City of Jackson Distribution System Assessment: Summary of Findings and Assessment Team Recommendations

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BACKGROUND

The City of Jackson (COJ) operates two community water systems that serve the City and neighboring areas. The larger system is a surface water system with two treatment plants. The distribution system of each COJ community water system is operated independent of the other. The surface water system utilizes a chloramine residual as a secondary disinfectant, whereas the groundwater system uses a free chlorine residual. The service population of the surface water system is approximately 160,000 customers. The other water system has several well sources and serves approximately 16,000 customers in Southwest Jackson.

Region 4 became more engaged with COJ in 2016 when a significant Lead Action Level exceedance occurred in the southern section of the distribution system. In response to the COJ's Lead and Copper Rule (LCR) issues, Region 4 joined Mississippi State Department of Health's (MSDH's) efforts to help the COJ return to compliance with state and federal regulations.

NEIC Investigation – February 2020

EPA's National Enforcement Investigation Center (NEIC) conducted an investigation of the COJ's water system on February 3 – 7, 2020. NEIC's team documented significant deficiencies in both the surface water and groundwater distribution systems. They discovered that both surface water treatment plants were in poor operating condition and not maintained well, contributing to poor water quality and availability in the distribution system.

EPA Region 4 Enforcement Responses – 2020 to Present

Following the NEIC investigation, Region 4 issued a SDWA §1431 Emergency Order on March 27, 2020, in response to the imminent and substantial endangerment of Jackson's water customers. A SDWA §1414 Administrative Order on Consent was issued on July 1, 2021. Both orders mandated that the COJ repair both treatment and distribution systems on an established schedule.

MSDH Bureau of Public Water Supply Sanitary Surveys

The MSDH conducted sanitary surveys in February 2020 and November 2021. Both surveys identified significant deficiencies. Overall, the water systems were not operated and maintained properly at the time of both sanitary surveys.

Financial and Governance Assessments by the Environmental Finance Center

Using ARPA funding, Region 4 contracted with the Environmental Finance Center (EFC) at the School of Government at the University of North Carolina. The EFC is performing a financial health checkup and affordability assessment for the water and sewer enterprise fund and a review of the current governance structure of Jackson's water operations.

Distribution System Assessment

The Region 4 drinking water program identified the need for compliance assistance focused on the distribution systems for both the surface water and groundwater systems that the COJ operates. Region 4 drinking water program staff, through participation in EPA's Area-Wide Optimization Program (AWOP), concluded that using optimization tools to examine the distribution systems could inform the development of a blueprint for the COJ to move forward and make sound investments in rehabilitating the distribution infrastructure and improving operations. See AWOP Overview for a description of the program. Region 4 staff collaborated with TSC's AWOP staff to organize a team and arrange for a distribution system assessment which was initiated by a site visit to the COJ on March 2 – 3, 2022.

APPROACH

The Assessment Team worked with COJ staff to obtain pertinent historical data for review and analysis of distribution system performance. No additional water quality samples were obtained during the site visit. The team, comprised of representatives from Region 4, TSC's AWOP staff, Process Applications, Inc. (PAI), and MSDH, assessed water quality against AWOP distribution system goals (described in the Appendix, see Figure 1) and water line breaks against Partnership for Safe Water Distribution System (PSW DS) goals (see PSW DS Program Overview). Meeting those goals will not only lead to compliance but will ultimately result in water quality improvements that go beyond compliance. While evaluating the performance of the two COJ water systems relative to optimization goals, the team identified a number of findings and recommendations for improvement.

FINDINGS

Distribution System Operation and Maintenance

Line Breaks:

1. Water line break data from 2017 through 2021 indicate that line breaks occurred at an average annual rate of 55 breaks per 100 miles of line. The rate exceeded the Partnership for Safe Water's recommended goal of 15 breaks per 100 miles of line per year and the five-year trend is upward, but the rates have declined in the two most recent years. See Figure 2 in the Appendix.

2. Spatial analysis of water line breaks showed distinct areas within the COJ distribution systems with a high number of breaks, including the North Jackson and Seneca Street areas. These areas corresponded to locations where small diameter pre-1910 cast iron pipe is still in use. See Figures 3 – 5 in the Appendix, juxtaposing water main break density maps with pipe size maps from 2013 COJ Master Plan.

General Operation and Maintenance:

In part due to lack of staff, the following four activities are not being conducted in the COJ distribution systems. These could be implemented by internal COJ staff or with contractor support.

1. The COJ does not collect and record continuous pressure data, which could be used to identify areas in need of pressure improvements to prevent contamination in the distribution system.

2. Routine flushing of the distribution system has not been performed. Flushing can be utilized to reduce water age and optimize chlorine residuals.

3. Valve locations and operational status are not well documented. This could result in large areas being affected by main breaks and low-pressure events, since isolation valves cannot be located.

4. Valves and hydrants have not been routinely exercised, and maintenance has not been performed. This could result in areas of the distribution system being impacted by valves that cannot be opened (i.e., water is not flowing into an area where it is needed) or valves that cannot be closed (i.e., water could be moving unintentionally from one area to another).

Storage Tanks:

1. Many storage tanks have been cycling infrequently since early 2021. Tanks with high average turnover times included Forest (42.5 days), Mill Street (46.6 days), and Cedar Hills (51 days). Average turnover times of less than five days will generally maintain an adequate chlorine residual in the distribution system. The Maddox and Spring Hill tanks were not evaluated because the tank levels never changed (i.e., water was not draining from or filling the tanks). See Table 1 in the Appendix for a summary of tank turnover times.

2. Mixing performance ratios for eight of 17 tank evaluations showed the potential for poor mixing when compared to a recommended mixing performance ratio of ≥ 1.0. The mixing performance ratio is an estimate of the ratio between the actual level of mixing and desired mixing (the level of mixing required to achieve 95 percent uniformity throughout the tank). When actual mixing is equal to or greater than a theoretical desired level of mixing, (mixing performance ratio ≥ 1.0), chlorine residuals are expected to be maintained. See Table 1 in the Appendix for a summary of tank mixing performance ratios.

3. The southern-most elevated storage tank on the surface water distribution system (the Byram tank) has never filled as expected. Startup of a bottling plant near the Byram tank increased demand and caused additional difficulty in filling the tank.

Customer Complaints:

1. An analysis of customer complaint data from 2011 through 2022, that was provided by the water utility, indicated the following:

   A. Discolored water complaints have been trending lower in recent years, as indicated in Figure 6 in the Appendix.

   B. There was a huge spike in pressure complaints in January 2018 (521 complaints documented that month). Pressure complaints have increased since 2014, from 5 - 10 per month to 10 - 30 per month, as indicated in Figure 7 in the Appendix.

   C. Odor complaints have been increasing on a monthly basis since 2016, as indicated in Figure 8 in the Appendix.

Groundwater Distribution System Water Quality

1. Disinfectant Residuals –

    A. Free chlorine residuals at the points of entry to the distribution system generally ranged from 0.5 mg/L (Wiggins Road) to 4.2 mg/L (Siwell Road). Example free- and total-chlorine residual paired-sample results for the Wiggins Road and Siwell Road sites are shown in Figures 9 and 10 in the Appendix. The trend graphs represent data collected from daily monitoring performed by operators at the first customer after each chlorination facility in the groundwater system. Trends at the other chlorination facilities fall within the range indicated in the example charts.

    B. Free chlorine residual varied from 0.3 to 3.4 mg/L in monitoring of nineteen different locations in the groundwater distribution system between January 2021 and February 2022. This system met the free chlorine residual optimization goal of $\geq$ 0.20 mg/L in 100 percent of compliance samples evaluated during this time period. It is not known, however, whether the samples were collected in a manner that would represent the quality of water in the main at the sample site (e.g., sample was collected using a calculated flush time or volume, etc.).

    C. Total and free chlorine residuals are measured throughout the system. The difference between total and free chlorine residual ranged from 0.3 to 0.5 mg/L entering the distribution system from the wells, and it was as high as 2.5 mg/L within the distribution system, based on data collected in the year prior to the site visit. Figure 11 in the appendix shows the annual average free and total chlorine residuals for each monitoring location within the COJ groundwater system.

        1) Mapped data indicated large differences between total chlorine and free chlorine on the eastern side of the groundwater distribution system; large differences between the free and total chlorine residuals could indicate an interference in the free chlorine measurement. Many sites were near the presumed groundwater and surface water systems' boundaries.

            a) Specific locations include areas along Maddox and Raymond Roads.
            b) Additional isolated locations of this same trend were identified.
            c) An example of these trends is provided in Figure 12 of the Appendix.

2) Groundwater with a free chlorine residual would be expected to have similar free and total chlorine residuals. Because the surface water carries a chloramine residual and the groundwater system carries a free chlorine residual, the discrepancy between total chlorine and free chlorine residuals may indicate that surface water is entering the area of the system supplied by groundwater, due to leaking or inadvertently open valves.

2. Disinfection By-products – Limited TTHM and HAA5 data (April 2021 through January 2022) were available for review in this portion of the distribution system. The TTHM data met regulatory requirements and met the individual site optimization goal (LRAA ≤ 0.070 mg/L) at all sites, but there was not enough quarterly data to assess system performance against the long-term optimization goal (average maximum LRAA from the past eight quarters ≤ 0.060 mg/L). With respect to HAA5s, two of the four sites exceeded the individual site optimization goal (LRAA ≤ 0.050 mg/L), with values of 0.052 and 0.058 mg/L.

<u>Surface Water Distribution System Water Quality</u>

1. Disinfectant Residuals – The surface water system met the total chlorine residual optimization goal of 1.50 mg/L in 67 percent of compliance samples evaluated between May 2018 and February 2022. Some sites within this system were meeting the goal in less than 10 percent of samples. Discussions with the staff responsible for collecting samples indicated that sampling may not be representative of distribution system water quality (e.g., if a low chlorine residual was detected, the sampler initiated low volume flushing by opening a hydrant and returned later to re-collect the sample). In this case, only the higher (post-flush) chlorine residual was recorded. Figure 13 in the Appendix shows the percent of total chlorine residuals meeting the optimization goal, by sample location, during the time period analyzed. The percentages would likely have been lower for each site if the initial chlorine measurement data were recorded prior to flushing.

2. Disinfection By-Products – Data were reviewed for the surface water system for the period of February 2018 through October 2021. Between February 2019 and October 2021, this system met the individual site goal (LRAA ≤ 0.070 mg/L) at all sites and the system long-term optimization goal for TTHMs (average maximum LRAA from the past eight quarters ≤ 0.060 mg/L), based on the available data (see Figure 14 in the Appendix). During this same period, five of eight monitoring sites, with at least four quarters of data, exceeded the HAA5

individual site optimization goal (LRAA ≤ 0.050 mg/L) in 14 quarterly LRAA calculations, as shown in Figure 15 in the Appendix. Overall, TTHMs and HAA5s are decreasing in the surface water portion of the distribution system.

3. Water Quality Parameters (WQPs).

   A. The distribution system entry point pH at both surface water treatment plants (SWTPs) was frequently outside of the assigned optimized water quality parameter (OWQP) pH range of 9.0 – 9.5 units between March 2021 and February 2022. See Figure 16 in the Appendix.

   B. The Curtis plant entry point alkalinity generally met the goal of ≥ 15 mg/L (only one sample below this minimum was collected). The Fewell plant had several instances of entry point alkalinity measurements below the minimum OWQP of 15 mg/L. See Figure 17 in the Appendix.

