External Review of Austin Water Quality Events

January 2023

The University of Texas

Center for Water and the Environment

Austin Water (AW) currently operates three water treatment plants. Handcox, Davis and Ullrich water treatment plants (WTPs) have a combined capacity of 335 million gallons per day (MGD). These plants treat water from the Lower Colorado River to serve more than 1 million people in the Austin metropolitan area, which encompasses more than 548 square miles. AW has a long history of providing high quality water that meets national and state standards. Since 2018, however, several incidents have resulted in significant water service interruptions and/or created concerns related to either the quality or aesthetics of water delivered to AW customers. While several of the events affected all three plants, this review focused primarily on the Ullrich Water Treatment Plant (Ullrich WTP) and addressed the organization and management, operations, infrastructure, emergency response, communications, and power supply.

The most important observations are: 1) Ullrich WTP is capable of producing ~120 MGD of high-quality drinking water that meets national and state standards; and 2) the processes used at the Ullrich WTP to treat Lake Austin source water are appropriate for meeting all regulatory requirements for drinking water. The review also revealed areas of vulnerability with respect to maintaining and delivering high water quality during future events similar to those specifically identified by the City Council for assessment. Of particular concern, the review identified areas of weakness in AW's organizational structure and conditions at Ullrich WTP. This report provides recommendations that could improve AW's ability to protect public health by providing safe drinking water to the City of Austin residents during both normal operations and extreme events.

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Executive Summary

Objectives

The objective of this special request from the City Auditor was to review five past incidents, identified by the Austin City Council, in which AW failed to deliver potable or palatable (i.e., aesthetically acceptable) water to the City of Austin, to evaluate current conditions at the plants with respect to their ability to address similar events in the future, and to provide recommendations for improving resiliency. With regard to recommendations for capabilities that will be needed to promote more resilient water quality during future dynamic water source events, the team focused on the following underlying questions:

1. How does water quality produced by the watershed impact raw water quality entering the plant and create risk to water treatment, considering both normal and extreme (flood, fire, drought, storm, spills, etc.) conditions?
2. From an engineering perspective, is/are the plant(s) capable of handling this range of water quality?
3. From a staffing and organizational perspective, is AW positioned to operate the plant over the range of water quality conditions observed during normal operations and extreme events?

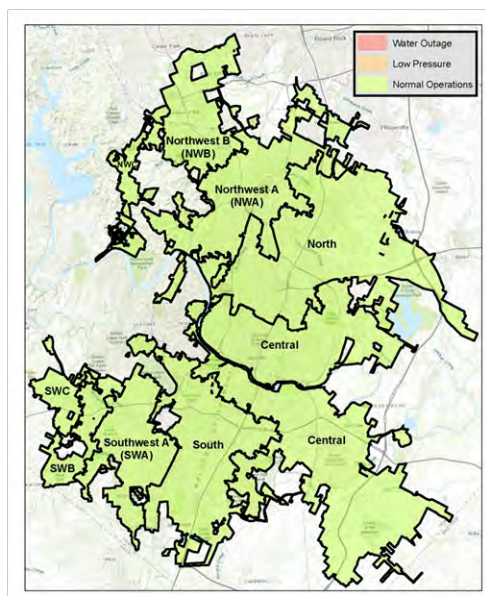
Background

In February 2022, following a Citywide boil water notice that affected water service, the Austin City Council passed resolution 20220217-060 directing the City to procure an external review to review the five most recent significant negative water quality events and water supply service interruptions. The goals were to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of our water system. The Austin City Council directed the City Auditor to select an independent third-party and manage the agreement.

Per the resolution, this review was to be conducted by an independent third-party nongovernmental entity or multidisciplinary team with expertise in the operation and management of large-scale water utilities. (Allowable exceptions included universities that may be a governmental entity.)

Austin Water System

Austin Water has been providing water and wastewater services for more than 100 years and today serves more than 1 million people in the Austin metropolitan area, across more than 548 square miles. The utility draws water from the Lower Colorado River into three water treatment plants—Handcox, Davis and Ullrich—with a combined capacity of 335 million gallons per day.

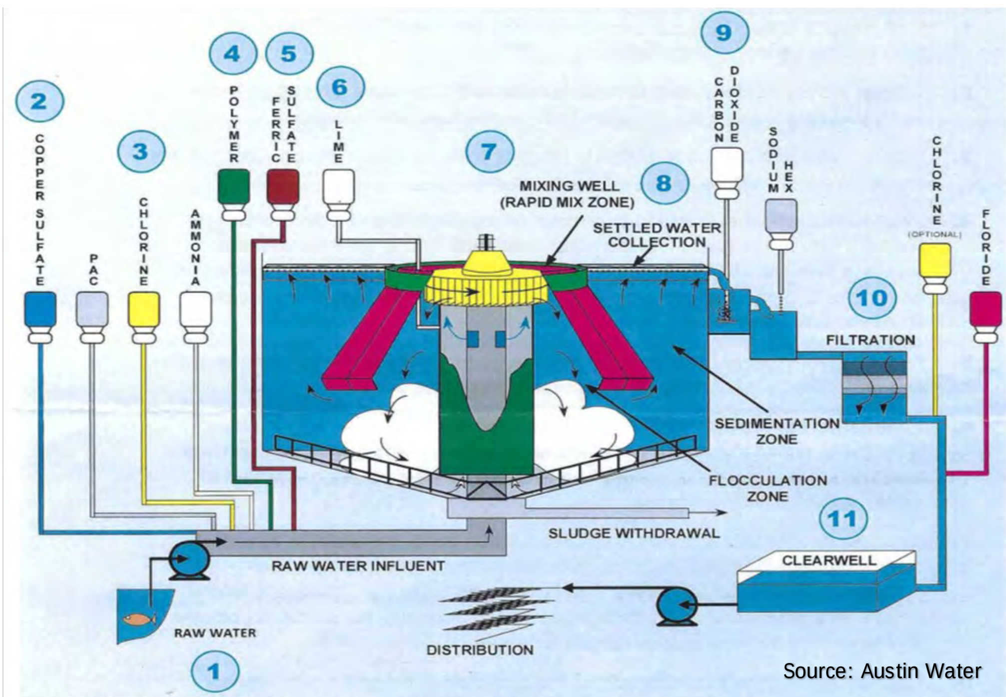


Source: https://www.austintexas.gov/article/winter-weather-after-action-report-and-resources

In Spring 2022, the Office of the City Auditor hired the Center for Water and the Environment (CWE) at the University of Texas at Austin to perform the review. A copy of executed Work Order No. 2022-01-UT-OCA, Under Master Agreement No. UTA19-000382, is provided in Appendix 1-B. The University formed a team comprised of university researchers and independent consultants with expertise in the areas of water quality, water treatment and operations, emergency response, communications, and energy operations (see Appendix 1-D).

The primary focus of the investigation and assessment was on Ullrich WTP, due to the limited time frame of the project and the minimal potential for value added by assessing all three WTPs. Ullrich WTP was at the center of three boil water notices and a zebra mussel event, which are four of the five events identified by the City of Austin. A fifth incident, in which fire foam entered the water distribution system, was not associated with operations of any of the WTPs. Therefore, a detailed investigation of Ullrich WTP provided the most relevant information for assessing WTP operations. In addition, a number of the findings and recommendations for Ullrich WTP are generalizable to the other plants, and the team included recommendations that are applicable to those other plants as well.

Water Treatment in Austin



Austin Water's three water treatment plants utilize the same treatment process train and chemicals, one designed to meet the Environmental Protection Agency's primary drinking water rules and regulations under the Safe Drinking Water Act and those established by the Texas Commission on Environmental Quality. The primary goal of these rules and regulations is to produce water that protects human health by limiting the levels of contaminants in drinking water (USEPA, 2022).

Because the Lower Colorado River water source for the plants carries hard water (i.e., high levels of calcium and magnesium salts), the water is prone to producing scale in pipes, boilers and water heaters. Thus, a key secondary goal for AW is to remove hardness using a lime softening process that promotes precipitation, settling and removal of hardness containing solids. These solids are also responsible for entrapping and removing turbidity causing particles (e.g., bacteria, silt, organic matter) that are present in the raw untreated source water.

Summary

The treatment processes at the plant are appropriate for Lake Austin water quality, current watershed monitoring is appropriate for a large water utility, and the plant produces water of consistent quality that meets national and state standards during normal operations. As designed, the lime softening/conventional filtration treatment train used by Ullrich WTP is well suited to treat the moderately hard, high alkalinity water of the Lake Austin source. A review of process performance data and treated water quality over multiyear periods highlights the consistency of these processes. However, water treatment plants are not typically designed to treat the most extreme water quality conditions that may occur over the life of a plant. Our review of Ullrich WTP performance indicates the plant was unable to successfully treat water during extreme turbidity[1] conditions, which historically occurred approximately 0.1% of the time in Lake Austin. In other words, as designed, the Ullrich WTP has demonstrated its ability to treat Lake Austin water for over 99.9% of the time.

Although modifications have been made over the past several years (e.g., addition of polymer systems) to improve resiliency during extreme conditions of high turbidity, further effort should be made to develop contingency plans, emergency response plans, and operational strategies for optimizing the processes under varying water quality scenarios. Under such scenarios, successful operation of the plant may require reduced water production, additional staffing, and additional strategies for solids handling management. A review of the historical data suggests that the low likelihood of occurrence of extreme turbidity events may not warrant major modifications to the plant infrastructure; rather the focus should be on short-term reduced water production and operational adjustments to the existing treatment processes.

The water quality issues at the AW treatment plants (boil water events and the zebra mussel event) cannot be attributed to a single cause and were not all specific to Ullrich WTP. While the corrective actions arising from the After Action Reports (AARs) are improving flood preparedness, power backup alternatives, and control of zebra mussels, a number of barriers remain that hinder Ullrich WTP's ability to consistently deliver high quality water to the City of Austin in the future and during extreme events. These barriers fall within the areas of organizational conditions that include structure and management, human resources, communication (internal and external to AW), and capital improvement processes. These limitations directly affect the plant's ability to respond effectively to emergencies, maintain and upgrade infrastructure, prepare for emerging potential source water quality issues, and recruit, train and retain staff. Several issues are not under the control of AW and must be addressed at the City level.

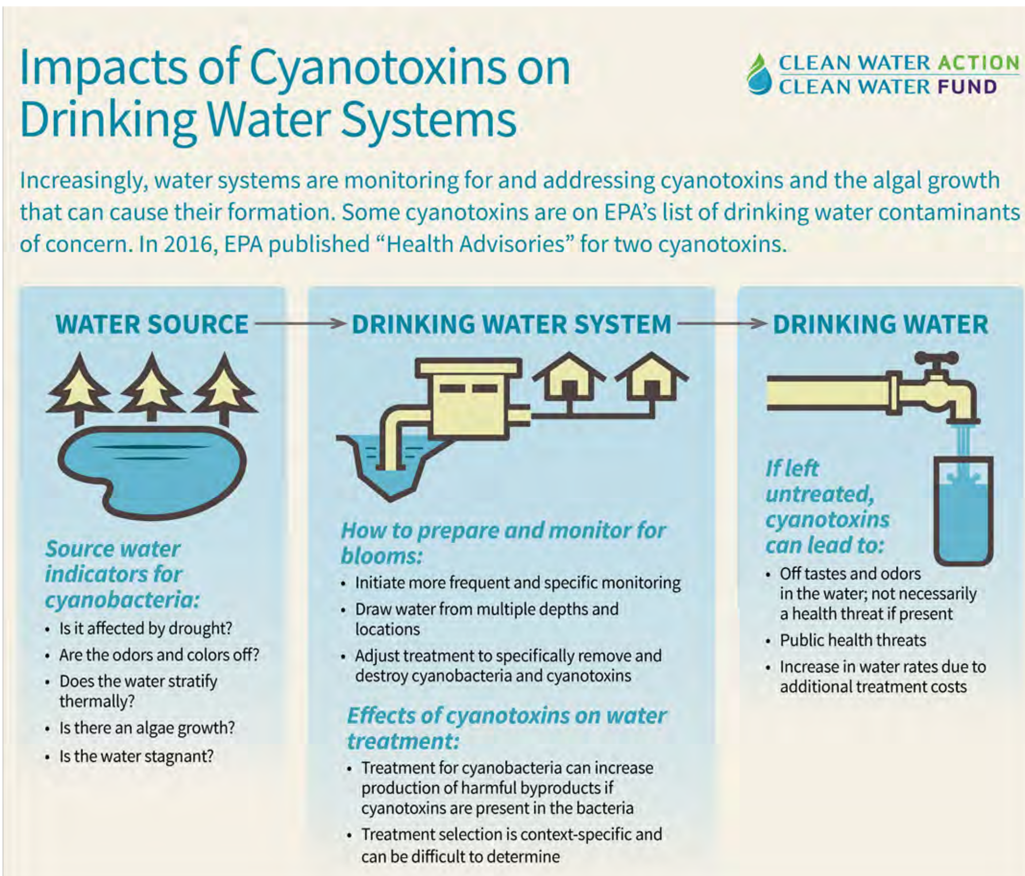
[1] Turbidity is a measure of the 'cloudiness' of water caused by small particles in water. The unit of measure for turbidity is nephelometric turbidity unit abbreviated as NTU.

Question 1

How does water quality produced by the watershed impact raw water quality entering the plant and create risk to water treatment, considering both normal and extreme (flood, fire, drought, storm, spills etc.) conditions?

Because of regional limestone bedrock geology, Lower Colorado water quality is very consistent. In only a few cases have exceptional conditions changed the water quality to the point of impacting AW's ability to provide water to the City of Austin. Lake Austin water quality can be characterized as moderately hard (due to the dissolution of calcium and magnesium ions

Evaluating Emerging Concerns: Cyanotoxins



Source: https://cleanwater.org/harmful-algal-outbreaks-and-drinking-water

Cyanotoxins are produced by certain cyanobacteria (blue-green algae) in warm, nutrient abundant water and pose health risks in drinking water. While WTPs such as Ullrich can remove cyanobacterial cells and low levels of cyanotoxins from source waters, other conventional treatment plants have been challenged when extreme algae blooms occur. AW began testing for cyanotoxins in 2015 and has not had a detection of cyanotoxins above the EPA health advisory level in either the raw water or treated drinking water. Nevertheless, AW has enhanced treatment protocols over the past two years based on EPA guidance, and a recent report from consultants provides a treatment optimization protocol for AW to implement.

from limestone, dolomite, and other minerals present in the bedrock) and high in alkalinity (containing carbonate and bicarbonate ions that provide resistance to changes in water pH). Review of water quality data over a 12- to 22-year period (depending on the selected water quality parameter) showed relatively consistent values for the raw water (i.e., untreated lake water from the Lower Colorado River that serves as the intake water to the water treatment plants) parameters that are critical to performance of Ullrich WTP, including turbidity, total organic carbon, pH, total hardness, and alkalinity. However, short-term anomalies of watershed conditions that deviate excessively from the expected water quality conditions may occur during flooding and droughts and can impact turbidity. The primary water quality deviations observed to affect Ullrich WTP process operations are characterized as high turbidity events with increased total organic carbon and decreased alkalinity and calcium concentrations. Even during such events, Ullrich WTP has consistently produced water meeting all regulatory requirements, regardless of raw water quality, with the only exceptions occurring during the 2018 storm event and the 2022 boil water event. The 2022 Boil Water event was not related to WTP source water quality (i.e., the water from the Lower Colorado River). Since lime softening relies on the presence of calcium and carbonate based alkalinity to precipitate calcium carbonate solids and these components of the raw water are reduced during intense storms, efforts to improve operational strategies should include studies by AW to evaluate the risks of more frequent and intense storms. A possible means to mitigate the challenges of dramatic changes in water quality due to upstream storm and flooding events would be to coordinate with LCRA to manage releases into Lake Austin during major storm events.

The Watershed Protection Department (WPD) in the City is responsible for the major efforts to protect Lake Austin. The City's watershed protection ordinance, the main vehicle for managing the small watersheds within the City's jurisdiction, is very detailed and addresses watershed impacts in the framework of a zoning ordinance. LCRA also manages a water quality program that includes sampling for Lake Austin. In addition to the changes in alkalinity, turbidity, and total organic carbon content of the water that have been observed during flood events, other changes in water quality produced by invasive species, urban development, wildfires as well as changes in regulations of known or emerging contaminants should be proactively monitored. AW is involved in ongoing efforts to address such concerns. One example relates to possible cyanotoxins in Lake Austin. Other emerging concerns include wildfires, perfluorinated contaminants ("forever contaminants"), expanded regulation of certain disinfection by-products, and microbial contaminants such as *Legionella*.

The City of Austin (and therefore AW and WPD) does not control the upper watershed beyond Lake Austin. The WPD works to influence decisions arising around wastewater permits beyond those near Lake Austin, but Austin's impacts in the arena of water quality further out from the City are limited. LCRA is responsible for forecasting the impacts of development on water quality over time and focuses on changes in land use that may affect the quantity and quality of runoff into the local water bodies.

Question 2

From an engineering perspective, are the processes capable of handling this range of water quality?

Overall, the infrastructure at the Ullrich Water Treatment Plant is properly designed and should have sufficient capacity to treat raw water from Lake Austin at the design flow rate. The existing Ullrich WTP processes (including lime softening, filtration, and chloramine disinfection) are well-suited for the moderately hard, highly alkaline water typical of Lake Austin. The quality of finished water (i.e., water served to AW customers for consumption) is independent of raw water turbidity 90 percent of the time. While raw water turbidity ranges from 6 NTU to 20 NTU 90 percent of the time and does not exceed 20 NTU 99 percent of the time, the facility produces finished water that is less than 0.3 NTU 99.99 percent of the time. This analysis shows that the 2018 flooding event, which created raw water turbidity values higher than 300 NTU (as reported in the AAR), represents a less than 0.1 percent occurrence. The addition of the polymer system to Ullrich WTP (and to the Davis and Handcox WTPs where the installations of polymer systems are underway) provides additional protection against loss of performance under very high turbidity conditions. Further studies may provide additional options for increasing robustness. It is beyond the scope of this review to assess whether the level of risk of another event as extreme as that observed in 2018 warrants additional changes to the AW infrastructure that could make the plant even more resilient to increased turbidity, high total organic carbon, and low alkalinity and hardness. However, further assessment of potential risks and associated costs for further risk reduction should be considered because the analysis of plant performance during the 2018 extreme event (high raw water turbidity, low alkalinity and hardness, and high total organic matter) suggests that, even with the polymer systems in place, the water treatment plants in Austin may be unable to remove sufficient turbidity at design flow rates under a similar future scenario. In such instances, significant reductions in finished water production would be necessary if it is not possible to generate enough calcium carbonate solids to produce the dense, settleable solids that the Ullrich WTP clarifiers are designed to separate from the water. During the 2018 flood, Davis WTP did reduce flow significantly and operators reported that they were able to maintain water quality.

The assessment of Ullrich WTP infrastructure also included an analysis of each process at the plant and concluded that the plant processes are capable of meeting current water quality standards at the design flow rate of 167 MGD. The upflow clarifiers are quite effective at removing hardness from the water by producing calcium carbonate (and magnesium hydroxide) solids. These solids effectively entrap suspended particles (e.g., silt, bacteria, clays) in the raw water and reduce turbidity. The filtration system operates adequately to remove the remaining turbidity from the water to levels that meets national and state standards. The chlorine and chloramine systems offer sufficient disinfection, and the high pH associated with lime softening yields minimal disinfectant decay within the distribution system, even for areas of the city with long water ages. It should be recognized, however, that the plant typically operates at approximately 35 percent of capacity and has rarely operated above 120 MGD. As a result, the facilities have not been evaluated or optimized at design flow rates. Future stress tests of the system to evaluate and continuously optimize process operations are needed.

Critical to the successful operation of the plant is the solids handling facility that removes settled solids from the clarifiers and dewaters the solids before truck transport. The centrifuge system, a major component of the solids handling system, is used to dewater the solids from the lime softening clarifiers. Both dewatering centrifuges are past their useful life, and each machine has been repaired multiple times. While the centrifuge system operates as intended, its age and condition have made it very maintenance intensive. Moreover, the extensive maintenance required for the dewatering systems demands significant time and energy from operations and maintenance staff. Staff identified these as historical issues, and projects to address them have lagged. Implementation of improvements recommended by recent studies to rehabilitate/replace the existing system are pending. Most recently, a preliminary engineering report (May 2020) for the solids dewatering system included an evaluation of the existing system and facilities and provided recommendations for rehabilitation, but more rapid progress is needed on the upgrades to these facilities.

With respect to facilities for emerging concerns, AW has implemented a treatment system that deters zebra mussel settlement in the plant infrastructure, and a report addressing enhanced protocols for treatment of cyanotoxins has been completed that demonstrates proactive assessment of a potential emerging contaminant.

Finally, while the facilities are adequate for providing high quality, safe water to the City of Austin, and while the critical importance of Ullrich WTP for providing water to South Austin is evident through the dedication and commitment of the staff at Ullrich WTP, effective operation of a treatment plant as complex as Ullrich WTP requires a full complement of operators, a better-trained staff, ready access to standard operating procedures, and coordination among staff, supervisors and managers at Ullrich and across AW.

Ullrich Water Treatment Plant Processes

Source: Austin Water

State of the Water Industry (SOTWI)

The 2022 American Water Works Association (AWWA, 2022) SOTWI report ranked aging workforce the No. 4 challenge for the water sector and talent attraction and retention the No. 11 challenge. Other challenges included retention of institutional knowledge, operator certification, mentorship, pay scales, and compensation. Pay scales are often based on certification levels.

TCEQ Water Operator Certification Requirements

Class	Education	Experience
Class D	H.S. or GED	No work experience
Class C	H.S. or GED	2 yrs experience (1 yr hands-on & 1 yr in specific license field)
Class B	B.S related discipline	2.5 yrs "hands-on" experience, (1.25 yrs in specific license field)
	H.S. or GED	5 yrs of experience (2.5 yrs "hands-on" and 2.5 yrs in specific field of certification)
Class A	M.S.related discipline	4 yrs experience in public water system operations (all hands-on)
	B.S related discipline	5 yrs experience in public water system operations (all hands-on)
	H.S or GED	8 yrs experience in public water system ops. (6 yrs hands-on)

In 2021, EPA spearheaded a national initiative to address the issue. EPA awarded grants to 10 organizations to "help build the water workforce and connect individuals to water careers." As an example, AWWA in partnership with the WaterNow Alliance has developed the Transformative Water Leadership Academy that will graduate its first cohort in 2023.

Question 3

From a staffing and organizational perspective, is AW positioned to operate the plant over the range of water quality conditions observed during normal operations and extreme events?

The review team's analysis of organizational structure, management, staffing and communications revealed a serious disconnect between upper management's efforts to improve operations across AW and the engagement of Ullrich WTP staff in these efforts. The nationwide challenge associated with recruitment and retention of water treatment plant operators is evident in Austin, and it has hindered preemptive assessment of facilities, staff training, and retention of operational knowledge at Ullrich WTP. These issues must be addressed for AW to improve its ability to provide high quality water during extreme events and plan for future water treatment challenges.

Reliable and consistent water treatment plant operations require effective leadership and staffing at all levels that are horizontally and vertically aligned with organizational goals. The organizational structure must have clearly defined roles and responsibilities at all levels of the organization, include the necessary job functions to ensure continual and effective operations, allow for efficient communication and dissemination of information, and be staffed with people who have the experience, skills and competencies needed to operate and maintain the plant during both day-to-day and atypical operating conditions. Moreover, strong resource management and continual staff development are essential to ensuring efficient response to extreme events that affect operations, as well as proactive facility maintenance, staff training and long-term planning for emerging contaminants, water quality changes, and potential regulatory changes.

During this review both effective leadership and adequate staffing at Ullrich WTP were identified as areas of concern. For instance, two superintendents at the plant are focused individually on maintenance and on operations, but a global, singular head of the treatment plant team does not exist.

The operating and maintenance teams are divided, and morale is low. Currently, the unfilled positions at the plants range from 28 to 30%, putting AW at higher risk when emergencies require additional staff capacity. Understaffing also creates safety concerns at Ullrich WTP when operating teams are reduced to only two staff members.

At present, training of new and existing staff is too dependent on what each person can learn from a limited number of more experienced staff through "on the job training". AW has initiated a program that has a dedicated trainer for operations at each plant; development of a sustainable, strong, and consistent training plan and then implementing it will take time and commitment of experienced operators, engineers, and supervisors. Continual staff development is essential to ensure efficient response to extreme events that affect operations, as are proactive facility maintenance, staff training, long-term planning for emerging contaminants and water quality changes, and potential regulatory changes.

Interviews with Ullrich WTP personnel revealed a perceived inattentiveness to the day-to-day needs of the plant by senior management. Concerns include poor compensation, frustration over the lack of effective training, inconsistent availability of standard operating procedures, and time required to obtain capital improvement funding and execute capital projects at the plant.

Some of these problems may be related to the current AW organizational structure, which poses challenges to efficient internal communications, emergency response, and attention to plant needs. The current organizational structure is quite wide and flat; however, Austin Water is a highly complex City department with geographically dispersed employees (e.g., across multiple plant and office locations), and undergoes a great deal of public scrutiny. Such public attention requires high degrees of collaboration, and would likely benefit from a narrower span of control (e.g., no more than 1:5 direct reports per supervisor). The current number of reports under the Operations Assistant Director position, for example, potentially inhibits prompt and effective response in emergency situations. Additionally, there exists a disconnect with efforts at the executive level (e.g., scenario planning, system for following standard operating procedures (SOPs)) and the operations occurring at lower hierarchical levels (e.g., limited scenario training for plant staff, inaccessible SOPs).

Responses made, to date, to the previous events or atypical operating conditions have led to improved public communication during extreme events. A number of aspects of communication have been added or refined, including the use of social media, more consistent use of multiple languages in messaging to the public, and communications training, all of which are imperative for promoting end-user voluntary compliance regarding the water received and protecting human health. Internal plant communication deficiencies were also identified that highlight the need for improvement in this area as well. Austin Water made all regulatory notifications in compliance with TCEQ requirements; however, the review team concluded that the process for notifying the public has some inherent delays that may be related to notification protocols within the city management. It should be noted that AW did meet reporting timeframes required by TCEQ for all of the events. Delays in notification or escalation may be exacerbated by not following the existing protocol that outlines internal notification thresholds, which may be due to lack of operator familiarity with the Risk Reporting Guidelines. The current reporting structure also hinders timely response; the Director should have a direct line to the City Manager's Office.

What We Recommend

The review generated over 50 recommendations that the team considered to be important for improving operation and resiliency of the plant, response to extreme events, organizational management of AW, and staff engagement. The recommendations also addressed improving communication both within AW and with the Austin community. Of highest priority are recommendations related to staffing. Hiring and retaining staff at base levels is needed to facilitate many of the other organizational and managerial challenges at the Ullrich WTP. The most pressing resiliency gap is that the organization lacks the staffing capacity to handle extraordinary impending, immediate, and ongoing events. This overarching need is essential for the success of other recommendations that relate to staff training, scenario planning and infrastructure stress testing, increased preventive maintenance, improved accessibility to standard and emergency operating procedures, watershed management planning, and improved power resiliency. A complete list of recommendations is provided in Appendix 2-G.

Why We Did This Report

This special report responds to a request from the Austin City Council regarding Austin Water's five most recent significant negative water quality events and water supply service interruptions.

Project Type

This project is considered a non-audit project under Government Auditing Standards and was conducted in accordance with the general standards (Chapters 1-4).

External Review of Austin Water Quality Events

1 Introduction

The City of Austin City Council (Council) requested a review of Austin Water (AW) following several incidents that impacted the City's safe water delivery. A team of experts, gathered under the aegis of the University of Texas Center for Water and the Environment (CWE), completed a review of a wide range of documents, data, interviews with AW staff, and site visits to review five incidents selected by the City Council and gain an understanding of the current operating and management conditions at the utility. The recommendations offered in this report arise from the information reviewed. A copy of the Austin City Council Resolution, the work order prepared by the Office of the City Auditor, and the CWE scope of work for the project can be found in Appendices 1-A, 1-B and 1-C, respectively. In addition, the members of the review team and their affiliations are provided in Appendix 1-D.

This report summarizes the major issues identified in the review conducted by the project team and provides recommendations with respect to these issues for consideration by the City and AW. The intent of the recommendations is to provide a suggested path forward for improvements that AW may implement.

1.1 Description of Austin Water

AW is a large municipal water utility that operates similarly to a large, complex company. A primary function of AW is to deliver safe drinking water on demand, every day, 24 hours a day, to more than 1 million people across the Austin metropolitan area. To accomplish this goal, the three AW treatment plants pump approximately 140 million gallons of water per day (about 125 gallons per day per capita) to the distribution system, which includes 44 pump stations, 38 water reservoirs, and 3,800 miles of water mains. Another primary function of AW is proper wastewater collection and treatment for the entirety of Austin; while Ullrich WTP has no control over this area, it is important to note when discussing the events of Winter Storm Uri.

All the treatment plants receive very consistent quality raw (untreated) water delivered by pumping from the Lower Colorado River to the plants. The typical raw water is characterized as moderately hard, high alkalinity and relatively low turbidity. Turbidity is one of the key metrics used to infer removal of bacteria and other harmful particles in water. Raw water from the Lower Colorado River contains suspended matter such as clay, silt, natural organic matter, and microorganisms. Disinfection (typically with chlorine compounds) is one of the primary goals of water treatment. However, some organisms, such as protozoa, are not effectively removed by chlorine or chloramines. Removal of protozoa relies on particle removal processes. The metric that AW and regulatory agencies use to measure particle removal at the plant is turbidity, which is akin to cloudiness and is measured in Nephelometric Turbidity Units (NTU). In addition to aesthetic impacts, turbid water is more likely to harbor harmful bacteria and viruses. A primary goal of safe drinking water treatment is to remove turbidity and possible microorganisms. A secondary goal of water treatment in Austin is to remove hardness, which is aesthetically unacceptable to most customers and causes scaling in pipes within both the distribution system and premise plumbing.

The treatment process combination of lime softening, filtration, and chloramine disinfection is appropriate for the Lower Colorado River water characteristics. The Handcox Water Treatment

Plant, AW's newest WTP (2014), draws water from Lake Travis and has a current capacity of 50 million gallons per day (MGD). The Davis Water Treatment Plant is the oldest of the three plants (in service since 1954), draws water from Lake Austin, and has a capacity of 118 MGD. Ullrich Water Treatment Plant, located further downstream, draws water from the tail end of Lake Austin near Tom Miller Dam. It is the largest of the three plants and the primary focus of this report.

The rated treatment capacity of Ullrich WTP is 167 MGD. However, operations have historically limited process flows to less than 120 MGD, as typical distribution system demands are less than 120 MGD and increasing treatment requires labor and time intensive equipment and infrastructure transitions that are infrequently used. Ullrich WTP is similar to the other two AW treatment plants, Davis and Handcox WTPs, in that all employ the same types of water treatment processes. Ullrich WTP is a more complex plant (relative to the other WTPs) to operate; there are seven clarifiers (i.e., treatment basins) that operate as separate entities with respect to chemical doses and mixing. The number of clarifiers in operation at any given time depends upon maintenance status and the City water demand. If the water quality in the source water to the WTP changes significantly, treatment adjustments must be implemented across all operating clarifiers by a three-person operating team (at times comprised of only two people). These operators are on the front line of providing drinking water to Austin, making good decisions about treatment under changing operating conditions, and they require support, training, and resources to maintain and perform these critical tasks.

Once the water is treated at each of the three WTPs in the system, it must be distributed to customers. This is accomplished by pumping water through many miles of pipes and storage facilities that deliver water to customers. The distribution system operates across several elevations across the city, and to maintain water delivery, different pressure zones are set within the distribution system to manage water flow. Fifty percent of water from Ullrich WTP is piped to pressure zones south of the Lower Colorado River, and 50% is piped to the central zones around downtown Austin. Much of the southern half of the water system can be supplied only by Ullrich WTP because the piping, pumping, and pressure zone systems limit the amount of water pumped from the central zones produced by Davis WTP or Handcox WTP to reach the southern system.

When the southern half of the city requires more water than is currently safely available from storage (some stored water is always reserved for fighting fires), the AW Pumping Division notifies Ullrich WTP staff that more water is needed and the operations staff acts to increase flow, which may require bringing additional clarifiers online. When the extra supply is no longer needed, clarifiers are taken offline, adjusting to the new demand levels. These changes must be managed by the two- or three-person teams mentioned above.

All the Austin WTPs use a lime softening process to produce drinking water, and a significant amount of sludge (lime and water) is produced in the water treatment process. The sludge must be dewatered and hauled from the treatment plants on a regular basis; there is no permanent sludge storage at the plants, and sludge is not typically discharged to the wastewater system. If sludge dewatering and hauling is disrupted, water production at Ullrich WTP (as well as the Davis and Handcox WTPs) will be greatly decreased or cease entirely if sludge cannot be properly managed. This requires that maintenance and operating staff pay close attention to the equipment involved in all aspects of sludge handling.

Ullrich WTP differs in significant ways from the Davis and Handcox facilities. First, Davis and Handcox are smaller facilities. Handcox is similar in design to Ullrich but has only two clarifiers;

it is relatively new, and it is less complex to operate. Davis WTP performs lime softening with a single process train for coagulation and flocculation, followed by a split in flow to eight long rectangular settling basins. This configuration creates less impact to operations staff when treatment rates must be adjusted than does the operation of the Ullrich WTP clarifiers. Ullrich WTP has undergone several expansions over the years, which contributes to differences in the clarifiers and their responses to treatment adjustments. This diversity in clarifier response requires close attention to water quality and operating conditions, which can be challenging for a two- or three-person operating team.

Within the utility, staff must act in concert to maintain consistent water delivery. The teams at each water plant are critical to the success of water production and delivery. Historically, AW has accomplished this mission without interruption, consistently delivering high quality drinking water in accordance with state, federal and industry standards. The recent disruptions to delivery of safe drinking water to City of Austin residents, however, have raised questions, particularly about the operations and maintenance of the AW treatment plants.

