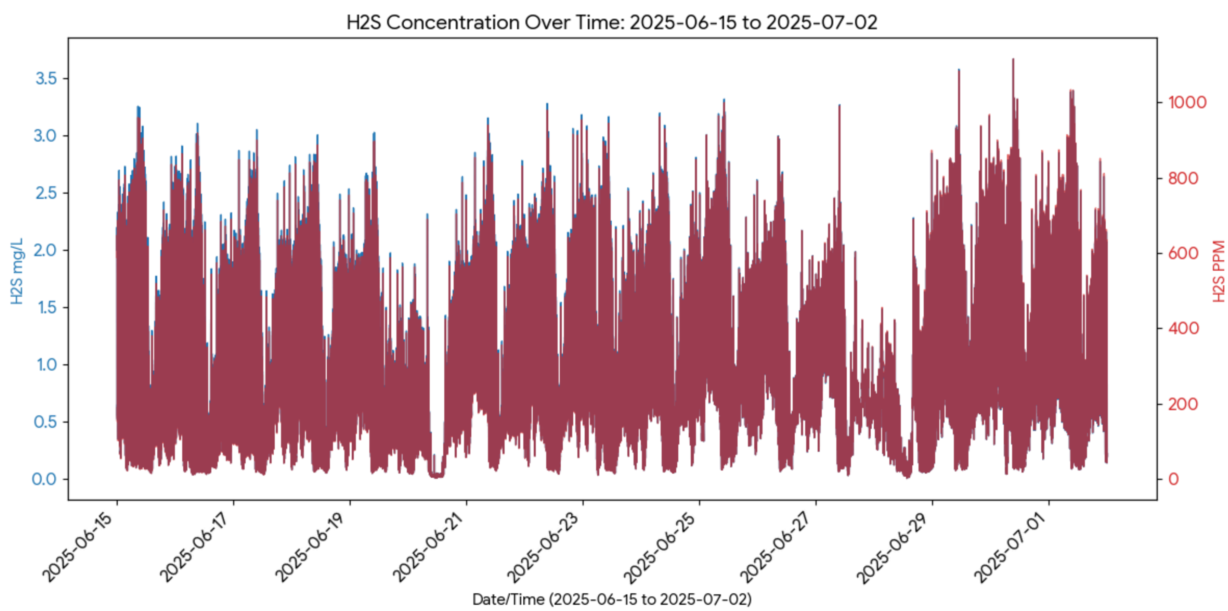


Figure 8: WRF Sulfilogger Data

WRF H_2S Concentration Statistics (June 15th - July 2nd)

The average and maximum values for this specific date range are:

- **Average H_2S mg/L:** 0.78 mg/L
- **Maximum H_2S mg/L:** 3.67 mg/L
- **Average H_2S PPM:** 233.92 PPM
- **Maximum H_2S PPM:** 1,116.14 PPM

Conclusion & Recommendations

Central NC Region SPS

The data gathered during the study of the Sanitary Pump Station (SPS) system clearly demonstrates that the current **Calcium Nitrate treatment strategy is ineffective** at mitigating severe hydrogen sulfide (H_2S) production, especially during warmer summer months. H_2S levels consistently reached concentrations at or above the OSHA "**Immediately Dangerous to Life or Health" (IDLH) classification of 100 PPM** and peaked at nearly **2,400 PPM** at the Water Reclamation Facility (WRF).

Value of Advanced Oxidation

The most significant finding is the **immediate and substantial impact** of the **ETX process**. Initial testing with ETX reduced H_2S readings by approximately 50%, cutting the typical mid-day spike from over 200 PPM to below 10 PPM at Air Release Valve (ARV) 107. With increased dosing, the ETX process achieved an **80% reduction in sulfide averages and a 60% reduction in peak sulfide** measurements.

The high sulfide concentrations observed, with a summer average of 0.83 mg/L S^{2-} and a peak of **14.77 mg/L S^{2-}** despite treatment, pose an extreme and immediate threat of **Microbial-Induced Corrosion (MIC)**. Sulfide levels above 7.0 mg/L can reduce infrastructure life expectancy to less than 5 years, and even 1.0 mg/L can reduce it to 25 years. The cost to replace a single corroded lift station or sewer main can easily **exceed $1–2 million**. While the effective dose rate of the ETX process required to maintain control was determined to be higher than the current annual budget of $30,000, this **proactive chemical treatment** is a **small fraction** of a single emergency repair and is necessary to prolong the infrastructure's designed lifespan.