   C. Monthly distribution system pH data for February 2018 through February 2022 showed a variation from 6.84 – 9.75 units, indicating that the WQP goal for distribution system pH (> 8.6 units) was not always met. See Figure 18 in the appendix.

   D. In monthly distribution system data collected between February 2018 and February 2022, alkalinity varied from 3 to 60 mg/L and increased in variability over time, indicating that the WQP goal for distribution system alkalinity (≥ 15 mg/L) was not always met. See Figure 19 in the Appendix.

   E. The SWTPs feed different chemicals (e.g., lime and soda ash to supplement alkalinity).

4. Chloramination.

   A. Spikes in the finished water free chlorine residual at the Curtis plant in spring and autumn of 2021 indicated a disruption in chloramine process control. The ammonia feed rate is programmed into SCADA and cannot be easily adjusted by operations staff, which may lead to either overfeeding or underfeeding ammonia (i.e., improper chlorine-to-ammonia ratio). See Figure 20 in the Appendix for March 2021 through February 2022 data.

   B. During the 12 months prior to the assessment, the monochloramine residual in the Curtis plant effluent was at times less than the optimization goal of 1.5 mg/L. See Figure 20 in the

Appendix for an example of the monochloramine residuals at the point of entry from the conventional plant.

1) The Fewell plant effluent showed less variability in total chlorine and monochloramine residual than the Curtis plant over the past 12 months, indicating relatively better process control. See Figure 21 in the Appendix.

2) The plant staff target a free ammonia goal of 0.1 – 0.3 mg/L at both plants, but data reviewed for the previous 12 months indicated some periods when free ammonia was $\geq$ 0.55 mg/L as N, which is the maximum detection limit of the method used for analysis. Free ammonia above the optimization goal of $\leq$ 0.10 mg/L as N may contribute to nitrification in the distribution system. Figures 22 and 23 in the Appendix show the free ammonia levels at the Curtis conventional plant and the Fewell plant.

3) Historical chloramination process control may have been impacted by lack of functional equipment in addition to operational practices.

5. Continuous chlorine analyzers were being improperly calibrated and maintained at the time of the visit. Verification standards were not available for portable chlorine test kits.

Administration

1. The Utilities Manager position was vacant at the time of the visit. The COJ explained that this was due to budget limitations.

2. There was no succession plan for the utility at the time of this site visit.

3. Jackson's water utility is governed by the Jackson City Council and does not currently operate as an independent enterprise. The University of North Carolina Environmental Finance Center (EFC) is evaluating the current governance structure to determine whether another model would be successful in Jackson.

4. Considerations related to staffing were included in reports generated for the COJ in 2015 (Raftelis Financial Consultants) and 2021 (Jacobs). In addition, MSDH staff have provided staffing level recommendations to the COJ.

A. There are insufficient operators to consistently staff three shifts, seven days per week. Staff are unable to take time off without forcing remaining staff to work extra hours. Supervisors are working shifts in addition to their managerial responsibilities. Distribution system crews are sparsely staffed and are unable to conduct preventive maintenance.

B. Operator turnover is high. Operators indicated instances of working up to 75 hours per week without receiving overtime pay.

   1) The City Council approved salary increases for treatment plant operators in November 2021.

   2) No salary increases for maintenance technicians, instrument technicians, or distribution system staff have been implemented to date, coinciding with a loss of staff in these roles.

C. The COJ relies on a consultant for operator training and treatment advice.

D. The utility does not have adequate plant and distribution system staff to perform preventative maintenance that could reduce overall operational costs of the system.

5. Plant administrators indicated that malfunctioning water meters have contributed to a 32 percent decrease in revenue since 2016. While meters are currently being replaced, there is uncertainty about whether the new meters will be capable of communicating with the billing system.

   A. COJ explained to EFC staff that the City's billing system and meter replacement project may take 18 months to complete. At the time of the EFC Kick-off meeting in March of 2022, approximately 14,000 bills were recently *"stranded"* (i.e., not sent to/received by customers).

   B. COJ reported to the EFC that non-revenue water is ~50 percent; it is unclear how much is due to meter issues or water loss.

   C. Due to problems with the billing system, COJ was unable to provide a complete list of customers at the time of the visit. COJ explained that some customers were not receiving bills, others were receiving large bills, solid waste charges were not being included as they should be, etc. The COJ cannot currently calculate its collection rate. This is not expected to be resolved until late 2024.

6. An analysis conducted by the EFC illustrates that Jackson's enterprise fund revenues have been rapidly decreasing since 2015. Metrics (such as operating ratio, debt service coverage ratio, day's cash on hand) that should be staying level or increasing are decreasing. The billing and metering issues are a big contributor to this loss in revenue as well as a loss of large customers (i.e., hospitals and local schools).

RECOMMENDATIONS

Towards meeting optimization goals and improving public health protection, the Assessment Team recommends that COJ consider the following prioritized actions and implement them, as practical, to improve public health protection. These recommendations will require a commitment of resources by COJ; some may be implemented by current staff, while others may necessitate additional staff or contractor resources.

1. Develop a plan to document valve locations and positions (open/closed) and develop a standard operating procedure for exercising valves and hydrants.

2. Conduct continuous pressure monitoring in the distribution system to characterize pressure loss issues.

3. Develop and implement a flushing program to improve distribution system water quality.

4. Conduct investigative sampling in the surface water portion of the distribution system to assess performance against the monochloramine residual goal of 1.5 mg/L and related chloramine parameters.

5. Develop a surveillance plan to detect the occurrence of nitrification in the distribution system.

6. At the surface water treatment plants, ensure chemical feed equipment is operational and reliable and provide chloramination process control training on chlorine dosing, entry point monochloramine residual, and free ammonia targets.

7. Conduct investigative sampling in the groundwater system, beginning at the wells and moving into the distribution system, to analyze water quality parameters (e.g., total chlorine, free chlorine, monochloramine, free ammonia, pH, others) and conduct a careful review of groundwater/ surface water system boundaries and valve locations/positions.

8. Evaluate and implement HAA5 control strategies for groundwater and surface water sources.

9. Once desired corrosion control treatment is installed, implement process control related to pH and alkalinity adjustment at the treatment plant.

10. Perform investigative water quality monitoring near selected tanks to assess whether tank operation is having a negative impact on distribution system water quality.

APPENDIX

Area-Wide Optimization Program Disinfection By-Product and Distribution System Optimization Goals and Guidelines[1]

Monitoring & Operating Goals Summary

Category	Goal/Guideline	Status	Description	References
Disinfection By-Product	Plant Effluent Monitoring Goal	Adopted	• Collect quarterly total trihalomethane (TTHM) and haloacetic acid (HAA5) samples at the plant effluent with distribution system compliance sites.	WRF Project #4109
Disinfection By-Product	Enhanced Coagulation Monitoring Goal[2]	Adopted	• Collect monthly raw and treated water total organic carbon (TOC) samples.	Stage 1 D/DBP Rule
Disinfection By-Product	Disinfection Monitoring Goal	Adopted	• Record disinfectant residual, temperature, and pH at maximum daily flow in the treatment plant for CT calculations.	U.S. Environmental Protection Agency, 2004
Distribution System	Disinfection By-Product Monitoring Goal	Adopted	• Collect quarterly DBP samples at all compliance locations at systems in compliance with the Stage 2 D/DBP Rule. • Collect monthly DBP samples at all compliance locations at system *not* in compliance with the Stage 2 D/DBP Rule.	Stage 2 D/DBP Rule
Distribution System	Disinfectant Residual Monitoring Goal	Adopted	• Monitor disinfectant residual at bacteriological and DBP compliance sites, all active distribution system entry points, all storage tanks (preferably while draining), and at a minimum of four critical sites (one in each quadrant of the system) identified by investigative sampling. • Conduct monitoring at least monthly and more frequently during warmer weather.	American Water Works Association, 2013; American Water Works Association, 2017
Distribution System	Chloramination Process Monitoring Goal	Adopted	• Monitor free ammonia in raw water, prior to the addition of chlorine in the treatment plant, and in the plant effluent on a routine basis. Raw water should be monitored at least weekly and other locations should be monitored at least daily. The frequency of analysis at each location should be adjusted based on variability.	American Water Works Association, 2013
Distribution System	Nitrification Monitoring Goals	Adopted	• Monitor monochloramine, free ammonia, and nitrite at system entry points and in the distribution system (see *Disinfectant Residual Monitoring Goals* for locations and frequency). • Monochloramine and free ammonia should be monitored at all locations. • Nitrite should be monitored at samples locations where monochloramine is ≤ 1.50 mg/L; nitrate may also be monitored to further assess nitrification.	American Water Works Association, 2013

Performance Goals & Guidelines Summary

Category	Goal/Guideline	Status	Description	References
Disinfection By-Product	Plant Effluent Performance Goal	Adopted	• Adopt System Specific Targets: Discrete value or range based on a running annual average (RAA). Suggested goals may be 30% to 50% of long term locational running annual average (LRAA) goals (e.g., 20-30 ppb for TTHM, 15-20 ppb for HAA5).	WRF Project #4109
Disinfection By-Product	Enhanced Coagulation Performance Goal[1]	Adopted	• Meet Stage 1 D/DBP Rule TOC removal requirements for enhanced coagulation, which are based on source water alkalinity and TOC levels, or an alternative compliance criterion, as a RAA of the performance ratio (PR) (actual/required removal) plus a factor of safety of 10% (or PR ≥ 1.1).	Stage 1 D/DBP Rule
Disinfection By-Product	Disinfection Performance Goal	Adopted	• Meet CT requirements to achieve inactivation of Giardia and viruses plus a system-specific factor of safety.	U.S. Environmental Protection Agency, 2004
Disinfection By-Product	Disinfection By-Products Performance Goals	Adopted	• Individual Site Goal: Quarterly maximum LRAA TTHM/HAA5 values not to exceed 70/50 ppb. • Long-Term System Goal: Average of maximum LRAA TTHM/HAA5 values not to exceed 60/40 ppb (the average of the last 8 quarters cannot exceed 60/40 ppb).	*Under Development*
Distribution System	Disinfection Performance Goals	Adopted	• Maintain ≥ 0.20 mg/L free chlorine residual at all monitoring sites in the distribution system, at all times in systems that use free chlorine as a secondary disinfectant. • Maintain ≥ 1.50 mg/L monochloramine residual at all monitoring sites in the distribution system, at all times. In systems that use chloramines as a secondary disinfectant.	American Water Works Association, 2013; American Water Works Association, 2017
Distribution System	Chloramination Process Performance Goal	Adopted	• Maintain a detectable free ammonia residual in the plant effluent ≤ 0.10 mg/L as NH_3-N.	American Water Works Association, 2013
Distribution System	Chlorine and Ammonia Dosing Operational Guideline	Adopted	• Maintain a chlorine-to-nitrogen mass ratio between 4.5:1 and 5.0:1 (or chlorine-to-ammonia mass ratio between 3.7:1 and 4.1:1), which should result in a detectable free ammonia in the plant effluent that is ≤ 0.10 mg/L as NH_3-N.	American Water Works Association, 2013
Distribution System	Storage Tank Operational Guideline	Adopted	• Maintain an average turnover time < 5 days; or establish and maintain an acceptable water turnover rate at each storage facility to maintain water quality. • Maintain good mixing (i.e., PR[3] ≥ 1) at all times; for tanks where the PR cannot be calculated, adequate mixing (i.e., uniform water quality) should be confirmed by alternate means (e.g., tank profiling/water quality sampling).	WRF Project #284; Grayman et al., 2000

Footnotes:
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References:
[illegible]

Figure 1. Area-Wide Optimization Program Disinfection By-Product and Distribution System Goals

MAIN BREAKS/LEAKS CRITERIA - OUTPUT

Main Breaks and Leaks System-wide Summary Table	
Utility Name:	City of Jackson
Number of Occurrences/100 Miles of Pipe/Year:	
Average [1]	55.4
Minimum [2]	18.5 (2017)
Maximum [2]	71.0 (2019)
Number of Years:	
Analyzed	5
Criteria is Exceeded	5
Criteria is Not Exceeded	0
Since Last Exceedance	0
Annual Average Percent Change[1]:	-0.9%

Note 1. Annual Average Percent Change is the average annual percent increase or decrease based on the trend line shown on the 'Analysis' worksheet. of the trend line times 100.