1.2 Project Objectives, Scope and Approach

1.2.1 Objectives

The objectives of this special request were to review five incidents identified by the City Council in which AW failed to deliver potable or palatable water to the City of Austin, to evaluate current conditions at the plant with respect to the plants' ability to address similar events in the future, and to provide recommendations for improving resiliency. With regard to the recommendations for future capabilities needed to promote more resilient water quality during dynamic water source events, the team focused on the following underlying questions:

1. How does water quality produced by the watershed impact raw water quality entering the plant and create risk to water treatment, considering both normal and extreme (flood, fire, drought, storm, spills, etc.) conditions?
2. From an engineering perspective, is/are the plant(s) capable of handling this range of water quality?
3. From a staffing and organizational perspective, is AW positioned to operate the plant over the range of water quality conditions observed during normal operations and extreme events?

1.2.2 Scope

The agreement between the City of Austin and the Center for Water and the Environment at the University of Texas (CWE) followed the work order provided in Appendix 1-B and the scope of work provided in Appendix 1-C. In summary, CWE was asked to review AW's five most recent significant negative water quality events and water supply service interruptions that occurred between calendar years 2018-2022, to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of the City of Austin's water system. The scope included an evaluation of overall management, policies and practices, and facilities and operations, especially as related to capabilities and performance during extreme events. The investigation and assessment focused primarily on the Ullrich Water Treatment Plant, due to both the limited time frame of the project and the minimal potential for value added by conducting the assessment across all three AW treatment plants. Deliverables include this report highlighting progress made by the City of Austin and AW in implementing recommendations identified in past relevant reviews and AARs, and providing recommendations for additional changes to improve internal policies, treatment process management, communication with the public, organizational staffing, and facility improvements. The first section of the results (2.1) and Appendix 2-A provide an overview of the five most recent significant negative water quality events and water supply service interruptions that affected the City of Austin; these events were identified by the Austin City Council. Following that section, the report gives an assessment of the current and future potential of the Ullrich Water Treatment Plant to provide potable and palatable water to the City of Austin. The strengths of AW, as well as major issues identified by the project team, are highlighted through the course of the review.

The primary focus of the review was the Ullrich WTP because this plant was significantly impacted by the major events. While the review did address issues associated with Watershed Protection and the water distribution system, detailed review of each of these was beyond the scope of the review.

1.3 Approach

To complete this special request, a project team was formed with expertise in the areas of water quality, water treatment plant operations, water treatment plant infrastructure, energy and power, communications and organizational structure, and emergency response. The team was divided into four groups, consisting of consultants and academicians with expertise in water quality and treatment, communications and emergency response, infrastructure and energy requirements, and organization and support. The composition of the teams is provided in Appendix 1-D. To complete this project, we performed the following steps:

- Interviewed staff in Austin Water and Austin Energy.
- Interviewed external stakeholders, including industry experts and staff members from educational institutions and community organizations.
- Researched best management practices related to water quality protection and operation of drinking water treatment systems.
- Reviewed federal, state, and local water quality regulations and case studies.
- Reviewed Austin Water policies, procedures, and other documentation related to water quality, water supply, watershed protection, emergency response, communications, staffing practices, and succession planning.
- Reviewed department memos and other documentation on current and planned water supply and demand management strategies including Austin’s Water Forward Plan.
- Reviewed water treatment plant design specifications, process control descriptions, process instrumentation diagrams, onsite chemical generation capabilities, distribution system schematics and maps, and operations and maintenance manuals.
- Evaluated water treatment plant maintenance records.
- Evaluated power sequence of events for Austin’s Ullrich Water Treatment Plant.
- Evaluated asset management programs and capital improvement spending plans and identified funding sources.

- Reviewed training materials and records.
- Evaluated department organizational charts and staff marketing study, and practices related to recruiting, hiring, and retention.
- Evaluated internal and external communications with key stakeholders including other city departments and Texas Commission on Environmental Quality.
- Analyzed water quality data including monthly operating reports, operator log entries, plant alarm and shutdown records, and emergency reports for the five events included in the project.
- Analyzed historical data from source water monitoring and intakes for Austin's Ullrich and Davis Water Treatment Plants.
- Analyzed historical raw and finished water data from Austin's Ullrich Water Treatment Plant.
- Reviewed past After Action Reports, reviews, and corrective action plans for the five events included in this project and obtained a status for each recommended action.
- Reviewed organizational and management strategies for similar types of organizations (see references).

This written report addresses the scope of work outlined in the contract. Specific details of each major task are provided in Appendix 1-C.

2 Results and Recommendations

2.1 Summary of Water Quality Events of Concern

The City requested that an evaluation of the five incidents of concern be included in this document. Detailed summaries of these incidents and a summary of their recommendations and implementation status, ordered chronologically, are included in Appendix 2-A and 2-B, respectively. Two of the incidents of concern are associated with weather related factors, including unprecedented raw water quality changes during a flooding event in Fall 2018 and prolonged freezing conditions during Winter Storm Uri. Lack of adequate preparation for an emerging zebra mussel issue led to the development of serious taste and odor issues at Ullrich WTP when a raw water pipeline was placed into service: apparently not all the dead mussels had been removed from the pipe. One of the events was the result of a failure of the plant staff to respond appropriately to an ongoing operational issue in February 2022. Finally, a fifth event was associated with infiltration of fire-foam into the water distribution system; this event was not related to AW and it appears that AW responded promptly and appropriately.

AW has responded favorably to recommendations from the AARs and effectively implemented a majority of the recommendations provided in the AARs to improve overall resiliency (see Appendix 2-B). Some of the recommendations implemented by AW include the definition and documentation of roles/responsibilities for personnel, winterization of catwalks and heat tracing piping, installation of a copper sulfate chemical feed system to control zebra mussels in the raw water intake, and standardizing procedures for disseminating critical information during an emergency such as a service area-wide boil water notice. AW is continuing to implement relevant recommendations detailed within the AARs per their priority.

2.2 Organizational Conditions, Including Structure and Management Practices

This task reviews the effectiveness of the organizational structure, management practices, and communication across the organization with respect to its impact on Ullrich WTP's ability to recruit, train and retain staff, conduct normal operations, maintain the infrastructure, and plan for the future. In this task, we conducted interviews, reviewed AARs, reviewed documents provided by AW (e.g., organization charts, training information, operator license and job descriptions, emergency response documents) and observed the Department Operations Center. We approached the task by evaluating communication and operations during normal operating conditions and compared them to emergency and potential emergency situations.

Based on interviews conducted with staff across both Davis and Ullrich WTPs and management personnel across AW, it was apparent that the personnel are very committed to AW and understand the importance of their work for broader public health. Many of these individuals discussed their expertise, displaying their deep knowledge of the facilities and their investment in the personnel who directly report to them (direct reports). In addition, AW has made significant capital investments in the Ullrich WTP over the past two decades. Nonetheless, there is also evidence that AW's organizational structure, management practices, and internal communications at Ullrich WTP have led to deficiencies that make operations more vulnerable to mistakes, especially during emergencies.

2.2.1 Evaluation of Management Practices

Upper Level Management Span of Control. AW has designated the Operations Assistant Director (OAD) as the person responsible for all the operations divisions within the utility; this position has a very broad span of control. Divisions under this manager include Water Treatment, Wastewater Treatment, Water Distribution, Wastewater Collection, Environmental Engineering and Technical Services, Operations Support, and the Advanced Metering Infrastructure Program. In total, these divisions comprise more than 800 positions, which is approximately 70 percent of the AW workforce.

The ideal span of control for utilities depends on a number of factors including the complexity of work, degree of risk, degree of public scrutiny, geographic location/dispersion of subordinates, and degree of coordination required. A narrow span of control is more appropriate for work that is complex by nature, high risk, receives a high degree of scrutiny, requires a great deal of coordination, and is geographically dispersed (Gordon et al., 2015). This span allows a manager to focus on specific areas of the work and provides the opportunity for direct interaction with staff, as well as providing subordinate staff with access to their manager. Currently, the span of control of the OAD is excessively broad and appears to limit the direct interactions the Assistant Director has with plant staff. During interviews, plant staff reported that the OAD visited the plant only twice a year even though the OAD's calendar indicated that he visited quarterly. Whether the number of annual visits was two or four, the staff reported wanting the OAD to be more visible.

Per the Organizational Chart dated 4/11/22 provided to the Review Team by AW, seven Operations Managers report to the OAD and 16 Division Managers are dotted line reports to the OAD, bringing a total of 23 direct or dotted line reports to the OAD. It should be noted that per the 4/11/22 Organizational Chart no other Assistant Director in the organization is responsible for more than four Division Managers as direct reports or for more than three dotted line reports. This is clearly an unbalanced structure, which asks more of the OAD than any other Assistant Director. The Review Team cannot help but conclude that this unbalanced structure has contributed to the operational shortcomings observed at the Ullrich WTP.

All direct reports under the Assistant Director's management would benefit from a strong advocate at the executive manager level to support financial needs, staff requirements, and special projects. In the current organizational structure, the OAD will likely be constrained in ability to advocate for any one group over others, and there may be an inherent conflict of interest in supporting the requests of one division over another.

Another way of thinking about the relationship between the managers and the plant staff is to define who is the client in the relationship. Since one critical product of the utility is safe drinking water, the staff who directly impact the quality of the water can be considered the critical clients of every other group in the utility. As such, the OAD responsible for the water plants must have close intimate knowledge of what is happening in the plants and with staff. Management needs to be very responsive to plant needs (e.g., staff, equipment, resources, training). Being responsive at the frequency required may not be possible with as wide a management span of control as the AW OAD currently has. The OAD stated that much of this authority is delegated to the Operations Managers on many fronts ranging from disciplinary to purchasing to training approval, etc.

Mid-Level Water Treatment Management. Two management positions are responsible for all three water plants, and these include a Water Treatment Division Manager who reports to a Water Treatment Operations Manager. It is evident that the two current managers have established a good working relationship, and they have divided the duties of that managerial level between them. This may be disadvantageous to the WTPs because interviews revealed that plant staff do not see a single point of responsibility at the level above plant superintendents. This dispersion of responsibility may also be exacerbated at Ullrich WTP because it has two plant superintendents. This may also be unsustainable in, for example, the case that the two managers do not have a good working rapport due to lack of clarity in defined roles, authority, and responsibility. The unease reported among Ullrich WTP staff may be rooted in the lack of clear lines of management authority.

Ullrich WTP Management. Currently, Ullrich WTP has two superintendents of equal rank assigned to run the plant. Within Ullrich WTP, the two superintendents frequently have different approaches to managing the plant. One superintendent has taken charge of maintenance, while the other has taken charge of operations.

One of the superintendents spent significant periods of time previously working at the Davis WTP, which has a type of softening plant design different from that at Ullrich WTP, and the other recently worked at the Handcox WTP. Several years are required for an experienced operator to learn the intricacies of a water treatment plant, and as such, the two superintendents, each 1-3 years into their tenure at Ullrich WTP, are understandably not entirely familiar with certain details of plant operation. Rampant among some of the operations staff is the notion that Davis WTP is a "better" plant than Ullrich WTP. It is essential that management find ways to develop staff unity, morale, and commitment at Ullrich WTP.

The staff is aware that the two superintendents do not get along well. Staff interviews repeatedly and specifically mentioned that this adversely impacts the work environment at Ullrich. There appears to be no overarching direction to staff at the plant, with the accompanying issue that no single set of standards is used to either reward staff or hold them accountable. Strong division amongst the staff supporting one or the other of the superintendents' approaches to the work is apparent, which disrupts staff teams who are "taking sides." Ultimately, this results in the inability of the plant staff to operate as a team, with the work not being well directed and unacceptable behaviors going uncorrected.

Industry Standards. The American Water Works Association (AWWA), in association with the American National Standards Institute (ANSI), develops standards for a wide range of equipment and processes used in water and wastewater treatment systems. An American National Standard implies that the industry has achieved a consensus among those substantially concerned with its scope and provisions. A series of management standards has been developed for use by utilities, including the standard for water treatment plants: ANSI/AWWA Standard G100, Water Treatment Plant Operation and Management. This standard, which sets out the basic requirements for a well-run water treatment plant, was first developed in 2005 and most recently updated in 2017. The first two requirements stated in Standard G100 are regulatory compliance and management goals. To consistently produce high-quality water, a water treatment plant must set goals, and the plant personnel must understand the goals and how to meet them. G100 recommends that plant personnel be involved in goal setting because staff is then more likely to take ownership of the goals and work toward meeting them. Goal setting also promotes consistency of operational approaches between operating teams, which needs fostering at Ullrich. In its present state, Ullrich WTP meets regulatory requirements (with the exception of recent incidents). However, collaborative development of team goals and buy-in was not apparent during our interviews with plant staff.

G100 warns that managers need to guard against complacency among the staff and develop an environment that encourages and empowers staff so they can respond to all kinds of water conditions. This does not appear to be happening at Ullrich WTP; in fact, multiple staff interviewees at the plant did not seem to consider themselves part of a plant team. Some empowerment does exist within small operating groups and teams, but across the entire staff, there are many instances of finger-pointing and other behaviors that are not conducive to team building. For instance, during the interviews many staff members blamed others for problems occurring with team dynamics or issues that arose day-to-day at the plant.

Standard Operating Procedures. Consistency of operations conducted by the plant staff is another major theme in the ANSI/AWWA G100 standard, which recommends setting up standard operating procedures and following them. For instance, our interviews revealed that there are at least three different approaches to backwashing a filter at Ullrich—a practice that absolutely should be standardized (Logsdon et al., 2002). A consistent backwash procedure should be established and taught to all staff, impressing on them the need to be consistent in treatment operations. This need for consistency is true for all standard operating procedures.

Plant operations and maintenance staff reported that it is generally difficult to access the existing SOPs, and as a consequence, the SOPs may not be utilized as needed. Multiple plant staff indicated that they know of only a few SOPs; others indicated that the SOPs reside in an electronic O&M manual. This is contradictory to what we heard from the executive level, which is that AW has invested in an online O&M Manual that is available to staff. When the project team reviewed the O&M Manual, it became clear that approximately 80 SOPs do exist. Based on the names and dates logged on the SOP documents, all but one of the SOPs were written by a consulting firm in conjunction with development of the Manual. The major portion of the SOPs are dated in 2013-2014, with a few newer ones dated 2022. AW indicates that work is ongoing to update the O&M Sharepoint System (as of 5/2022).

Plant management reported that there is an ongoing program to review and revise the SOPs that are in the O&M Manual. This is a large undertaking, especially for a team that is already functioning without a full staff. We recommend that staff review and revise the SOPs as soon as time is available. By engaging staff in the updating of information contained in the SOPs, more buy-in to their use and content can be expected. This effort should be part of an established protocol/program for updating both SOPs and other training materials. Providing staff time to develop SOPs is essential to success at Ullrich WTP.

Since SOPs are an essential tool for a well-run plant, ensuring O&M staff access to the electronic O&M Manual is critical. Equally critical is making sure that the staff knows that the SOPs are to be utilized and followed. If a staff member believes an SOP to be incorrect, it should be put high on the list for revision.

Management Improvements. AW should engage a management consultant to review, evaluate and make recommendations regarding changes in the management structure to best support the plant operations staff.

AW should put a single person in charge of Ullrich WTP and provide them with guidance and training regarding leadership, goal setting, holding staff accountable, and other assistance as requested. The objective should be to have a single leader who regularly communicates the purpose of the plant, motivates staff to meet the plant purpose, and gives direction. AW should establish reporting requirements and assign accountability of this individual to a single treatment manager.

When we asked if the plant superintendents and other levels of operations management had individual development and leadership development plans, we were told no. While it is very difficult to develop and grow personnel at a time when plants are severely understaffed, these plans are important for retention and continual improvement. Regular team-building exercises should be required of all staff. To be successful, all management levels, from the superintendent to the assistant director, must provide tangible and visible support for these efforts.

2.2.2 Evaluate staffing with respect to education, certification, quantity

Staffing. Hiring and retaining staff at base levels is needed to facilitate many of the other organizational and managerial challenges at the Ullrich WTP.

Staffing of water utilities is a nationwide problem (see AWWA 2022; AWWA, 2021; and WWD 2021 for discussion of this nationwide challenge). The current organization chart for Ullrich WTP shows 32 Treatment Operations and Maintenance job slots. Of those jobs, currently 11 are not filled, representing a 30% deficit in staff. As a result, operating teams sometimes function with only two operators on a team. Especially at night, when supervisors, superintendents and mechanics are not at the plant, operating the plant with two people is simply not safe. The plant is very large and has a wide array of mechanical and electrical equipment, hazardous chemicals, and multiple ways that even attentive staff may be injured. If only two operators are on duty, one must be in the control room monitoring processes and responding as needed, while the other operator is performing rounds in the plant looking at the water, checking equipment, taking samples and attending to small mechanical problems. A two-person shift is risky, as staff injury is a very real possibility, and such an event could result in adverse impacts to water treatment.

While it can be made to work temporarily for short periods of time, staffing the plant with only 70% of the required people will eventually lead to operator "burn-out". Recent research indicates that workers report that staff shortages are contributing to burn-out. Workload and balancing work and personal lives are cited as the major causes of burn-out (Eagle Hill Consulting, 2022). When someone needs to be away from work for any reason, the likelihood increases that shifts will be reduced to two-person coverage, resulting in even more stress. During unusual events, such as those that have challenged AW recently, the lack of sufficient staff coverage aggravates the ability to respond rapidly to emergency conditions.

Some of the staff have not yet qualified for a D level operating license, which is the entry level for a treatment operator. D level operators are not allowed to make independent decisions regarding changes in water treatment without specific direction from a more senior operator. The low level of staffing experience puts finished water quality at risk because not enough trained eyes, hands and brains are at work to keep things going smoothly.

In spite of efforts to hire new operators, the level of vacancy at Ullrich WTP (and the other plants) remains at 30%. Hiring is difficult for a number of reasons: the number of people applying is low, their qualifications are often insufficient, and when an experienced operator does apply, the plant staff reported not being able to hire at a rate above the lowest level operator, even if the potential new hire has experience and a license at higher than a D level. The plant staff reported that even when an applicant has qualifications matched to the entry level, the salary scale is such that offers are not competitive with other entry-level employers in Austin. Some upper-level operators have left the utility for jobs in neighboring communities where salaries are at least a dollar more an hour. Several interviewees reported that they routinely receive attractive offers from other municipalities. In addition, there is no mechanism for performance-based salary increases, which may blunt enthusiasm for improved staff performance. Some of these concerns are governed by decisions made by corporate Human Resources, including determinations not to implement approximately 50 percent of the salary adjustments requested by AW in association with a recent market study.

At the time interviews were conducted, operators were aware that over the past year and a half, a market study was conducted to determine whether changes should be made in operator salaries. At the same time, the project team was told that the market study was currently in the hands of the City of Austin Human Resources and had been in their hands for several months. The fact that nothing had come from the market study, not even an explanation of what had been or planned to be implemented, clearly impacted morale at the plant. Ultimately, as a result of the market study, some salaries were adjusted; however, in early October a change was made by the City to the minimum wage across all departments and the perceived benefit garnered by the adjustment was lost.

As a result, the staff across multiple interviews indicated that they were frustrated and irritated, feeling that their concerns about compensation were not fairly or adequately addressed. AW should communicate the details of any changes that arose from all of this activity to the operations staff and let them know what is going to change and what is not. Competitive operator/mechanic salaries are critical so that the utility can hire and retain qualified people.

AW should consider partnering with other utilities or with the Texas Section of AWWA (TAWWA; a water professional organizational) to develop a pipeline for young people to learn about water treatment and water operations and get some basic training. Some utilities have helped to set up 2-year programs at community colleges to give young people basic training as operators. TAWWA currently is working on training modules that will be used in high schools to teach high school students about water operations, and AW has participated in the creation of one of these training modules. AW should make an effort to continue and to expand participation in this and similar activities that foster the development of future operators.

AW should also work to make it acceptable and simple for all the divisions to hire above the starting level when a candidate is qualified. By establishing a better partnership with HRD to better implement timely and effective solutions, the utility may be better able to define job requirements and job qualifications. The team should find new ways to recruit potential hires, look in new places for talent, and screen candidates differently. Refer to the Rocky Mountain Section of AWWA, Utility Management Committee's workforce program (ref: Rocky Mountain Water Publication, September-October 2022).

Operator Training. Operation of complex treatment plants requires operators that are well educated, trained to manage a wide range of equipment and understand the interrelationships between multiple treatment goals. Provision of appropriate training is essential to having a well-operated plant. Staffing levels must be appropriate to the plant configuration and size, ensuring adequate labor time to keep the plant operating under all conditions and taking into account work practices, such as the level of human intervention required in process operating events and the necessary levels of maintenance, as well as other activities.

An assessment of the core competencies required of individuals staffing the plant, and comparison of those skill requirements to those of current employees, provides a way to establish a training program. The Association of Boards of Certification (ABC) "Need-to-Know Criteria for Water Treatment Operations" can be used as a baseline of core competencies for effective and efficient operation and maintenance of water treatment plants. A detailed staffing study is beyond the scope of this review, as it entails interviewing in detail everyone who works at all three of the plants, including the Water Operations Manager, superintendents, and all levels of operators, but such a study would provide value to the utility by ensuring that operators are meeting core competencies. The results would also be useful in updating job descriptions and requirements for hiring at all levels and would provide human resources staff with critical information for review of potential hires.

At Ullrich WTP, the less experienced operators interviewed by the project team indicated that the operator training program is insufficient. All new operators are currently trained using an On-the-Job (OJT) training approach. Thus, each new(er) person learns whatever the most senior level operator on the team teaches—both good and bad habits—making overall training, and subsequent operations of the WTP, inconsistent. Higher level operators have not participated in externally sponsored training for a while (possibly Covid-19 pandemic related); this is unfortunate because such longer, in-depth classes are prepared by professionals and are often the best learning options.

In addition to being minimal, the OJT approach cannot be expedited because it can only occur alongside running the plant. Experienced operators are constrained to teach only what is in front of them on a daily basis. As a result, the new operator sees each scenario that happens to come along while they are on duty, but there are no chances to think through what could happen to the plant under stressful circumstances that happen only every few years. Training should include practice drills for critical emergency conditions that arise in the plant. Successful training requires a formal roadmap and consistent content for all new operators.

All water and wastewater utilities struggle with the loss of knowledge that occurs when older experienced operators retire. The electronic O&M Manual is an effort to document knowledge about the plant operations. A number of utilities have initiated efforts to document more institutional knowledge through the development of standard procedures or short descriptions of unusual conditions in the plant. Documents generated for specific types of events such as floods could easily be included in the electronic O&M Manual.

Incorporating new trainer positions completely into the plant and pushing them to develop or find training tools should significantly increase the training quality, quantity, and effectiveness for both new hires and existing operators. AW should promote the consistency of training through the requirements placed on the trainers.

AW should conduct a work-force assessment to determine the current effectiveness of the plants' teams and provide recommendations for all three water treatment plants, then utilize the assessment to inform staffing levels, training programs, and job descriptions that are consistent with industry standards. Results could also inform the processes utilized by human resources to screen new hire candidates.

Cross Training Between Operations and Maintenance. Historically, the AW water plants did not cross-train operators and mechanics. Approximately 10 years ago a training program was initiated to rotate operators and mechanics, so that all of them could do either job. It is impractical to expect such a program to be successful when 30% of the staff slots are empty; the significant number of relatively new treatment plant workers and entry level (Grade D) operators on staff make such an approach very challenging. Based on the State of Texas Need to Know Criteria for operator licensees (ref: State of Texas) and on the project team's experience working with many water treatment plants, it takes about five years at any large treatment plant to train a strong operator who is then competent and ready to get a B license. Supervisors must have a B license, and Superintendents typically have A licenses. With insufficient staff, rotation every 6 months is likely to slow down the process of learning what an operator needs to know. In addition, some people have more innate skills in either operations or mechanics. Consideration could be made to place people in accordance with their aptitude and skills. This observation does not minimize the value of all WTP personnel being familiar with basic mechanical knowledge or operating skills; it simply recognizes the high value of specialization in both maintenance and operations.

AW should develop a plan to manage the impacts of cross training for new O&M technicians. Cross training and broad knowledge of a facility have been shown to be very valuable, reducing plant risks during times of stress. An effort should be made to set up the program in such a way that those who want to specialize in one area can do so.

2.2.3 Ullrich's approach to communicating risk and responsible parties: A review of internal communication and culture

A key component of an effective organizational structure is communication. Lack of effective internal communication is a major inhibiting factor to organizational effectiveness (Campbell et al., 2020). Effective internal communication during normal operations and emergencies, both within organization levels (e.g., between operators and maintenance workers on a single shift or during shift turnover) and between levels (e.g., O&M staff and supervisors), leads to more efficient process operations and maintenance at the water treatment plant level. In the absence of effective communication, vulnerabilities arise with respect to both short term and long-term resilience of the plant. Such vulnerabilities were observed in the review of the After Action Reports in Section 2.1. For instance, the lack of effective communication between normal operating shifts contributed to the boil water notice in February 2022.

The interviews also revealed serious communication deficiencies and challenges at multiple levels of plant management, as well as between some operators and managers at Ullrich WTP. These communication challenges, along with inconsistent practices and management styles, create complacency, confusion amongst employees, and conflicts between employees. Almost all of the employees interviewed highlighted this concern and noted that negative attitudes and behaviors were counterproductive towards the mission at AW and are detrimental to a safety culture at Ullrich. Staff at different levels of the organization shared frustrations with co-workers, subordinates and supervisors. There were reports of general insubordination, employees with complacent attitudes, and a lack of respect among employees. Poor communication is at the heart of these issues.

High Reliability Organizations. These culture issues are important because AW is a High Reliability Organization (HRO)[2]. An HRO is an organization whose operation is complex and is responsible for people's lives and safety. An HRO has five core characteristics[3]: 1) commitment to proactive continual improvement to mitigate current and future risk, 2) development of systems and procedures that are matched to the criticality and complexity of the task to be accomplished, 3) alertness to outside forces which can affect operations, 4) commitment to resilience with formal systems in place to assist in recovering from errors, and 5) respect for expertise, regardless of the rank of the individual.

Many aspects of HRO communication are not consistently present at Ullrich WTP. The following are specific characteristics that should be prioritized and improved:

(1) Organizational culture of reliability (referred to below as Safety Culture);

(2) Intensive training and continuous learning;

(3) Effective patterns of communication;

(4) Adaptable decision-making with flexible organizational structures;

(5) System and human redundancy;

(6) Human resource management practices that support reliability; and

(7) Precise procedures in managing technology.

Safety culture. Safety issue responses at Ullrich WTP lack consistency, especially with respect to plant employee safety. We reached this conclusion by comparing information gathered from both Ullrich WTP and Davis WTP as well as referencing published research on HROs and water utilities (Bradshaw et al., 2011). Specifically, multiple interviewees said that safety is not discussed daily and they do not feel it is prioritized. When the OAD was asked about the safety metrics that were tracked, he discussed general plant safety metrics. Managers at Ullrich WTP indicated in interviews that safety incidents sometimes lacked follow-up, consequences, or remedial training. As an example of the impact of this complacency, there have been repeated chlorine accidents onsite. Risk Management has published multiple corrective action plan that managers are responsible for implementing; but risk managers were not interviewed as part of the project scope.

[2] see Bradshaw et al., 2011 for further discussions on water utilities as HROs

[3] see Weick & Sutcliffe, 2001 for discussion on HRO core principles

Intensive training and continuous learning. A critical communication need within HROs, like utilities, is sharing consistent knowledge through job-related training. As mentioned, inadequate staffing, indicated by the high vacancy level at the plant, has compromised Ullrich WTP's ability to prioritize training and engage their staff in continuous learning. The lack of training noted by operators and supervisors has led to noteworthy concerns, such as inconsistent knowledge across employees of the same or similar job functional roles. While the importance of engaging training personnel to resolve these issues was recognized across the interviews, there is some disagreement with respect to whether the trainers should be located within the Talent Development Division of the Employee and Leadership Development program area or within the plant. Notably, however, the plants do not currently have the capacity to handle training in a manner that is efficient, complete, or consistent. People with institutional memory reference that the city used to offer greater educational opportunities, including in-person education. Discussions with interviewees revealed that since the COVID-19 pandemic, these opportunities have been limited and/or shifted on-line, and this on-line training has not been as effective. The training issues have been exacerbated by a lack of consistent cross-training of operators in both maintenance and operations roles. While staff shortages limit cross-training opportunities at Ullrich WTP, it is known that cross-training contributes positively to human redundancy, another core HRO characteristic.

Effective patterns of communication. According to HRO research on water utilities, "HROs create information-rich environments where processes are measured and understood, with data made transparent and available to all" (Bradshaw, 2011, p. 635). There should also be a willingness to raise concerns before they become major issues and for managers and operators to communicate effectively. For example, the February 2022 incident revealed poor judgment and decision making and an inability to adapt to an emerging incident. An apparent lack of communication by operating staff to management increased the seriousness of the situation. The reasons that the staff did not report the issues to management are not clear, but their actions speak to the questions regarding communication up and down the chain of command.

Moreover, the Ullrich WTP the interviews revealed that:

- It was reported that a few managers have limited contact with the people they supervise.
- Many of the managers who were interviewed expressed frustration in their inability to effectively discipline due to a lack of consequences for poor behavior or to reward personnel for positive performance, due to City policies.
- Ullrich cannot be characterized as a robust standard operating procedure-driven environment. There is an on-going effort to revise and write SOPs and make them readily accessible, but many newcomers are trained on the job and the training experiences vary between trainers. This leads to a lack of consistency in how processes and technologies are maintained and operated.
- It was reported that some people in management at Ullrich WTP ignore directives from those in higher organizational roles, and this was openly stated in interviews. Specifically, many interviewees mentioned that those employees with longer careers at AW tended to ignore new directives. There were many references to the resistance to new policies and the inability to enforce changes due to the difficulty in imposing disciplinary consequences.

Adaptable decision making with flexible organizational structures. The severe lack of adequate staff, inability to hire beyond entry level, and inadequate pay (also discussed in detail in Section 2.2) suggest there is not adequate human capacity under normal operating conditions, and naturally the problems are worse in emergencies. The inability to hire knowledgeable operators suggests another HRO-related issue: human resource management practices do not support reliability. The lack of system redundancy is discussed in Section 2.2.

Reporting to the City Manager. AW currently reports to the Assistant City Manager (a fairly recent change). AW should be seated next to Austin Energy and report directly to the City Manager. This is not only key during an emergency, but necessary for a federally mandated critical infrastructure institution. While AW is often involved in mobility activity due to the location of its infrastructure, placing them in a reporting structure with mobility is not a good fit for its health and safety responsibilities.

2.2.4 Recommendations for Communication at Ullrich WTP - Internal Communications

- Clear communication around the importance of safety should become a daily priority and metrics should be discussed with staff.
- Managers, including the AD responsible for Ullrich WTP, need to be walking around the plant on a regular basis discussing safety and the importance of providing a quality product, and reinforcing that they value the operators and managers who report to them.

The perceived (as stated by interviewees) unproductive and hostile attitudes in parts of Ullrich WTP must be addressed by managers. This could mean separating individuals who exhibit negative attitudes so they do not influence new hires and the quality of work of their team. Attitude issues need to be addressed, or nothing will change.

- Hiring and increasing pay (discussed more in Section 2.6) are essential for this plant to have capacity to address day-to-day operations. Full staffing is important for the personnel capacity needed to handle events that are not routine.
- The managers (at all levels) need HR to provide better screening of applicants that is more focused on actual skills and experience needed to perform the positions.
- The managers need control over their plant-specific training to ensure that the training provided is related to the current knowledge gaps and future needs; they need the staff to make that ongoing training sustainable.

2.2.5 Recommendations for Organization Considerations

	Issue	Recommendation
2.2-1	No single point of responsibility for the Ullrich WTP. Plant staff not functioning as a team with a leader.	Establish a position for a single person to be in charge of Ullrich WTP and provide that person with guidance and training regarding leadership, goal setting, holding staff accountable, and other assistance as requested. The objective should be to have a

	Issue	Recommendation
		leader with a well communicated message for staff that is promoted and enforced.
2.2-2	Eliminate confusion regarding single point of responsibility above the plant superintendent.	Establish reporting requirements and accountability of the plant superintendents to a single treatment manager. Investigate ways to better support managers in the plants with their conflict management skills, and team building efforts, potentially providing external support for developing all leaders at the plants.
2.2-3	Management structure does not seem to support water operations and maintenance staff to continuously produce high quality drinking water.	Engage a management consultant to review, evaluate and make recommendations regarding changes in the management structure to best support the water plant operations and maintenance staff.
2.2-4	Plant SOPs are apparently hard to access or operators don't know how. Operators do not reference or follow SOPs.	Teach all O&M staff how to access SOPs. Emphasize that they are expected to follow SOPs. Continue the program/process for updating existing SOPs and assign staff to participate as soon as time is available. Provide staff time to develop any new SOPs needed.
2.2-5	Staff are frustrated and divided from one another by the confusion of directions from management and do not feel that they are part of a team.	Continue regular team-building exercises and require attendance by all staff. To be successful, all management levels from the superintendent to the director should provide tangible and visible support for these efforts.
2.2-6	Staff are frustrated and irritated by the results of the market study, and it creates friction in the operations team.	Communicate to the operations staff and let them know what is and is not going to change regarding compensation and other significant HR decisions.
2.2-7	Salaries do not appear to be adequate to recruit and retain qualified operators.	Continue to advocate strongly for increased operator/mechanic salaries so that the utility can hire and retain qualified and interested people.
2.2-8	Supervisors say job candidates referred to the plant are not all minimally qualified.	Partner with other utilities or with the Texas Section of AWWA (TAWWA) to develop a pipeline for young people to learn about water treatment, water operations and get some basic training. Some utilities have helped to set up 2-year programs at community colleges to give young people basic training as operators. TAWWA currently is working on

	Issue	Recommendation
		training modules that will be used in high schools to teach high school students about water operations, and AW has participated in the creation of one of these training modules. AW should make an effort to continue and to expand participation in this and similar activities that foster the development of future operators.
2.2-9	Hiring the best qualified staff is critical to the success of the plant.	Support the ability for all the utility divisions to hire above the starting level when a candidate is qualified.
2.2-10	Many HR roadblocks to hiring appear to reside in the City HR system. Hiring is critical.	Establish greater autonomy for AW Human Resources, distinct from the City Human Resources, to better define job requirements and job qualifications. Encourage AW HR to find new ways to recruit potential hires, look in new places for talent and screen candidates differently. Refer to the Rocky Mountain Section of AWWA, Utility Management Committee's workforce program.
2.2-11	Training is inconsistent and incomplete for new hires and for existing staff.	Continue incorporation of the new trainer positions completely into the plant and push them to develop or find training tools that significantly increase the training quality, quantity, and effectiveness for both new hires and existing operators. Promote consistency of training for all O&M staff. Emphasize in-person training. Re-educate staff regarding their reporting options when they notice discipline or safety violations.
2.2-12	Hiring is critical, and any activities that will facilitate filling empty FTEs should be undertaken.	Engage an expert in staffing evaluations to complete a detailed staffing evaluation of all three water treatment plants. Utilize the study results to inform staffing levels, training programs, and job descriptions. Results could also inform the processes utilized by human resources to screen new hire candidates.
2.2-13	Staff and the plant benefit from cross-training, but it cannot interfere with plant operations. Positions are currently 28-30% vacant (depending on the day), so moving staff around inside the plant to learn both operations	Develop a plan to manage the impacts of cross-training between operations and maintenance, particularly in the training program for new O&M staff. Cross training and broad knowledge of a facility has been shown to be very valuable, reducing plant risks during times of stress. An effort should

	Issue	Recommendation
	and maintenance aggravates issues associated with minimal staff.	be made to set up the program in a way that those who want to specialize in one area can do so.
2.2-14	Communication of water regulations, water quality issues, and capital improvement plans are not reaching operations staff effectively.	Develop a regulatory and water quality training program and a CIP progress update that occurs on a more frequent basis to teach plant staff in person to address this need to know.
2.2-15	AW reports to Assistant City Manager	AW should report directly to the City Manager due to its criticality for both public health and safety as a critical infrastructure.