Recommendations:

1. **Increase Chemical Budget for Liquid Injection (Long-Term Corrosion Control):**

   Action: Increase the chemical allocation budget for the SPS to effectively implement the **ETX process**, particularly during the high-load summer months.

   Rationale: The ETX process proved capable of reducing dissolved sulfide concentrations in the force main. Since dissolved sulfide is the root cause of MIC and infrastructure collapse, **controlling it at the source** offers the greatest long-term financial return by **preventing catastrophic corrosion damage**. Further testing should be conducted to verify that a lower dose can be used during winter.

2. **Reallocate Funds to Vapor Phase Treatment (Immediate Odor Relief):**

   Action: Reallocate the current annual budget (approximately $30,000) to install M2 Vapor Phase units (see Appendix A) at the primary community pain points, ARV 107 and ARV 108.

   Rationale: An M2 unit at ARV 107 is simple to install, requires **ZERO capital expenditure**, and has a proven track record of removing hundreds of PPM of H_2S. Utilizing the Standard Tier service plan (under 200 PPM) at $2,025.00/month would provide community and health relief while remaining within the current budget. This addresses the acute risk of odor and high H_2S exposure near neighborhoods immediately.

Appendix A – Vapor Phase H_2S Option

Vapor Phase H_2S Treatment Services (M2 Units)

Scope of Service:
Provision of turnkey Hydrogen Sulfide (H_2S) treatment via M2 Vapor Phase units. This is a comprehensive Service-Only Agreement.

ZERO CAPITAL EXPENDITURE:
This proposal requires no purchase of equipment and no separate purchase of chemicals. The pricing below is a single, all-inclusive monthly fee that covers the use of the M2 unit, all required chemistry, and technical service labor.

Pricing Schedule -The following monthly service fees are tiered based on the average inlet H_2S ppm (parts per million) readings.

Tier	Inlet H_2S Concentration	Monthly Service Fee	Service Inclusions
Standard	**< 200 ppm**	**$ ~~**	• **Equipment use included** • All chemistry included • Monthly site visits • Chemistry change-outs (up to 2x/year)
High Load	**200 ppm – 300 ppm**	**$ ~~**	• **Equipment use included** • All chemistry included • Increased site visit frequency • Increased chemistry swap frequency
Critical	**> 300 ppm**	**Quote upon Request**	• *Consultation required to determine custom scope and pricing.*

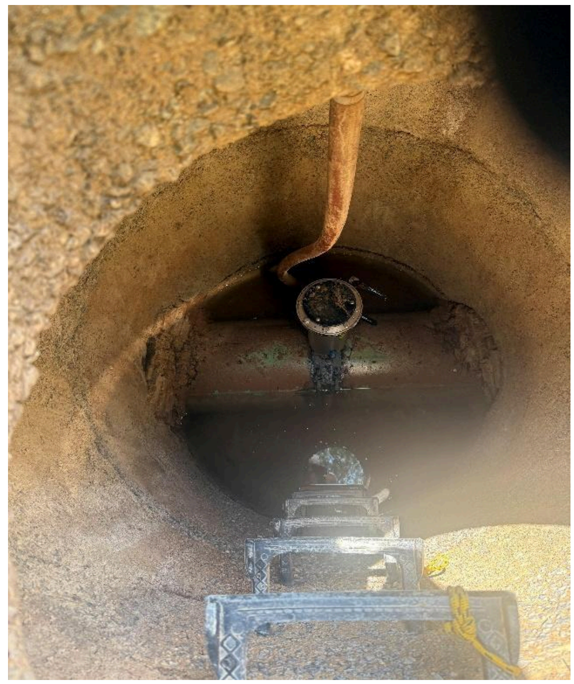
Operational Notes & Conditions

- **All-Inclusive Model:** The monthly fee is the sole charge. The City of Durham is not responsible for ordering chemicals, purchasing parts, or acquiring assets.
- **Standard Tier Limits:** The Standard Tier ($~~.00/mo) covers normal operations not exceeding one site visit per month and two chemistry replacements per calendar year.
- **High Load Adjustments:** Should inlet averages consistently fall between 200–300 ppm, the increased fee covers the additional labor and chemical consumption required to maintain compliance.