2. Minimum and maximum show the value and year of occurrence in parenthesis.

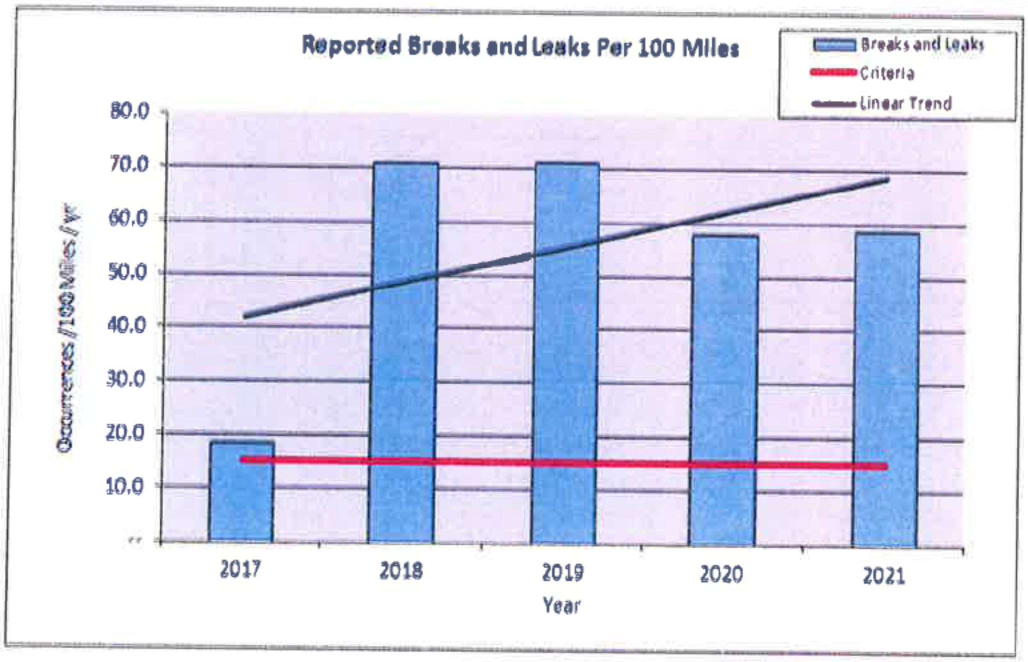


Figure 2. Line Break Assessment

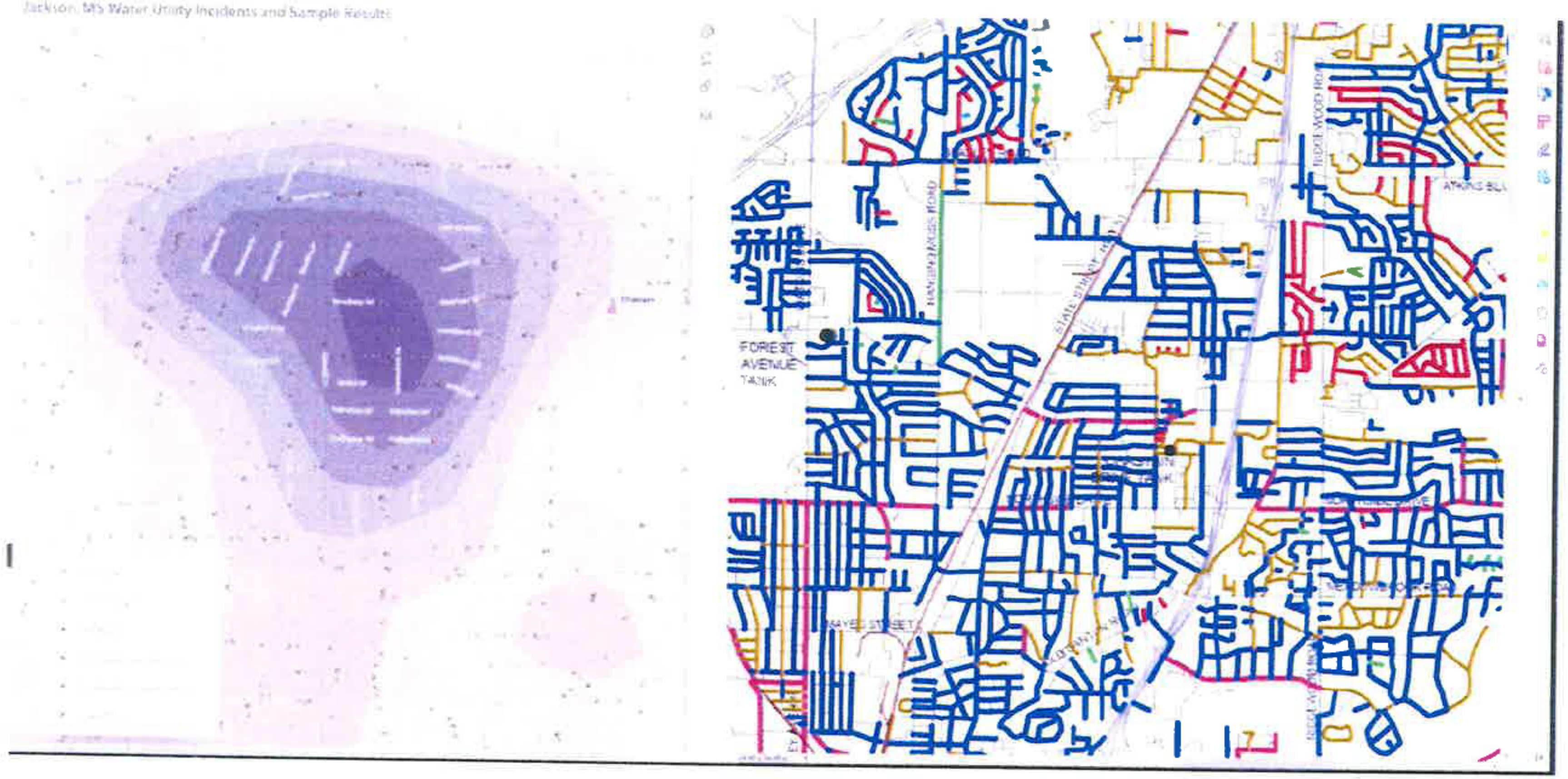
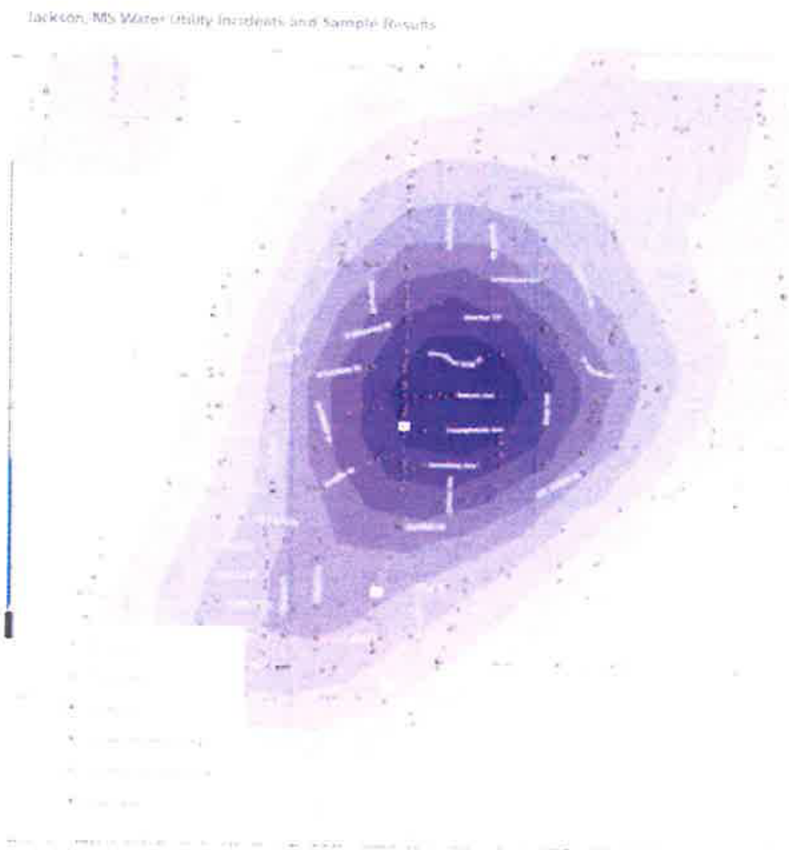