2.3 Emergency Responses and Operations

This task reviews how current emergency response plans and protocols were followed and identifies potential opportunities for improvements in responses and internal communications that would increase the utility's resiliency during extreme events. The task includes recommendations for staffing during emergencies and assessment of the need for changes to the current emergency response plans and protocols.

To evaluate this task, we conducted interviews, reviewed AARs, reviewed documents (e.g., notification thresholds), and toured the department operations center (DOC) at a time when no incidents were active. We approached the task by evaluating communication and operations during normal operating conditions and comparing them to emergency and potential emergency situations.

2.3.1 Review of emergency response plans and protocols including internal communication

The DOC emergency management facility appears to be well designed and suitably structured to handle events that deviate from standard operations.

AW has a robust, online emergency management platform, VEOCI (virtual emergency operations center). It is important to note that VEOCI was *not* available for use in emergencies discussed in this document prior to the February 2022 Ullrich WTP Boil Water Notice. VEOCI is a cloud-based emergency management and daily operations software used to prepare for, respond to, and recover from any crisis or emergency. It can also help manage daily tasks, routine inspections, or special events. VEOCI uses GIS mapping to visualize incidents and critical tasks happening in the field and share curated views of closures and impacted areas. It can instantly alert teams with notifications and work orders, and it can use timelines to help manage task assignments. VEOCI is used in municipalities across Texas and the country, including Port of Houston, Harris County Flood Control, The Texas Department of Transportation (TxDOT), Fort Bend County, City of Amarillo, City of Leander, the National Transportation and Safety Board (NTSB), and the City of Los Angeles Emergency Management, to name a few. It should be noted that VEOCI's full functionality is still under development by AW.

The Fire Foam (see Tanglewood Forest AAR) incident demonstrates that AW is capable of responding effectively and quickly to no-notice events. In the early hours of January 22, 2020 AW dispatch began receiving calls indicating foamy/soapy water coming from residential taps in the Tanglewood Forest neighborhood; this foam that entered the water distribution system was used by Austin Fire Department to fight a fire. When the initial reports came in, AW dispatch directed crews to begin investigating the complaints, confirming the presence of foam in the potable water lines, and setting up for initial flushing operations. By noon, with additional complaints reported to dispatch and Austin's 311 system, AW crews began targeted sampling and unidirectional line flushing. The water protection group initially suspected a faulty back-flow preventer located at one of the two car washes near the area of concern. The water protection group tested both back-flow preventers, conducted on-site inspections at both car wash facilities, and determined that neither car wash was the source of the soapy water. Their response was both timely and appropriate.

Additional Staffing Capacity. The most pressing resiliency gap is the ability of staff to respond when workload increases beyond expectations to handle impending, immediate, and ongoing events. Ullrich is understaffed and has too many tasks for the few people available. Multiple interviewees commented that Ullrich is vulnerable to another boil water notice due to low staffing. For instance, one interviewee stated, "If you keep [Ullrich understaffed] you will definitely get another boil water notice". In another conversation, referring to understaffing issues, a person commented: "There are things that have been neglected for 20 years. We prioritize, but things do not get done" due to the high vacancy rates. A common theme amongst interviews was the repeatedly noted concerns regarding staffing numbers (e.g., only two individuals overnight) and current vacancies. While there are standard operating procedures available to all of the plants, multiple staff interviewed at the plants indicated that they did not know how to access those and relied largely on institutional memory.

2.3.2 Implementation of emergency and extreme operation plans

AW has an Incident Management Team (IMT) and a DOC in alignment with FEMA National Incident Management System and Incident Command System (NIMS/ICS) standards. The IMT consists of pre-selected and pre-trained staff who respond during an emergency.

Training. Multiple interviewees stated that not all personnel who use the emergency management software (VEOCI) have received adequate training and also that the training requirements are not currently being enforced. It is important to note that VEOCI is still a relatively new system and AW is making great progress in getting this system integrated into their communication and coordination routines. However, currently, multiple people characterized this training as being voluntary. Furthermore, they are not using the VEOCI system on a regular basis; this means they are not practicing with the system during low-stakes events so as to be ready to activate in an emergency.

The gap in staffing capacity in the organization, in terms of both quantity and expertise, means that teams cannot effectively prepare for extreme events. Several interviewees noted that limited scenario planning or training is provided by those within the plants (e.g., plant supervisors, operators). Notably, scenario planning and discussions do seemingly occur at higher hierarchical levels of AW.

2.3.3 Points of failure not included in plans

Notification thresholds. Not all staff understand the current AW Decision Matrices and Risk Guidance Criteria. Escalation processes appear to be unclear to many of the line staff, despite having them well documented. These "notification thresholds" should be identified in advance and understood by all staff that might use them. The procedures used for notifying the appropriate level of management must also be specific and documented. Some interviewees discussed the difficulties that personnel had in identifying issues during the 2019 zebra mussel incident and Feb 2022 Ullrich WTP Boil Water Notice.

Reporting structure. For effective action during an emergency, the Director needs a direct line to the City Manager's Office to facilitate notification.

2.3.4 Emergency responses for significant changes in raw water quality, drought, flooding and spills

According to TCEQ standards, AW consistently produces a high-quality product, and the data in Appendix 2-D confirms this. As demonstrated by the Fire Foam event in 2020 (discussed in Appendix 2-A), in which the organization was able to react quickly to the problem at hand, the organization has the capability for effective response and immediate action.

Perceived Blame Impacting Response. Multiple interviewees who discussed responses to events indicated that the perceived cause of the events appears to impact the response speed. Events that are perceived to be caused by factors external to the organization (e.g., Fire Foam Incident 2020) are handled in a more transparent and timely manner than those that are perceived to be the fault of AW. The latter are perceived as less transparent and often resulted in response and notification delays.

Lack of scenario planning across all hierarchical levels. AW currently completes two scenario planning activities a year that include people at all hierarchical levels. This does not mean that all individuals in all plants participate in scenario planning, but these activities are in line with what similar organizations do. At the individual plant level, some scenario planning and training for emergencies that can directly impact water quality will be valuable when the next emergency occurs. These efforts should focus on drought, flood and spill challenges to the treatment plant. Plant staff repeatedly indicated that this was absent and that they had not partaken in such exercises.

2.3.5 Staffing quantity and needs during emergency response scenarios

Additional Staffing Capacity. The most pressing resiliency gap is that the organization lacks the additional staffing capacity to handle impending, immediate, and ongoing events. The lack of personnel (both in terms of quantity and expertise) has resulted in an inability to effectively plan for or respond to extreme events. Due to high attrition, AW has lost many of their experienced staff, and newer employees lack the training and experience to troubleshoot and respond during emergency events.

2.3.6 Evaluate communication needs

The organization has a professional, committed, and well-organized Public Information Office staff who are capable of effectively communicating with the public, as discussed further in Section 2.4. The DOC staff are also well-trained and capable of effectively communicating and supporting response efforts. Interviews revealed that the PIO staff must be maintained at the current level or increased to ensure adequate staffing during disasters. While the current staff have been able to cover social media in past events, the demands of the public are increasing, and we anticipate additional staff is likely needed to address social media and communicate more consistently with the public in the future (See section 2.4.2).

The organizational chart suggests that the current broad span of control for the Director and the Operations AD may also hinder effective emergency and internal communication (see Task 2.2).

2.3.7 Overall recommendations

	Issue	**Recommendation**
2.3-1	Staffing at plants is not sufficient to respond to non-routine and emergency events. AW faces barriers by not being able to fully implement AW's market study, along with continued competition from other cities and other City of Austin departments that can offer additional pay. AW does have hard to fill positions that need market study pay adjustments.	Continue to recruit and retain skilled workforce across organization; prioritize filling vacant positions.
2.3-2	The city management notification protocols during emergencies severely impact AW’s ability to communicate time-sensitive safety information to the public.	Replace existing protocol and have AW directly report to the City Manager. Similar recommendation found in section 2.4.
2.3-3	Inexperienced plant personnel could contribute to an ineffective response or inability to resolve or properly escalate issues. This inexperience can pose a vulnerability across the WTP and can be due to the number of new hires, attrition, or training that occurs with onboarding. A verification of the knowledge base of each staff member may be needed.	Train personnel for plant-specific knowledge. Employ at higher certification levels where necessary. *Important to note, the recommendation for this item was initiated by AW in March 2022 with the approval of technical trainers at each WTP. Staff were recently hired and an Onboarding program is being developed by the AW Ops/Certification Training team.*
2.3-4	Not all personnel who use the emergency management software (VEOCI) have received adequate training. “Voluntary compliance” is not adequate for emergency training.	Enforce training on VEOCI for all personnel who need to work in the system.

	Issue	Recommendation
2.3-5	Inconsistent utilization of VEOCI during standard, day-to-day operations. Note that VEOCI was implemented in 2020 and is currently being expanded to full functionality.	Continually exercise VEOCI system on small low-stakes or no consequence events to enable its effective and efficient use during high-profile or high-consequence events.
2.3-6	Scenario planning at the plants has not been adequately conducted for potential extreme events (e.g., floods, drought, spills, wildfires, protection of roads for just-in-time deliveries under different conditions).	Evaluate the current emergency planning and training available at each plant. Develop scenario challenges for training plant staff so that staff are engaged in the planning and become aware of expectations during emergency events.
2.3-7	There are delays in action by plant staff and leadership due to recognizing real problems too late, using unnecessarily bureaucratic approval processes, and having unclear notification thresholds.	In advance of no-notice events, establish notification thresholds that are documented and understood by all staff to ensure effective response. These thresholds need to be applicable at all organizational levels (e.g., when is it appropriate to enter into VEOCI, escalate to top organizational levels).
2.3-8	Not all staff understand the current AW Decision Matrices and Risk Guidance Criteria. Escalation processes appear to be unclear, despite having them documented.	In advance of no-notice events, establish notification thresholds that are documented and understood by all staff to ensure effective response. These thresholds need to be applicable at all organizational levels (e.g., when is it appropriate to enter into VEOCI, escalate to top organizational levels).
2.3-9	In past events there has been confusion around the roles of the Executive Team when the Department Operations Center (DOC) is activated.	Emergency incidents can be confusing, and it is important to communicate roles and responsibilities (beyond Executive Leadership) prior to events and immediately upon activating for incidents. Continued training for broad understanding across AW is important.
2.3-10	During emergencies, communication needs to happen quickly, and given that some managers have a large number of direct reports, communication flow up and down the chain of command can be inhibited.	Reduce span of control to allow for more responsive organizational actions during emergencies. Recommended to have no more than 3-5 direct reports for the Director and all ADs.

	Issue	Recommendation
2.3-11	There is a “complacency” present with select staff, especially at Ullrich. Subordinates do not follow directives, a frustration discussed at multiple levels of employees within the organization. Accountability is hard to enforce, organization-wide. Multiple individuals in supervisory roles mentioned that they could only write reports and issue verbal and written warning but could not issue corrective actions. Some corrective measures cannot be implemented without an investigation first, which often lasts long periods of time.	There need to be strong messages around the importance of bringing potential issues forward and prioritizing safety, and the training should be at the level expected of an HRO. There must be consequences for noncompliance, and corrective actions should be a norm. Recommendations in Section 2.3 discuss this as well.
2.3-12	Due to bureaucratic barriers in purchasing, the organization is inhibited during impending emergencies to be proactive in responding to vulnerabilities.	When not in an emergency, AW should find avenues to increase purchasing capability and authority at the operations level to expedite rapid purchasing for impending emergencies (e.g., purchasing pumps).

2.4 Communication with the Public

In approaching this task, AW employees were interviewed, all social media surrounding the five events that are the focus of this report were reviewed, and documents and correspondence provided by AW (e.g., PIO org chart, detailed written explanations in response to communications questions) were reviewed. Review of the five incidents of concern identified by the City Council highlighted the important role of communication with the public to educate them about water quality, watershed management, and potential risks associated with the delivery of potable and palatable drinking water. Risk communication requires an understanding of the goals of the organization and a commitment to these goals. It also requires the resources for effective and inclusive public communication.

2.4.1 AW’s approach to educate the public regarding risk and water quality and public outreach practices

For these tasks, we interviewed the communication staff and examined social media messages, After Action Reports, and the approaches they use to communicate small-scale boil water notices. We used both the EPA’s Office of Water Designing Customer Complaint Surveillance (2017) as well as the American Water Works Association’s (2019) Trending in an Instant: A Risk Communication Guide for Water Utilities, to assess AW’s current practices. While TCEQ provides the regulations around timing and the specific language required to notify the public, the EPA and AWWA provide current recommendations around communicating through social media and working through customer complaints.

AW meets the communication requirements set forth by TCEQ, but staff report delays in getting approvals from City personnel before they can post some messages for the public. The AAR generated after the Winter Storm event revealed a host of communication challenges, but AW acknowledged them and appears to be working to improve them. Many external communication practices are adequate. The recent addition of a customer portal is a good approach to overcome a major concern: parts of the customer satisfaction journey are handled by the AW group located at Austin Energy. The PIO team appears to work well together and, considering there are 4 of them capable of being on a 12-hour shift during an emergency, this appears to be adequate staffing for emergency PIO operations. However, for long-duration events, this can drain the PIO resources.

Social Media. According to Mix et al. (2021), "Utilities are taking advantage of social media for three main purposes: For general outreach and customer engagement, to communicate with their customers during a crisis, and for actively monitoring and listening to their communities to proactively identify and respond to any issue, including water quality concerns." The following are specific ways AW is using social media well during emergency events as identified by Mix et al. (2022). They are:

- Pushing information to the public relatively quickly during events (see Appendix 2-C): multiple updates a day, and often repeating information. This is needed considering the sporadic way that people consume social media.
- Responding to almost all of the public's posts. While most of the public comments on social media are quite negative, AW does a good job acknowledging people's frustration and providing factual information (a best practice identified by multiple sources).
- Addressing rumors and misunderstandings in their posts (a best practice).
- Humanizing the utility and putting personality behind the messages. Specifically, they periodically show empathy with the public, and they express their own concerns around trying to resolve issues quickly. Feb. 19, 2021: "We so desperately want to give you that answer as soon as we can."

Mentioned in AWWA's (2019) risk communication guide, AW does the following:

- They often use the Caring Concern, Actions, Perspective (CAP) approach. Specifically, they name the concern with a caring attitude, they explain the actions they have taken or will take, and they provide information that puts the message into perspective.
- They often include key emergency messages (boil water notices, and lifting a boil water notice) in Spanish, and occasionally in the following languages: Arabic, French, Burmese, Vietnamese, and Chinese (see Appendix 2-C).
- Some quality infographics are shared (important in communicating complex issues around water-related concerns).
- There are FAQs and links to videos and websites where people can learn more.

- The team has a clear process and does a good job going door-to-door and getting the attention of communities when there are small areas of the city under boil water notices.

During an emergency event, AW coordinates translations through the City of Austin's Corporate Public Information Office (CPIO), as they have teams on hand at the EOC to provide services as needed. During routine and daily operations, AW works directly with contracted CPIO's and approved vendors to provide translation services of materials. The five most commonly used languages in Austin (other than English) are Spanish, Vietnamese, Chinese, Korean, and Arabic. In an emergency, the CPIO expands that list of languages to include Hindu, Burmese and others to disseminate life safety or essential health information.

Boil Water Notice information has been translated to the expanded list. AW is currently undergoing an update of all emergency scripting and its translations. However, one aspect that creates complexity and the need to adjust those documents is that TCEQ templates and notices must be specific for each event. As an example, the Boil Water Notice template for the 2018 flood is different than the 2021 Boil Water Notice template for low systematic pressure/water loss. While AW is attempting to cover potential scenarios, it is important to recognize that delayed timing issues may arise if specificity is needed for each particular issue.

Challenges and areas to explore

- AWWA's (2019) Risk Communication Guide provides templates for planning communication responses. While AW likely does this in some cases, their messages might be more consistent if they used templates more heavily and had these readily available prior to events impacting the public.
- Several messages appeared to attribute service issues to TCEQ; it is important they both acknowledge and view this organization as a partner in keeping the public safe (Feb. 8, 2022: "We're waiting on all test results to be reviewed by TCEQ" could be interpreted as placing blame on TCEQ).
- Sometimes there are absolute messages published (e.g., Feb. 16, 2021: "There are NO plans to disrupt water service. Our plants are operating normally. AW customers, there is NO need to boil your water.") and the next day, a completely different message was issued: "A city-wide boil water notice has been issued due to power loss at The Ullrich Water Treatment Plant…" This can undermine the public's trust when it appears that the utility is changing its mind. Definitive statements during uncertain times should be cautiously and sparingly used.
- While there have been posts made in Arabic, French, Burmese, Vietnamese, and Chinese, we could not identify a pattern to when they posted (see Appendix 2-C).
- There was at least one case on Twitter where the message was in Spanish, but the infographic was in English. See February 16, 2021.
- The first emergency announcement is almost always published in both English and Spanish, but subsequent messages are only occasionally in Spanish. During non-emergency times, we could not identify a pattern for AW posting messages in Spanish.

Challenges with Staffing and Responsibilities of the PIO/Communication Team

- The team is required to work with the Assistant City Manager and wait for approval from the City Manager before notifying the public of a boil water notice. Not only during emergencies, but during day-to-operations, AW should be seated next to Austin Energy and report directly to the City Manager. This is key not just during an emergency, but always, as a federally mandated critical infrastructure institution with public health and safety responsibilities.
- In the AW 2023 Strategic Plan, customer service is listed first. The Customer Service Center for Dispatch Services division does not currently report to the AD for Communication, but our interviews suggest this is being transitioned to their program area this fiscal year. Knowing issues customers are reporting as quickly as possible is essential to being proactive and responsive to potential issues.
- AW and Austin Energy share responsibility for the customer experience because Austin Energy manages the City of Austin Utilities Customer Care call center and respective utility billing activities. As such, AW communications does not currently own the entire customer experience. We understand some of this is being resolved, but it is very important that, as soon as possible, AW own their entire customer experience, including receiving complaints and concerns that could impact water-related issues. This should also be staffed appropriately as determined by the PIO group and AW as a whole.
- The team is currently understaffed. Considering the public's rapidly growing expectations for fast response, and their desire to post problems publicly, this team will need support to address the public's needs.
- The Public Information Office within AW's Customer Experience Program Area has received City Council approval through the COA Budget Process to hire a media lead. That position is reflected on the organizational chart as a "marketing communications consultant." AW has not received approval to utilize that title despite Austin Energy utilizing that title in a similar manner. This title and job functionality have the appropriate pay grade and experience requirements to ensure that AW can hire an appropriately knowledgeable staff member for this intrinsically important role. It is our recommendation that Corporate HRD partner with AW to support its hiring needs in this role, as well as across the organization.
- There is currently little bandwidth in this team to address Internal Communications.
- Community outreach appears to happen in multiple places within AW and it might be better, when Communications staffing is sufficient, to consolidate it here.

Staffing and Responsibilities of the PIO/Communications Team. AW should report directly to the City Manager and not to the Assistant City Manager. Direct reporting to the City Manager reduces delays in communication of critical issues that impact public health and processes that support the day-to-day functioning of AW. This reporting structure would be similar to the reporting structure that we understand Austin Energy has with the City.

There is a clear plan for how to add staff in FY23 and on into the future to address the public's demand for information. It is recommended that AW move forward with this plan; the AD does need to hire staff in the area of social media and get more help with graphic design and the websites. Having extra capacity should help them use more templates and plan some of their (AW's) public communication tasks (e.g., templates of social media messages) before emergencies hit. It is important to note that AW will not be able to control all the messaging that happens around emergencies or routine operations, but supporting their growing staff needs should help them manage the increasing demands of the public for timely communication.

It is our understanding that community outreach will also be consolidated under this AD in the near future, which we believe is an important decision and recommend that it happens quickly. They will need a Manager for this program and staff with expertise in Community Engagement. Looking at the case studies AWWA compiled around communication challenges other water utilities have faced, we believe this could help avoid some of the problems other utilities have encountered.

2.4.2 Overall Recommendations pertaining to Public-Facing Communication

	Issues	**Recommendations**
2.4-1	Messages in multiple media platforms coming from AW during emergencies are sometimes inconsistent. It appears that only the PIOs have media training.	Leaders and staff communicating on social media or press-conferences should be trained and coordinate efforts with the PIO staff at all times, but especially during non-routine events.
2.4-2	On social media, publishing messages in languages other than English seems inconsistent and may not reach desired audiences in a timely manner.	The team needs to make conscious decisions concerning how they approach publishing information in languages other than English. Standard practices should be established.
2.4-3	The PIO team is obligated and trained to communicate correctly and quickly with the public. Current reporting protocols slow down the process of notifying the public and could jeopardize public health.	The Director and ADs, working with the PIO team during emergencies, should: (a) notify the City Manager of an emerging crisis or situation, (b) brief the City Manager of the immediate actions necessary and required to protect the public, (c) immediately move forward with decisions related to public communications. This is similar to the recommendation made in Section 2.2.
2.4-4	AW and Austin Energy share responsibility for the customer experience because Austin Energy manages the City of Austin Utilities Customer Care call center and respective utility billing activities. As such, AW and the Assistant Director of Customer Experience do not	As AW continues to implement the My ATX Water program and its customer portal, AW should continue to plan and hire staff to handle more water (and wastewater) concerns.

	Issues	Recommendations
	currently own the entire customer experience.	
2.4-5	Inability to hire at necessary titles for experience and knowledge appropriate for role	Allow AW to easily develop its own titles as appropriate for a critical infrastructure institution; or develop a process through the AW HR team to manage its titles, pay, and job scope.
2.4-6	Timing delay in posting for multiple languages	Issue initial generic language (that is, template/pre-determined) to the public in all languages and then post detailed information after updates are made pertaining to that emergency.

2.5 Source Water Quality Protection

The source water for the two large AW treatment plants comes from Lake Austin, and the water for the Handcox WTP comes from Lake Travis. These lakes are a part of the Highland Lakes that stretch northwest across Texas. Watershed protection efforts are the responsibility of the Watershed Protection Department within the City of Austin. This task reviews watershed monitoring and protection programs and discusses potential ongoing and future risks to the watershed as it pertains to impacts on the raw water sources to the AW drinking water plants. A number of AW, LCRA and Watershed Protection Department documents pertaining to these issues were reviewed, including watershed plans, maps and sampling programs; Water Forward Plan; Source Water Assessment from TCEQ; the AW Monitoring Plan as required by TCEQ; Austin's Drought Contingency Plan; and Water Management Plan for Highland Lakes.

2.5.1 Review watershed monitoring program and watershed protection programs

Monitoring Program. Water quality in the source of supply (Lake Travis and Lake Austin) for the drinking water plants is monitored on a routine basis by taking samples in fixed locations on the lakes every two weeks and analyzing them for a specific group of potential contaminants, as well as measuring the typical raw water parameters used in water treatment. The water laboratory is in charge of this monitoring scheme and execution; the data is available for utility users in the water quality database. The laboratory uses specific trigger levels for specific parameters to initiate email notification to the water plant superintendents, the treatment division manager, and the operations manager for the water plants. The laboratory recently acquired a FlowCam instrument, which is a newer technology for counting microorganisms in water, and once enough data has been collected to adequately "train" the FlowCam on the raw water supply, the laboratory may establish new notification triggers.

Staff from AW meet every two weeks with LCRA to discuss water quality issues and concerns. AW indicated that LCRA is cooperative and helpful in sharing data, particularly the current data on the density of zebra mussel veligers in the lakes. Other water quality data from the lakes is available from the LCRA website and is utilized by AW as a supplement to their internal sampling program.

The program for monitoring source water is similar to those managed by other large water utilities. It provides information regarding changes in water quality in the lakes and is appropriate for decision-making by the utility.

Watershed Protection. The Watershed Protection Department (WPD) in the City is responsible for the major efforts to protect smaller watersheds within Austin and to manage the larger watersheds under the City's control, including Lake Austin, Lady Bird Lake, and Walter E. Long Lake. The City's watershed protection ordinance, the main vehicle for managing the small watersheds within the City's jurisdiction, is very detailed and addresses watershed impacts in the framework of a zoning ordinance. LCRA also manages a water quality program that includes sampling for Lake Austin, Lake Travis, and Lake Buchanan. Water quality data collected by LCRA can be accessed on their website.

Regular conversations are ongoing among multiple staff members from both AW and WPD, particularly regarding possible cyanotoxins in the raw water. This is an appropriate approach to obtaining adequate information and understanding the locations and levels of cyanotoxins and whether they are an impending risk for drinking water quality. Cyanotoxins have been identified in and near algae colonies by WPD. In that context, cyanotoxins pose a risk for dogs that come in contact with and consume algae, usually by licking their paws. To date, however, cyanotoxins have not been observed at levels relevant to human health in the water column away from the algae. Currently, two sample sites on Lake Austin and five around Town Lake are monitored routinely for cyanotoxins.

An ongoing issue is that the City of Austin (and therefore AW and WPD) has little control with respect to protecting the upper watershed beyond Lake Austin. The WPD has some input but no authority regarding wastewater permits beyond those around Lake Austin, so the ability of Austin to manage potential adverse impacts to water quality upstream of the City is very limited. LCRA is responsible for understanding the impacts of development to water quality over time and focus on changes in land use that may affect the quantity and quality of runoff into the local water bodies.

Drought Preparedness / Water Forward Plan. Increased temperatures and low rainfall have led to periods of drought in Central Texas. These conditions reduce available water volume in the Lower Colorado River and impact water availability to the WTPs. Currently, the drought status for Austin Water is Stage 1. In Stage 1, automatic irrigation for residential homes, commercial property, and public schools is allowed once per week to conserve water. When the water storage levels reach 900,000 acre-feet, Stage 2 restrictions will be put in place, further restricting outdoor water use.

The Lower Colorado River Basin has a history of droughts, with the most recent drought spanning from 2007 to 2015 declared as the worst ever for Central Texas. Three major policies were established in response to drought concerns (Table 2.5.1).

Table 2.5.1. Summary of Major Drought Preparedness Policies (2016-2020)

Year	Plan	Highlights
2016	**Revised Drought Contingency Plan** approved by Austin City Council	• Progressive water conservation standards such as once-per-week watering year-round, exceeding what is required by LCRA • Gradual steps and increasing water restrictions to manage through droughts
2018	**Water Forward Plan**, Austin's 100-year integrated water resource plan approved by Austin City Council	• Includes development of new water supplies, water conservation, and demand management strategies • Strong emphasis on water conservation and the effect of climate change on our water supplies • Plans for Austin's population and business growth
2020	Updates to **Water Management Plan for Highland Lakes**, approved by Texas Commission on Environmental Quality	• Improves methods of preserving water for cities during droughts • Resulted in higher lake levels during current drought (more water stored) • Used by Lower Colorado River Authority to manage Highland Lakes

The Water Forward Plan is a high-level plan that considers actions that will mitigate the impact of droughts and increased demand from population growth projected for the following 100 years. The Water Forward Plan includes evaluations of four strategies to mitigate the impacts of climate change: aquifer storage and recovery, indirect potable reuse, off channel reservoir, and brackish groundwater desalination. All of these additional water supply options have been considered and/or implemented by other major water utilities across the country. Currently underway is a more detailed study of aquifer storage and recovery to assess feasibility, requirements and costs. As the work progresses and options are better defined in terms of available water and costs, Austin should have adequate information to make decisions regarding water supplies for the future. The Water Forward Plan does not address changes in water quality arising from climate change that could impact current water treatment processes.

In addition to these plans, other methods Austin Water provides to conserve water include water conservation rebates, information on identifying and fixing leaks, and water saving tips. Austin Water disseminates information and alerts on the My ATX Water Customer Portal to ensure that their customers are up to date on the drought conditions and are properly informed of what actions they can take to conserve the water supply.

2.5.2 Review of changes in watershed data for water quality episodes, with attention to specific impacts from flooding, zebra mussels, and algae blooms

Impacts from Flooding. Water quality data related to the water quality treatment challenges that occurred as a result of the 2018 flood are discussed in Appendix 2-A and Section 2.7 and detailed in Appendix 2-D and include a focus on treatment concerns and challenges. The data clearly show that parameters of concern for treatment (e.g., alkalinity, hardness) were temporarily impacted by the flood, but levels quickly returned to typical historical levels once the flood water passed through the lakes. This is typical of rain hydrographs and is a normal reaction to floods in a river channel. No long-term raw water quality effects were observed.

Impacts from Zebra Mussels. In addition to impacts on the WTP infrastructure (see Appendix 2-A), zebra mussels also significantly modify the water quality because they filter out particulates and nutrients as they feed. Water clarification promotes algae growth at lower depths and may promote nuisance plant growth as light penetration of the water column increases. Mussels firmly attach to surfaces and colonize in dense mats, smothering native plants and animals. The extent of these potential changes in water quality and ecosystems due to the advent of zebra mussels has not been studied to date in the Lower Colorado River.

Managing and eliminating mussel populations in the watershed is not practical as all the lakes are now populated with them. The LCRA regularly samples at two locations for veliger (final zebra mussel larvae growth stage) density: the Mansfield Dam and Tom Miller Dam. The results indicate that the veliger density closely tracks changes in temperature of the water, with seasonal veliger increases at warmest temperatures. In addition, the data show that the veliger density is increasing over time, with peaks in the range of 100 to 150 veligers/liter in 2018 to peaks in 2020 and 2021 between 150 and 250 veligers/liter. Because mussels are now a permanent population in the lakes, management is limited to mitigating impacts to infrastructure and water quality.

Impacts from Algae Blooms. Algae blooms in the lakes are monitored by the AW Laboratory, WPD and LCRA in various frameworks and at multiple locations. The two major concerns from algae in drinking water supplies are the generation of taste and odor compounds and the potential for cyanotoxins. Both AW and WPD are tracking cyanotoxins, as discussed above. Algae blooms related to taste and odor issues are tracked by the water laboratory and the lake sampling that occurs every two weeks. In addition, each water plant runs a Threshold Odor Number (TON) test daily, as does the water laboratory. This data is used to determine dosages of powdered activated carbon at each plant. The procedures for managing taste and odor issues are long-standing and have been successful in controlling the majority of taste and odor events.

2.5.3 Review flood early warning systems associated with weather, water quality, and watershed knowledge and identify actions implemented to prepare for flooding.

Flooding warning information comes from various sources to AW and the water treatment plants. LCRA hosts an internet Hydromet site that reports flow. Certain areas of the lake system can affect the WTPs, so the utility staff monitor particular stations for changes in flow. Water releases through the Highland Lakes are also available from LCRA.

Weather information is available to the plants from weather radio, and staff know that it is critical to keep informed about the rain patterns in the watershed. During the 2018 flood, communication between plants was excellent with regard to raw water quality and flows. Estimations of flow times are not exact and depend on a number of factors. Historical knowledge of typical patterns in the watershed is important; for example, under some circumstances, flows move more rapidly through Lake Travis than might be expected. When the water in the bottom of the lake is cold and rain inputs are warmer, the flow is across the top of the lake due to differences in density.

Weather is the major factor in determining the risk of difficult water treatment conditions due to floods. To better understand this risk, AW could sponsor a climate study that would evaluate the likelihood of more frequent and intense storms in the watershed. If participation in the study by LCRA can be arranged, part of the evaluation could include novel approaches to managing the watershed during flood events that could reduce the impacts to water quality affecting treatment.

2.5.4 Review of plans for reacting to spills in the watershed, on the plant site, or in the community.

A spill response plan for oil spills into the watershed was developed in 1999-2000, in conjunction with the Longhorn Pipeline Environmental Assessment. The plan refers to spills entering the Lower Colorado System that would reach the AW WTPs. The AW plan includes activated carbon column additions to the treatment plants as the Best Available Technology (BAT) for removing oil from water. The carbon column systems have not been added to the plants but implementing emergency portable columns at the plants are part of the plan. A review and update of this older oil spill response plan is warranted, particularly with respect to current flow requirements, treatment plant facilities, suppliers of temporary equipment and costs

At the plant sites, minor spills of chemicals are cleaned up by plant staff. An occasional larger spill of sludge does occur. Plant resources are utilized to clean these spills as well, according to the dictates of the Watershed Protection Department. AW vacuum trucks are available to the plants on the occasion that a sludge spill occurs.