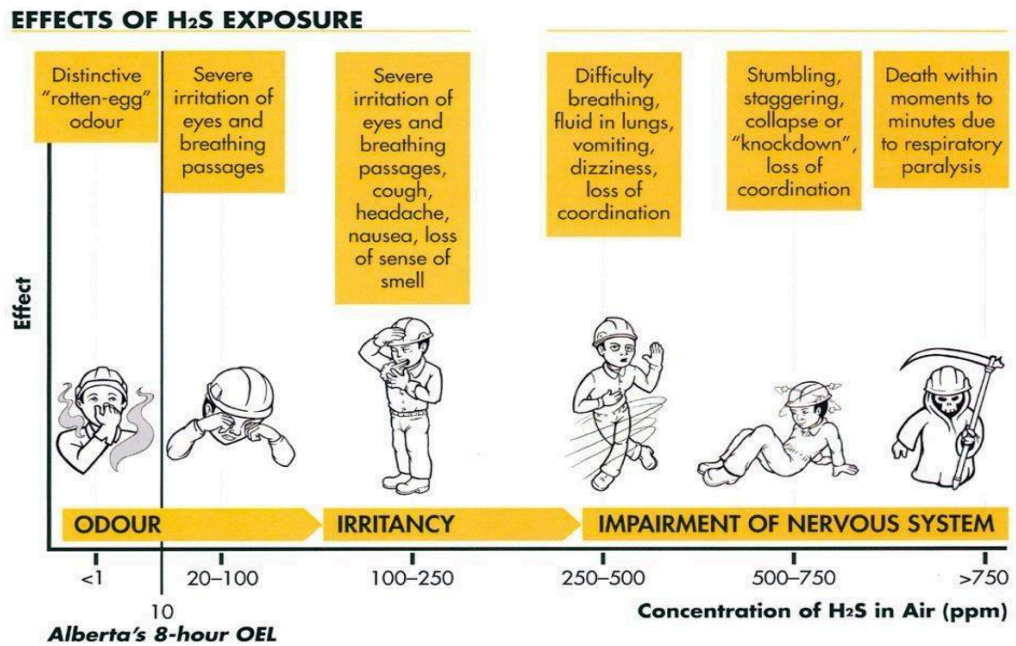
- **Loading Changes:** If average inlet H_2S levels rise above 300 ppm, [Your Company Name] reserves the right to re-evaluate the service plan and provide a revised proposal.

Improved Solutions of ARV H_2S Control

Installing an M2 at ARV 107 would be relatively simple, do to the existing infrastructure. While the existing carbon unit is unable to maintain control over H_2S off-gassing in the neighborhood, an M2 has a proven track record of unbiasedly removing hundreds of PPM without compromising quality.



Appendix B - Effects of H_2S



One of the methods for determining sulfide loading in solution is to use a portable colorimeter device and the methylene blue method. This test helps identify how many milligrams per liter (mg/l) of sulfide are in solution. 1 mg/l of $S^{=}$ can form over 100 parts per million (PPM) of H_2S. Gas detection equipment can be deployed throughout the collection system to determine the concentrations of H_2S in specific locations. Once H_2S has formed, corrosion will occur.

Depending on turbulence and pH, understanding the concentrations of sulfide in solution can help determine the life expectancy of infrastructure.

Effect of Sulfide on Infrastructure Life Expectancy

Target: 3′ diameter concrete pipe (1″ cover")
*neutral pH scenario
*Source of chart EPA website

Effect of Sulfide on Infrastructure Life Expectancy

Sulfide (mg/L)	Life Expectancy
0.5	>50 yrs
1.0	25-50 yrs
1.5	25 yrs
2.0	10-25 yrs
2.5	10 yrs
3.0	10yrs
4.0	5-10 yrs
7.0	5 yrs
>7.0	< 5 yrs