Figure 3. North Jackson Line Break Frequency (2017 through 2021)/Pipe Size Map



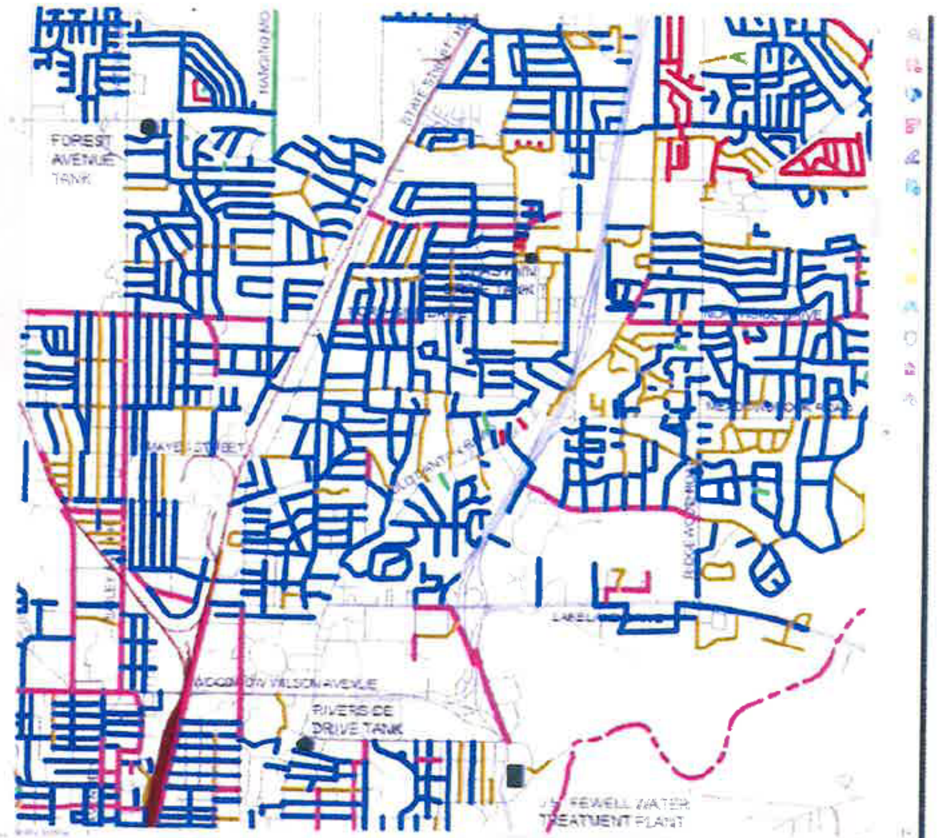
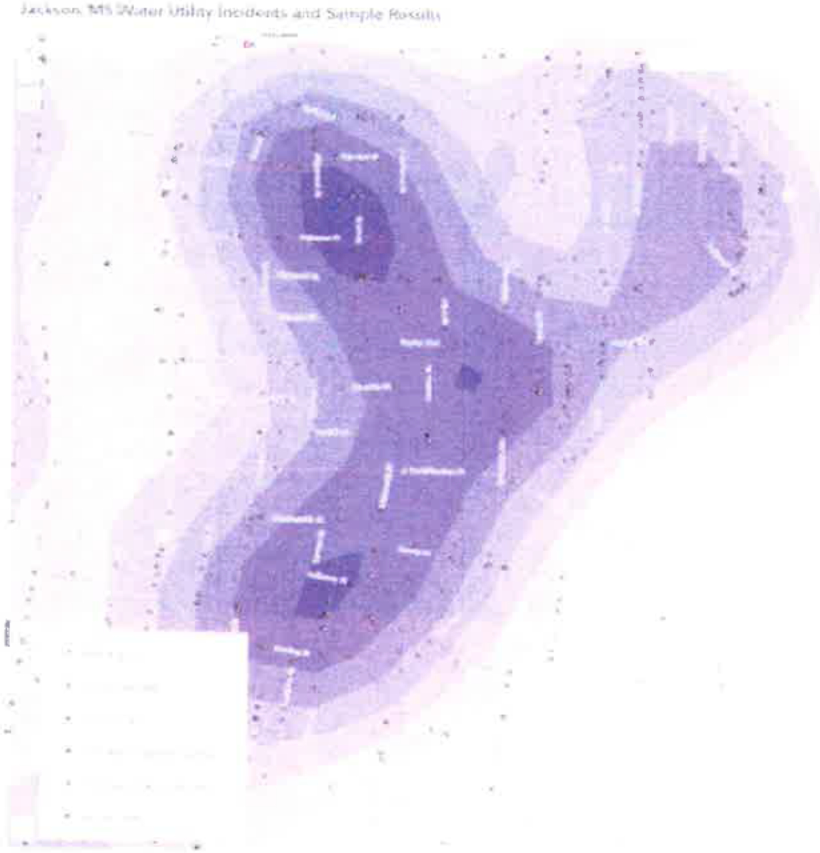


Figure 4. Seneca Street Area Line Break Frequency (2017 through 2021) /Pipe Size Map



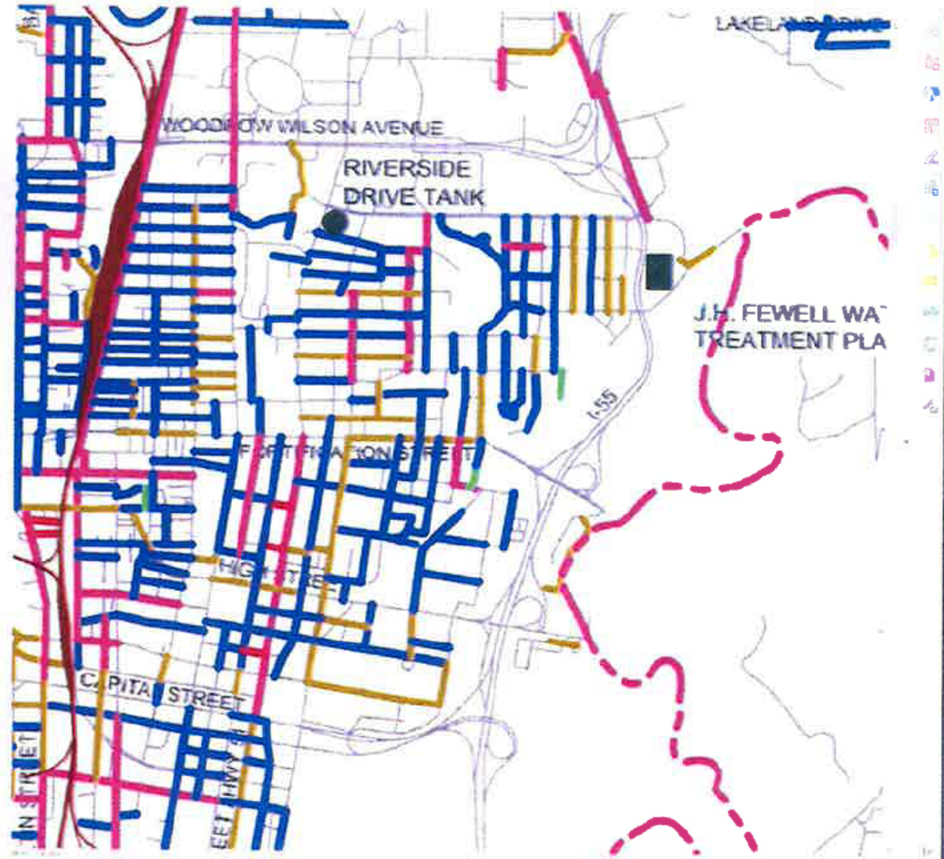


Figure 5. Fortification Street Area Line Break Frequency (2017 through 2021)/Pipe Size Map

Table 1. Jackson Storage Tank Performance Summary

Tank	Average Turnover Time (days)	Mixing Performance Ratio (Measured/Desired)
Chastain (Dec. 6 – 24, 2020)	5.9	0.97
Elaine (Dec. 6 – 21, 2020)	2.3	1.64
Forest (Jan. 2020 – Jan. 2021)	42.5	2.65
Northwest (Sep. 6 – Oct. 9, 2020)	7.6	1.18
Livingston Park (Dec. 6 – 22, 2020)	9.0	0.49
Riverside (Dec. 5 – 23, 2020)	7.7	0.72
Lynch (Dec. 6 – 22, 2020)	7.0	0.64
Suncrest (Jul. 1 – 16, 2020)	1.1	4.02
Mill St. (Jul. 1 – Aug. 27, 2020)	46.6	0.61
Mill Street (Dec. 1 – 30, 2020)	16	1.04
Magnolia (Jul. 1 – 9, 2020)	2.2	1.39
Magnolia (Dec. 5 – 14, 2020)	2.1	1.41
Byram	Out of service	
Presidential Hills (Jul. 2 – 16, 2020)	3.5	0.65
Presidential Hills (Dec. 6 – 11, 2020)	1.3	0.67
Groundwater System		
TV Road Collector	Out of service	
Maddox Road – Hwy18	Not analyzed	
Springridge (Summer)	11.7	0.75
Springridge (Winter)	TBD	TBD
Cedar Hills (Jun. 2020)	4.0	1.04
Cedar Hills (Nov. 2020 – Feb. 2021)	51	1.09