Spills can occur in the community from sludge hauling trucks or from the wastewater system. These spills are cleaned up by utility staff using utility resources in accordance with WPD requirements.

On very rare occasions, a waterline pipe break occurs in an area where treated drinking water spills into a running stream. When this occurs, cleaning up the treated water is not possible, and the chlorine in the water kills fish in the stream. In these instances, the Texas Department of Wildlife is involved; the utility is required to pay for lost fish.

The utility takes seriously the need to follow up on any spill with clean up and restoration. Spills do occasionally occur, but responses are rapid and complete.

2.5.5 Review of internal communication protocol for transmitting watershed data to plants

Watershed data is communicated by the water laboratory to the plant superintendents, treatment division manager, and operations manager by email whenever the measured parameters fall outside of a specific range. The parameters for notification include fluoride, sodium hexametaphosphate, free ammonia, and taste and odor compounds. In addition, the laboratory staff notify the plants by email of high algae counts and any other anomalies observed in raw water quality data. Because the plants measure a wide range of parameters in their respective laboratories, much of the information that is needed to determine adjustment to the treatment process is available on site. The AW approach to data collection and management is similar to that of most large utilities. The project team did not find any areas for concern with respect to data availability or internal communication of water quality information.

2.5.6 Recommendations for improvements to watershed monitoring and protection

	Issue	Recommendation
2.5-1	A spill plan dating to 2000 is no longer adequate for current conditions.	Review oil spill response plan and update it where needed, particularly with respect to current flow requirements, treatment plant facilities, suppliers of temporary equipment and costs.
2.5-2	Risk to AW is that more frequent, intense storms could occur.	AW should sponsor a study looking at the risks of more frequent and intense storms. Include an evaluation of LCRA's approach to management of the watershed during major storms and whether changes in their approach could positively impact water treatment challenges.

2.6 Water Treatment Infrastructure[4]

The team reviewed the existing Ullrich WTP primary unit processes based on current regulatory design requirements, with consideration of water quality characteristics defined by the original design documentation and historical plant data and previous process evaluations performed by others. In addition to the site visits and AW Staff interviews, the team reviewed documents associated with facility designs, reports and assessments, operational data from the Supervisory Control and Data Acquisition (SCADA) System, and pertinent regulatory rules. The team obtained, processed, and reviewed preserved plant operational data using SEEQ, an advanced data analytics tool, to evaluate hourly SCADA data (January 2013 to September 2022) and examine historical treatment process operational practices for comparison with design criteria and regulatory requirements. Design information was compared to State of Texas rules and regulations for public water systems established by the Texas Commission on Environmental Quality (TCEQ): Title 30 of Texas Administrative Code, Chapter 290, Subchapter D (TCEQ 290D).

This review determined that the defined basis of design for the Ullrich WTP primary treatment processes aligns with regulatory requirements and the processes are well-suited for the existing source water (Section 2.7). However, this review identified limiting factors that affect operational and maintenance capacity respective to facility size and treatment processes. Recommendations to address these factors and to enhance facility process redundancy and resiliency are summarized in this section.

[4] Section 2.6 summarizes the observations and associated issues and recommendations from the process review performed for this report under the supervision of Chad D. Bartruff, P.E. (#91688) (Brown and Caldwell, F-2139, December 29, 2022), as formally documented in Appendix 2-E of this report.

2.6.1 Process Review

The existing Ullrich WTP water treatment processes and the associated facilities and equipment were defined based on specific design criteria and conditions to treat Lake Austin water in compliance with state and federal regulatory requirements. This process review examined the design and function of the processes relative to these criteria and conditions. This section summarizes the process review analysis and findings. Appendix 2-E includes additional assessment details, site observations, and related process review information in support of this summary.

The existing Ullrich WTP facilities and treatment processes were established through various projects. The design and operational characteristics of the primary water treatment facilities and process were defined and upgraded as part of the Albert H. Ullrich Water Treatment Plant 167 MGD Plant Expansion (2003). The following subsections include brief descriptions and notable observations of specific facilities and treatment process units, which make up the overall Ullrich water treatment process. Figure 2.6.1 illustrates a process flow diagram of the primary Ullrich WTP facilities and process units examined, inclusive of the following:

- Low Service Pump Station
- Upflow Clarifiers
- Filters, Disinfection System
- Medium/High Service Pump Stations
- Solids Handling System
- Chemical Systems

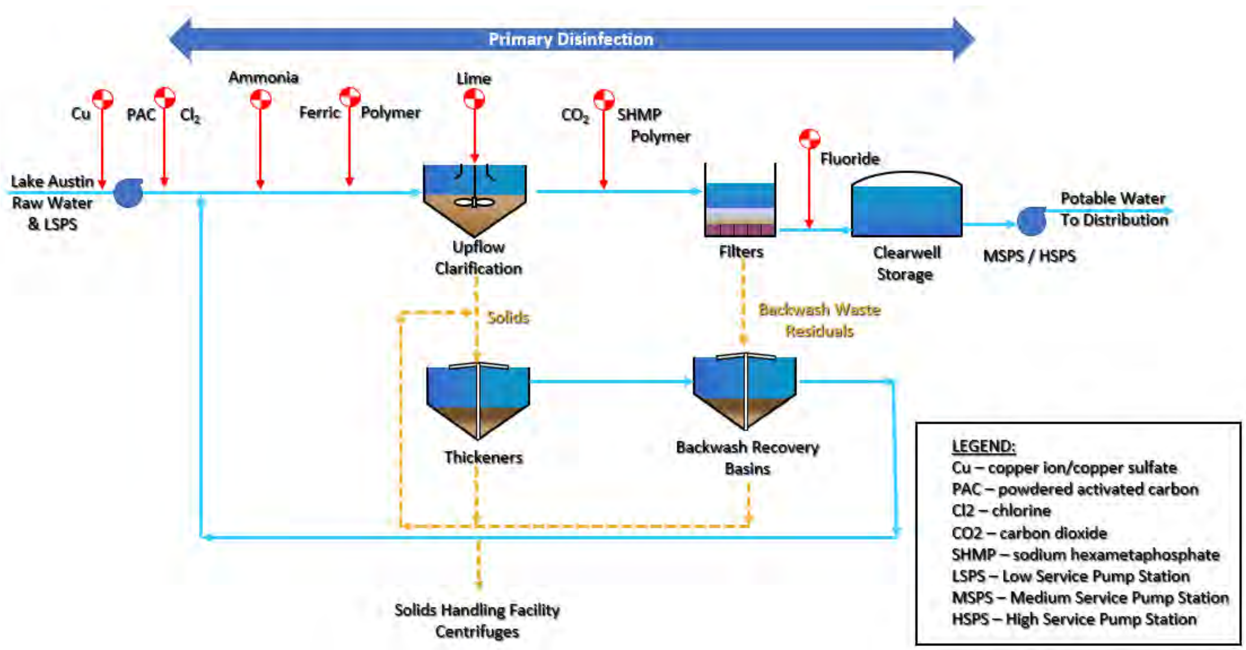


Figure 2.6.1: Ullrich WTP Process Flow Diagram

Low Service Pump Station. The Low Service Pump Station (LSPS) supplies source (raw) water from Lake Austin to the Ullrich WTP (Figure 2.6.2). Intake screens integral to the LSPS remove large debris before water is pumped and conveyed through a redundant set of pipelines to the Ullrich WTP site. Drinking water treatment chemicals are applied within the pipeline system in advance of the Ullrich WTP (Figure 2.6.1) treatment processes.

LSPS / Pipeline Capacity. The existing LSPS pumping system includes multiple pumps with combined design capacities comparable to the Ullrich WTP rated (167 MGD) and maximum (185 MGD) treatment capacities. The pumping system design was configured with redundant pump equipment typical for municipal drinking water facilities. The multiple raw water pipelines

Figure 2.6.2: Ullrich WTP and LSPS Facilities Plan, Not to Scale (Image from Google Earth)

provide redundancy comparable to the LSPS; however, the 2003 expansion design defined specific pipeline combinations to accommodate LSPS pump operational ranges.

Plant operations staff identified to the project team that the LSPS and pipeline operational capacities were less than the 2003 expansion design definition. Specifically, plant staff stated the transmission pipeline capacity is less than the defined design capacity of the plant.

Further investigation of the noted variances between the reported and designed capacities of the LSPS and raw water pipeline systems was not an element of this assessment. A hydraulic evaluation of the LSPS with the available pipeline options is recommended to confirm operational scenarios and the associated raw water delivery capacities.

Pipeline Operations. Ullrich WTP operations staff reported initiating operation of an offline pipeline necessitates a cleaning and flushing procedure. The procedure is performed to address organic build-up, potential zebra mussel growth, and other water quality issues. Plant operations staff advised that the time required to complete the procedure impacts responsiveness to increased water production requests from distribution. Staff reported that they are formally developing a standard operating procedure to determine operational triggers for when to bring a pipeline in service, which should help reduce response time to distribution requests.

Zebra Mussels. In addition to water quality considerations described in Section 2.5, zebra mussels will impact LSPS and pipeline operations and raw water delivery capacity to Ullrich WTP. Zebra mussel control and periodic maintenance were emphasized following the 2019 event (Section 2.1) and an evaluation identified preferred mitigative approaches. AW chose to implement a copper sulfate feed system solution (Zebra Mussel Mitigation Project, 2020) and a copper ion generating system (Zebra Mussel Mitigation Project, 2021) and proceeded with design and installation. These mitigative measures will facilitate zebra mussel control and benefit LSPS and pipeline operations.

Upflow Clarifiers. As illustrated in Figure 2.6.1, water from Lake Austin is pumped via the LSPS to the Ullrich WTP upflow clarification process for pretreatment. Traditional drinking water pretreatment utilizes chemical coagulation to create particle 'flocs' that can be physically removed by gravity settling (clarification) prior to filtration. The Ullrich WTP utilizes a combination of chemical coagulation and lime softening for pretreatment in upflow clarifiers (UFCs). In addition to clarification benefits, the lime softening process reduces 'hardness' of the Lake Austin water.

The UFCs are basins where water enters at the center of the basin and moves outward and upward towards basin surface. As the water moves outward, suspended solids natural to the raw water and those resulting from the coagulation and lime softening processes settle towards bottom of the basin, where they are collected and removed for management via the Solids Handling System. The clean water is collected at the top of the basin for further treatment via the downstream filtration process.

The pretreatment process requires application of drinking water treatment chemicals (Figure 2.6.1) upstream and within in the UFCs. Additional treatment chemicals are added to mitigate naturally occurring organics (tastes and odors), provide disinfection, and stabilize the process water. Carbon dioxide is applied to the clarified process water downstream of each UFC. This recarbonation of the process water lowers the water pH and stabilizes the water prior to filtration. If the recarbonation process is not adequately monitored by operations staff, excess lime solids from the UFCs may carry over to the downstream filtration process and negatively affect filter performance.

The upflow clarification process is well suited for the lime softening process and the normal range of Lake Austin water quality conditions, as discussed in Section 2.7. However, the UFCs are susceptible, and have limited ability, to accommodate rapid changes (shock-loading) in hydraulic flow rate and raw water quality. UFCs require more operational control by experienced operations teams than a traditional clarification process. Well monitored and controlled UFCs with relatively consistent raw water quality should nevertheless operate over a broad range of their defined design flow capacity. Plant operational staffing should be coordinated with UFC and recarbonation operations to provide appropriate monitoring of process conditions and performance. As noted in previous events (Section 2.1), conflicting responsibilities distracted staff from UFC monitoring and resulted in a process upset.

This assessment examined the documented physical design criteria and related design information for the Ullrich WTP upflow clarification process. Appendix 2-E includes a tabulated comparison of the process design criteria and regulatory requirements. Based on the comparison, the defined basis of design for the UFC process units is aligned with TCEQ regulatory requirements and industry standards.

This assessment analyzed UFC operational data from January 2013 through September 2022 for comparison to the defined design criteria. Appendix 2-E includes a tabulated comparison of the operational data with the process design criteria, detailed graphical representations of the process operations, and discussion of specific observations from the analyzed data for each UFC. Primary observations from this review are summarized as follows:

Operational Range Verification. Data indicated frequent fluctuation in individual UFC operation (online/offline) and limited ranges of operation as compared to the rated design hydraulic capacity of each unit. Limited range of operation can restrict operational flexibility and result in shock-loading during process flow changes.

- Efforts to align operations (number of UFCs on/offline) with anticipated distribution system demands to balance hydraulic loading across operational units and to manage process changes is recommended.
- UFC operations benefit from well managed process conditions. Validation of UFC operational range (% of rated design hydraulic capacity) through full-scale testing is recommended. Data indicated that UFCs were not operated over the range documented in AW standard operating procedures (SOPs). Available operational data for UFC No. 4 appeared to demonstrate possibility for expansion of the operational range beyond the SOP definition.

Process Performance Validation. Data indicated that individual UFCs were typically operated over a range slightly below or above their design hydraulic capacity. Resultant process performance, based on process water turbidity, was typically variable and periodic performance deviations from action levels documented in AW operational procedures appeared to occur. Short-term performance deviations are expected during start-up of an offline UFC and changes in process conditions; however, the data set limitations did not permit correlation to start-up events.

- Following verification of operational range, 'stress-testing' of the UFC process units and recarbonation processes to evaluate performance when subjected to changes in hydraulic conditions is recommended.
- Parallel to the stress-testing, a review of operational staff capacity to manage the process operations is recommended.
- Based on findings from the stress-test, the following actions are recommended:
    - Define target range of operational conditions (hydraulic) relative to seasonal water quality.
    - Evaluate if a process operations plan may be developed/modified to optimize unit operations (on-line/off-line process units) based on anticipated seasonal flow rates and verified operational ranges of individual process treatment units.

Process Operational Staffing. Previous events (Section 2.1) demonstrated potential process impacts if staffing is not complimentary to UFC operations.

- Identification of operations and maintenance staffing (numbers and experience) to support normal and extreme UFC operational situations is recommended.
- Evaluation of staffing in conjunction with overall facility and process requirements, not simply UFC operations, is recommended (Section 2.7).

Filters. Following the clarification and recarbonation processes, process water is filtered to remove remaining suspended particles that did not settle in the UFCs. The filtration process utilizes layers of sand and anthracite, broadly referred to here as "the media", to capture particles while allowing the process water to pass downward through the media.

Over time, particle accumulation in the media becomes restrictive to the water flow or excess particles are measured following filtration. When this routinely occurs, a media cleaning operation (backwashing) is performed to remove the filtered particles from the media. During a backwash operation, air and treated water is passed upward through the media to dislodge and remove the collected particles.

The used (waste) backwash water, or washwater, is collected in the backwash recovery basins, suspended solids are allowed to settle, the solids are removed to the Solids Handling System, and the remaining washwater is reclaimed to the raw water upstream of the Ullrich WTP treatment process. This process flow is illustrated in Figure 2.6.1.

This assessment examined the documented physical design criteria and related design information for the Ullrich WTP filtration process. Appendix 2-E includes a tabulated comparison of the process design criteria and regulatory requirements. From review of the design criteria and related information, the defined basis of design for the filtration process is aligned with TCEQ regulatory requirements, and it was noted that TCEQ approved a filtration design variance as part of the 2003 expansion project. Also, the existing filtration process includes 18 total filters; however, 13 filters may be operated to treat the rated design capacity of Ullrich WTP (167 MGD).

This assessment analyzed filtration operational data from January 2013 through September 2022 for comparison to the defined design criteria. Appendix 2-E includes a tabulated comparison of the operational data with the process design criteria, detailed graphical representations of the process operations, and discussion of specific observations from the analyzed data for the filtration process. Available data indicated that the filters operate efficiently, meeting regulatory requirements, but consistently operate at approximately 50% of the approved TCEQ capacity. When compared side-by-side with the UFC performance, it appears that the filters have effectively mitigated short-term UFC process inefficiencies. Primary observations from review of the operational are summarized as follows:

Process Performance Validation. Data indicated normal operation (filter loading rate) of the individual filters was approximately 50% of the TCEQ approved rated capacity. Historical Ullrich WTP production requirements (approximately < 120 MGD) and excess filter capacity (number of filter units) permitted this operational approach. As a result, the filters operated efficiently, exceeding original design assumptions, and meeting regulatory performance requirements, exclusive of isolated incidents (Section 2.1).

Filter operation at reduced capacity is beneficial for overall process operations – increasing filter efficiency, reducing backwash frequency, extending media life, providing flexibility for backwash operations, and facilitating waste backwash water management. However, a limited range of operation does not permit validation of filtration process performance, nor confirm necessary operations staff attention at increased flow conditions, up to the rated plant design capacity (167 MGD).

- Stress-testing of the filtration process units to evaluate performance and efficiency up to TCEQ approved capacity (filter loading rate) is recommended.
- Parallel to the stress-testing, a review of operational staff capacity to manage the process operations is recommended.
- Based on findings from the stress-test, the following actions are recommended:

- o Evaluate filter backwash procedures (queueing, operations, and performance) and identify potential optimization efforts.
- o Validate capacity of waste backwash water residuals management system (storage, clarification, and return pumping) based on observed filter efficiency.
- o Evaluate if a process operations plan may be developed/modified to optimize unit operations (on-line/off-line process units) based on anticipated seasonal flow rates and verified operational ranges of individual treatment units.

Filter Media Monitoring. Site visit discussions and interviews with operations staff identified inconsistent backwash procedures as a common issue. However, the available operational data set was limited and insufficient to further evaluate staff comments. Also, during the site visit, operations staff advised that media depth in individual filters required verification.

Definition of backwash procedures consistent with the filtration process design and media type and consideration of waste backwash residuals management capacity is required. Incorrect backwash operations can result in loss of filter media via the waste backwash flow, upset of the filter media profile, incomplete media cleaning, use of excess backwash water, etc., which can impact filtration process performance and regulatory compliance.

- Definition and implementation of a routine filter monitoring program for periodic verification of filter performance, execution of preventative maintenance, and validation of backwash procedures is recommended. Industry guidance documents may be referenced, such as AWWA Research Foundation "Filter Maintenance and Operations Guidance Manual", 11/01/2002.
- Conduct a seasonal backwash performance evaluation to optimize backwash procedures (media bed expansion, water/air flow rates, and sequence durations) to minimize potential media loss and optimize filter waste backwash residuals management.

Primary Disinfection. In conjunction with the lime softening clarification and filtration treatment processes, the Ullrich WTP primary disinfection strategy utilizes free chlorine and chloramine disinfectants to meet regulatory requirements for virus and *Giardia* inactivation. As shown in Figure 2.6.1, chlorine is applied to the raw water pipeline. Chloramines are formed by ammonia application prior to the upflow clarifiers and are then maintained through the treatment processes and clearwell storage.

Successful disinfection with chlorine and chloramines is dependent upon the time of disinfectant contact with the process water (contact time), the disinfectant concentration (residual), the water temperature, and pH. Contact time at Ullrich is achieved in the raw water pipeline, treatment process units, and the two finished water clearwells.

As noted in Section 2.7, plant operations consistently exceed the minimum primary disinfection requirements. Available design record documentation indicated that the existing raw water pipelines, process units, and clearwells can provide sufficient contact time to achieve disinfection requirements for the rated plant capacity and design water quality conditions. However, operations staff must regularly monitor water quality, disinfectant residuals, water temperature, and pH with consideration of the process flow rate to ensure that minimum requirements are exceeded.

Anomaly water quality events, such as the October 2018 flood event, can significantly increase concentrations of organic constituents in the raw water supply. Increased organics will necessitate process operational changes and will typically require increased application of disinfectant chemicals. As specific water quality impacts of anomaly events cannot be predicted, well-defined SOPs to manage and operationally respond to such events must be defined, communicated, understood, and followed by plant operations staff. Additionally, operations staff must have adequate training and experience to interpret the observed conditions and respond appropriately. Section 2.7 should be referenced for further discussion of water treatment operations and facility SOPs.

High and Medium Service Pump Stations. The High Service Pump Station (HSPS) and the Medium Service Pump Station (MSPS) deliver finished water from Ullrich WTP clearwell storage to the distribution system South Zone and Central Zone, respectively. Combined, the design firm capacity of the HSPS and the MSPS is approximately 185 MGD.

The MSPS pumps are driven by dual-voltage, dual-speed (low and high) motors due to distribution system hydraulic characteristics. Normal water distribution demands (approximately < 120 MGD) are met using the low-speed operation. To pump increased flows and up to the design firm capacity, staff reported that the electrical configuration for the MSPS pumps must be switched for high-speed operation, the switching requires an on-site electrician, and historically the personnel to perform this work were not staffed on-site. Thus, depending on electrician availability, the implementation of necessary electrical modifications and the response to distribution system requests for additional pumping may be delayed. Considerations and recommendations related to the electrical switching operation are discussed in Section 2.9.

Solids Handling System. The solids handling system manages solids collected and removed from the upflow clarifiers and filter backwash process. Ultimately solids are collected and hauled offsite for disposal. The Ullrich WTP utilizes solids thickening and mechanical dewatering processes to remove excess water from the collected solids to facilitate hauling and disposal. Water reclaimed from the dewatering and filter backwash process is returned to the treatment process upstream of the upflow clarifiers.

The thickening process relies on gravity settling of the suspended solids. Thickened solids are transferred to holding tanks where mixers maintain the solids in a uniform suspension. Solids are pumped to the mechanical dewatering equipment, called centrifuges. Centrifuges spin a vessel at a high speed to separate water from the solids. Dewatered solids are then collected in trucks and hauled offsite. If the solids handling system is not fully operational or limited in capacity, Ullrich WTP production capacity will be impacted accordingly.

AW staff reported that each of the four existing centrifuges has required multiple repairs to extend their useful life. Each machine repair required adjustments that restricted space for installation and operations and maintenance and required modification of equipment structural supports. Although the Ullrich WTP operations staff have successfully performed repeated centrifuge equipment repairs so that they operate as intended, the equipment is maintenance intensive due to the system's age and condition. Staff identified these as historical issues and advised that rehabilitation projects were not previously prioritized.

AW initiated an evaluation of the existing solids handling system and facilities, and a preliminary engineering report (Ullrich Water Treatment Plant Solids Handling System Improvements, May 2020) provided recommendations for rehabilitation of the solids handling system, including an equipment evaluation for centrifuge equipment replacement. This evaluation included assessment of treatment process adjustments to address anomaly water quality events, such as potential flood events. Because the solids handling system was recently evaluated, the design of the solids handling system and related facilities were not examined in detail as part of this assessment.

AW advised that projects were initiated to address the recommended improvements from the May 2020 evaluation. Due to the criticality of the solids handling system for Ullrich WTP operations, the age and condition of the existing equipment, and the maintenance intensive operations, a capital project to replace the centrifuge equipment and related system elements as recommended in the evaluation should be prioritized.

Chemical Systems. The following drinking water chemicals are used throughout the treatment process and Figure 2.6.1 illustrates the primary application point of for each:

- Copper Sulfate
- Powdered Activated Carbon (PAC)
- Chlorine
- Ammonia
- Polymer (Cationic)
- Ferric Sulfate
- Lime
- Carbon Dioxide
- Sodium Hexametaphosphate
- Fluoride

TCEQ regulations stipulate water treatment bulk chemical storage facilities are to have capacity for at least a 15-day supply of each chemical. Dependent upon the chemical, TCEQ typically will accept a bulk storage capacity less than 15 days if reliable supplies are confirmed available. Exclusive of the lime system, the 2003 expansion and subsequent projects that implemented or modified Ullrich WTP chemical storage and feed systems defined design criteria for compliance with the TCEQ 15-day requirement. AW staff advised during interviews that two lime supply contracts are established with local providers for supply redundancy and chemical contracts are established for other drinking water chemicals critical for treatment.

TCEQ requires chemical feed system installations to have standby or reserve unit(s) to ensure feed capacity applicable to the treatment process. Previous Ullrich WTP chemical system designs indicate provision of standby chemical feed capacity. Based on current treatment techniques and chemical dose requirements, it is recommended that the existing feed systems be evaluated concurrent with the recommended process stress-testing to confirm performance and available redundancy for operation up to the Ullrich WTP rated design capacity.

Based on incident recommendations for the Winter Storm Uri event, it is understood that AW initiated and is continuing to evaluate chemical system capacity improvements at their treatment facilities, including Ullrich WTP. Additionally, AW is defining procedures regarding non-critical chemical use during emergency events. As procedures are updated, comparable staff training and procedure documentation is recommended to confirm staff understanding.

2.6.2 Facility Process Observations

A two-day site visit to Ullrich WTP was conducted on August 8-9, 2022. The focus was to observe the condition of the plant facilities, treatment units, and associated equipment and to interview facility engineering, operations, and maintenance staff. Observation and interview notes can be found in Appendix 2-E.

During the site visit, the project team observed the WTP as clean and tidy but also noted that equipment preventative maintenance was lagging, affecting operational readiness. The plant staff acknowledged this and stated that a plan was established to catch up on preventative maintenance activities, but that low priority preventative maintenance tasks are commonly deferred due to staff shortages at the plant. Staff advised that maintenance is prioritized based on safety, public health, and treatment capacity.

The following is a summary of notable observations and staff feedback from the site visit and recommended measures to further investigate and address each item. As referenced below, specific staff items overlap with the process review in Section 2.6.1 or other sections of this report.

Process Operational Range. AW staff members expressed confidence in Ullrich WTP's ability to meet treatment requirements normal operations, which they identified as generally less than approximately 120 MGD. but uncertainty of water treatment performance above 120 MGD reduces staff confidence in Ullrich plant's ability to meet higher demands. It was noted that monthly operating reports recorded isolated daily water production events greater than 120 MGD.

Validation of process operational range up to the Ullrich WTP rated design capacity is needed to plan and prepare for facility and system operational readiness. Section 2.6.1 included recommendations to stress-test the primary treatment process units, as possible, to their rated design capacity.

Existing staffing limitations may necessitate engagement of other internal (from other AW facilities) and/or external (e.g., third-party engineer or contractor) resources for these efforts. The following activities are suggested in parallel with the testing:

- Complete parallel condition assessment of process systems. Identify process performance-limiting factors and equipment deficiencies witnessed during the stress-test.
- Utilize findings to adjust preventative maintenance schedules, develop equipment replacement plans, and to identify facility improvement recommendations.
- Coordinate recommendations for implementation into the Capital Improvements Plan.

Operational Staffing Limitations. Regarding their ability to produce regulatory compliant water at flows greater than 120 MGD and up to the rated WTP capacity (167 MGD), staff consider procedures to increase water production beyond approximately 120 MGD to be labor intensive, and due to their multiple responsibilities, a potential water quality risk. Staff advised that such increases cannot be completed quickly as specific operations (e.g. raw water pipelines and medium service pumps) require multiple steps to implement and coordination with others.

Normal process monitoring activities and assignments vary dependent upon process flowrates – increased flowrates require additional operations and maintenance staff. Staff resources, responsibilities, and training must be complimentary to the designated assignments, including labor intensive operations outside of normal day-to-day tasks.

It is recommended that AW engage the water production, distribution system and AW emergency response teams to review coordination of operations, specifically the planning, coordination, and communication for system flow changes with consideration of current staffing situations. Consider engagement of internal/external resources to facilitate review and refinement of staffing assignments, action levels, communication protocols, and standard operating procedures for increasing plant production.

Operational simulations for significant production changes and maximum water production operations are recommended at the Ullrich WTP to train and maintain staff familiarity with assignments and procedures.

Conduct a post event debrief with the participating AW teams. Update staffing assignments and standard operating procedures, as applicable, to reduce risks identified during the event and/or simulation.

Preventative Maintenance. Staffing limitations have created a backlog of preventative maintenance (PM) and condition assessment tasks, which are utilized to evaluate operational risks and prioritize capital projects. Maintenance is therefore prioritized based on safety, public health, and treatment capacity. The backlog of PM activities and staff limitations has inhibited ability to address equipment issues and failures or has resulted in maintenance intensive systems (e.g., solids handling centrifuges and chlorine system). The impacts of the task backlog can be amplified during extreme operational events. Ullrich WTP staff advised that a plan was established to catch up on PM tasks but acknowledged that task prioritization is required due to ongoing staff shortages.

Staff also gave inconsistent reviews regarding the facility/equipment computerized maintenance management system (CMMS), which is necessary to identify, track and monitoring existing assets and PM status. Recent CMMS updates were implemented in mid-2022, which provide additional functionality to monitor and track assets. It was noted that via the current asset management program AW began systematically validating the preventative maintenance programs at the treatment facilities to ensure that the appropriate maintenance was scheduled at the appropriate frequency. It is understood that the validation efforts are ongoing with completion expected in mid-2023.

The implementation of short-term assistance measures to remedy the backlog of PM and condition assessment tasks and to identify capital improvement projects is recommended, such as:

- Temporary reassignment of knowledgeable maintenance staff from other AW facilities with similar equipment.
- Contract with original equipment manufacturers or third parties (contractors) to supplement if staff are not available to support.
- Identify projects that may be performed internally and those which require contracted engineering and construction support.
- Verify staff training and as possible identify to staff the position/role-specific benefits maintaining and monitoring the CMMS provides to them.

Regarding long-term considerations, verify the current staff resource plan to confirm that defined positions, including current staff and proposed hires, are comparable to the facility needs.

Solids Production Management. Ability to manage solids production, due to existing condition of the centrifuge dewatering system was expressed as a significant risk to plant operations because of the staff time commitment required to keep the system operational. AW efforts to identify and address solids handling system issues and implement improvements are discussed in Section 2.6.1.

Development Time for Capital Improvement Projects. Ullrich WTP staff view the capital improvements project timeline – identification, planning, design, and construction – as excessively long. AW engineering staff acknowledged that up to 10 years may be required for completion of a capital project from identification to construction completion. Project size and complexity will affect development timeline; however, inability to effectively develop and implement projects is considered an operational risk. A specific example cited by the operations staff was the pending solids handling system centrifuge equipment replacement project.

AW utilizes a risk-based protocol for routine internal condition assessment of facilities, systems, and equipment as part of the asset management program. Assets are evaluated and scored (INFOR EAM 11.4 Design Guide, March 2021) to determine capital project prioritization. The assessment process, which is the responsibility of facility engineers and operations staff, considers asset condition, criticality, and risk mitigation measures. Due to staffing shortages (facilities engineers and operations staff), staff advised that the internal condition assessment process has not progressed as intended. AW management uses these assessments to determine capital budgets and to prioritize projects.

Refer to discussion of 'Preventative Maintenance' above regarding recommendations to remedy PM and assessment tasks backlog. Expediting these efforts is proposed in order to facilitate evaluation of operational risks and identification and definition of projects.

Project identification, definition, prioritization, and budgeting are key to capital projects planning, and AW has established protocols for this process. An effective CIP planning process requires detailed evaluation and communication between all levels of the AW organization. It must be acknowledged that individual staff perspectives regarding project prioritization will vary, and they may not align with final CIP determinations.

This assessment did not include detailed evaluation of CIP planning and communication. However, based on operations staff commentary and cursory examination of the capital planning process, it is suggested that AW work to enhance understanding of the CIP process throughout the organizational levels so that critical projects are identified as soon as possible and are given priority to minimize operational risks.

Upflow Clarifiers. The assessment team visually identified that the outlet weir launders within UFC No. 5 are unlevel, which can result in short-circuiting of process flows through the treatment unit.

Remediate Upflow Clarifier No. 5 launder level deviation and verify launder elevation uniformity for all units.

Filters. AW staff members reported potentially varying media depths in the filters and assessments of the filter media depth and age is not consistent.

Management of filter conditions and operations is needed for efficient operations compliant with regulatory requirements. Assessment of current filter conditions can be used to prioritize filter rehabilitation if needed. Refer to Section 2.6.1 for further discussion and recommendations associated with this noted observation.

Lime System. AW staff indicated there are operational difficulties with the existing lime slakers and feed valves and that these were not included in the most recent lime slurry project scope.

The Ullrich WTP Lime Feed Loop project (January 2020) addressed specific elements of the existing lime storage and feed system. AW advised that system training is ongoing to increase operator familiarity with the improvements.

Due to the stated staff concerns, a review of prior lime feed and delivery system condition assessment(s) and their findings with plant staff to confirm their stated concerns is recommended. Review efforts should identify remaining issues, if any, and determine response actions. Evaluate the system in parallel with the recommended process stress testing to verify and further identify potential performance limiting factors.

Chlorine Feed System. The liquid chlorine and ammonia feed systems are essential for water treatment. Ullrich WTP staff identified the existing chlorine feeders (chlorinators) as maintenance intensive equipment that requires regular staff attention to ensure operations. Staff expressed reliability and potential safety concerns regarding the existing chlorine and ammonia systems.

AW initiated the Ullrich WTP Conversion project to convert the existing gas chlorine and ammonia feed systems to on-site sodium hypochlorite generation and liquid ammonium sulfate systems, respectively. This conversion will eliminate reliance on the existing chlorinators and reduce the potential hazards associated with storing and operating gaseous chemical feed systems. The project basis of design report (June 2021) was completed, and the engineering design is being developed. The disinfection process is critical for water treatment; it is recommended the project continue as currently scheduled, with efforts taken to minimize any delays.

2.6.3 Process Water Quality Considerations for Incidents of Concern

Water treatment facilities are not typically designed for anomaly water quality events, and when subjected to anomaly conditions, they should not be expected to perform as they do when treating water quality within designed conditions. In such cases, it is often possible to maintain finished water quality by reducing the volume of water treated and being prepared to adjust process operations based on observed conditions.

Appendix 2-A provides a detailed summary and review of the incidents of concern. The following paragraphs discuss process considerations related to specific observed water quality events that affected the AW system.

Colorado River Flood Event (October 2018). As characterized in the respective After Action Report (AAR) and Section 2.1, the flood event was a historic incident resulting in defined source water impacts. As previously noted, water treatment facilities and processes are designed for specific ranges of water quality conditions and process loading rates. The observed water quality conditions for this event were outside of design conditions and not ideally suited for operation of the primary treatment processes at design flow conditions and loading rates. Maintenance of operations during an event such as the 2018 Flood requires pre-planning scenario training for observation and evaluation of water quality, definition of process operational adaptations based on observed conditions, and development of situational staffing plans.

Zebra Mussel Water Quality Event (February 2019). With respect to the Zebra Mussel event discussed in Section 2.1, the Ullrich WTP is equipped with a copper sulfate feed system which is being replaced by a copper ion generating system in the Ullrich WTP LSPS. These systems, in combination with a standard operating procedure for monitoring of infrastructure conditions and periodic exercising of infrequently used infrastructure, such as the raw water line from the LSPS to the WTP, will facilitate management of water quality issues associated with zebra mussels.

Winter Storm Uri (February 2021). Winter Storm Uri disrupted the primary power supply to Ullrich WTP from the main substation. Details of this event and its impacts are discussed in Sections 2.1 and 2.9 and the related event After Action Report. Based on provided information, AW efforts are progressing to address the respective AAR, which recommended mitigative measures, including planning and progression of larger capital projects.

High Turbidity Event at Ullrich Water Treatment Plant (February 2022). A high filtered water turbidity at the Ullrich WTP required issuance of a boil water notice in February 2022. As indicated in Section 2.1, operational error was identified as the root-cause of the incident. The UFC No. 6 start-up issues were considered an isolated event in which procedures were not followed and staff were overloaded. The dewatering centrifuge system did not directly cause the incident, but rehabilitation of the centrifuge system would reduce time required for maintenance by operational staff, allowing staff to focus on operations.

2.6.4 Primary Power Redundancy/Resiliency

Determination of power redundancy and resiliency measures for a water treatment facility requires definition of minimum operational requirements. Minimum operational requirements must consider the overall water system inclusive of complimentary raw water supply, water treatment, and distribution system capabilities and vulnerabilities.

The State legislature passed Senate Bill 3 in June 2021 to address critical infrastructure issues that arose during Winter Storm Uri. Senate Bill 3 (SB3) requires public utilities to develop an Emergency Preparedness Plans (EPP) to support emergency water treatment plant operations during extended power outages lasting more than 24 hours. The EPP includes a detailed review and evaluation of facility and system requirements to meet the stated water system operational objectives.

The AW EPP, as submitted to the TCEQ, defines facility-specific electrical infrastructure hardening features, criticality designations, and staffing plans for individual facilities. For Ullrich WTP, the EPP proposed the following actions for compliance with SB3 requirements:

- Maintain redundant electrical primary services (common source) with automatic transfer capabilities.
- Implement tertiary electrical primary service (alternate source) with automatic transfer capabilities.
- Implement maintenance plans (tree trimming) for protection of electrical infrastructure.
- Upgrade and replace existing electrical infrastructure (raw water pump station substation).
- Maintain designation as a Tier 1 Critical Load facility.
- Designate specific facility staffing plans and personnel to support electrical redundancy measures.

The electrical system configuration and the associated redundancy provisions indicate that operation of Ullrich WTP up to rated capacity is required, and therefore no alternative minimum operational capacity was defined. Given the existing and planned redundant primary feed services to Ullrich WTP and the facility designation as a Tier 1 Critical Load facility, the EPP does not alternatively identify on-site power generation systems for Ullrich WTP facility.

Ullrich WTP primary electrical power redundancy and resiliency strategies (both existing and planned) as defined in the submitted EPP are considered typical of comparably sized, process configured facilities. With approval of the submitted EPP and implementation of the identified strategies, periodic evaluation of plan adequacy is recommended, and it should be updated and resubmitted in accordance with TCEQ requirements. Adequacy of the EPP and implementation of on-site electrical generation might be considered after completing further evaluation of minimum operational requirements. Reference to Section 2.9 is recommended for further discussion of considerations and potential improvements to enhance the redundancy and resiliency of Ullrich WTP electrical systems.

2.6.5 Summary of Findings and Recommendations

Table 2.6.1 consolidates and summarizes the identified issues and recommendations presented in the preceding sections. Refer to the preceding sections regarding details associated with each issue and the individual recommendations.

Table 2.6.1 Summary of Recommendations for Infrastructure

	Issues	**Recommendations**
2.6-1	Upflow Clarifier operations indicate frequent fluctuation in individual UFC operation (on/offline) and limited range of operation, which can restrict operational flexibility and process resiliency due to shock-loading.	Align clarifier operations with distribution system demands and balance hydraulic load variation across on-line units. Increase/improve communication between Pumping and Plant Operations.
2.6-2	Limited operational history above 120 MGD reduces staff confidence in Ullrich WTP's ability to achieve treatment requirements up to rated plant capacity (167 MGD) and restricts operational flexibility.	Verify operational range of primary processes (UFCs) to enhance operational flexibility. Update SOPs based on findings. Validate performance of primary processes over confirmed operational range via stress-testing. Update SOPs based on findings. Concurrent with stress-testing, evaluate related process systems and complete condition assessments for PM and CIP planning. Evaluate operational staffing (numbers and experience) requirements for operational range of process systems inclusive of normal and emergency conditions.
2.6-3	Inconsistent filter backwash operations and variable filter media conditions were reported, which can impact filtration process performance.	Conduct a seasonal backwash performance evaluation. Define and implement a routine filter media monitoring program.

	Issues	Recommendations
2.6-4	Staff identified historical issues with the Solids Handling System centrifuges and reported that projects to address them have lagged. Significant time and energy are required to operate and maintain the centrifuges, diverting the attention of the plant operations staff. This was a significant factor in the February 2022 event.	Prioritize centrifuge replacement based on equipment evaluation in the Ullrich Water Treatment Plant Solids Handling System Improvements, May 2020 report.
2.6-5	Staffing constraints impact start-up activities and on-line operations. To increase water production above 120 MGD requires multi-step and time intensive operational activities.	Engage AW teams to review coordination of operations for system flow changes with consideration of current staffing situations. Consider internal/external resources to facilitate review of staffing assignments, action levels, communication protocols, and SOPs Conduct simulations to train and maintain staff familiarity with assignments and procedures. Conduct a post event debriefing with participating AW teams. Update SOPs and staffing assignments to reduce operational risk.
2.6-6	Staffing limitations created a backlog of preventative maintenance (PM) and execution of asset assessment procedures, which are used to evaluate operational risk and prioritize capital projects. Staff perception of the asset CMMS system is inconsistent.	Implement short-term assistance measures to remedy the PM backlog. Verify staff training and identify to staff the position/role-specific benefits that the CMMS provides. Evaluate long-term staff planning considerations; verify the current staff resource plan to confirm that defined positions, including current staff and proposed hires, are comparable to the facility needs.
2.6-7	Staff view the capital improvements project timeline as excessively long.	Enhance understanding of the CIP process throughout the organizational levels so that critical projects are identified as soon as possible and are given priority to minimize operational risks.
2.6-8	Upflow Clarifier No. 5 was observed to have a damaged and unlevel outlet launder.	Remediate Upflow Clarifier No. 5 launder and verify launder elevation uniformity for all units.

	Issues	Recommendations
2.6-9	Staff reported concerns with lime feed system capacity. Lime slakers and valves were identified as performance limiting factors.	Review prior lime feed and delivery system condition assessment(s) and their findings with plant staff to confirm their stated concerns. Identify remaining issues, if any, and determine response actions.
2.6-10	Staff stated process reliability and safety concerns with the existing chlorine and ammonia systems.	The disinfection process is critical for water treatment; continue Ullrich WTP Conversion project as currently scheduled, with efforts taken to minimize any delays.

2.7 Water Treatment Operations

In addition to reviewing a wide range of documents, the project team toured Ullrich WTP with staff from the plant and from Process Engineering and interviewed plant managers, plant superintendents, plant operations supervisors, and plant operations and maintenance technicians. The project team also interviewed managers of operations, distribution, pumping, planning, water regulations, facility and process engineering, human resources, and administration. Documents reviewed covered a wide range of subjects including operator training, licensing and job descriptions; process information such as designs for chemical feed; decision process tables; the 10-yr CIP program; HAB treatment documents; water quality sampling programs and the computerized Operations and Maintenance Manual. Data sources reviewed and/or utilized for the treatment analysis include monthly operating reports (MORs) for each incident month and for finished water data, water quality standards for assessment of performance, intake and lake run data, and any data demonstrating changes in water quality.

The data collected in this task was used to understand the management strategies and identify staffing issues discussed in Section 2.2 and to assess the performance of the plant with respect to the stability of raw and finished water quality.

Many of the project team recommendations regarding challenges to operations are reflected in the discussion of management, staffing and training (Section 2.2). Excellence in operating a treatment plant is grounded in the strength and competence of the plant staff and managers and their ability to problem solve daily, including under emergency conditions. See Section 2.2 for details of the review of these elements at Ullrich WTP.

2.7.1 Review of Water Quality Data

Drinking water plants are planned and designed to use processes that are best suited to treat the raw water source. As designed, the lime softening/conventional filtration process used by Ullrich WTP is well suited for treating the moderately hard, high alkalinity water of the Lake Austin source. The lime softening process, using up-flow clarification followed by conventional filtration, is a mature, well-established technology.

Several raw water parameters are critical for the performance of Ullrich WTP, including:

- Turbidity, measured in Nephelometric turbidity units or NTU
- Total organic carbon, TOC, measured in mg/L C
- pH
- Total Hardness, measured as mg/L $CaCO_3$
- Alkalinity, measured as mg/L $CaCO_3$

See Appendix 2-D for additional information on the water quality data. The data set consists of 22 years of turbidity data (1/2000 to 5/2022) and 12 years of data for the other parameters. These time spans are adequate to identify ongoing changes in water quality.

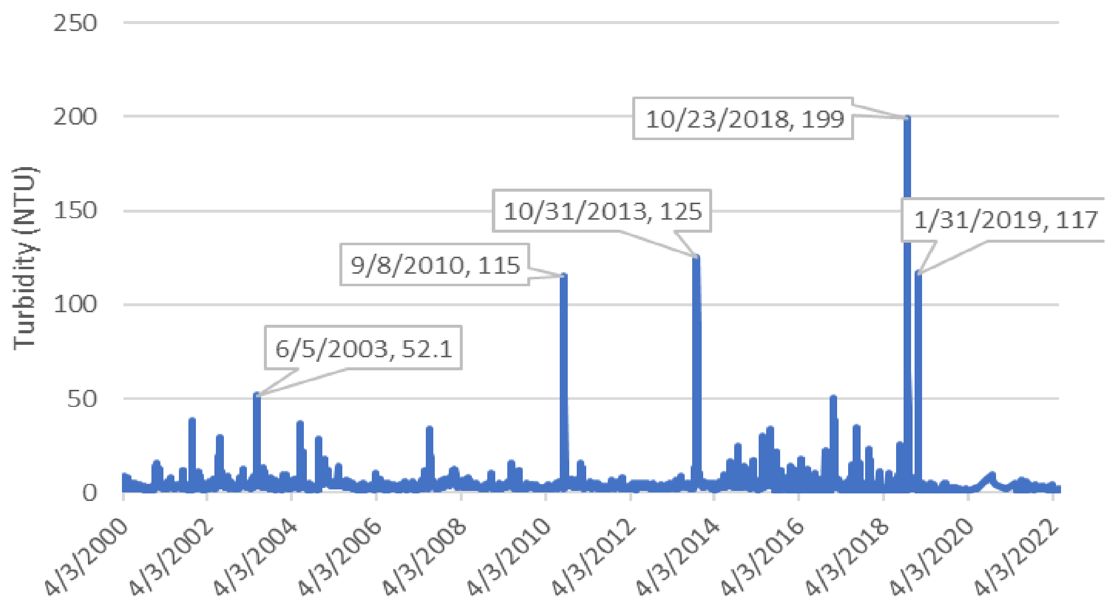


Figure 2.7.1 Raw Water Turbidity at Ullrich WTP Intake

Raw water turbidity over the past 22 years has averaged 4.2 NTU with occasional turbidity spikes. This level of turbidity is relatively low with respect to most surface water supplies and is typically easily treatable. For 99% of the time the intake turbidity has not exceeded 20 NTU. The turbidity spikes are shown in Figure 2.7.1. Basically, the turbidity of the water is very consistent over time, with the exception of changes due to occasional intense storms. The history of storm events exhibits similar water quality changes as October 2018, but not as severe. During prior events, water quality remained within the range of treatability, and the record shows no evidence of long-term changes in raw water quality over the last 20+ years. Ullrich WTP has consistently produced water meeting all regulatory requirements, regardless of raw water quality, with the only exceptions being the 2018 flood event and the 2022 boil water event (which was not related to raw water quality).

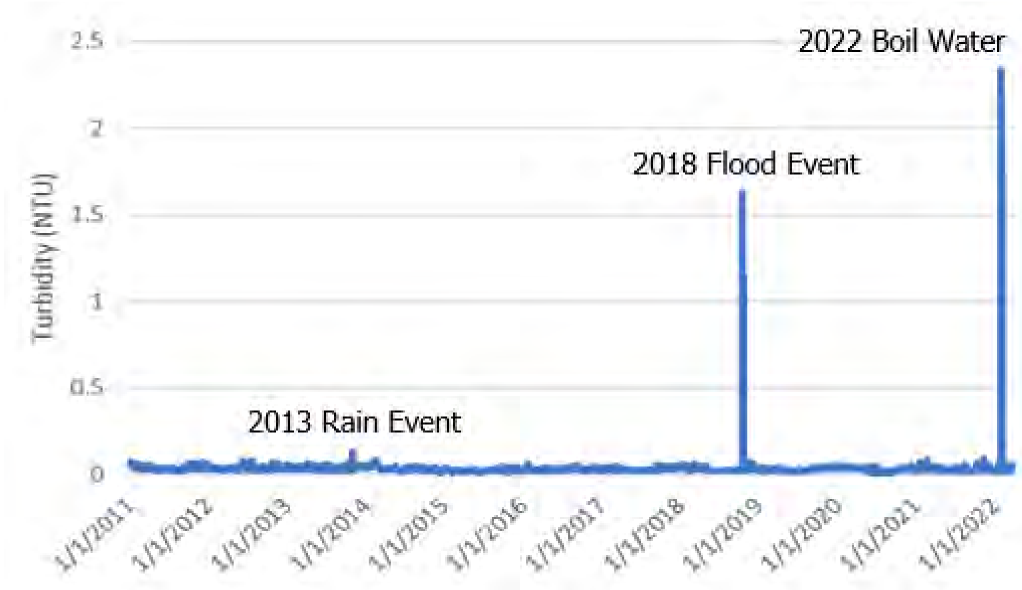


Figure 2.7.2 Ullrich WTP Treated Water Turbidity

Treated water turbidity is shown in Figure 2.7.2, illustrating the consistency of treated water coming from Ullrich WTP. The regulatory standard for treated water turbidity is 0.3 NTU. Most plants target a turbidity level below the regulatory level. Between January 2011 and March 2022, for 99.7% of the days during this period, treated water turbidity was less than 0.1 NTU. This performance is excellent and reflects the plant meeting their treatment target for turbidity almost all of the time. However, there were seven days when treated water turbidity exceeded 0.3 NTU. These were October 21-25, 2018, during the 2018 flood event and February 2-3, 2022, during the 2022 Boil Water event.

A number of parameters are regulated by the TCEQ drinking water rules, one of which is total organic carbon. Besides being regulated for removal to manage the formation of byproducts when water is disinfected with chlorine, TOC is also of interest to chip manufacturers because high levels interfere with the manufacturing process.

Figure 2.7.3 shows the raw and treated TOC values for Ullrich WTP for January 2017 – December 2021. During this period the average raw water TOC was 3.8 mg/L C and average treated water TOC was 2.5 mg/L C. Throughout this period, the Ullrich WTP was in compliance with the regulatory removal requirements for TOC.

Evident from the plot of the data is that the Ullrich WTP is fully capable of removing large spikes of TOC that occur from time to time, maintaining a fairly stable treated water TOC level. This helps the plant manage the disinfection process, and it helps the chip manufacturers because they can count on a stable TOC removal requirement for their own manufacturing water treatment processes.

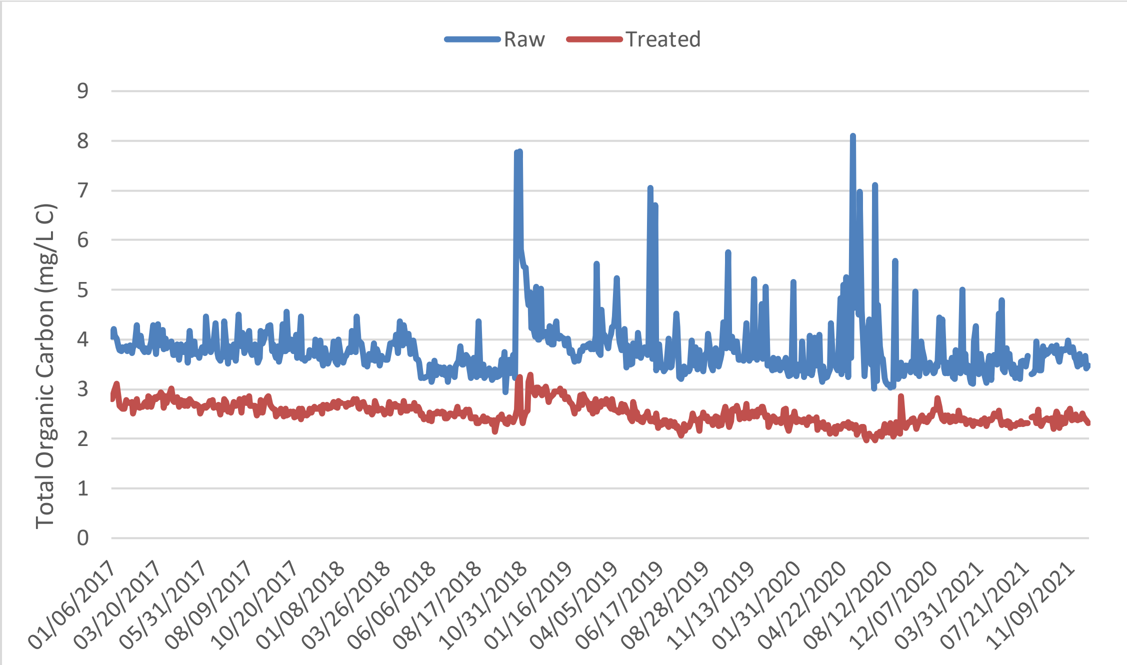


Figure 2.7.3 Ullrich WTP Raw and Treated Water TOC

The 2018 storm event was extreme and unprecedented. Water quality conditions, including turbidity, hardness and alkalinity, changed enough that the softening process could not succeed. Hardness is caused by the presence of calcium and magnesium in the water. The softening process targets the removal of calcium. While many processes can soften water by removing calcium, most of them are not cost effective when treating tens of millions of gallons per day. For a plant the size of Ullrich WTP, lime softening is the industry standard and the most cost-effective and practical process to perform softening. In studies

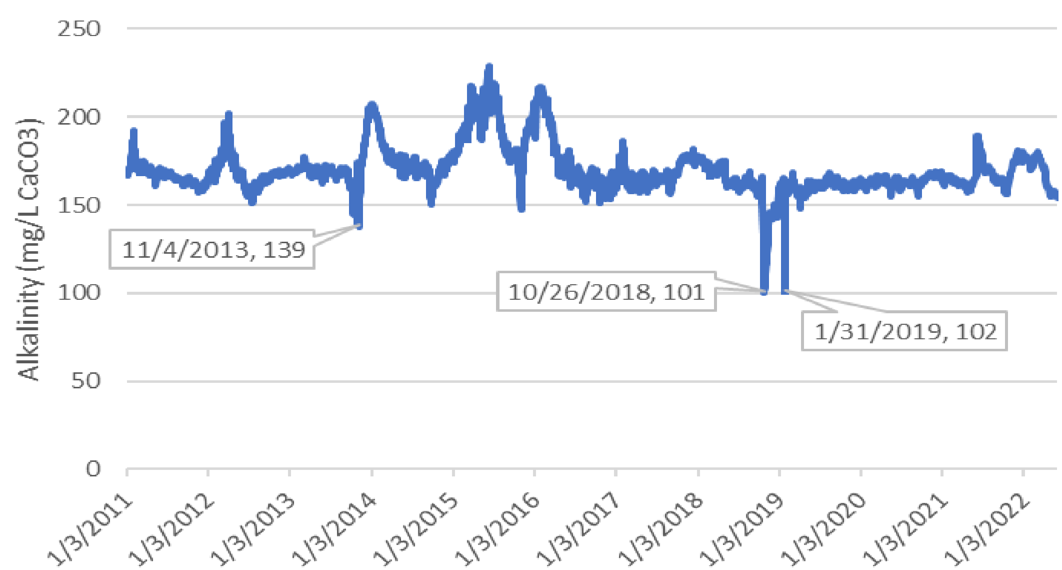


Figure 2.7.4 Ullrich WTP Raw Water Alkalinity

completed by the utility that considered alternatives to lime softening, none of the alternatives were considered satisfactory.

Softening chemistry is based on adding lime to the water to raise the pH to the point where calcium in the water precipitates to form solid calcium carbonate ($CaCO_3$). This requires the presence of bicarbonate, typically supplied by natural alkalinity, in the water. The alkalinity in the 2018 runoff was much lower than normal, such that inadequate bicarbonate was present for the minimal lime precipitation to remove high levels of turbidity. The plant was thus unable to successfully remove turbidity to the levels required by the regulations. Conversely, for the rain event in October 2013, the plant was able to maintain an adequate softening process to remove turbidity below regulated levels. Figure 2.7.4 shows the Ullrich intake alkalinity from January 2011 to May 2022.

While the newly installed polymer feed system may provide some improvement in settling under low alkalinity conditions, AW may want to further evaluate whether it makes sense to have an added source of carbonate for the plant to feed under similar low alkalinity conditions. In addition, since the new polymer feed system is being operated year around, AW should evaluate whether with additional training the staff could be prepared to start up the polymer system under specific water quality conditions. The benefit to AW would be eliminating the cost of operating the system year around. Another mitigation approach to better address low alkalinity source water episodes would be to decrease production rates through the plant thereby lowering filter loading and managing filtered water turbidity. This approach was effectively implemented by the Handcock WTP during the 2018 flooding event. We suggest that AW review the likelihood and risks of more frequent and intense storms and identify if LCRA could improve management of the watershed during these events.

Preparing Ahead for Extreme Events. Of the incidents of concern to AW, two involved some impacts from naturally occurring events that altered raw water quality. The flood of 2018 and the arrival of zebra mussels at the facility intake can be categorized as such events. The freezing conditions experienced with Winter Storm Uri were also a naturally occurring event but did not result in altered raw water quality. However, for each of these events, some prior planning had been accomplished and likely made the events slightly less onerous. AW would benefit from scenario planning, including a more staff inclusive and expanded review of what can happen. It is critical that the utility routinely think through possible solutions for such events.

For example, if groups of staff members at the plant were asked to think about one or more of these events in a planning exercise, they may identify actions that could be taken to avoid or mitigate similar issues in the future. If a flood is expected from a major rainstorm upstream in the watershed, experienced plant staff will likely know when the impacted raw water would be expected at the plant intake. Planning to keep distribution storage tanks full until the changed water quality arrives at the intake would alleviate strain at the WTPs. Other ideas could surface that would help the plant during the altered conditions. This sort of approach can be undertaken at any time, with hypothetical or retroactive consideration of events. Operators often have more knowledge than they are credited for or that they themselves recognize; it is incumbent on plant management to utilize such a resource.

The zebra mussel event differs slightly but might have been avoided if plant staff had been engaged in thinking through what would happen when the mussels colonized the plant piping. Perhaps the complexity of cleaning the mussels out would have become more apparent if the consequences of letting them grow had been thoroughly assessed, drawing on the knowledge of the plant infrastructure and industry experience regarding the possible issues with cleaning. The water industry knew the rate at which mussels were moving across the country, and when the first ones were identified in Dallas, mussel veligers traveling in a motorboat hull could have made it to Austin in 3 to 4 hours on a recreational boat brought to the Highland Lakes. Mussels are highly adapted to the water quality conditions and temperatures in the Texas lakes, and they reproduce very quickly. Better planning for responses to the appearance of mussels in the Austin lakes was very possible.

Scenario planning by AW will provide opportunities to learn and plan for future issues. To do this, AW should identify possible future scenarios, study them, identify possible solutions, and plan implementation programs for possible and probable future water quality and treatment challenges. It is important to incorporate all possible consequences of water quality and treatment decisions when developing the scenarios. Recommended scenarios include:

a) PFAS (per- and polyfluoroalkyl substances) occurrence in finished water (for detailed information on PFAS see https://www.epa.gov/pfas/pfas-explained).

b) Oil spill into the lakes.

c) Climate change impacts (cold and hot).

d) Flood water management. Identify tools to predict the flow time from the storm location to the intake and document it, providing insight into time of impact and possible mitigating treatment adjustments (using such sources as historic information, experienced staff, LCRA data). Possible mitigation activities may include filling all storage tanks (communication and cooperation from Pumping), ensuring chemical supplies are on site, and bringing all clarifiers on-line. Go to the intake and look at the raw water at regular intervals to visually check for increased sediment.

Increased Flow Capacity. Ullrich WTP was designed to treat 167 MGD but has not produced that quantity of water because city demand is generally not high enough in the area it serves. However, there is also a plant operational issue. In order to treat 160+ MGD, specific valves have to be operated, and it was reported that such appurtenances have not been operated in the tenure of anyone currently working at the facility. If the valves should fail when turned, staff knowledge of plant equipment and the possible workarounds will be critical for maintaining water delivery. In addition, some of the pumps require electrical alterations by an electrician to increase pumping capacity. As noted in the staffing discussion above, present staffing levels are unlikely to be sufficient for staff to operate all treatment basins at once. Plant production near or at the maximum capacity of 167 MGD would sorely stress plant sludge management capacity.

As recommended in Section 2.6, the Ullrich staff should stress test the plant at 167 MGD. This effort will require very careful planning and setting up contingencies prior to testing. It is essential to plan where to put the treated water, as demand has never reached 167 MGD. Lessons learned from stress testing should be incorporated into SOPs that describe actions necessary to increase flow above 120 MGD.

Sludge Management

Sludge dewatering and disposal management (see section 2.6.2) is a serious operational issue at Ullrich WTP at all flows, primarily because there are no emergency discharge options (e.g., to a sewer line). Failure to dewater sludge and remove it from the plant site can shut the plant down. The sludge must be dewatered to transport it to the disposal site. Centrifuges are used to dewater sludge, and lime sludge is hard on equipment. Maintaining the centrifuges in good condition is very time consuming, and they are now 20+ years old. Sludge handling appears to be at the center of many Ullrich operational/maintenance problems; it consumes an inordinate amount of operator and maintenance effort and time. Sludge management is one of the concerns that requires re-evaluation of the prioritization status of capital projects at the plant. Project priorities should be based on a comprehensive assessment developed through communication with plant staff.

2.7.2 Evaluate coordination between distribution system management and plant management in times of stress

Because the day-to-day operations of the utility depend on good coordination between the plants and the pump stations and reservoirs division, the staff has a lot of practice in maintaining a strong and competent relationship. However, Ullrich staff did report that at times the individual treatment plants and the pumping division appear to act independently, without consulting across the plant/distribution system line. Typically, plant operators have an operating plan for the plant clearwell[5] that does not always match what the pumping division would like to have. There are long-lived arguments at many treatment plants about whether the clearwell belongs to the plant or to the distribution system. In reality, the regulations require plant operators to be responsible for ensuring that adequate disinfection is provided for the treated water, and because much of that disinfection time occurs in clearwells, the plant “owns” the clearwells.

The Pumping Division does have concerns about the Davis Lane Pump Station being a bottleneck to delivering water to the south part of the city. If Davis Lane fails, all southern portions of town go down. This makes the power supply at Davis Lane a critical asset.

Coordination between these two sections must be in top order and a top priority. The Pumping Division requests production from the water treatment facilities to maintain tank levels and system pressure. It was reported that at times, the need for increasing water delivered to distribution varies significantly over a relatively short period of time. Rapid change in flow rate is difficult to manage in a large lime softening facility such as Ullrich WTP. It takes significant time to stabilize treatment, and flow changes must be managed judiciously. Lime softening processes require careful adjustment, and Ullrich, as an older plant with staffing and maintenance issues, is at risk for treatment upsets if rapid changes are implemented. Bringing clarifier flow rates up or down must be done carefully and relatively slowly to ensure treatment quality. Several hours’ notice regarding increased water needs from the Pumping Division to the WTP staff is necessary for smooth operations. Communication between the two sections should focus on collaboration to produce quality water in quantities needed in an organized and timely manner.

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[5] A clearwell is a storage unit that contains the treated water before it is pumped into the distribution system. It is often used to ensure that the filtered water has had adequate time for disinfection.

2.7.3 Summary of Recommended Improvements for Operations

	Issue	**Recommendation**
2.7-1	Staff reported inconsistent backwashing process, which impacts the overall performance of the plant.	Establish a consistent backwash procedure and teach it to all staff, impressing on them the need to be consistent in treatment operations. Develop appropriate, readily accessible SOPs for backwashing and other critical operations.
2.7-2	Under low alkalinity conditions, the softening process is not as successful at removing particles, so polymer is fed year around.	Evaluate the cost of continual polymer feed and compare to the cost of extra training for staff on how to start up polymer feed when needed. Implement extra training if the latter is found to be cost efficient.
2.7-3	Forward-looking planning is lacking for essential future changes to the treatment process.	Identify possible future scenarios, study such scenarios, identify possible solutions, and plan implementation programs for possible and probable future water quality and treatment challenges. Include all subsequent effects from decisions that are being made regarding water quality and treatment. Recommended scenarios include: a) PFAS occurrence in finished water b) Oil spill into the lakes c) Climate change impacts (cold and hot) d) Flood water management
2.7-4	Both engineering and plant staff spoke about projects not being well defined or thought through, frustrating everyone.	Re-evaluate the scope and status of capital projects at the plant based on more comprehensive condition assessments and communication with plant staff.

2.8 Distribution System Management

Overall, the AW Distribution system is well organized, engineered and operated. The City has endeavored to minimize dead ends and minimize stagnant water opportunities. Engineering has prioritized pipe and tank installations to ensure that the entire city will have multiple routes of water delivery, essentially providing redundancy in water delivery. Not all zones have met that expectation at the present time, but projects are underway or in planning to ensure system-wide redundancy.

Because distribution systems and their layouts are the accumulation of decades of engineering projects, directives and goals that have sometimes conflicted over the years, utilities must work with the legacy pipe systems they have and improve upon those, given their limitations. AW is managing these issues well.

AW operates three water treatment plants, of which Ullrich WTP is the largest, with a rated capacity of 167 million gallons per day (MGD). Davis WTP has a rated capacity of 118 MGD and Handcox WTP has a rated capacity of 50 MGD. After being treated at these three WTPs, drinking water enters the transmission and distribution system. This system, comprised of infrastructure that includes water mains, storage reservoirs, and pump stations, is operated to send treated drinking water throughout AW's service area at adequate volumes and pressures to serve customer demands, plus fire flow availability for emergencies.

AW divides its service area into nine major pressure zones that operate to serve customers at varying ground elevations. These pressure zones are interconnected such that water can move between zones through distribution system infrastructure. AW Operations staff, using a supervisory control and data acquisition (SCADA) system, continuously monitor the performance of the distribution system on both a system-wide and pressure zone basis. Staff adjust operations to maintain the system within normal operational ranges.

Ullrich WTP, AW's largest WTP by treatment capacity, is critical in supplying the water system. Ullrich WTP serves as the main water supply to customers generally south of the Lower Colorado River, and primarily those within the Central, South, and Southwest A/B/C pressure zones. During normal operations, Ullrich WTP also provides water to areas north of the Lower Colorado River. While AW does have some capacity in the distribution system to supply customers south of the Lower Colorado River when Ullrich WTP is off-line, it is limited, and AW should develop additional pathways for water supply to reach south pressure zones.

Some key parameters used to evaluate distribution system performance are treated water pumpage (the rate of water entering the system), water usage (the rate of water consumption in the system), and system storage (the volume of stored water available for use). Similar parameters exist within the WTPs that can impact the distribution system performance, including water production (the rate of water being treated) and clearwell storage (the volume of treated water available for pumpage into the distribution system).

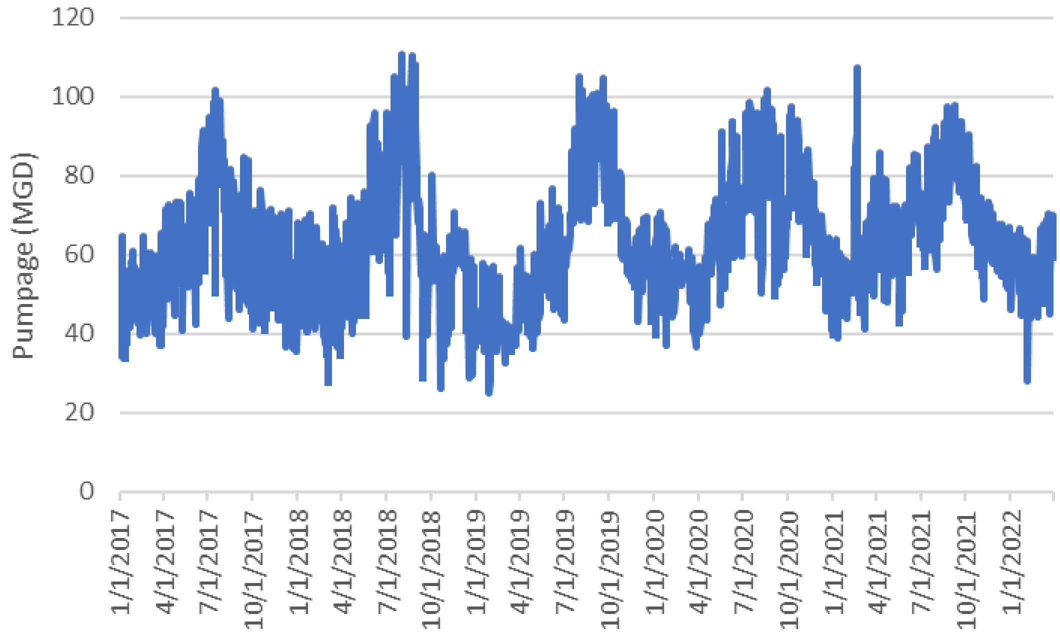

Figure 2.8.1 Daily Pumpage from Ullrich WTP

Pumpage, or the volume of treated produced per day by Ullrich WTP, for the period January 2017 – March 2022 is plotted in Figure 2.8.1. During this period average production for Ullrich WTP was 62.7 million gallons per day (MGD). The maximum pumpage was 110.7 million gallons on 8/2/2018 and the minimum was 25.2 million gallons on 1/29/2019. Ullrich WTP produced water every day during this period. As can be seen in the figure, peak production occurs during the summer and minimum production during the winter, although there was a peak day in 2021 during Winter Storm Uri. This anomalous peak is attributed to pipe breakage throughout the distribution system and customer plumbing due to freezing in that winter event.