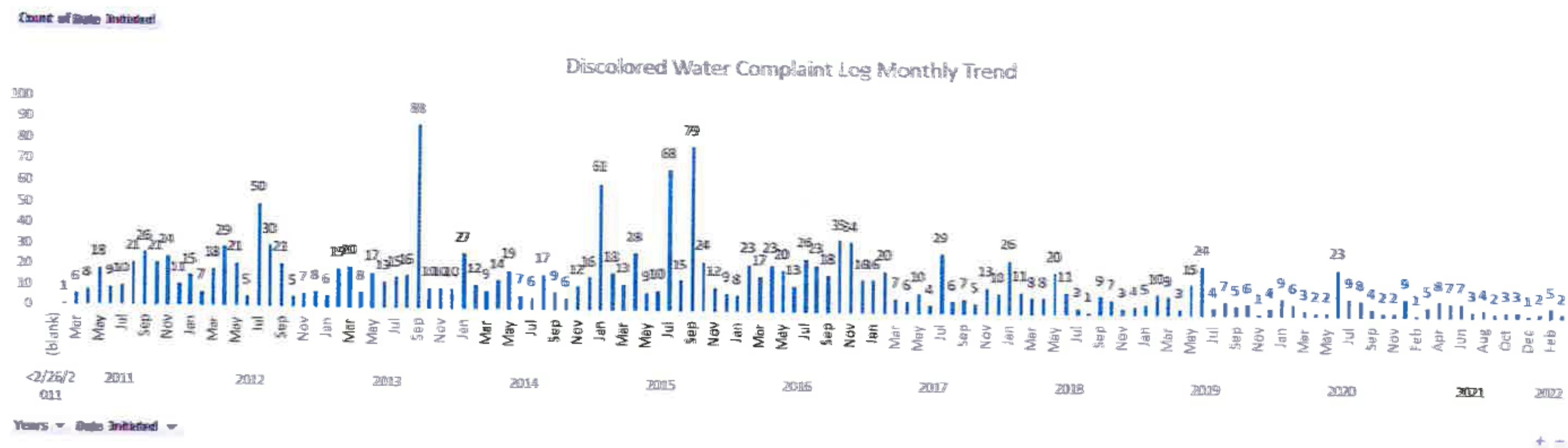


Figure 6. Long-Term Trend of Discolored Water Customer Complaints

Figure 7. Long-Term Trend of Low-Pressure Customer Complaints

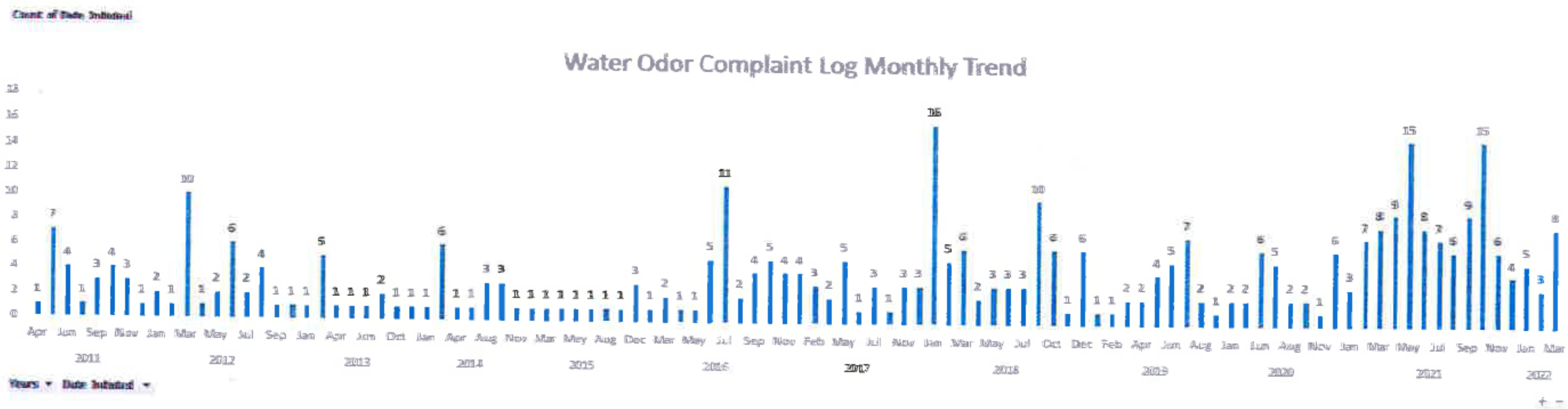


Figure 8. Long-Term Trend of Water Odor Customer Complaints

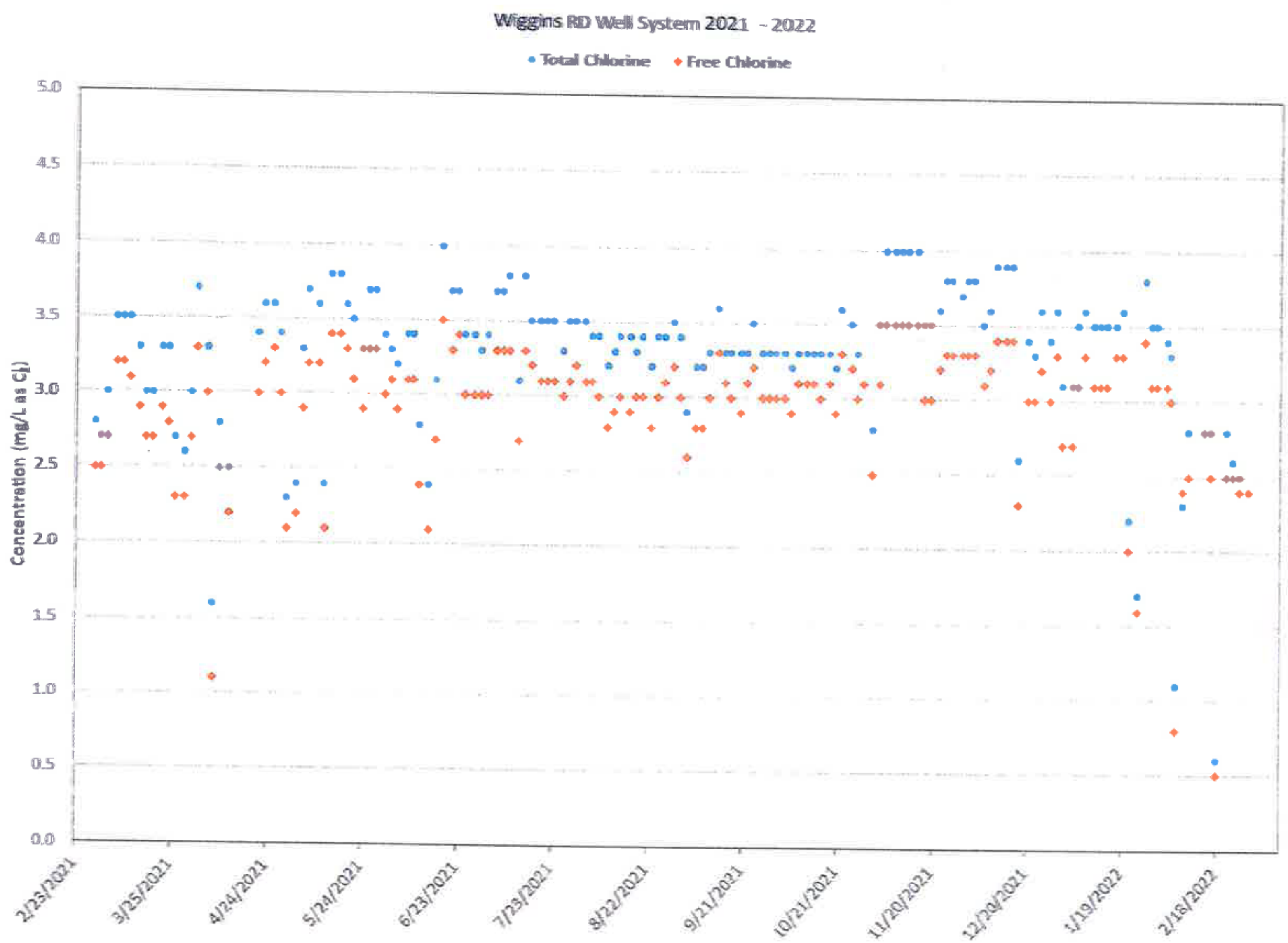


Figure 9. Long-Term Trend of Free and Total Chlorine Residual from Daily Monitoring at Wiggins Road First Customer Site

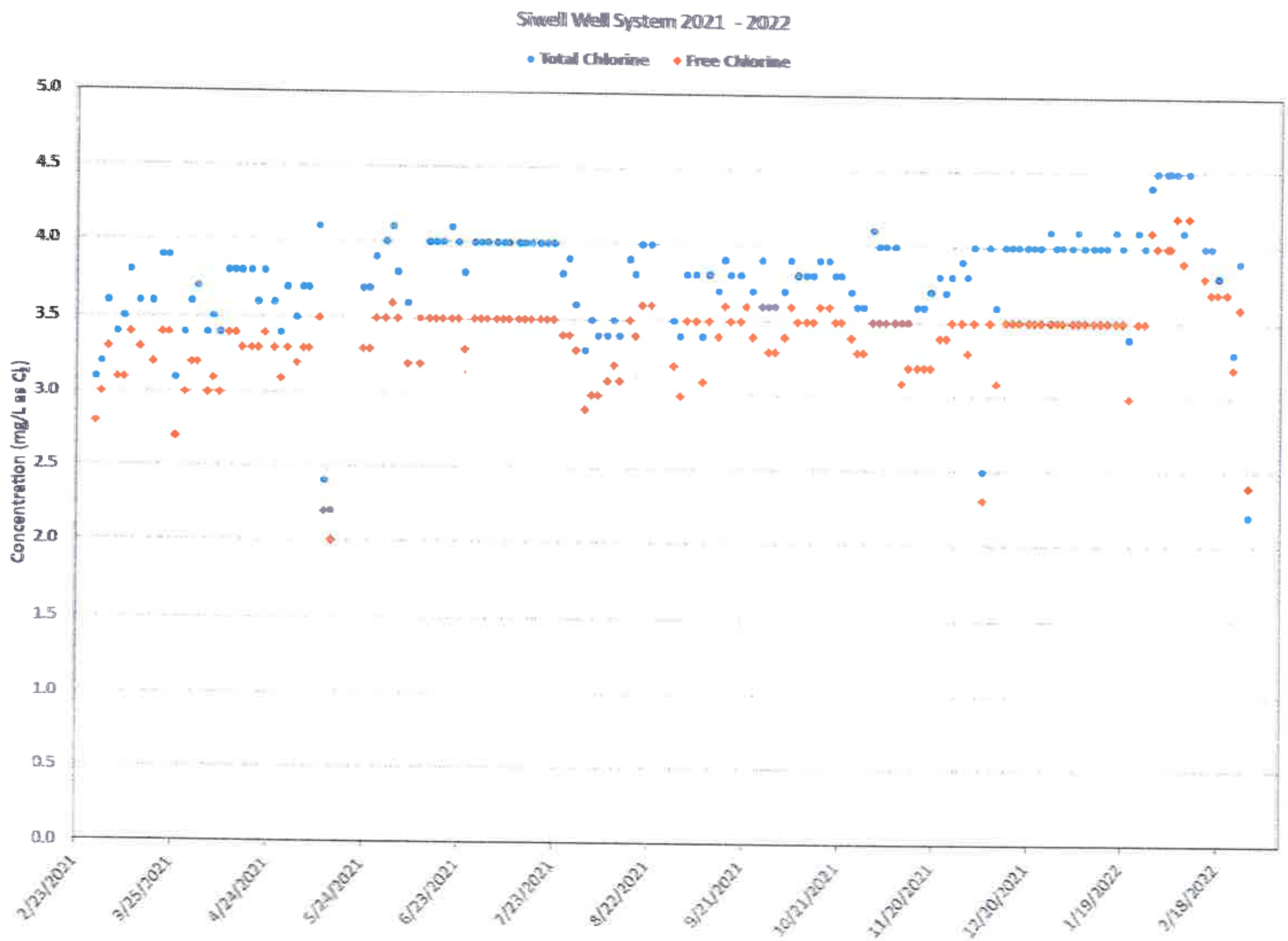


Figure 10. Long-Term Trend of Free and Total Chlorine Residual from Daily Monitoring at Siwell Road First Customer Site