One significant limitation is that Davis WTP can generally deliver only about half (or less) of the volume of water that Ullrich WTP can deliver to the Central pressure zone, due to pumping and transmission main (TM) limitations. Ullrich and Davis WTPs deliver water into the Central pressure zone through their medium service pump stations and TMs. Water is then transferred through the Central pressure zone both north and south. The existing Davis Medium Service TMs are 60 to 70 years old and have limited capacity, and AW is currently in the process of replacing the Davis Medium Service Pump Station. Also, AW has initiated a preliminary engineering study for an additional TM out of the new Davis MSPS (Davis Medium Service Water TM CIP project) to increase AW's capacity to pump water from Davis WTP into the Central pressure zone. These and other projects will provide increased supply, reliability, and resiliency that can also be used to supply customers south of the Lower Colorado River.

2.8.1 Water Quality Parameters Measured in the Distribution System

Water quality in the distribution system is monitored in accordance with the AW Sampling Plan, in compliance with TCEQ regulations for monitoring in the distribution system. Samples are collected either by laboratory personnel who take samples at designated locations within the distribution system or by TCEQ and its agents. Occasionally, special studies are done in distribution systems to establish new sampling sites or to follow up on water quality issues reported to the utility.

AW is continuously in compliance with all required sampling and results in the distribution system. Compliance in the distribution system is facilitated by the Water Quality Manager, who is notified by laboratory staff if a chloramine residual in the system is outside a specified range. In turn, the Pumping Division is notified, and storage tanks are turned over more frequently, which manages water age, freshens the water and increases the chloramine residual.

State and federal regulations specify the number of samples for bacteriological sampling based on population served; AW is required to collect and test at least 300 samples each month. The sample collection program spreads the sampling sites out evenly over the geographic area and across the entire month. Samples are collected in accordance with standard methods on most business days, which facilitates the completion of required analysis during work hours and are analyzed for total coliform and *E. coli*. Compliance calculations are done in accordance with TCEQ requirements.

AW is required by regulations to maintain a specified level of disinfectant in the water in the distribution system. AW has set a minimum operational goal of at least 1.0 mg/L for reservoir and distribution samples. Texas regulations require that the chloramine residual in the water in the distribution system and reservoirs be at least 0.5 mg/L. Having more than 5% of distribution compliance samples with residuals less than 0.5 mg/L in two consecutive months constitutes a violation. The running annual average of daily chloramine residuals must be less than 4.0 mg/L. AW consistently meets these standards.

Disinfectant residual monitoring is conducted daily with samples being taken at the same time as the bacteriological samples or from representative locations in the distribution system on days the bacteriological samples are not collected. The TCEQ monitoring plan provides a list of the sampling sites, along with a map, as part of the Sample Siting Plan. Chloramine residual samples are analyzed in the field with methods approved by the TCEQ.

Disinfection by-products (e.g., total trihalomethanes, THM, and haloacetic acids, HAA5) are sampled quarterly by the TCEQ or its agent at eight sampling sites and analyzed by a TCEQ designated laboratory. Compliance with the MCL of 0.080 mg/L for total THM and 0.060 mg/L for HAA5 is determined based on a locational running annual average of quarterly samples.

Lead and copper are sampled once every three years; the most recent sampling took place in 2021 at 50 sample sites selected per the TCEQ requirements. The system is in compliance with the lead and/or copper action levels if the 90^{th} percentile sample contaminant level is equal to or less than the action level specified by the regulations. The action level for lead is 0.015 mg/L and the action level for copper is 1.3 mg/L.

The regulations require that water systems demonstrate with water quality parameter (WQP) results that the system has Optimal Corrosion Control Treatment (OCCT). AW is deemed to have OCCT without the installation of corrosion control treatment. TCEQ has provided a letter indicating that large systems deemed to have OCCT are not required to do water quality parameter sampling. AW has never exceeded a lead or copper action level, and the 90^{th} percentile levels of lead and copper have been lower than the Practical Quantitation Levels defined in the regulations. Nonetheless, AW does routinely collect WQPs internally and monitors them in accordance with the triennial sampling for lead and copper. Ten sample sites are randomly selected from the bacteriological sampling sites for WQP sampling.

Asbestos sampling occurs at a reduced regulatory level once every 9 years at a single location that is associated with asbestos cement pipe. The last sampling occurred in 2021. The TCEQ contractor takes the sample and sends it to a certified laboratory. The utility is in compliance if the MCL of 7 million fibers per liter is not exceeded, and AW meets this requirement.

2.8.2 Fire Flow Requirements

AW adheres to fire flow design criteria established and enforced by TCEQ. Historically, municipal water systems were developed in response to catastrophic fire events in cities and not necessarily for potable water needs. As a result, many distribution system components are oversized compared to what is optimal for potable water needs but needed for fire flow. Fire flow requirements, dictated by national, state, and local code requirements, are intended to provide adequate pressure and quantities of water to fight fire; in general, these requirements conflict with typical distribution system designs and operations that optimize water quality in the distribution system. For example, pipe diameters are usually larger than needed for potable water, so that enough water can be delivered to a hydrant for fire control. In addition, distribution tankage is usually managed at higher levels than conducive for optimal potable water quality, again to assure that adequate quantities of water are available for firefighting. The AW distribution is adequately designed for fire flow requirements.

One event that the project team was asked to review included a backflow incident related to firefighting. It was determined in this incident that Fire Department staff did not adhere to backflow prevention SOPs.

2.8.3 Pressure

The City is served by nine different pressure zones. Both Ullrich WTP and the Davis WTP pump into the Central zone, but each can also pump into the next highest pressure zone, with Ullrich WTP pumping to the south zones and Davis pumping to the north zones. The Handcox WTP is located at an elevation on the north side of the city such that their water is pumped into the NWA (Northwest A) Zone. Each of the nine zones has at least one elevated storage tank and one pump station, but most have more than one of each. There is no pathway for large volumes of water to reach the south zones other than from the Ullrich High Service Pump Station, while there are multiple routes from all three plants to send water to the higher north zones. This makes Ullrich WTP the critical link in providing water to all the south zones. Planning efforts for increased connectivity in the distribution system were discussed earlier in this section. With the exception of the Winter Storm Uri event and its associated household distribution system freeze and burst events, AW meets the Texas requirements for maintaining distribution system pressure.

2.8.4 Summary of Recommendations for the Distribution System

	Issue	Recommendation
2.8-1	Staff mentioned that not all level controllers are working.	Confirm that all level monitors and controls in storage tanks in the distribution system are working properly. If not, repair and/or replace.
2.8-2	Sudden requests for additional water impact water treatment.	Increase/improve communication between Pumping and Plant Operations, especially with regard to flow changes.
2.8-3	Redundancy of water feed to south pressure zones is lacking.	Develop additional pathways for water supply to reach south pressure zones.
2.8-4	Although AW PIO has done a huge amount of work to educate AW customers on how they can help reduce water loss, high rate of water loss during winter storms needs to be reduced to preserve system pressure.	Continue to implement plans for communicating ways to manage water loss in premise plumbing during freeze events. • Consider taking advantage of Advanced Metering Infrastructure technology • Implement recommendations from upcoming consultant review of water loss programs

2.9 Power Supply and Energy Requirements

This task targeted the electrical power challenges Austin Water (AW) faced during Winter Storm Uri in February 2021, as this extreme weather event provided the greatest opportunity to assess current and future issues. The team's primary purpose with this task was to review relevant documents and regulations and to interview AW and Austin Energy (AE) personnel familiar with both the issues that arose during the event and the after actions taken to address future planning and prevention of similar concerns.

A high-level summary of energy availability at AW indicates that power outages that halt the WTPs' ability to treat and produce water are rare due to existing resiliencies:

- WTPs are considered critical infrastructure by AE; WTPs are not subject to electricity reduction during events requiring load-shedding.
- Water is stored within the system to shore up gaps should water production be interrupted for any reason.
- Every WTP has at minimum dual feeders (two independent power feeds from external power supplies) to avoid interruptions in power.

These resiliencies, however, were not sufficient to prevent a power outage that interrupted water production and reduced water pressures to below regulatory standards during Winter Storm Uri.

2.9.1 Summary of major issues during Winter Storm Uri

Winter Storm Uri exposed vulnerabilities that have rarely, if ever, been experienced before in Austin. The prolonged sub-freezing temperatures that led to increased power demand, coupled with a loss of generation capacity due to failures across the grid infrastructure, left thousands of Austin residents (and millions of Texans) without power for extended periods of time.[6] The power crisis soon became a water crisis as water infrastructure froze and failed at the utility, distribution, and residential levels. Icy roads made it more difficult for AW and AE personnel to get to damaged equipment to make necessary repairs. In addition, during this time water demand reached record high levels as a result of water main breaks, burst pipes, and residents across the service area dripping their faucets in attempt to stave off damage to their home or property. It should be noted that AW has improved their communications regarding cold weather preparedness with detailed instructions on how and when to drip a faucet and thaw pipes.

The review of the major impacts of Winter Storm Uri is documented in the After Action Reports and summarized in Section 2.1. The main challenges and takeaways from the review are:

- The Boil Water Notice was in effect for multiple days due to low system water pressure as a result of a combination of a) high water demands, b) damage in the system requiring repair, and c) a power outage at Ullrich WTP. The loss of power to many homes across the city made it difficult and often impossible for customers to boil their water to ensure it was safe for drinking.
- The prolonged sub-freezing temperatures of the winter storm coupled with the ensuing power outages across the City of Austin and the state revealed areas of vulnerability with respect to ensuring adequate energy resiliency. Per Senate Bill 3, AW was required to develop—and has submitted—an Emergency Preparedness Plan (EPP) to the Texas Commission on Environmental Quality (TCEQ). In that plan, the utility details various measures and approaches it will take to combat a similar storm in the future. The EPP requires that the utility determine a way to provide water for a weather-related power outage lasting longer than 24 hours.
- AW and AE worked closely during and after the event to resolve and repair issues as indicated in the Winter Storm Uri Update, Jan 20, 2022; Q1-2022-WinterStormAAR-Update, 2022 and detailed timelines provided by staff.
    - AE remotely re-energized and restored power to the substation 6 minutes after debris caused its failure. At the time, AW electricians were addressing lift station outages and arrived at Ullrich WTP about an hour and 25 minutes later to begin assessing the situation and restoring power, following all safety protocols. Ullrich WTP began producing water and ramping up treatment capacity about 3.5 hours after power was restored to the substation.

[6] https://www.sciencedirect.com/science/article/pii/S2214629621001997d

- Equipped the existing feeds with automatic transfer scheme at all WTPs
- Exploring possibilities and locations for on-site power generation via third-party vendors to act as Resiliency as a Service

- The Improvement Plan in AW's After Action Report for Winter Storm Uri listed more than 50 recommendations that were prioritized by their Winter Storm Working Group to resolve the issues above and make AW more resilient to future winter storm events (AW_Winter Storm Uri_After Action Report, Nov 3 2021; Winter Storm Uri Update, Jan 20, 2022). Many of the recommendations have already been implemented. A full table of these recommendations can be found in Appendix 2-B, but some examples include the following:
  - Replace automatic transfer switch at Davis Springs #1 and Texas Plume lift station sites.
  - Enable automatic switching capability for the third electric feed at Ullrich as well as second feeders at all WTPs.
  - Electricians now stationed at Ullrich WTP (also at the other WTPs) during business hours, are on call 24/7, and have an added level of awareness and stationing during inclement weather.
  - Improvements to Critical and Non-Critical Process Piping and Equipment (more detail in Table 4 of Appendix 2-B).
  - Always maintain at least 15 days of chemical storage for critical chemicals.
  - Additional tire chains procured for treatment plant and field service vehicles that would be active in an emergency response.
- Further actions have been taken to educate the public on better ways to drip their faucets during freezing conditions (i.e. dripping only the faucet furthest from the water meter) (AW_WinterWeather_PrepTips, available in English, Spanish, Arabic, Korean, Simplified Chinese, and Vietnamese)

One of the goals for these improvements is to increase the resilience to future inclement weather events.

2.9.2 Resiliency and redundancy – current, planned and typical for WTPs

The industry recognizes the importance of power supply resiliency but leaves it to individual utilities to select an appropriate course of action. AW's general philosophy is to have a minimum of two electric feeders for each treatment plant. The feeders are typically from the same substation but on different transformers. Each of the three feeders into Ullrich WTP can supply enough power to run the entire facility. Many (but not all) of the feeder lines are underground—which adds resilience to weather-related outages—from that substation to the main plant. The drawback of receiving electricity from a single substation is that loss of power to that substation means the plant will also lose power.

During Winter Storm Uri, switching electric feeders was done remotely and manually by an AE employee via the Electrical Control Center (ECC). Thus, for the switch to occur, someone at AE either had to notice there was an issue or be made aware of the issue and then perform it manually. The switch in this case occurred six minutes after power was lost. Turning on or restoring power to a water facility requires a series of steps, so although Austin Energy quickly restored power to Substation Bee Feeder 1, AW electricians followed safety protocols to inspect the systems at Ullrich and manually restart the plant, a process that lasted several hours. While this process is lengthy, it is ultimately necessary to adhere to safety culture and AW has no fault in making sure the plant was re-energized properly. Since the storm event, AE and AW have "enabled an automatic transfer scheme" according to the AAR for switching to the secondary electric feeder in the event that the first feeder loses power. While this change means that the switch is no longer manual, the water treatment plant would still lose power and require inspection and re-powering of equipment and facilities. This automatic transfer scheme is going to be implemented at all WTPs.

None of the AW WTPs currently have capabilities to maintain drinking water treatment operations via onsite generation. AW does have some onsite generators that are used only to support "life safety" equipment in occupied buildings such as emergency exit lights, fire alarms and related equipment to protect building occupants during emergencies. AW is currently collaborating with AE to explore the feasibility to generate enough power onsite to be able to operate independently during emergency situations. While loss of power at the WTP can happen, there is also water storage in the system to help shore up gaps due to power outages, equipment failures, etc.

2.9.3 Grid connectivity to water systems with respect to reliability and sustainability.

Senate Bill 3, passed in November 2021, requires that all water providers in the state of Texas submit an Emergency Preparedness Plan (EPP) to the Texas Commission on Environmental Quality (TCEQ). Per the TCEQ's EPP webpage, "the plan proposes to TCEQ how the affected utility will maintain a water pressure of 20 and 35 psi throughout the distribution system when the power has been off for more than 24 hours during an emergency".[7] In adherence with SB3 requirements, AW completed their EPP and submitted to TCEQ for review and approval.

We reviewed the EPP and think that the plan is sufficient to build in additional resilience for Austin Water because it addresses the need for sufficient water storage, hardening of the electric transmission/distribution system, additional auxiliary generation, implementation of emergency water demand rules, etc.

2.9.4 Staffing expertise in power and energy within water utility

From discussions with the head of the Electrical Services Division at AW, it appears that AW has dedicated and knowledgeable staff for electrical services. They answered detailed questions regarding electrical requirements and setups of the various treatment plants and explained the challenges faced during the storm, as well as what solutions and repairs were required.

While it is AE's responsibility to ensure that power is being supplied to WTPs, it is up to this team of electricians at the WTP to make sure that its infrastructure is operating correctly. In the incident of Winter Storm Uri, it was not a lack of expertise or training that was an

[7] https://www.tceq.texas.gov/drinkingwater/homeland_security/disasterprep/epp

issue, rather the fact that staff who could handle the restarting process were away from the facility handling the other issues occurring throughout the system. This led to the After Action recommendation and implementation of having an electrician from this team onsite at Ullrich WTP during business hours, on call 24/7, and with an added level of awareness and stationing during inclement weather (AW Winter Storm Uri After Action Report, Nov 3 2021).

2.9.5 Recommendations for improvements to resiliency as it pertains to power needs

Having reviewed the power outage incident at Ullrich during Winter Storm Uri, including the AARs from both AW and AE and the Emergency Preparedness Plan authored by AW and submitted to TCEQ, we do not have any recommendations for this section.

AW and AE should continue completing the various projects and tasks identified to address vulnerabilities related to extreme winter events (See Appendix 2-B: Table 4). AW and AE worked diligently during the emergency to respond to the power outage at Ullrich and got the plant back up safely.

We learned that each WTP has two electric feeders that originate from the same substation. Many water utilities have feeders coming originating from different substations in order to increase resilience. That said, we do not recommend AW change their current setup, as geographical and cost constraints make having feeders from different substations unrealistic.

Ullrich WTP and all the WTPs have properly trained electricians onsite during business hours to help address issues. It is important that AW and AE continue the course on the various projects identified and in progress. These are necessary to increase AW's resilience in the face of future emergencies.

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2.11 Abbreviations

Abbreviation	Meaning
%	Percent
AARs	After Action Reports
ABC	Association of Boards of Certification
AD	Assistant Director
AE	Austin Energy
ANSI	American National Standards Institute
ASAP	As soon as possible
AW	Austin Water
AWWA	American Water Works Association
BAT	Best Available Technology
C	Carbon
$CaCO_3$	Calcium carbonate
CIP	Capital Improvement Project
CMO	City Manager’s Office
d10	Diameter at which 10% of filter media is finer
d60	Diameter at which 60% of filter media is finer
DOC	Department Operations Center
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
EPP	Emergency Preparedness Plan
FAQ	Frequently Asked Question
FEMA	Federal Emergency Management Agency
FLR	Filter loading rate
FY23	Fiscal Year 2023
GIS	Geographic information system
gpm/sf	Gallons per minute per square foot
HAA5	Five Haloacetic Acids
HRO	High Reliability Organization
HSPS	High service pump station
IMT	Incident Management Team

Abbreviation	Meaning
in	Inches
L/d	Ratio of filter depth L to filter media diameter (in mm)
LCRA	Lower Colorado River Authority
Max	Maximum
MCL	Maximum Contaminant Limit
mg/L	Milligrams per liter
MGD	Million gallons per day
Min	Minimum; minute
mm	millimeter
MSPS	Medium service pump station
NIMS/ICS	
NTU	Nephelometric turbidity units
O&M	Operations and Maintenance
OAD	Operations Assistant Director
oC	Degrees Celsius
OCCT	Optimal Corrosion Control Treatment
OJT	On the job training
PAC	Powdered activated carbon
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
PI	Public Information
PIO	Public Information Office
PSAs	Public service announcements
psi	Pounds per square inch
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SOG	Standard Operating Guideline
SOP	Standard Operating Procedure
SOR	Surface Overflow Rate
SSO	Sanitary Sewer Overflow
TAWWA	Texas Section American Water Works Association

Abbreviation	Meaning
TCEQ	Texas Commission on Environmental Quality
THM	Trihalomethanes
TM	Transmission Main
TOC	Total organic carbon
TON	Threshold Odor Number
TxDOT	Texas Department of Transportation
UFC	Upflow clarifier
UFRV	Unit filter run volume
VEOCI	Virtual Emergency Operations Center
WPD	Watershed Protection Department
WQP	Water Quality Parameters
WTP	Water Treatment Plant
µg/L	Micrograms per liter

Appendices

Appendix 1-A Austin City Council Resolution No. 20220217-060

RESOLUTION NO. 20220217-060

WHEREAS, Austin Water ratepayers expect and deserve access to safe and reliable drinking water; and,

WHEREAS, Austin Water has experienced five significant negative water quality events and water supply service interruptions in fewer than five years, including: three that required boil water notices, one that involved zebra mussels and one that involved fire retardant impacting customers in the Tanglewood Forest Limited District; and,

WHEREAS, Austin's continued economic success is dependent upon a consistently reliable public source of drinking water; and,

WHEREAS, concrete action is required to restore public trust in Austin Water; and,

WHEREAS, the public interest will be most effectively served if accurate and complete information is provided, considered, and acted upon expeditiously; **NOW, THEREFORE,**

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Manager is directed to procure, as quickly as possible, an external audit to review the five most recent significant negative water quality events and water supply service interruptions, to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of our water system.

At a minimum, the evaluation shall include an investigation into the following data and dimensions:

1. A review of Austin Water's overall management of these events, including emergency response and after-action assessments;

2. A review of policies and practices with respect to how Austin Water prepares for water supply crises;

3. A review of whether and how Austin Water is following national best practices for source water quality protection and for the operation of drinking water treatment systems;

4. A review of the timeline for each event, detailing management's response and communication to the public and whether that response endangered the public or impacted public confidence in Austin Water;

5. A review of whether and how these situations impacted health and safety risks of Austin Water customers;

6. Description of how knowledge gained from responses to these significant events affected future water supply planning strategies within Water Forward, Austin's integrated water management plan; and,

7. A review of whether Austin Water's facilities and operations are adaptive to seasonal and long-term water quality variability including extreme events.

Austin Water and other relevant City of Austin departments shall cooperate with the audit. City staff and plant operators shall be available for interviews. Austin Water and other City of Austin staff shall furnish internal communications and operational information related to these specific episodes, and all other relevant policy and procedural documents relating to emergency preparedness of Austin's water supply;

BE IT FURTHER RESOLVED:

This audit shall be conducted by an independent third-party non-governmental entity or multidisciplinary team with expertise in the operation and management of large-scale water utilities. Allowable exceptions include universities who may be a governmental entity. While the chosen entity, individual or multidisciplinary team, regardless of type, may include individuals with existing knowledge of Austin Water history, processes, and systems, they shall not have a conflict of interest.

The selected independent third-party entity must have demonstrated previous successful expertise and experience managing or evaluating similarly sized organizations and or competency with public utilities.

The City Auditor shall develop this contract with input from external sources with appropriate expertise as allowable by the City's purchasing rules. The department under evaluation shall not select its own evaluator for this contract.

The City Auditor shall select the independent third-party entity best qualified and suited to conduct the independent audit and the associated report mandated by this resolution and bring the resulting contract forward for approval. The City Manager is directed to determine appropriate funding sources, with the understanding that Council's preference is for the cost to come from Austin Water's budget.

If after completing market research for a prospective solicitation, it is determined any specification within this resolution cannot be met as stated, the City Auditor shall return to Council with a recommendation for changes to the contract specifications that are consistent with the direction established by this resolution;

BE IT FURTHER RESOLVED:

A written audit report shall be completed by the selected independent third-party entity. Should the independent third-party entity, in advance of the audit completion date, determine actionable recommendations, the entity shall report those recommendations to the City Manager for consideration. The City Manager may implement these recommendations on an ongoing basis. The City Manager shall provide updates to Council, as soon as possible, on whether and how recommendations from the independent third-party entity will be implemented;

BE IT FURTHER RESOLVED:

To the extent legally permissible, the written audit report shall be posted in a prominent place on the City's website at least one week in advance of presentation to Council. The audit report shall be delivered and presented by the independent third-party entity conducting the evaluation to the Water and Wastewater Commission and shall be presented to Council during a meeting which allows for public testimony. Any other City of Austin commission or task force may receive a formal presentation by the City Auditor as mutually scheduled;

BE IT FURTHER RESOLVED:

The audit report shall include:

- How the City of Austin and Austin Water have made progress on recommendations identified in past relevant audits and after-action reports:

- Possible changes to internal policies;
- Possible changes to current practices, including treatment processes and management of the distribution system;
- Possible changes to how the City of Austin and Austin Water communicate information to the public during significant events such as these;
- An action plan for how the City of Austin and Austin Water should implement recommended changes, including a prioritization of the recommendations;
- Possible change or enhancements to organizational staffing, staffing practices and policy;
- Opportunities for better working conditions, facilities, tools, technology, and resources;
- The necessary frequency of reviews, assessments, and audits including recommended content of reviews, assessments, and audits and the sharing of data and findings from these reviews and audits to the Council and the public;
- Any further comprehensive assessments to be taken on by Austin Water or the City Council;
- How to improve transparency and the ongoing sharing of data and findings to the Council and the public; and
- Affirmation of what is going well and should be continued;

If a response is not provided to any of the above, the third-party entity conducting the audit should clearly state why in the report;

BE IT FURTHER RESOLVED:

The report shall not preclude any additional actions the City Manager or Austin Water shall deem appropriate including but not limited to an internal after-action report.

ADOPTED: February 17, 2022 **ATTEST:** ______________________
Myrna Rios
City Clerk

Exhibit A

Work Order No. 2022-01-UT-OCA

Under Master Agreement No. UTA19-000382

Review of Austin Water Utility Negative Water Quality Events

Office of the City Auditor and the Center for Water and the Environment

Purpose

This proposed study is to review Austin Water's five most recent significant negative water quality events and water supply service interruptions, to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of the City's water system.

Background

The mission of the Office of the City Auditor is to provide audit and investigative services that foster transparency, accountability and continuous improvement in Austin city government. The City Auditor reports directly to the 11-member City Council. For more information about our office, visit our website at http://www.austintexas.gov/department/auditor.

Austin Water has been providing water and wastewater services for more than 100 years and today serves more 1 million people in the Austin metropolitan area, across more than 548 square miles. The utility draws water from the Colorado River into three regional water treatment plants, Handcox, Davis and Ullrich, which have a combined capacity of 335 million gallons per day. The utility also has two wastewater treatment plants, Walnut Creek and South Austin Regional, that can receive up to 150 million gallons per day of sewage to treat. This wastewater is cleaned into high-quality effluent and delivered to reclaimed water customers for non-potable use or safely returned to the Colorado River to augment environmental flows.

In February 2022, following a Citywide boil notice that interrupted water service, the Austin City Council passed resolution 20220217-060 which directed the City to procure an external audit to review the five most recent significant negative water quality events and water supply service interruptions, to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of our water system. In that resolution, the City Council directed the City Auditor to select an independent third-party and manage the resulting agreement.

Per the resolution, this audit shall be conducted by an independent third-party nongovernmental entity or multidisciplinary team with expertise in the operation and management of large-scale water utilities. Allowable exceptions include universities who may be a governmental entity. While the chosen entity, individual or multidisciplinary team, regardless of type, may include individuals with existing knowledge of Austin Water history, processes, and systems, they shall not have a conflict of interest, as determined by the City in its sole discretion.

Project Timeline

This Work Order shall be effective as of the date of last signature and shall remain in effect until June 30, 2023.

Statement of Work (Please include the questions to be researched)

The University shall review Austin Water's five most recent significant negative water quality events and water supply service interruptions, to identify what went wrong and how to prevent future failure, and to evaluate technology, operations and related issues that could improve the overall resilience and functioning of the City of Austin's water system.

The City will provide a Project Manager who will oversee the project schedule and implementation. Prior to allowing any person or entity to perform work on this project, the University shall provide the City Project Manager with sufficient information about the person or entity to enable the City Auditor's Office to determine, in its sole discretion, whether such person or entity has a conflict of interest that would preclude them from working on this project.

At a minimum, the evaluation should include an investigation into the following:

- A review of Austin Water's overall management of these events, including emergency response and after-action assessments;
- A review of policies and practices with respect to how Austin Water prepares for water supply crises;
- A review of whether and how Austin Water is following national best practices for source water quality protection and for the operation of drinking water treatment systems;
- A review of the timeline for each event, detailing management's response and communication to the public and whether that response endangered the public or impacted public confidence in Austin Water;
- A review of whether and how these situations impacted health and safety risks of Austin Water customers;
- Description of how knowledge gained from responses to these significant events affected future water supply planning strategies within Water Forward, Austin's integrated water management plan; and
- A review of whether Austin Water's facilities and operations are adaptive to seasonal and long-term water quality variability including extreme events.

The investigation and assessment will primarily focus on the Ullrich Water Treatment Plant ("Ullrich Plant") due to the limited time frame of the project and potential for minimal value added by conducting the assessment across all three water treatment plants in Austin. The Ullrich Plant has experienced the three boil water notices and zebra mussel issues. Therefore, detailed investigation of the Ullrich Plant seemingly will provide the most relevant information. In addition, it is expected that many of the findings and recommendations for the Ullrich Plant will be generalizable to the other plants and the team will include recommendations that are applicable to the other plants.

The University shall complete a written audit report and the report, at a minimum, shall include:

- How the City of Austin and Austin Water have made progress on recommendations identified in past relevant audits and after-action reports;
- Recommendations to include:

  a. Possible changes to internal policies;

  b. Possible changes to current practices, including treatment processes and management of the distribution system;

  c. Possible changes to how the City of Austin and Austin Water communicate information to the public during significant events such as these;

- An action plan for how the City of Austin and Austin Water should implement recommended changes, including a prioritization of the recommendations;
- Possible change or enhancements to organizational staffing, staffing practices and policy;
- Opportunities for better working conditions, facilities, tools, technology, and resources;
- The necessary frequency of reviews, assessments, and audits including recommended content of reviews, assessments, and audits and the sharing of data and findings from these reviews and audits to the Council and the public;
- Any further comprehensive assessments to be taken on by Austin Water or the City Council;
- How to improve transparency and the ongoing sharing of data and findings to the Council and the public; and
- Affirmation of what is going well and should be continued.

If the University, in advance of the audit completion date, determines actionable recommendations, the University shall provide them to the City's Project Manager for consideration.

To the extent legally permissible, the written audit report shall be posted in a prominent place on the City's website at least one week in advance of presentation to Council. The University will deliver the report to the City so that the City may post the report for this purpose.

The University shall deliver and present the audit report to the Water and Wastewater Commission and the City Council during a scheduled meeting which allows for public testimony. Any other City of Austin commission or task force may receive a formal presentation by the City Auditor as mutually scheduled.

The University should retain support for its conclusions and recommendations.

Project Deliverables

University agrees to complete and submit the following deliverables:

Deliverables/ Milestones	Description	Timeline (due/completion date, reference date, or frequency)	Performance Measure/ Acceptance Criteria
Entrance Meeting with City Auditor	Meeting with City Auditor and an Austin Water designee to discuss the audit in detail, including but not limited to background information, timeline, preliminary approach, and expectations for evidence.	Within 20 Business Days from the date of execution of this Work Order	N/A
Project Plan	Plan detailing the University's plan for completing the audit including timeline and specific steps.	10 Business Days from the Entrance Meeting	City Auditor Approval
Conflict Review	List of any personnel or sub-contractors intended to perform work on the project for review by the City Auditor	Timeline to be agreed upon by the University and City Auditor	City Auditor Approval
Preliminary Findings	Detailed summary of all findings and discussion of the evidence obtained by the University that led to the findings.	Timeline to be agreed upon by University and City Auditor	City Auditor Approval
Final Report	Detailed draft report of all findings and recommendations.	Timeline to be agreed upon by University and City Auditor	City Auditor Approval
Final Presentations	Presentation of final report to relevant City Commissions and City Council	As scheduled following report completion	N/A
Monthly Status Reports and Evidence	Detailed updates of information learned from the prior month including all information obtained during the applicable timeframe.	Monthly	N/A

Budget (not to exceed $890,000)

Period of Performance	Date of Last Signature to June 30, 2023
Budget Category	**Amount**
Total Direct Costs*	$709,619
Personnel / Salary	$246,357
Travel	$72,160
Materials & Supplies	$0
Equipment	$0
Consultants / Services	$369,340
Other	$21,762
Total Indirect Costs**	$106,443
Total Cost Estimate	$816,062

***Direct Costs** (e.g. salary, fringe benefits, project-specific equipment, consultants, subcontracts, and materials and supplies) can be identified specifically with a particular final cost objective or can be directly assigned to such activities relatively easily with a high degree of accuracy. Costs incurred for the same purpose in like circumstances must be treated consistently as either direct or indirect (F&A) costs.

****Indirect (Facilities and Administrative – F&A) Costs** means those costs incurred for a common or joint purpose benefitting more than one cost objective, and not readily assignable to the cost objectives specifically benefitted. These costs include building depreciation, general purpose equipment and capital improvement, utilities, custodial services, general administration, research administration, the libraries, accounting, and purchasing.

Funding Source	Department - Unit - Object Code	Finance Contact name	Joseph Gonzales, Austin Water Utility
FDU	Fund Dept Unit Object 5020 2200 6806 5860	Phone #	512-972-0539
		Email	joseph.gonzales@austintexas.gov

Invoicing Instructions

In accordance with the terms of the Master Agreement, the University shall submit monthly electronic invoices to City at the following e-mail address:

Kathie Harrison Supervising Senior Auditor
kathie.harrison@austintexas.gov

The City's Project Manager must sign off on each proposed invoice before it is submitted to the City for payment.

Special Terms and Conditions (if necessary)

The University has determined that Institutional Review Board or Institutional Animal Care and Use Committee review and approval are required in accordance with Article III of the Master Agreement, due to research on non-exempt human and/or vertebrate animal subjects:

Yes ☐ No ☒

Data Security Requirements

This project requires access to the following City data:

City documents, data, and information regarding the operations of the Austin Water Utility, including but not limited to records/data requests, interviews, and similar activities.

The project also requires access to City staff reasonably necessary to complete the review.

The University acknowledges that any documents created for purposes related to this Work Order—except for the final report—and any information shared and communications made by the City pursuant to this Work Order may be considered audit working papers of the City of Austin's Office of the City Auditor, and may contain information which is confidential, privileged, or otherwise excepted from disclosure under Texas Government Code § 552.116. If the University receives a public information request for information or documentation shared pursuant to this Work Order, the University agrees to promptly notify the City so that the City has reasonable time to seek an appropriate protective order, consistent with the terms of Article XV of the Master Agreement.

City Data is considered:

Confidential Information	Yes	☒	No	☐
Personal Information	Yes	☐	No	☒
Highly Sensitive Personal Information	Yes	☐	No	☒
Austin Energy Confidential Information	Yes	☐	No	☒

Project Managers/Principal Investigator (PI)

UNIVERSITY

Dr. Lynn Katz
Director, Center for Water and the Environment
301 E Dean Keeton St. Stop C1786
University of Texas
Austin, TX 78712-1173
Phone: 512-471-0071
Email: lynnkatz@mail.utexas.edu

CITY

Corrie Stokes, City Auditor (Lead Project Manager) and
Kathie Harrison Supervising Senior Auditor
505 Barton Springs Road, Suite 200
Austin, Texas 78704
Phone: 512-974-2805 (office)
Email: corrie.stokes@austintexas.gov and kathie.harrison@austintexas.gov

Project Manager(s) may be changed by mutual written agreement of the Parties.

Other Key Personnel Involved

To be provided after execution.

The Effective Date of this Work Order is the date of last signature.

Executed by:

CITY OF AUSTIN	UNIVERSITY
By: Corrie Stokes	By: DocuSigned by: [signature] C68295FF86C841A...
Name: Corrie Stokes	Name: Mark Featherston
Title: City Auditor	Title: Associate Director, OSP
Date: 5/26/2022	Date: 2022-05-26 | 11:11:17 PDT

Approved by City Project Manager:

By: Corrie Stokes
Name: Corrie Stokes
Title: City Auditor
Date: 5/26/2022

Approved as to Form:

By: Holly Heinrich
Name: Holly Heinrich
Title: Assistant City Attorney
Date: May 25, 2022

Appendix 1-C Project Scope of Work

City of Austin

Audit of Austin Water Utility Negative Water Quality Events

Background

The City of Austin has experienced several drinking water quality events over the past several years. In order to determine how best to avoid future similar events, the City has commissioned an audit to review the five most recent significant negative water quality events and water supply service interruptions. The objectives of the audit are to identify what went wrong and how to prevent future failure, to evaluate whether current technology is sufficient for meeting regulatory requirements, operations and to identify related issues that could improve the overall resilience and functioning of the City's water system.

This work will analyze the five previous events identified by the City Council for review, evaluate current conditions at the plant with respect to the plants ability to address similar events in the future, and provide recommendations for improving resiliency with respect to these types of events. With regard to the recommendations for future capabilities needed to promote more resilient water quality during dynamic water source events, the team will focus on the following underlying questions:

1. What is the range of water quality that can be produced by the watershed, considering both nominal and extreme (flood, fire, drought, storm, spills etc.) conditions?
2. From an engineering perspective, is the plant(s) capable of handling this range of water quality?
3. From an operational perspective, is the staff prepared/capable of operating the plant(s) to treat this range of water quality?

Scope of Work

Task 1. Project Initiation and Management

The purpose of this task is to set up and maintain project management tools such as the Project Guide, accounting documentation, and information management. The project approach will be confirmed through a meeting with the City's staff and review of pertinent information.

Task 1.1: Project Initiation and Coordination with City

UT will initiate a Kickoff Meeting with City staff to confirm project goals, objectives and schedule, establish lines of communication, and discuss data needs. A meeting schedule will be established for future team meetings.

Task 1.2: Regular Project Coordination Meetings with City

Project team members will meet regularly with designated City staff on an agreed schedule to provide updates, coordinate access to utility staff, and request additional data. The project manager will maintain a master list of data/information requests and responses to manage the exchange of information between project team and City and utility staff Weekly meetings between the City and the PI will be held to ensure that data exchange and interviews are progressing on schedule: other project team members will participate as appropriate to discuss progress on particular tasks.

Task 1.3: Internal Team Meetings

To facilitate communication between internal project team members, regular team meetings will be held on a weekly basis predominantly by Zoom.

Task 1.4: Invoices, Budget Monitoring, and Project Management

Cost tracking on a weekly basis and monthly invoicing will be used to maintain cost control. Project team coordination and organization meetings will serve to organize work flow and track progress.

Task 2. Investigation and Assessment

Task 2.1: Water Quality Events of Concern

The purpose of this task is to review and summarize the five recent water quality/service interruption events, the circumstances that led up to the events, Austin Water's overall management of these events and emergency response and after-action assessments. The task will include an assessment of the management actions (i.e. reasonableness of the series of decisions made to prepare for and respond to events) for each event to determine whether management decisions endangered Austin Water customers. Each task will include background on the issue, requests for data, interviews with several stakeholders (e.g. plant personnel), summary of After Action reports and identification of issues to be addressed in the final report.

2.1.1: Flooding Resulting in Boil Water Notice of October 2018

2.1.2: Zebra Mussel Related Water Quality Event

2.1.3: Fire Foam Spill Event in Tanglewood Forest area in February 2020

2.1.4: Power Outage Service Interruption and Boil Water Notice (system wide damage and low system pressure) of 2021

2.1.5: Water Quality Boil Water Notice of February 2022

Task 2.2: Emergency Responses and Operations

The purpose of this task is to review if the current response plans and protocols were adequate in providing necessary guidance, how closely the emergency response plans and protocols were followed, as well as to identify potential opportunities for improvements in responses and internal communications that would provide more resiliency to the utility during flooding, spills, or other incidents that cause changes in source water quality. The task will include recommendations for staffing during emergencies and assessment of the need for changes to the current emergency response plans and protocols, especially with respect to internal communication and communication with TCEQ.

2.2.1: Review emergency response plans and protocols including internal communication (link to communication Task)

2.2.3. Identify how current operations and plans are being implemented, how operations during emergencies are modified and how extreme events are planned for

2.2.2: Identify points of failure not included in plans

2.2.3: Evaluate emergency responses for

- Significant changes in raw water quality
- Drought
- Flooding
- Spills

2.2.4: Evaluate staffing quantity and needs during emergency response scenarios

2.2.5: Task 2.5: Water Treatment Infrastructure

The purpose of this task is to assess treatment capability of the existing Ullrich Water Treatment Plant (the most vulnerable plant based on past incidents) primary process units and associated equipment and operations with respect to water quality characteristics defined by the original design documentation and the preceding Task 2.1 and Task 2.5.

This process assessment will identify process limiting factors and provide corresponding recommendations to enhance process resiliency for the identified water quality treatment conditions.

2.5.1: Review provided Ullrich WTP process design documentation, including preliminary design reports, as-built process drawings and specifications, and operations and maintenance information to support the task purpose.

2.5.2: Perform a site visit to review the existing process treatment units and associated equipment as defined by the provided documentation.

2.5.3: Assess adequacy of the existing processes with respect to water quality conditions identified in Task 2.1 and Task 2.5.

2.5.4: In support of Task 2.8, identify unit processes and equipment required to meet City-defined minimum treatment capacity requirements for the defined water qualities when operating from on-site power generation

2.5.5: Document assessment findings and provide ranked order of recommended improvements for water quality management

Task 2.3: Communication with City Officials, TCEQ and Public

The purpose of this task is to review documentation and staff understanding of communication processes with city departments, the public and other stakeholders and responsible parties (e.g., TCEQ) during extreme events and spill events. The task will include recommendations changes to current communication and reporting protocols, as well as recommendations for public outreach opportunities.

2.3.1: Evaluate plant/utility approach to communicating risk; identify responsible parties

2.3.2: Evaluate utility approach to educating public regarding risk and water quality during non-emergency times.

2.3.3: Evaluate utility approach to public outreach and responding to public requests during emergency events.

2.3.4: Review communications protocols among City departments for notifying the utility regarding spills that could impact water quality or power issues that could compromise treatment or have a water quality impact

2.3.5: Develop draft recommendations for improvements to utility communications related to water quality

Task 2.4: Source Water Quality Protection

The purpose of this task is to understand whether watershed protection is adequate to reduce the impacts on drinking water treatment associated with events typical of those identified in Section 2.1. The task will include assessment of the impact of current watershed quality on water treatment. The task will include assessment of water quality changes resulting from flooding, zebra mussels and algae bloom events and the resiliency of the water treatment plant for adapting to these events. The task will include recommendations for changes that may increase the resiliency of the utility to maintain water quality during these events. In addition, recommendations for improved monitoring to prepare for these events will be addressed.

2.4.1: Review watershed monitoring program and any watershed protection efforts

2.4.2: Review/evaluate changes in watershed data for water quality episodes with attention to specific impacts from flooding, zebra mussels, and algae blooms

2.4.3: Review/evaluate flood early warning systems associated with weather, water quality, watershed knowledge. Identify actions implemented to prepare for flooding

2.4.4: Evaluate approach to managing zebra mussels at Ullrich WTP intake and in the watershed.

2.4.5: Review/evaluate plans for reacting to spills in the watershed, on the plant site, or in the community.

2.4.5: Review internal communication protocol for transmitting watershed data to plants

2.4.6: Draft recommendations for improvements to watershed monitoring and protection

Task 2.5: Water Treatment Infrastructure

The purpose of this task is to assess treatment capability of the existing Ullrich Water Treatment Plant (The most vulnerable plant based on past incidents) primary process units and associated equipment and operations with respect to water quality characteristics defined by the original design documentation and the preceding Task 2.1 and Task 2.5.
This process assessment will identify process limiting factors and provide corresponding recommendations to enhance process resiliency for the identified water quality treatment conditions.

2.5.1: Review provided Ullrich WTP process design documentation, including preliminary design reports, as-built process drawings and specifications, and operations and maintenance information to support the task purpose.

2.5.2: Perform a site visit to review the existing process treatment units and associated equipment as defined by the provided documentation.

2.5.3 Assess adequacy of the existing processes with respect to water quality conditions identified in Task 2.1 and Task 2.5.

2.5.4: In support of Task 2.8, identify unit processes and equipment required to meet City-defined minimum treatment capacity requirements for the defined water qualities when operating from on-site power generation.

2.5.5: Document assessment findings and provide ranked order of recommended improvements for water quality management.

Task 2.6: Water Treatment Operations

The goal of this task is to assess whether the operations at the Ullrich Water Treatment Plant meet current industry standards and whether there is sufficient workforce capacity (staff numbers, training, experience) to operate under changing water quality conditions associated with flooding, zebra mussels, spills, power outages, etc.

2.6.1: Evaluate Ullrich WTP management practices with respect to industry standards such as the AWWA Standard G100 for Water Plant Operations and Management. Some consideration will be given to applicability of industry standards to the other two plants, but extensive evaluations of those plants are not included in the project scope.
2.6.2: Interview plant staff that were present at the time of each water quality event to understand plant proposals for making changes to avoid future events.
2.6.3: Review water quality data from Ullrich WTP pertinent to water quality events.
2.6.4: Evaluate staffing with respect to education, certification, quantity.
2.6.5: Evaluate coordination between distribution system management and plant management in times of stress.
2.6.6: Draft recommended improvements in operations and staffing.

Task 2.7 Distribution System Management

The goal of this task is to summarize the current needs of the water distribution system in terms of providing drinking water to the City of Austin, providing sufficient and reliable fire flow, and maintaining sufficient system pressure during extreme events such as flooding and power outages.

2.7.1 Water quality parameter goals that are measured within the distribution system
2.7.2 Fire flow requirements
2.7.3 Pressure

Task 2.8: Power Supply and Energy Requirements

2.8.1 Evaluate resiliency and redundancy – current, planned and typical for WTP

a. Identify points of failure with respect to maintaining power service at Ullrich WTP

b. Identify whether on-site generation is available, sufficient, and for what duration will the current on-site generation maintain WTP operations.

c. Determine the status of under-frequency load shed relays (automatic turn off if grid is in trouble) and their impact on water utility reliability

d. Review communication protocols for coordination between Austin Water and Austin Power

2.8.2 Evaluate current critical load meter list
2.8.3 Assessment of grid connectivity to water systems with respect to reliability and sustainability.
2.8.4 What is the prioritization of Austin Water facilities within Austin Energy's (AE's) power
2.8.5 Evaluate need for staffing expertise in power and energy within water utility
2.8.6 Draft recommendations for improvements to resiliency as it pertains to power needs

Task 3. Recommendations

This audit will provide valuable information to inform decision making. Recommendations in all areas of the audit investigation will be included in draft and final reports.

Task 3.1: Develop Draft Recommendations for Improvements

Recommendations related to the various avenues of the investigation will be assembled as a group to present to the City for review and comment.

- Recommendations will be prioritized within each area

Task 3.2: Develop Draft Audit Report

The draft audit report will include the following:

- Recommended changes to internal policies;
- Recommended changes to current practices, including treatment processes and management of the distribution system;
- Recommended changes to how the City of Austin and Austin Water communicate information to the public during significant events such as these;
- An action plan for how the City of Austin and Austin Water should implement recommended changes, including a prioritization of the recommendations;
- Recommended changes to organizational staffing, staffing practices and policy;
- Opportunities for better working conditions, facilities, tools, technology, and resources;
- The necessary frequency of reviews, assessments, and audits including recommended content of reviews, assessments, and audits and the sharing of data and findings from these reviews and audits to the Council and the public;
- Recommended additional comprehensive assessments to be taken on by Austin Water or the City Council;
- How to improve transparency and the ongoing sharing of data and findings to the Council and the public; and
- Affirmation of what is going well and should be continued.

Task 3.3: Take Comments and Finalize Audit Report

- Present to Water and Wastewater Commission
- Project team members will meet with City staff to accept and discuss review comments
- Audit report and Implementation Plan will be finalized and delivered to City
- Audit report will be presented to Council

Appendix 1-D Project Team Members, Roles and Affiliations

PROJECT MANAGEMENT

- Lynn E. Katz, Ph.D, P.E. , Director, Center for Water and the Environment, UT Austin
- Gerald E. Speitel, Jr, Ph.D., P.E., C.W. Cook Professor in Environmental Engineering, UT Austin

OPERATIONS, DISTRIBUTION SYSTEM, AND WATER QUALITY

- Sarah Clark, MS, PE, S. Clark Water Consulting LLC
- Philip Brandhuber, PhD, Brandhuber Water Quality & Treatment LLC
- Christine Owen, Director of Drinking Water and Reuse Innovations, Senior Associate, Hazen & Sawyer

ORGANIZATIONAL STRUCTURE, COMMUNICATIONS AND EMERGENCY RESPONSE

- Kasey Faust, PhD, Assoc. Professor, Civil, Arch. & Environ. Engineering, UT Austin
- Keri Stephens, Ph.D., Professor & Co-Director of the Technology & Information Policy Institute, UT Austin
- Harry Evans, Senior Research Fellow, UT Austin and Chief of Staff (ret), Austin Fire Department

INFRASTRUCTURE AND ENERGY REQUIREMENTS

- Chad Bartruff, PE, Project Manager, Brown and Caldwell
- Laurie Sullivan, *PE, Rockies Area Drinking Water Leader, Brown and Caldwell
- Kristin O'Neill, PE, Director, Central Texas Brown and Caldwell
- Yael Glazer, Ph.D. Research Associate, UT Austin

*not licensed in Texas

SUPPORTING RESEARCH STAFF

Jacob Goodman, EIT, UT Austin
Cristian Ortuno, UT Austin
Laura Lee, EIT, UT Austin
Pamela Cook, Editor, UT Austin

Appendix 2-A Review of Water Quality Incidents

As mentioned, the City requested that an evaluation of the five incidents of concern be included in this document. These five summaries follow, below, in chronological order of their occurrence. While each incident impacted the ability of AW to provide potable or palatable drinking water for all or part of the water system, each incident arose from complex actions and events, many of which were not in the control of AW. The summaries of the incidents provide the facts as the team understands them to be, without attribution of fault or inclusion of suppositions that were offered in conjunction with the review. AW has taken action after each of the water quality events to prevent future similar events from occurring, and these actions are also identified within this section.

More detailed descriptions of events can be found in the After Action Reports (AARs) for the incidents that were provided by the City to the project team.

1. Flooding Resulting in Boil Water Notice, October 2018

Rainfall throughout the central Texas region in early October 2018 caused Lower Colorado River flooding. Lake LBJ and Lake Buchanan watershed basins received heavy rainfall. Much of that rainfall drained to the Lower Colorado River through Lake Travis from the Llano River. As a result, the Lower Colorado River Authority (LCRA) commenced flood response operations for the Buchanan Dam, Mansfield Dam, and Tom Miller Dam on October 16, 2018, and AW began flood operations on the Longhorn Dam in coordination with the LCRA.

On Wednesday, October 17th, 2018 LCRA anticipated opening four additional gates at Mansfield Dam, which would result in flooding along Lake Austin, Lady Bird Lake and areas downstream of Longhorn Dam due to the amount of water released. On October 18th, the joint Austin-Travis County Emergency Operations Center (EOC) was activated to prepare for the anticipated results of additional flood gates opening. Water draining through the Lower Colorado River was fed by the washing out of a park along the Llano River and contained a significant amount of silt, sediment, and debris. On, October 19th, 2018 the Austin WTPs were operating as normal, but increased turbidity was becoming evident at the raw water intakes. The metric that AW and regulatory agencies use to measure particle removal at the plant is turbidity, akin to cloudiness, and is measured in Nephelometric Turbidity Units (NTU). In addition to aesthetic impacts, such as taste and odor, turbid water is more likely to harbor harmful bacteria and viruses. A primary goal of drinking water treatment is to remove turbidity and any associated microorganisms.

By October 20, 2018, the increase in water turbidity started to impact WTP operations. Water production diminished as clogged filtration systems were addressed. By October 21st, WTP capacity was reduced, and AW was challenged to meet required treated water turbidity levels. AW called for the community to reduce water consumption. At 8:00 p.m. on October 21, 2018, the AW Director recommended that the Austin City Manager initiate a boil water notice preemptively. At 6:00 a.m. on October 22nd, a press conference was held to announce the boil water notice, and on the same day a reverse 9-1-1 system was used to send out conservation and boil water notices to customers. By October 23rd, 2018, turbidity levels leaving the filters at Ullrich WTP triggered a mandatory boil water notice by TCEQ. The boil water notice lasted for seven days and was lifted on October 28th.

The extreme flood event dramatically changed the characteristics of the raw water supply to Austin's three WTPs. The turbidity of the raw water at Ullrich WTP increased from a typical 5-6 NTU to a peak of 387 NTU, based on the Monthly Operating Report filed with the TCEQ. During the period from October 19th to October 25th, the turbidity of the raw water treated at Ullrich ranged from 95 NTU to 387 NTU. Ullrich WTP needed to adjust operations in order to remove a substantially greater quantity of solids to meet the TCEQ finished water requirement of 0.3 NTU and the AW finished water quality goal for turbidity of 0.10 NTU.

The magnitude and duration of the raw water quality changes resulting from the October 2018 flood event were greater than past heavy rainfall events. In addition to the turbidity spiking, the flood significantly altered other raw water quality parameters that are critical to maintaining treatment, including total alkalinity, pH, total hardness, and total organic carbon (TOC).

Early in the flood event, City plant operations staff observed improved treatability by increasing the lime dose to achieve a softened water pH > 10.5, with additional improvement achieved by increasing the ferric sulfate dose. To the extent possible, the City also reduced flow through the WTPs to reduce the surface overflow rate through each clarifier. These steps represented typical approaches to managing increased raw water turbidity during past heavy rainfall events. The extreme level of rainwater inflow to the lakes during this event, however, caused severe changes in raw water quality incomparable to historic events.

The pH and alkalinity of the raw water, respectively, typically average 8.2 and 180 mg/L as $CaCO_3$. During the flood event, pH values dropped below the historical 5th percentile values, reaching as low as 7.91, and the alkalinity dropped from approximately 180 mg/L as $CaCO_3$ to a low of 100 mg/L as $CaCO_3$. The low alkalinity resulted in insufficient carbonate to precipitate out enough $CaCO_3$ for the City's WTP softening process to effectively reduce the high turbidity levels in the raw water. Total hardness in the raw water decreased from 190 mg/L as $CaCO_3$ to 88 mg/L as $CaCO_3$. The total organic carbon, which is a measure of natural organic matter in the water, doubled during the flood event from 3.44 to a peak of 7.78 mg/L. The very low alkalinity level and high turbidity made it difficult to precipitate sufficient calcium carbonate and coagulate the negatively charged particulates in the water to settle them out. Thus, a high volume of particulates was passed from the clarifiers to the filters, and the filters could not maintain removal rates required to meet the drinking water regulations. In addition, the very high organic content exerted an extra demand on the chemicals used to disinfect the water.

Ullrich WTP was designed to treat Lower Colorado River water as reflected by previous historical norms. The facility is equipped to adjust several operational set points in response to changes in water quality, but it did not have the capability to treat water with such a high turbidity loading as that seen during the October 2018 flood.

During this flooding incident, the City retained Carollo Engineers, Inc. (Carollo) to help provide on-site support at Ullrich WTP alongside the City plant operations staff and management working at the plant. Carollo evaluated treatment plant operations and capabilities to understand limitations and options for operating the plant while the raw water quality remained challenging to treat and suggested recommendations for WTP operational adjustments. The City also collected a batch of raw water on October 25th and stored it in a cold room for future batch studies. Carollo conducted bench tests on the saved flood water during winter of 2019 to assess the viability of various treatment options, including polymer addition, increased ferric sulfate coagulant doses, and addition of carbonate to the water. Bench scale testing on saved water can provide direction for future flood events, but the water quality is typically slightly altered due to being stored. Nevertheless, the studies indicated that treatment of the stored water with polymer could destabilize the negatively charged particles entering the plant from Lake Austin (allowing them to agglomerate and grow into larger settleable particles). The recommendations provided by Carollo included:

- Feeding ferric sulfate at doses typical of normal operation (i.e., 15 mg/L as solution).
- Feeding polymer 30 seconds or more after ferric sulfate to neutralize charge of particles in the water.
- Softening at pH typical of normal operation (i.e., pH 10.0-10.2).
- Feeding low doses of another polymer to the centerwell of the solids contact clarifiers at Ullrich to promote settleability.

The strategy developed by Carollo employs lime addition to achieve softening and pH targets, iron addition for TOC removal, PEC type polymer for charge neutralization, and PEA type polymer for particle bridging. To facilitate operations during extreme conditions of low alkalinity and hardness, high turbidity and high TOC, it was also recommended to use the polymers during normal operations. Ullrich WTP has since installed a polymer feed system and currently continuously feeds a low dose of polymer at all times. Similar systems are being installed at the other treatment plants as well, and supplies are on hand to set up temporary systems at those plants in an emergency. The polymer system is in continuous operation so that it remains familiar to operators and averts startup issues should another major water quality event occur.

Further details regarding the need for continuous addition of polymer during normal operating conditions and potential future concerns due to water quality changes are provided in Section 2.7 and Appendix 2-D. Table 2.1. in Appendix 2-B summarizes other relevant recommendations and progress to date from the AAR and Improvement Plan pertaining to the October 2018 flood and boil water notice. All of the listed recommendations have either been implemented by AW or are no longer applicable, indicating that there was an appropriate response to the recommendations in light of the incident. Of those listed, the recommendations of greatest importance include the procedures for sending alerts and protocols for dissemination of information during an emergency, such as a service area-wide boil water notice. With the implementation of the communication recommendations, critical information during boil water notices can be more effectively disseminated between different departments of AW and the City and to the public. Other recommendations of importance that were put into place are the addition of zeta potential instruments to manage polymer dosing (already implemented at Ullrich). The structural improvement recommendations allow the utility to better respond to the particle charge characteristics during high turbidity events and possibly enhance the flocculation process by neutralizing the particle charge with a cationic (positively charged) coagulant aid.

The low alkalinity and hardness associated with the October 2018 flooding event raise concerns regarding formation of the calcium carbonate solids typical of the lime softening process. While Carollo did assess the potential for turbidity reduction and settleability by adding supplemental carbonate alkalinity, the benefits of carbonate addition were not apparent for the stored water tested. Low alkalinity can, however, be a concern for lime softening plants that do not have sufficient carbonate hardness. Remediation scenarios that promote calcium carbonate precipitation during low alkalinity episodes should be considered further in future operational scenario testing and water treatment studies.

2. Zebra Mussel Related Water Quality Event, February 2019

The zebra mussel (*Dreissena polymorpha*) is a small bivalve originally native to the Caspian Sea region that colonizes natural water bodies. Zebra mussels reached North America in the mid-1980s in the ballast water of a ship and rapidly became established in the Great Lakes and the waters draining them. By 2012, zebra mussels had colonized most of the eastern half of the U.S. and had been found in north Texas. They have continued to spread across central Texas (Figure 1).

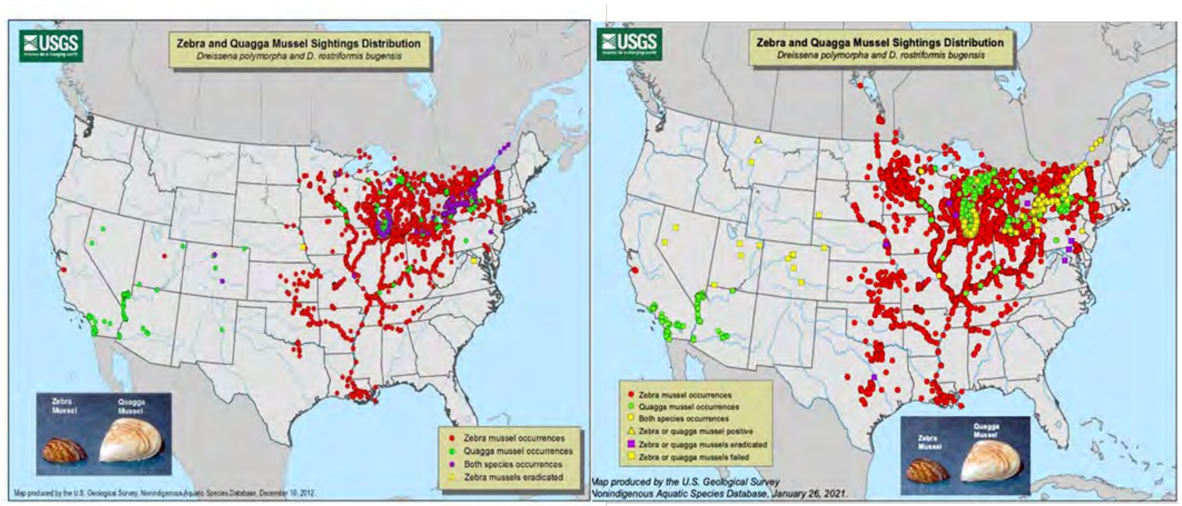


Figure 1. National mussel sightings distribution in 2012 (left) and 2021(right). (Map produced by the U.S. Geological Survey, Nonindigenous Aquatic Species Database; December 10, 2012 and January 26, 2021)

These mussels begin as eggs released by females that are fertilized externally in the water column, hatching to become veligers, planktonic entities that are free floating until they grow large enough to attach to a structure and grow a shell to become the adult mussel. Mature mussels can produce 40,000 to 1,000,000 veligers per year. Although some 90 percent of veligers die prior to attachment, the spread of mussels is very rapid. In the recreational waters of Texas, veligers can move through natural waterways or be transported from lake to lake in the bilge water of boats. Thus, when the mussels were known to have colonized several lakes in north Texas, the progression of the mussels into the rest of Texas was a foregone conclusion. This fact was well known in the drinking water community and was pointed out in a presentation made by a member of the project team in San Antonio to the Texas Section of AWWA in 2013.

The colonization of mussels is dependent on three factors in the environment: water temperature in the range of 18-25℃, dissolved oxygen above 8 mg/L, and adequate calcium for shell development. These are all characteristics of the water in the Highland Lakes. Mussels tend to colonize structures where there is some shade from hot sun and where water is flowing by continuously. The mussels feed on phytoplankton, which they syphon out of flowing water, so they are often found on protective screens around water intakes and in pipelines that are open to the lake (raw water pipelines).

By June 2017, zebra mussels were established all across Texas, including in Lakes Travis and Austin. In a presentation given to the Water and Wastewater Commission in September 2017, senior staff reported that monitoring was underway at the intake screens for mussel colonization, an inspection contract for divers was in place, and there was the need to research methods of control, which required hiring a consultant. In November 2017, all the plant intakes were inspected, with a few zebra mussels found on the upper screen of Handcox WTP and none found at the intakes of the Ullrich and Davis WTPs. In May 2018, AW established a contract with an underwater construction corporation to inspect and clean all intakes.

In September 2018, the Handcox WTP top intake screen was found upon inspection to be 100% covered with mussels. A consulting contract to determine what prevention method should be used for mussel infestation was issued in January 2019. Also in January 2019, divers removed ½ - 2 inch thick layers of mussels from all the plant intakes and discovered that mussels were in the Ullrich WTP water pipeline. By default, the initial management plan for mussels was to let them grow and then have them removed.

In February 2019, a serious taste and odor issue occurred at Ullrich WTP when a raw water pipeline was placed into service: apparently not all the dead mussels had been removed from the pipe. During this taste and odor event, Ullrich WTP continued to produce drinking water that was sent into the water system. Adjustments were made to the powdered activated carbon feed to reduce the level of taste and odor compounds in the water.

During 2019, AW was also retraining operations and maintenance (O&M) technicians to perform threshold odor number (TON) tests at every facility. This was an ongoing standard test prior to the zebra mussel event because the utility does, at times, experience taste and odor events related to algae growth patterns in the lakes. The test results provide early identification of the increase of taste and odor compounds in the water, allowing the plants to modify treatment using powdered activated carbon to adsorb these compounds.

The utility received TCEQ approval to feed copper sulfate at Ullrich WTP in January 2020. In May 2020, temporary copper sulfate feed facilities were installed, which add 5-10 µg/L of copper ion to the water to control the zebra mussels within the raw water intake pipes. Copper sulfate kills both the mature zebra mussels and the veliger stages of the mussels, thereby avoiding mussel colonization of the raw water pipes and intake wet well screens. The finished drinking water action level for copper ion is 1.3 mg/L, so this mussel control measure does not pose a significant risk to public health and complies with TCEQ guidelines. By July 2022, a bulk chemical copper sulfate system at Ullrich WTP became operational, requiring bulk chemical deliveries of the copper sulfate solution. The utility continues to conduct annual plant cleanings within intake structures, pump casings, pump pits, and other areas potentially impacted by the mussels since 2019. These cleanings have proven effective in reducing the accumulation of zebra mussels in the plant.

The copper sulfate feed system is being replaced with a copper ion generation system that will be located in the Low Service Pump Station. The copper ions will be dosed into the wet well at the pump station and will have the same effect of deterring mussel settlement as does the copper sulfate. The copper ion generation system has the advantage of not requiring bulk chemical deliveries or increasing the sulfate levels in treated water. The copper ion generation system is expected to be completed by late Spring 2023. Similar systems will be added to Davis and Handcox WTPs.

This taste and odor event grew out of a lack of early planning for zebra mussel infestations and some inattention to the condition of the raw water pipelines after cleaning was supposed to be complete. Chemical treatment for mussels could have been implemented several years prior to the actual installation of the copper sulfate feed system. Clean-out of established mussels was already known to be difficult, particularly inside pipelines. Table 2 in Appendix 2.B summarizes the relevant recommendations from the Zebra Mussel Mitigation documents. The copper sulfate feed systems that were recommended and installed can provide adequate treatment to address issues associated with zebra mussels. The implementation of the Copper Ion Generator Systems is currently underway. This indicates that AW is actively addressing the issue and proceeding in an appropriate manner in light of the zebra mussel manifestation it is experiencing. AW has also implemented new procedures for taking lines out of service for cleaning to reduce risks and eliminate taste and odor events.

3. Fire Foam Spill Event, Tanglewood Forest Area, January 2020

On January 22, 2020, a fire was reported in the Tanglewood Forest Area. At approximately 12:30 am, firefighters in routine response to the ongoing fire were required to prepare to use fire foam if necessary. The two engines that had arrived on the scene first (sequentially, E29 and E36) did not have working foam systems, so a line from a third engine (E43) with a working foam system was connected to E29. E29 supplied Class A foam while it was also connected to a publicly supplied fire hydrant. (Class A firefighting foams do not contain per- and polyfluoroalkyl substances - PFAS chemicals). Unfortunately, this connection allowed the foam to backflow into the City's distribution system since the pressure on the foam line was greater than that of the water line.

AW dispatch began receiving calls about foamy or soapy water in residential taps in the Tanglewood Forest Area in the early morning of January 22nd and began directing crews to investigate the complaints. The presence of foam in the potable water lines was confirmed, and AW began setting up for initial flushing operations. During this time, the AW executive team was notified, a targeted incident management team (IMT) was placed into service with the Operations Assistant Director as the Incident Commander (IC), and the IMT developed a public notice plan. This plan included: door knocks/hangers and Nextdoor App notifications through AW, and reverse911 phone calls through Homeland Security and Emergency Management. Complaints of this occurrence continued throughout the day; at noon/12:00 pm AW crews began targeted sampling and uni-directional line flushing, which continued until 2:00 pm. Visual inspection confirmed that there was still foam in the system, and additional flushing was ordered. At this point, the source of the foam was not known to AW; they tested both back-flow preventers and conducted on-site inspections at two local car washes that were suspected of being the source. The car washes were determined not to be the source only after these notification steps were taken.

The detailed timeline of events available through the joint AAR from AW and Austin Fire Department highlights the swift and appropriate action taken by AW to identify the issue, take action, and protect the public. The steps taken were reported in the AAR and demonstrate the responsiveness of AW to an event that impacted water quality to a small area of Austin. This incident was not a result of raw water quality changes, water treatment operations or infrastructure. AW provided timely and appropriate management that included public notification and communication, identification of the problem, availability of bottled water, and follow-up investigations and review.