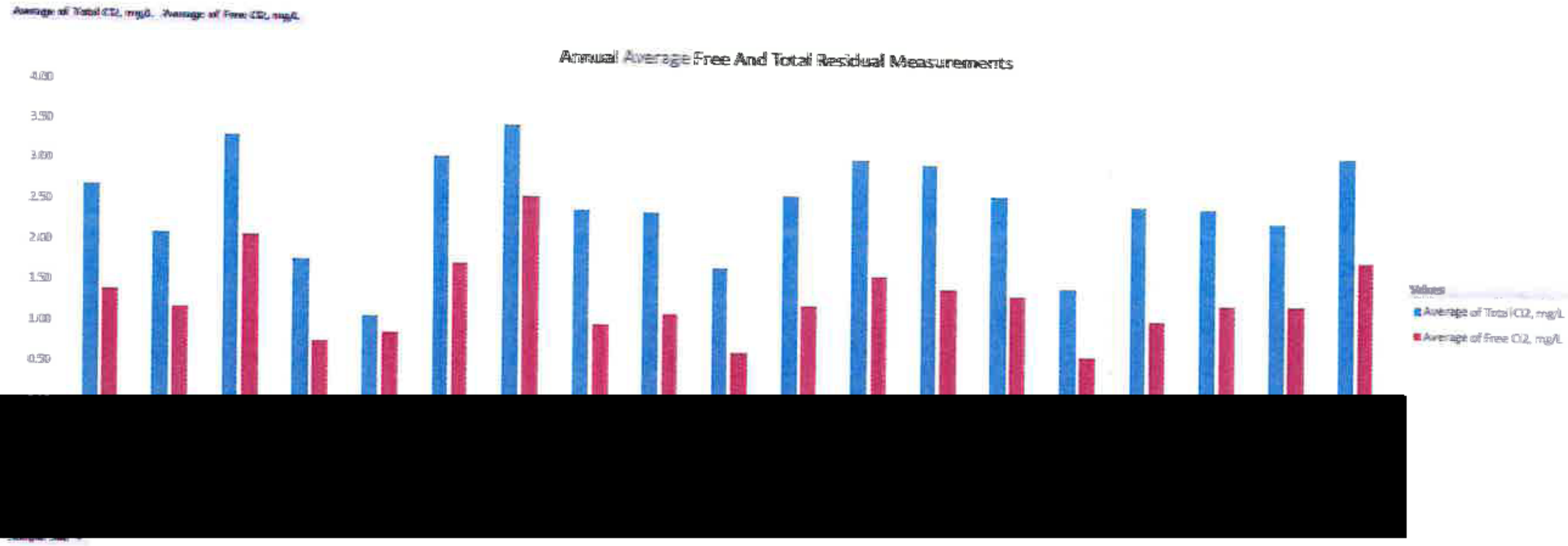
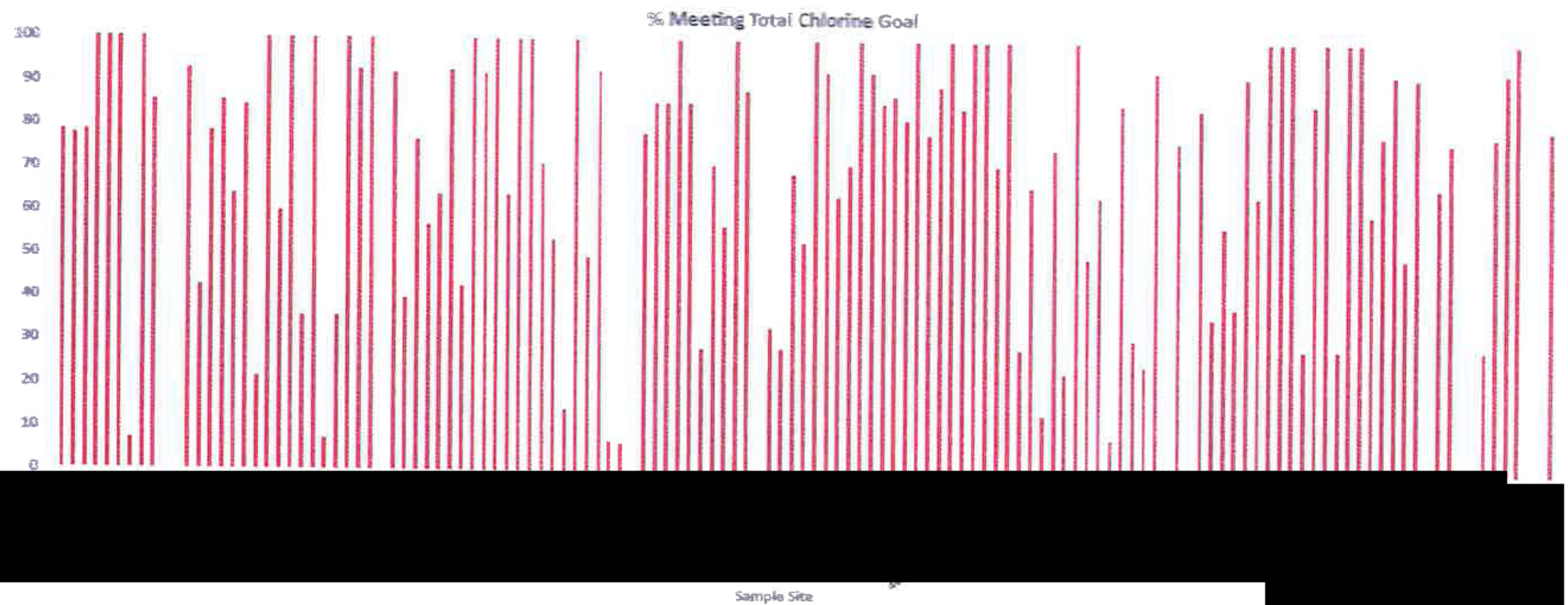


Figure 11. COJ GW System Distribution System Average Free and Total Chlorine Residual by Monitoring Location for the Year Preceding the Site Visit (January 2021 through December 2021)

[redacted]

Figure 12. Example of Average Difference Between Total and Free Chlorine Residual in the Groundwater Distribution System (January 2021 through February 2022).
(The larger differences are plotted in red and appear near the boundary with the surface water system.)



[redacted]

Figure 13. COJ Surface Water Distribution System Percentage of Monitoring Results Meeting the 1.5 mg/L Total Chlorine Goal by Monitoring Location (February 2018 through February 2022)

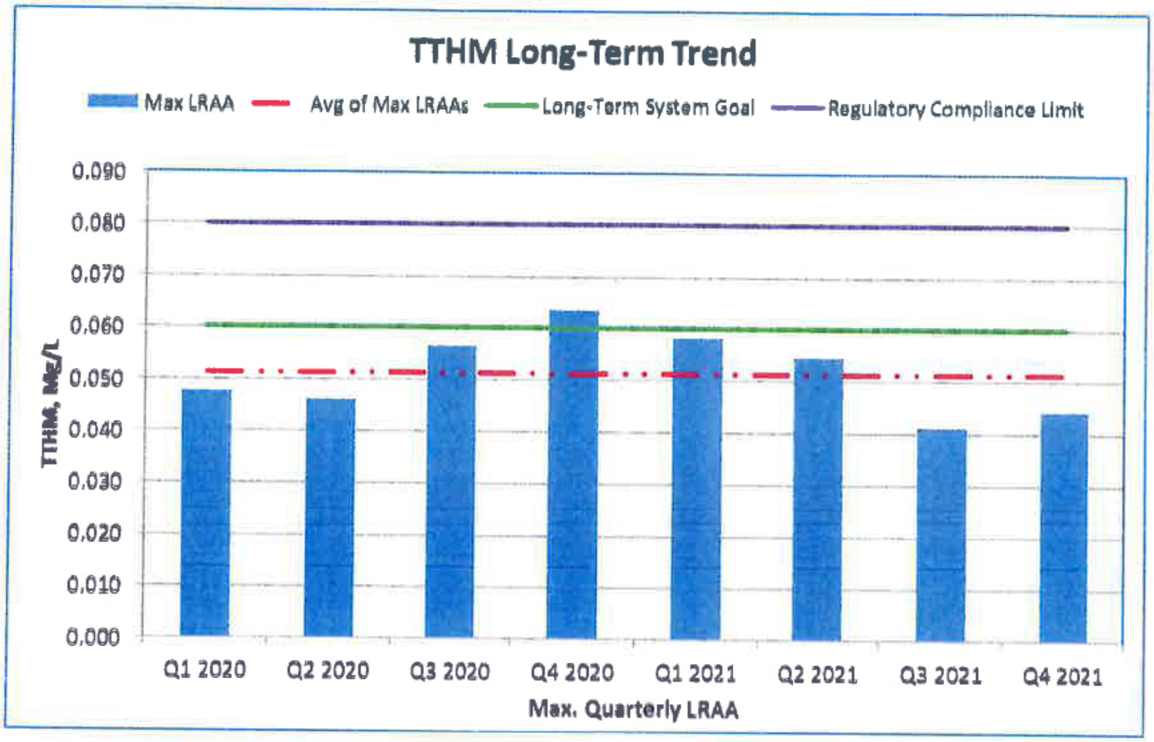


Figure 14. TTHM Long-Term Trend

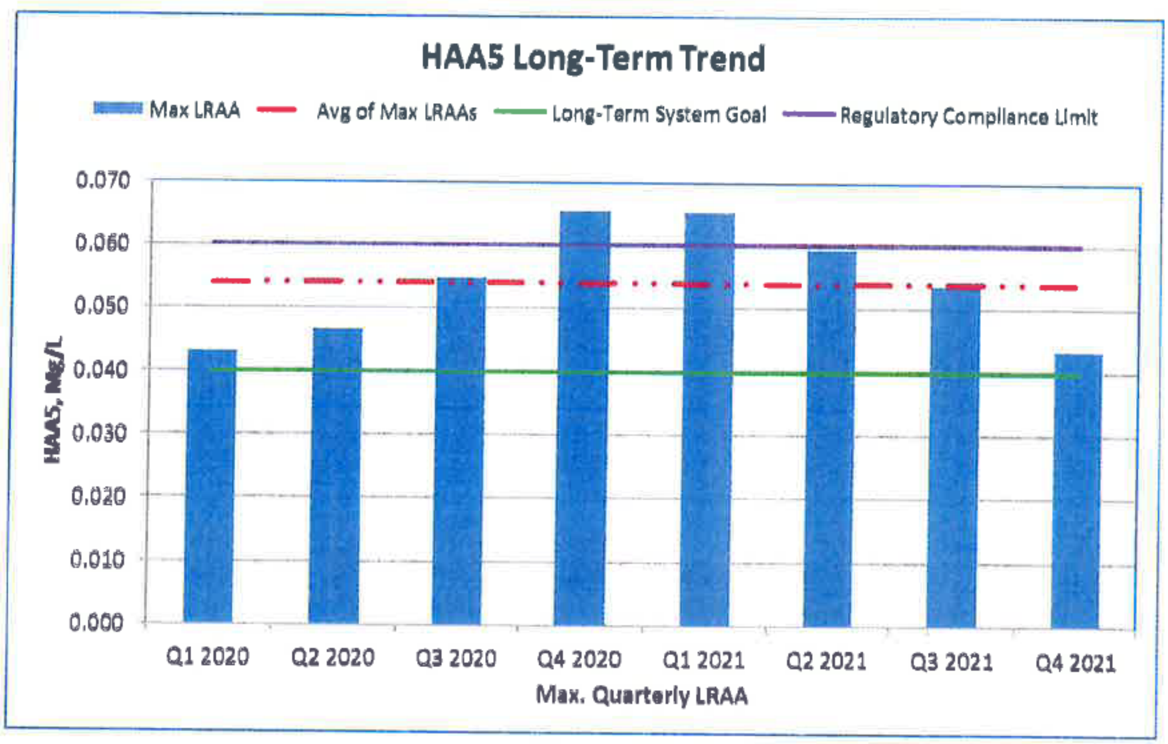


Figure 15. HAA5 Long-Term Trend

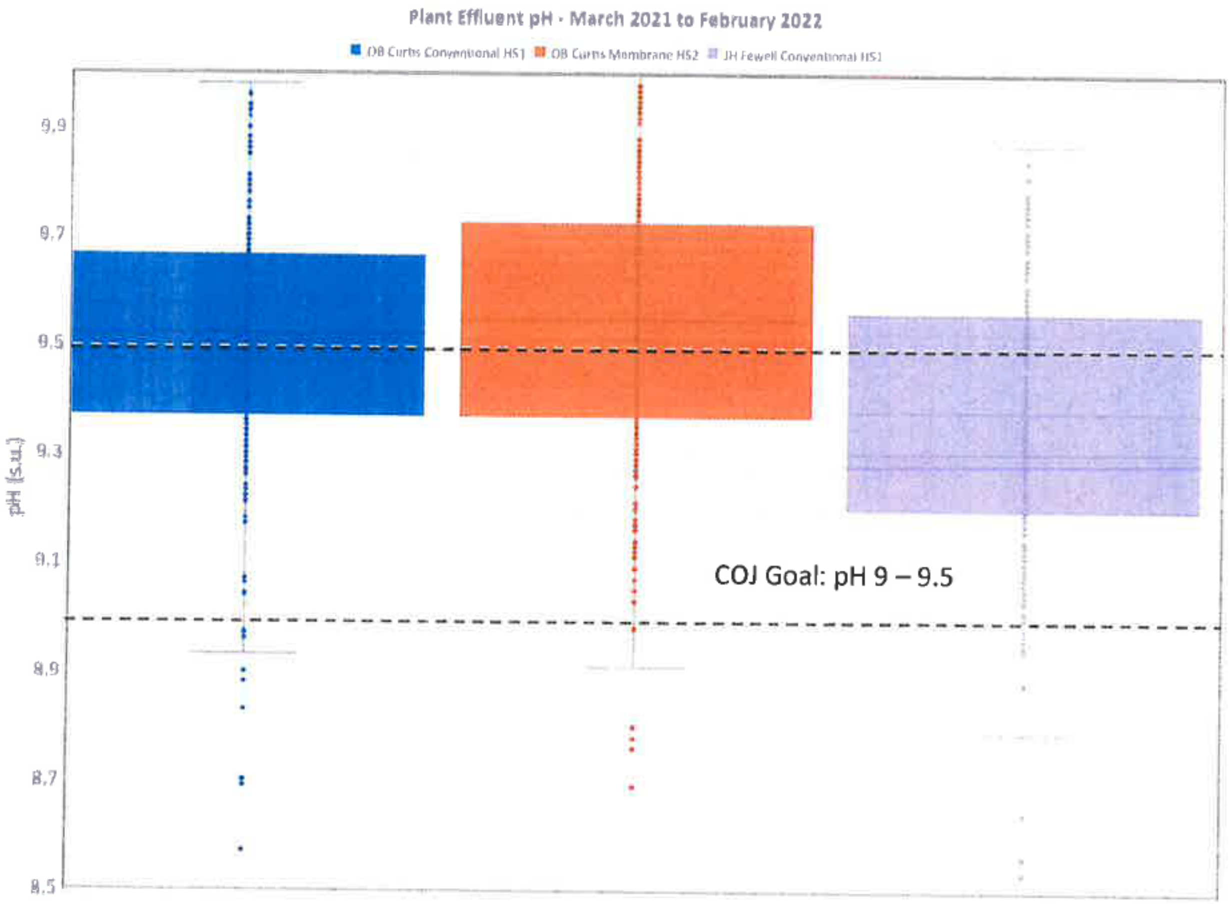
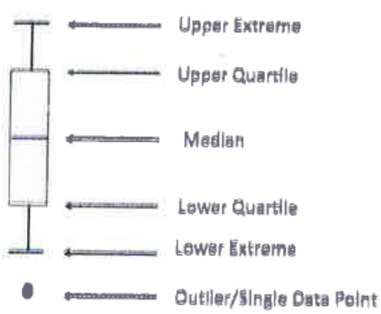


Figure 16. Plant Effluent pH Values from March 2021 through February 2022

Key to Reading Box and Whisker Plot Above:



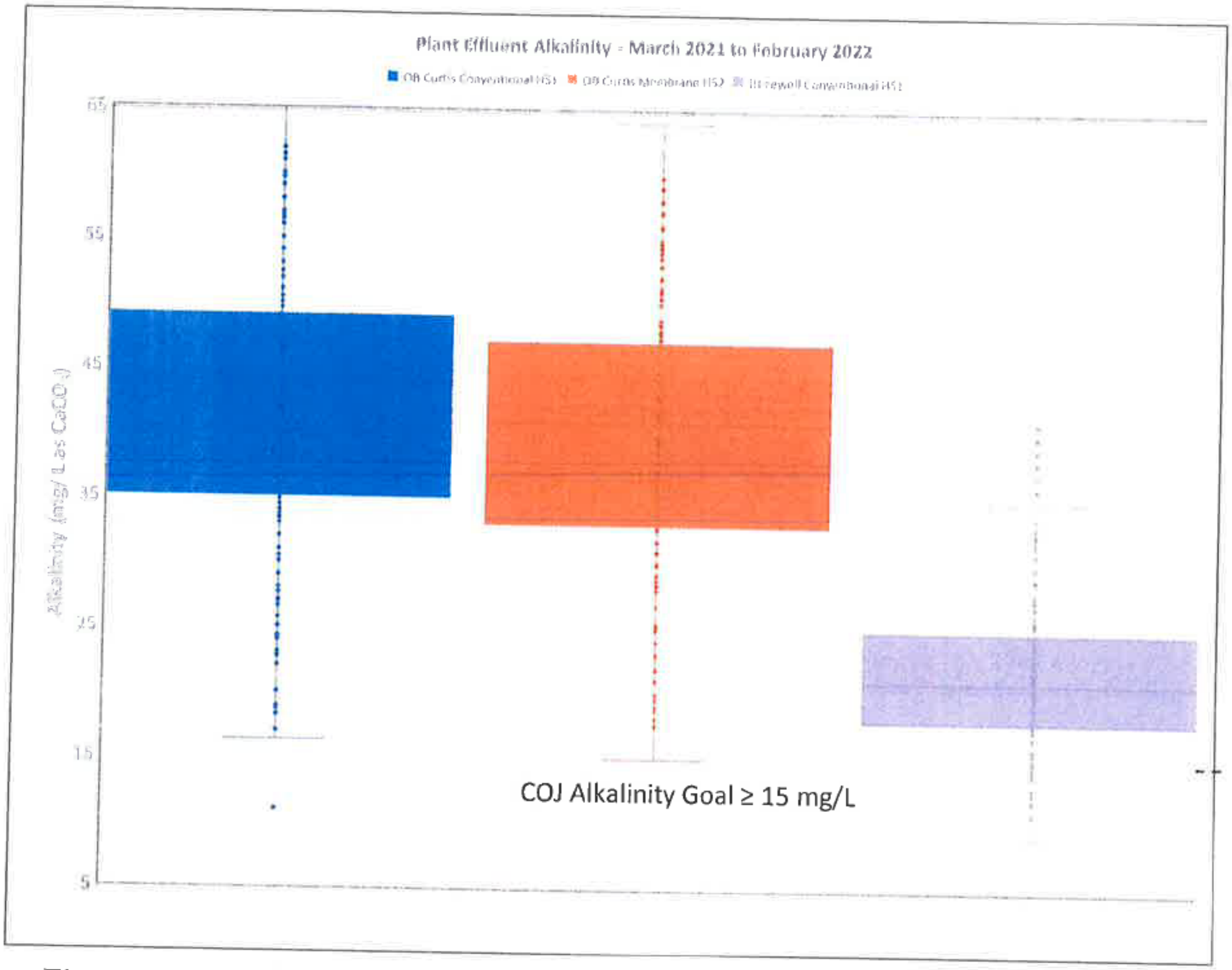
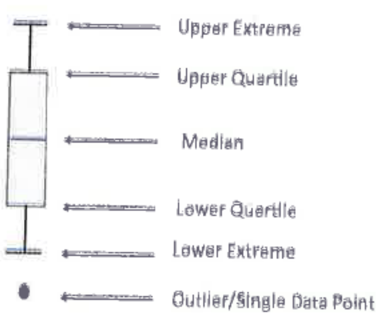
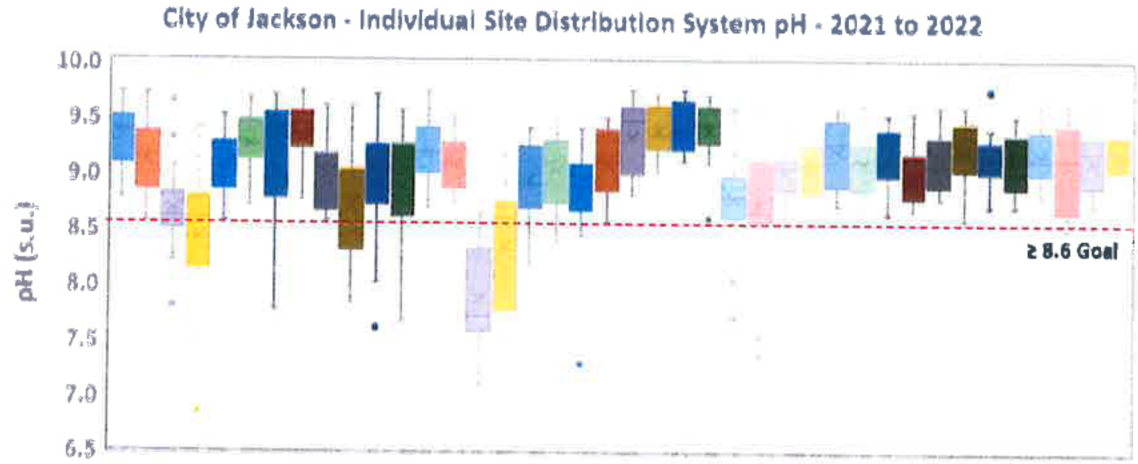


Figure 17. Plant Effluent Alkalinity Values from March 2021 through February 2022

Key to Reading Box and Whisker Plot Above:

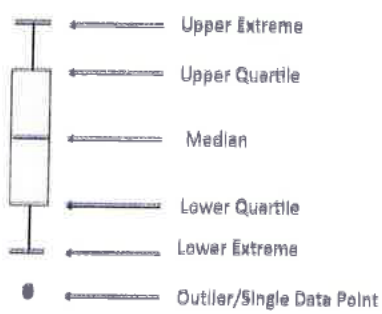


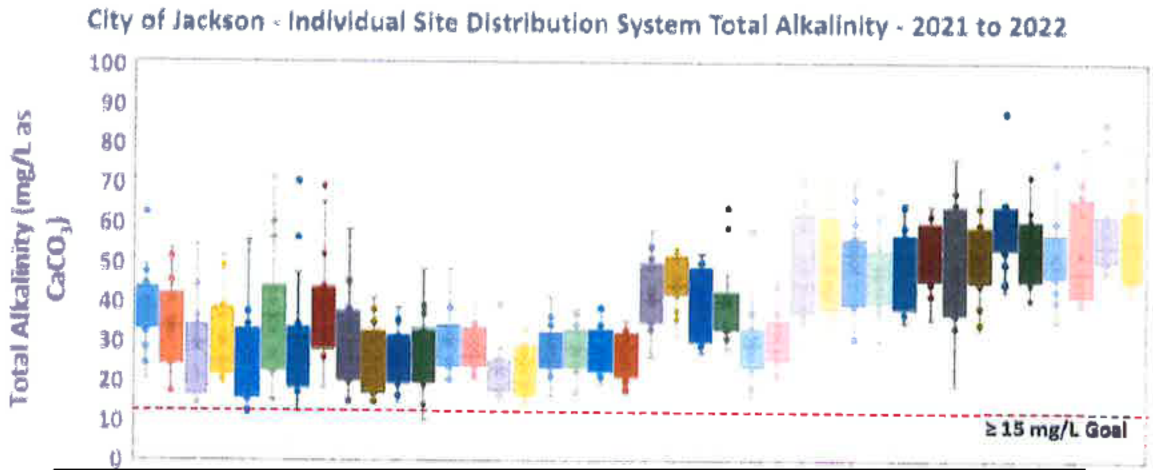


[redacted]

Figure 18. Distribution System pH Values from 2021 through 2022

Key to Reading Box and Whisker Plot Above:

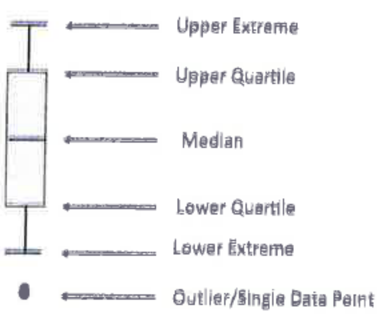




[redacted]

Figure 19. Distribution System Alkalinity Values from 2021 through 2022

Key to Reading Box and Whisker Plot Above:



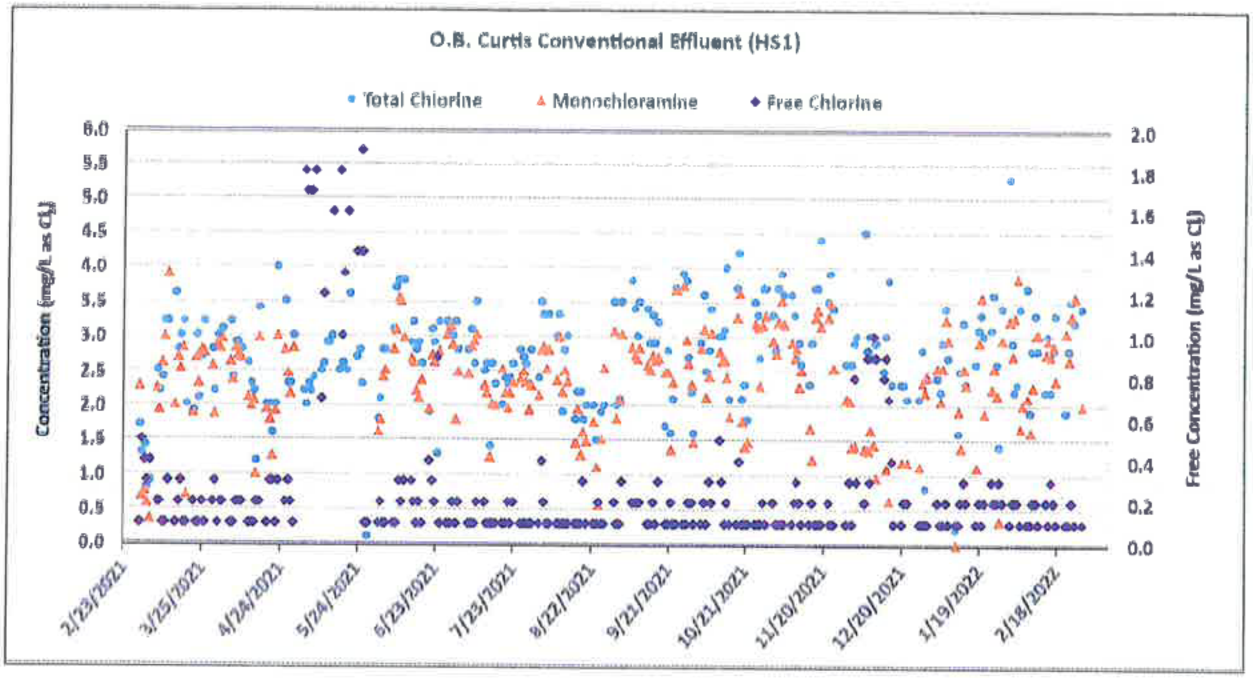


Figure 20. Curtis Plant Free, Total, and Monochloramine Residual Trend at the Entry Point

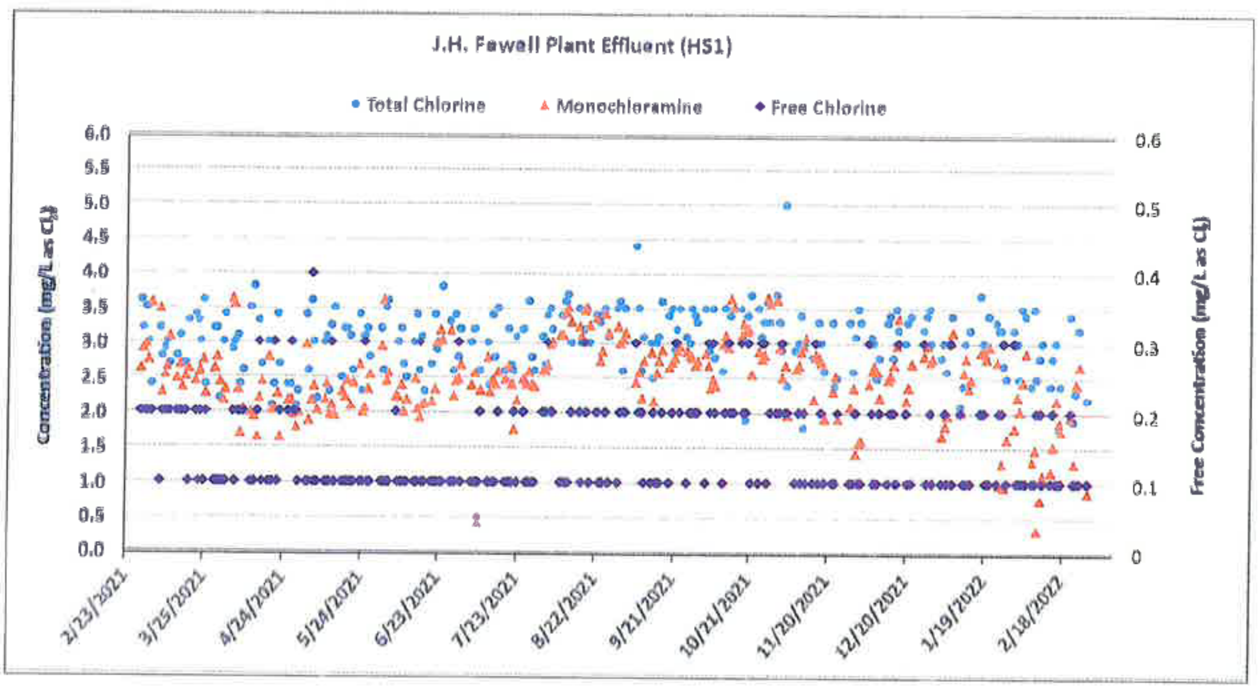


Figure 21. Fewell Plant Free, Total, and Monochloramine Residual Trend at the Entry Point

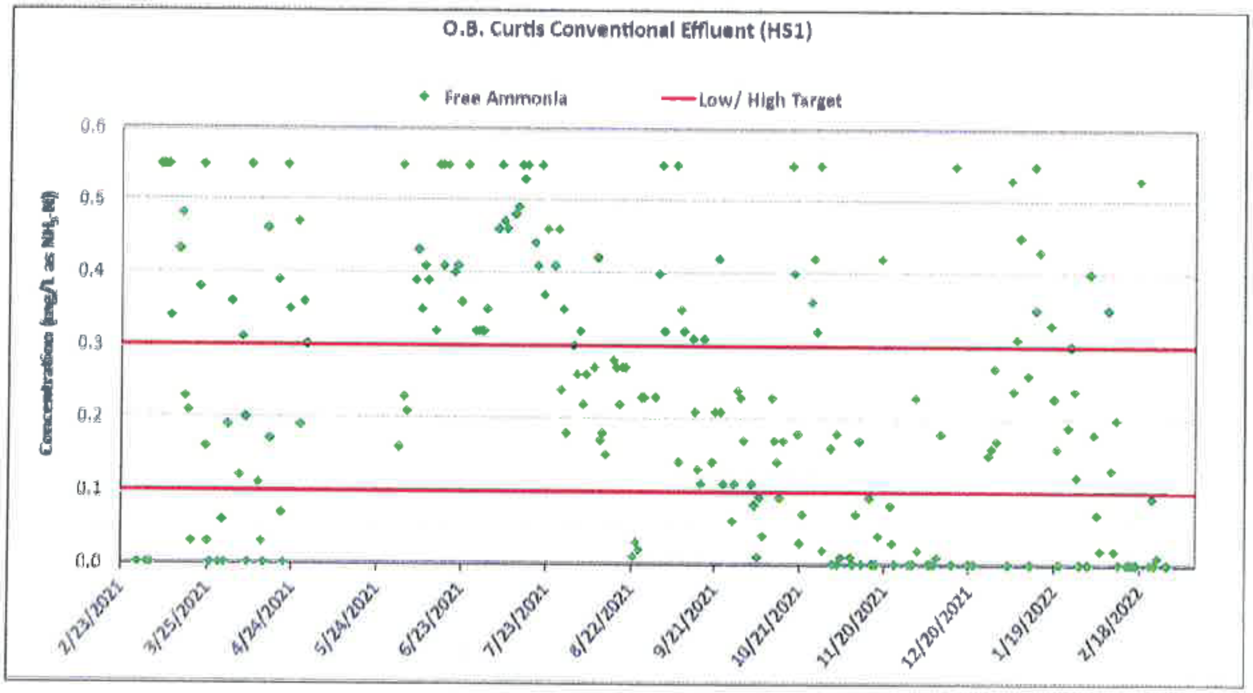


Figure 22. Curtis Plant Free Ammonia Residual Trend at the Entry Point

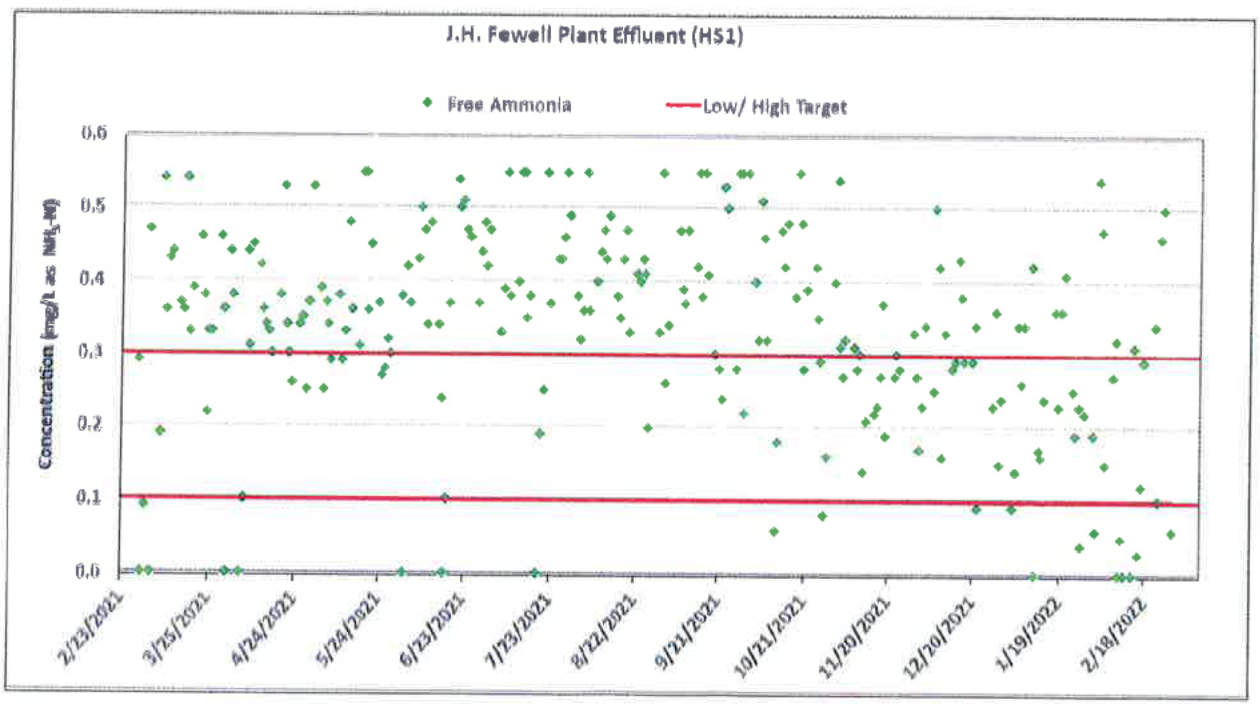


Figure 23. Fewell Plant Free Ammonia Residual Trend at the Entry Point