On Thursday, January 30, 2020, AW met with Austin Fire Department to discuss the cause of the incident. AW provided the results of the water sampling and pressure readings from the Pumps and Reservoirs group. Austin Fire Department reported on their internal investigations and concluded that fire ground operations at the West Oak Baptist church fire did introduce a 0.1% firefighting foam solution into the potable water system via a hydrant connection. From the initial Fire Incident Report, the following conclusions were reached and actions were taken:

- Austin Fire Department directed their own Education Services to share this scenario with current and future students. If one engine is sending Class A foam solution to another engine, the receiving engine should not be connected to another water source (hydrant).
- Backflow can be prevented by making sure fire engines are receiving flow from only one source.

Table 3 in Appendix 2-B summarizes the relevant recommendations from the Fire Foam Event AAR. The joint AAR from AW and Austin Fire Department also provided a short list of "Issues Encountered/Lessons Learned" including several recommended improvements for fire ground operations to prevent future back flows. Two errors in communication were identified, neither of these was attributed to AW.

Although not commonly appreciated, water distribution systems were initially built for fire protection and still are designed for minimum fire flow requirements. For example, fire hydrants are installed at specific intervals and are rated to provide specific flow rates, all focused on fire control and suppression. Fire department staff are expected to be thoroughly and carefully trained on how to operate hydrants safely and with as little disruption as possible to area piping. AW, like all other water systems, does not have absolute control over access to distribution system appurtenances and cannot control access to these features. The Tanglewood incident was the result of fire department staff incorrectly accessing a fire hydrant and causing a backflow condition that pumped fire foam into the local distribution system.

AW responded appropriately in a confined portion of the distribution system, and Austin Fire Department has made the relevant changes to avoid this situation in the future. While this incident did not reveal any issues with Ullrich WTP, it did shed light on how readily the WTP was blamed by the public and demonstrates the importance that Communications plays in maintaining the public's confidence in Ullrich WTP and AW, as well as to keep Austin citizens correctly informed of ongoing situations.

The Austin Fire Department implemented the recommendation for a fire foam SOP that would avoid Class A fire foams gaining access to the water distribution system via fire engines.

4. Winter Storm Uri Power Outage and Boil Water Notice, February 2021

Winter Storm Uri was a significantly different storm event than the flooding event of October, 2018. Raw water quality was not the source of concern; rather, the interruption in flow was due largely to an increase in water demand resulting from a confluence of issues including a) pipe breakage in mains and premise plumbing and b) thousands of residents dripping their faucets to avoid water damage to their home and property, compounded by the loss of power at Ullrich WTP. AW preparations for Winter Storm Uri began on February 9, 2021. Public communications warned residents to take precautions against freezing pipes, the AW incident management team was placed on standby, and other emergency preparations were underway to ensure that chemicals were on hand for treatment operations, AW and Austin Energy were monitoring and anticipating emergency operations, and operators and staff were prepared to shelter-in-place at the water treatment plants.

The duration of extreme low temperatures experienced from February 12th through February 19th had a significant impact on both Austin Energy and AW operations. Reduced natural gas production and electricity generation capacity throughout Texas led to load shedding by Austin Energy on February 15. Fortunately, the WTPs were not required to curtail power usage because they are listed on Austin Energy's critical infrastructure list. In contrast, 48 sanitary sewer lift stations lost electricity, but the AW staff was able to supply energy via auxiliary generators to minimize the impact. As a result, only nine sanitary sewer overflows occurred, and these were inspected and remediated. However, on February 15th water usage increased dramatically, and on February 17th Ullrich WTP lost power.

Power loss at Ullrich Water Treatment Plant. Ullrich WTP temporarily lost power at 1:50 pm on February 17th. Ullrich WTP is fed electricity from the Austin Energy Bee Creek Substation with two dedicated circuits and an additional backup circuit. The cause of the outage was due to falling vegetation debris during the storm event. Both dedicated circuits lost power. Six minutes later Austin Energy was able to remotely re-energize the substation and power to one of the feeders that serves Ullrich WTP (Bee Creek Feeder 1) was restored. AW electricians arrived at 3:15 pm and began assessing the situation, and they manually transferred power to the plant from [8]Bee Creek Feeder 1. By 4:15 pm, power was restored to Ullrich WTP after AW electricians, following all safety protocols, carefully inspected systems and ensured they were ready to have power restored to them. At 5:30 pm Ullrich WTP began producing water and ramping up treatment capacity. Treatment capacity was restored within about 11 hours.

Increased Water Demand. The sustained sub-zero temperatures led to water main breaks and residential/commercial water pipes bursting across Austin (and across the state of Texas). In addition to the increase in broken pipes, customers across the service area were dripping their faucets in an attempt to stave off pipe and water damage to their home and property. During this time, water usage in the AW service area rose from 150 million gallons per day (MGD) on February 15th to 260 MGD on the evening of February 16th and

[8] Ibid.

climbed to 330 MGD on February 17th, well above typical water usage and above high usage level expectations.

The city's high demand for water and the power outage at Ullrich WTP, which halted water treatment, caused the water storage and reserves to fall quickly and resulted in water pressure within the distribution system dropping below regulations, which require a minimum of 20 psi. This minimum pressure prevents infiltration of untreated water and maintains safe water quality. The system pressure loss resulted in the issuance of a boil water notice for Southwest Austin and Lost Creek neighborhood on the morning of February 17th and to all of Austin on the evening of the February 17th. By February 23rd, water service to the distribution system was fully restored, but AW continued to assist residents who were affected by private plumbing issues.

Many components of water and wastewater treatment plants, distribution systems, and premise plumbing froze during the extreme cold, rendering them non-operational during the course of the approximately seven-day event. AW crews worked 24 hours a day to repair and restore service. Public messaging and widespread communication was extensive, but even so the high number of inbound calls and website traffic made individual customer response challenging.

A review of reports and discussions with staff highlighted the significant role that freezing pipes had on the loss of system pressure and water delivery. It appears that the vast majority of pipe breakage occurred on the residential side of meters and in piping internal to residences. Because of power shortages in Austin, many residents left their homes, leaving no one to notice when service lines and internal plumbing froze, burst, thawed, and then flooded. These coincidences were compounded by the fact that extended freezes are rare in Austin, and most distribution piping is not buried deeply, making it subject to freezing during sustained cold periods.

Although it was a highly unusual set of circumstances, the level of effort by AW to restore water distribution was appropriate, and cooperation between AW and Austin Energy was evident. However, the storm did have severe consequences for AW and revealed resilience challenges in the system that were noted in the AAR.

The Improvement Plan in AW's AAR for the event listed over 50 recommendations prioritized by their Winter Storm Working Group to increase AW's resilience during future winter storm events. Insulation of piping at the WTP was completed, and repairs were made to broken pipes. Alternative tools were obtained for measuring chlorine residual that are not impacted by a power outage. The WTPs also stocked winter preparation supplies, such as deicing sand, and safety equipment for staff such as boot spikes, cots, blankets, and ready to eat meals. Winterization protocols and standard operation procedures for cold weather events were updated.

In addition to these efforts, Ullrich WTP has altered planned maintenance practices for treatment basins to ensure that treatment capacity in the winter months (typically when demands are lowest) is maintained at a level that can meet winter cold weather event needs. This means taking basins offline for maintenance for shorter periods, preferably during the swing seasons of spring and fall, to do major maintenance.

Winter Storm Uri highlighted the challenges associated with providing sufficient back up power for a large water treatment plant. A recent survey of energy intensity of water processes (water source and conveyance, treatment, and distribution) indicated that the mean energy intensity of water systems is 2,300 kWh/million gallons, a value approximately equal to the energy needed to power a small town (Young, 2015). As a result of these power issues, and as directed by State law, Senate Bill 3 (SB3), AW conducted a major review of power management. With the enactment of SB3, AW is required to develop an Emergency Preparedness Plan (EPP) to support emergency water treatment plant operations during extended power outages lasting more than 24 hours.AW has developed and submitted its EPP, as discussed in section 2.6.4 of this report.

Table 4 in Appendix 2-B summarizes the relevant recommendations from the Winter Storm Uri AARs, including those highlighted above. 94 of the 128 listed recommendations have already been implemented by AW or are no longer applicable. AW winterized the catwalks and carbon dioxide recarbonation system and heat traced their piping in preparation for another freezing event. The plant still needs to construct improvements to prevent the sludge truck hatches from freezing and implement electrical reliability services at the WTPs. Further discussion of actions taken and completed in response to energy resilience are provided in Section 2.9.

5. High Turbidity Event at Ullrich WTP, February 2022

The cornerstones of drinking water treatment are the processes of coagulation, flocculation and sedimentation. Most particles in water carry a negative charge, causing them to repel each other and stay in suspension (remain stable). In water treatment, a chemical coagulant is added to neutralize the charge or enmesh the smaller particles within larger, precipitated “flocs.” Once destabilized, the particles no longer repel each other, allowing for aggregation during the flocculation process. The resulting larger particles are denser, allowing them to settle by gravity. Essentially, particles are forced to aggregate and settle out of the water.

At Ullrich WTP, three stages of the softening treatment process—coagulation, flocculation, and settling—are combined in one treatment unit called a clarifier. The incoming process water enters the clarifier through the center of the unit or mixing well. This area is segregated from the rest of the unit by a bell-shaped partition or “skirt.” Within the mixing well, treatment chemicals (lime and ferric sulfate) are dispersed, initiating particle destabilization and the formation of larger, heavier floc particles. The formation of heavier particles is enhanced by the mixing of incoming destabilized particles with previously formed floc circulating within the mixing well. Adequate particle concentration, or solids density, in the mixing well is essential for interaction with the suspended particles, causing material in the raw water to form larger, heavier floc that can then settle by gravity to the bottom of the basin. Once settled, the solids must be removed from the basin to prevent excess buildup—a critical step.

Maintaining the balance of solids in the mixing well is crucial to the performance of the clarifiers. Operators collect samples from the mixing well and measure the solids concentration every 4 hours, and more frequently when the solids are outside the optimum range of 4-8% solids. When the solids in the mixing well are too low (less than 3%), the upflow clarification process does not perform optimally, resulting in higher turbidity in the settled water leaving the basin and proceeding to the filters. To correct low mixing well solids conditions, operators will “seed” a basin with solids that had previously been removed during the clarification process. These solids are pumped from the solids thickener basin to the clarifier that is deficient in mixing well solids. If solids are allowed to accumulate in the basin without removal, eventually the floc material will build up and reach the top of the basin, causing high settled water turbidity and an extra burden on the filtration process.

In the days leading up to freezing weather, which was forecasted to begin on Thursday, February 3, 2022, emphasis was placed on winterization efforts and increasing production at all three water treatment plants in preparation for potential impacts from below-freezing temperatures. These activities were completed in advance of the arctic cold front, and plant operations at Ullrich, Davis, and Handcox WTPs experienced no adverse impacts. In addition, during this time, distribution system storage tanks were operated at higher than normal ranges, in order to be prepared for potential freezing weather.

On Friday afternoon, February 4, Basin 6 at Ullrich WTP was brought online and operators began the process of seeding the basin for production. The seeding operation was noted by the Friday daytime operators in their daily report. A directive from the Superintendent was sent to all the operating teams to keep all the basins online to avoid freezing of lime feed assemblies. All basins in production increased sludge production and sludge handling, but Centrifuge 4 was not repaired and not operating. The plant was relying on Centrifuges 1 and 3 to process all solids.

When the night shift operations team arrived at 7:00 pm they began monitoring the centrifuges and trying to trouble-shoot issues with excess water being discharged to the hopper. Production at the plant had been increased to 75 MGD just prior to their arrival and was increased again, at the request of the Pumping Division, to 86 MGD at 9:00 pm. Throughout the night the seeding process for Basin 6 continued, resulting in rising turbidity and overloading the filters. Shortly after 4:00 am the Basin 6 blowdown valve was opened, beginning the process of removing solids from the basin. During this time the basin was left on, continuously sending high turbidity settled water to the filters. This operational error led to increased turbidity of the clarifier effluent/filter influent that was associated with the calcium carbonate solids added via the seeding and produced in the clarifiers.

Operation crews arriving for the day shift at 7:00 am. Saturday, February 5th, recognized that turbidity levels had exceeded regulatory requirements and shut down Basin 6 at 7:38 am. By that time, the highly turbid water from Basin 6 had overwhelmed the filters and inundated the clearwells and was out into the water distribution system. Ullrich WTP was shut down by 9:30 am on February 5th. Because plant finished water turbidity had exceeded TCEQ thresholds, a citywide boil water notice was issued on Saturday, February 5th at 7:30 pm. As Ullrich WTP was shut down, increased production from Davis and Handcox WTPs and distribution storage provided water service to the City until Ullrich WTP was brought back into service, after the boil water notice was in effect. The boil water notice was rescinded at 10:20 pm on Tuesday, February 8th.

A review of this boil water notice incident highlighted a number of concerns at the plant associated with internal communications, standard operating procedures and training, and staffing. A number of the recommendations from the AAR report address these issues. Table 5 in Appendix 2-B summarizes the relevant recommendations from the Ullrich WTP February 2022 High Turbidity Event AAR. All of the recommendations listed in the table are either implemented (25/34), underway (7/34), or planned (2/34). One recommendation of importance that is underway is the definition and documentation of roles and responsibilities for employees at Ullrich WTP. This is particularly crucial for the onboarding process so that operators clearly understand what is expected of them on the job. A major change at Ullrich WTP after the high turbidity event was to the SCADA monitoring system. The updated software now sends automated calls to the superintendents, supervisors, the water treatment operations manager, and the water treatment division manager when turbidity exceeds the regulatory set point. Thus, the entire senior staff is notified remotely when there is an apparent risk that regulatory turbidity levels will be exceeded.

Appendix 2-B AAR Recommendations and Implementation Status

Table 1: October 2018 Flood AAR Recommendations

Number	Recommendation	Reported Status	Estimated Completion Date
1	Develop protocols for sending alert notifications utility wide, including all internal stakeholders.	Implemented	
2	Develop information sharing platform to improve situational awareness during incidents.	Implemented	
3	Develop policy/protocols for mass communications and social media - use of smartphone applications.	Implemented	
4	Develop and disseminate Skype training to include use on laptops, smartphones, tablets, workstations, etc.	Implemented	
5	Provide WebEOC training for AW personnel.	Implemented	
6	Develop a dedicated Department Operations Center for AW.	Implemented	
7	Continue to provide ICS training and exercise for all IMT and other staff as required.	Implemented	
8	Expand IMT staffing to include Situation Unit and Logistics, and to create depth across entire IMT.	Implemented	
9	Develop pre-incident "Triggers" to enhance early activation and mitigation decision making for use in all-hazards planning.	Implemented	
10	Develop IMT Meeting Agenda templates for use during activations; provide training on use.	Implemented	

Number	Recommendation	Reported Status	Estimated Completion Date
11	Mitigate single point failures in Environmental Regulation and Wholesale Customer Services for IMT.	Implemented	
12	Implement zeta potential instruments at all water treatment plants.	Implemented	
13	Standard Operating Procedures developed and revised for flood event preparation.	Implemented	
14	Polymer feed system at Ullrich water treatment plant.	Implemented	
15	Polymer feed systems at Davis and Handcox water treatment plants.	Underway	7/3/2023 for permanent systems; temporary systems in place now
16	Provide the ability to add PEC upstream of softening at pH 10.2 (and to the filter influent to act as a filter aid polymer).	Implemented	
17	PEC should be added after ferric sulfate, with the chemical addition points ideally separated by 30 seconds or greater.	Implemented	
18	Measure zeta potential of settled water to confirm the PEC dose required to neutralize charge. Over time the correct zeta value will be determined but an initial target would be between - 4 and + 4 mV.	Implemented	
19	Work with lifeline critical infrastructure stakeholders (e.g., water, energy, transportation) to develop proactive and preventative trigger points to mitigate cascading impacts.	Implemented	
20	Develop job action sheets with information on specific roles when assigning representatives to the EOC.	Implemented	
21	City and County staff should use this incident as an example for simplifying complex information to the public and continue this practice.	Implemented	

Number	Recommendation	Reported Status	Estimated Completion Date
22	Utilize accessible and relatable social media communication. This should include creative communication including videos and other visual communication.	Implemented	
23	The simplified language disseminated to the public should be accurate and sufficient, in addition to the language that is being disseminated to meet regulatory requirements.	Implemented	

Table 2: Zebra Mussels Recommendations

Number	Recommendation	Reported Status	Estimated Completion Date
1	Construction is scheduled to begin on the Copper Ion Generator Systems in January 2023 and is estimated to be completed by Winter 2023.	Underway	12/31/2023

Table 3: Tanglewood Fire Foam Recommendations

Number	Recommendation	Reported Status	Estimated Completion Date
1	Austin Fire Department to create new SOP regarding the use of foam.	Implemented	
2	Austin Fire Department Education Services to share this scenario with current and future PADO students, so they'll be aware of this potential going forward.	Implemented	

Table 4: Winter Storm Uri AAR Recommendations, November 3, 2021

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
1	Continue to focus the Renewing Austin program, AW's water main replacement program, on small diameter cast iron pipes and utilize asset management principles to prioritize poor-performing pipes.	2-Medium	Underway	1/1/2050
2	Evaluate effectiveness of heaters in Ullrich WTP chlorine storage room.	1-High	Implemented	
3	Evaluate options such as infrared heaters and heat blankets at treatment plants and Shaw Lane disposal site to prevent sludge truck hatches from freezing.	1-High	Underway	1/1/2024
4	Winterize catwalks at all WTPs.	1-High	Implemented	
5	Coordinate with WCID-17 to winterize the PRV connection at Handcox.	1-High	Implemented	
6	Winterize Davis WTP CO2 system by adding heat trace/insulation or enclosing system within a building or shelter.	1-High	Underway	6/30/2023
7	Winterize Handcox filter backwash pumps and system by enclosing in a building.	1-High	Planned	1/1/2028
8	Construct improvements at treatment plants and Shaw Lane disposal site to prevent sludge truck hatches from freezing.	1-High	Planned	9/30/2026

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
9	Critical Process Piping and Equipment: • Require heated enclosures or buildings for all critical process equipment and piping where possible. • All other piping shall be professionally insulated and/or heat traced. • Utilize backup generators ATS for heat trace elements on small & critical systems. • Completely drain all lines associated with equipment that is not in use.	1-High	Implemented	
10	Non-Critical Piping: • Provide low-point drains for all non-critical piping to allow complete winterization when needed. • Completely drain all lines associated with equipment that is not in use.	1-High	Implemented	
11	Insulate and heat trace critical process lines (e.g., RAS) at River Place Remote Facility.	2-Medium	Implemented	
12	Winterize magnesium hydroxide feed equipment and tank at Dessau Remote Facility.	2-Medium	Implemented	
13	Winterize all non-process related piping by retrofitting ability to full drain piping during freeze (e.g., clarify spray). Install heat tracing and insulation on piping or pumps that must remain in service/cannot be drained.	2-Medium	Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
14	Add fail-close solenoid valve on french drain into Texas Plume lift station to automatically close drain into dry well in the case of power outage, preventing groundwater damage of equipment during power outage (sump pump out of power).	2-Medium	Implemented	
15	Use freeze-rated oil and winterize WAS screening gear box at Hornsby Bend BMP.	2-Medium	Implemented	
16	Extend or construct new heated garage-type enclosure over sludge hauling/truck loading bay and conveyors at Hornsby Bend BMP.	2-Medium	Underway	12/31/2026
17	Always maintain at least 20 days of chemical storage (based on permitted annual average flow) at a centralized storage location at each plant, for critical chemicals.	2-Medium	Implemented	
18	Critical Process Piping and Equipment: • Require heated enclosures or buildings for all critical process equipment and piping where possible. • All other piping shall be professionally insulated and/or heat traced.	2-Medium	Implemented	
19	Non-Critical Piping: • Provide low-point drains for all non-critical piping to allow complete winterization when needed.	2-Medium	Implemented	
20	Evaluate AW pipeline design criteria for opportunities to enhance freeze protection requirements.	3-Low	Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
21	Replace force main sections with shallow bury depth to prevent freezing.	2-Medium	Implemented	
22	Implement weatherization enhancements and replacements for instrumentation to prevent issues and failures caused by freezing or power loss.	1-High	Underway	3/31/2023
23	Replace Davis WTP ultrasonic level transducers on settled water channel with a different type of instrumentation, add backup level indicators, or update programming to limit flow through filters.	1-High	Implemented	
24	Connect sodium hypochlorite disinfection system to backup generator at Dessau Remote Facility.	1-High	Implemented	
25	Replace aging generator at Lost Creek WWTP site.	1-High	Planned	9/30/2025
26	Implement electrical reliability service at WTPs and PS identified in criticality assessment for system-wide power outage.	1-High	Underway	1/1/2025
27	Install natural gas backup generators at critical lift stations with access issues during winter storm (Cliffs Over Lake Austin, Mt. Bonnell Shores #1, Mt. Bonnell Shores #2,Cat Mountain #1,Cat Mountain #2,Riverplace #3,Bend-O-River, Ringtail Ridge I L.C. #4) in accordance w/ AW criticality assessment.	1-High	Planned	1/1/2031
28	Install backup generators at all facilities designated as critical based on AW ranking.	1-High	Planned	1/1/2031
29	Purchase portable backup generators to satisfy new policy goals.	1-High	Underway	1/1/2025

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
30	Add permanent generator at Dessau Lift Station site.	1-High	Planned	9/30/2024
31	Replace aging and unreliable automatic transfer switches at WWTP facilities.	1-High	Planned	12/31/2040
32	Replace automatic transfer switch at Davis Springs #1 and Texas Plume lift station sites.	1-High	Implemented	
33	Move generator and ATS from existing site to River Place WWTP for backup power. Add effluent pump station to backup power.	1-High	Underway	1/1/2025
34	Insulate and/or heat trace biodiesel generator at Pack Wagon Trail Lift Station Site.	1-High	Implemented	
35	Modify all sites and portable generators to standardize use of electrical quick connections.	1-High	No Longer Applicable	
36	Replace older PLCs that have issues maintaining memory.	1-High	Planned	1/1/2030
37	Implement the ability to automatically transfer to the available power circuit to restore plant operations after an incoming service power outage. MOU with AE is currently in review.	2-Medium	Underway	1/1/2025
38	Work with Austin Energy to directly connect cogeneration system to plant electrical to provide own power during power outage events.	2-Medium	Planned	1/1/2025
39	Implement maintenance and monitoring protocols for data transmission devices that rely on battery backup systems.	2-Medium	Implemented	
40	Conduct criticality assessment to determine which WTPs and PS are required to meet minimum demands during a system-wide	3-Low	Planned	1/1/2025

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
	power outage.			
41	In all seasons, use a projected maximum demand based on forecasted non-coincidental maximum daily demand (i.e., all pressure zones experiencing maximum day demand at same time). Until system improvements can be implemented to achieve this policy, evaluate alternative approaches that plan for higher demand year-round.	2-Medium	Implemented	
42	Document firm capacity for each WTP based on the specific components at each plant and the required maintenance protocols.	2-Medium	Underway	9/30/2023
43	Use the concurrence process for short-term operational decisions and for anticipated weather events.	2-Medium	Implemented	
44	Implement improvements at the WTPs to provide additional flexibility in maintenance scheduling.	3-Low	Implemented	
45	Reconfigure Davis raw water channel to allow one basin to be taken down at once.	3-Low	No Longer Applicable	
46	Develop an SOP for conserving chemicals in emergencies when supplies cannot be replenished.	2-Medium	Underway	9/30/2023
47	Construct additional lime slakers at Ullrich and Handcox WTPs to utilize existing storage silos. Adding slakers to HWTP would require expanding the lime building.	2-Medium	No Longer Applicable	
48	Increase storage capacity for sodium hypochlorite at SAR WWTP.	2-Medium	Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
49	Develop emergency sludge management SOP to be used until sludge management improvements are constructed.	2-Medium	Implemented	
50	Purchase/rent spare dumpsters to remain onsite to allow replacement and temporary storage of full dumpsters in the case that hauling is temporary unavailable.	2-Medium	Implemented	
51	Improve sludge management at Ullrich by adding on-site sludge storage and/or sewer improvements.	2-Medium	Planned	1/1/2040
52	Construct second sludge storage tank at Handcox.	2-Medium	Planned	1/22/2033
53	Transition to disinfection processes at wastewater treatment plants that do not require chemicals, eliminating the need for chemical procurement and storage for disinfection.	3-Low	Planned	12/31/2029
54	Maintain adequate pumping capacity in the distribution system to meet demand planning criteria.	2-Medium	Planned	1/1/2025
55	Implement Northwest A transmission main.	2-Medium	Underway	3/31/2026
56	New Southwest A Zone pump station and transmission main to SWA pressure zone.	2-Medium	Planned	9/30/2027
57	Maintain "reliable pumping capacity" (RPC) by pressure zone, defined as maintaining at least 20 psi for an emergency power outage of at least 24 hours in a pressure zone with the largest non-production pump station (i.e., a pump station that does not pump directly out of a WTP) in the pressure zone out of service, ≥ forecasted annual non-coincidental maximum day demand for that pressure zone and all downstream pressure zones.	2-Medium	Planned	1/1/2025

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
58	Document firm capacity of each pump station as the minimum of: • Pumping capacity with largest pump out of service. • Feasible capacity of discharge transmission line. • Feasible capacity of supply transmission line.	2-Medium	Planned	1/1/2025
59	High service pump station and transmission main from Handcox WTP to NWB pressure zone.	3-Low	Planned	1/1/2025
60	Expand Davis Medium Service PS and construct a parallel Davis Medium Service TM to the Central Pressure Zone.	3-Low	Planned	10/30/2035
61	Construct parallel transmission main from the river crossing near Parker/Woodland to Pilot Knob Reservoir.	3-Low	Planned	1/1/2025
62	New Elevated Storage Tank in SWB pressure zone.	1-High	Planned	3/31/2027
63	Maintain available elevated storage capacity equal to the storage needed for equalization plus emergency (fire flow) storage with one elevated tank per major pressure zone out of service.	1-High	Planned	1/1/2025
64	Develop guidance to trigger messaging on conservation and emergency water use restrictions based on system storage.	1-High	Implemented	
65	Expand cellular backup system to more locations and increase MPLS data throughput capacity.	1-High	Implemented	
66	Establish a central license server to host Webspace licenses that can be manually allocated to each facility as needed.	1-High	Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
67	Establish separate MPLS connection for VPN access (existing primary and secondary sites would remain backups for VPN access).	1-High	Implemented	
68	Extend the SCADA network further into existing facilities to provide monitoring and data collection for all major equipment including chemical storage and usage, power metering, and vendor equipment packages.	1-High	Underway	1/1/2025
69	Move security cameras to a dedicated cellular network to preserve SCADA network bandwidth.	1-High	Planned	1/1/2025
70	Develop analytic capabilities to provide real-time water distribution insights from operational data and AMI meters.	1-High	Implemented	
71	Evaluate Standard Operating Procedures for severe winter weather for distribution facilities.		Implemented	
72	Develop written winter storm SOPs for all wastewater treatment facilities.		Implemented	
73	Develop written winter storm SOP for wastewater collection system, specifically identifying overflow points and critical lift stations.		Implemented	
74	Coordinate with power providers to identify "critical water facilities" in accordance with SB3.		Implemented	
75	Collaborate with AE to add third electric feed to Ullrich WTP and enable automatic switching capability.		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
76	Store strap-on boot spikes at treatment plants to walk on icy/slippery areas.		Implemented	
77	Add low level lockouts and remote override at pump stations.		Implemented	
78	Purchase and utilize tire chains for select AW vehicles, and conduct trainings for installing tire chains and driving in icy/snowy condition.		Implemented	
79	Authorize TxTags for high priority fleet vehicles and develop plan for utility-wide implementation.		Implemented	
80	Continue installing Advanced Metering Infrastructure (AMI) meters for entire AW System.		Underway	12/31/2025
81	Conduct in-house training annually to meet department training requirements, and track conducted training.		Implemented	
82	Develop IMT depth to a minimum of three members at each identified position. Review IMT depth annually and expand as needed.		Implemented	
83	Implement reporting and accountability process annually to ensure full compliance with AW training and response requirements.		Underway	9/30/2023
84	Evaluate options for developing fleet assets that enhance response capabilities during emergency conditions.		Implemented	
85	Clarify the Public Information Officer role within the Incident Management Team, which includes strategic decisions on		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
	communications messaging.			
86	Conduct emergency response plan-related exercises that incorporate the ICS structure and use scenarios to test the communications area of the response in ways that are not easily anticipated.		Implemented	
87	Provide AW Communications staff at the City of Austin's Joint Information Center during emergency operations to help close information gaps and coordinate communications.		Underway	3/31/2023
88	Identify Communications staff to serve multiple shifts during emergency activations and additional AW staff who can support communication activities during emergency activations.		Implemented	
89	Include the Public Information Officer in IMT command meetings to develop updates which reflect potential uncertainty in future developments to accelerate communication releases.		Implemented	
90	Set the schedule for updates during an emergency based on a "planned transparency" approach to releasing information to media and the public that is synchronized with the news cycle.		Implemented	
91	Create a real time outage map on the AW website which displays water outages during normal operations and emergency conditions.		Implemented	
92	Conduct media training for staff who will represent AW in media interviews, press conferences, public meetings or similar roles during an emergency.		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
93	Develop standard operating procedures for using the Warn Central Texas notification system, notifications through the My ATX Water customer portal, and the Department of Homeland Security's Integrated Public Alert & Warning System (IPAWS).		Implemented	
94	Complete training of AW Communications staff to be familiar with the use of the IPAWS emergency alert system.		Implemented	
95	Enhance outreach prior to Winter 2021-2022 to demonstrate lessons learned during Winter Storm Uri.		Implemented	
96	Elevate visibility of winter weather prep information on the AW website.		Implemented	
97	Develop an outreach plan and materials for multifamily property management companies, tenant associations, and property managers.		Implemented	
98	Share more information with employees during emergency operations and include internal communications as part of overall emergency incident activities.		Implemented	
99	Designate staff to develop internal communications materials during each IMT shift.		Implemented	
100	Implement a streamlined communications plan during emergencies that emphasizes single points of contact and advanced coordinated efforts when practical and possible.		Implemented	
101	Repairs of all winter storm damage at Ullrich, Davis and Handcox water treatment plants. Examples of repairs include		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
	broken piping, broken valves, cracked basins, and damaged chemical feed systems.			
102	Repairs of all winter storm damage at South Austin Regional, Walnut Creek and Hornsby Bend wastewater treatment plants.		Implemented	
103	The remote wastewater treatment facilities have repaired generators and automatic transfer switches, including staging a portable generator until the permanent generator is installed. Other equipment issues have been addressed through repairs and/or acquiring inventory of replacement parts. Tire chains have been added to the fleet to assist with access issues.		Implemented	
104	Heaters, sand and deicing fluid has been procured to assist with future winter storm response.		Implemented	
105	Preventive maintenance procedures have been updated to more thoroughly inspect components that were impacted by the storm.		Implemented	
106	Insulation of all exposed piping is substantially complete, with full completion anticipated by the end of 2021.		Implemented	
107	Supplies have been purchased to enhance staff preparedness while sheltering in place at treatment plants during emergencies. Supplies include cots, bedding, hygiene products, potable water and ready-to-eat meals.		Implemented	
108	Electricians are now stationed at Ullrich WTP during normal business hours, and a plan has been developed to station		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
	electricians at other treatment plants.			
109	Automatic power transfer switches have been replaced at Texas Plume and Scotland Wells wastewater lift stations which experienced SSOs as a result of power failures during the storm.		Implemented	
110	At Texas Plume and Scotland Wells lift stations, valves were added to lines that drain groundwater that will automatically close when power is lost.		Implemented	
111	Repairs of winter storm damage at Cliffs over Lake Austin and Westpark lift stations were completed.		Implemented	
112	Updated winter storm preparedness and response messaging has been developed for implementation in future winter storm scenarios.		Implemented	
113	Meter box keys and hose bib covers have been received for distribution to community members.		Implemented	
114	A public-facing winter weather preparedness guide has been developed and translated into five languages.		Implemented	
115	Warn Central Texas notifications have been incorporated into communications tactics, including use during all water, wastewater and employee safety-related emergencies.		Implemented	
116	Use of My ATX Water customer portal for emergency notifications has been incorporated into messaging plans.		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
117	AW's Emergency Response Plan has been revised to include an Extreme Cold Weather Plan.		Implemented	
118	Additional tire chains have been procured for treatment plant and field service vehicles that would be active in a winter emergency response.		Implemented	
119	Three additional FTEs in the Emergency Management Division are included in AW's approved FY 2022 budget to focus on emergency response, preparedness, resiliency and community engagement.		Implemented	
120	ICS in-person training sessions are scheduled to resume beginning November 2021.		Implemented	
121	New processes to track ICS training and IMT depth have been launched.		Implemented	
122	One potable water delivery truck has been delivered and a second truck is pending delivery; both trucks will be commissioned by the end of 2021 to provide bulk water delivery to the community.		Implemented	
123	AW maintains an inventory of 275-gallon refillable water totes and fire hydrant adapter kits that can be deployed in case of water outages.		Implemented	
124	AW has increased its inventory of bottled water for distribution in case of water outages.		Implemented	

Number	Recommendation	Priority	Reported Status	Estimated Completion Date
125	AW collaborated with City of Austin Purchasing on a solicitation to establish a contract for local bottled drinking water to be used during water emergencies; the contract was executed in October 2021.		Implemented	
126	A script has been developed for routing wholesale customers' calls to appropriate AW staff, and the script has been provided to dispatch staff.		Implemented	
127	A schedule for annual valve exercises on emergency interconnect valves between AW and wholesale customer infrastructure has been established and execution has begun.		Implemented	
128	AW has initiated a quarterly newsletter to wholesale customers and holds regularly scheduled phone calls to each wholesale customer.		Implemented	

Table 5: February 2022 High Turbidity Event AAR Recommendations, April 2022

Number	Recommendation	Timeline	Reported Status	Estimated Completion Date
1	Review of "lead" responsibilities with staff.	Immediate	Implemented	
2	Provide additional oversight and quality review of daily status reports and updates to Facility Status comments in Veoci by 10 AM every day.	Immediate	Implemented	
3	Preparation and distribution of concise 2-page "Operations Parameters and Action Levels" document.	Immediate	Implemented	

Number	Recommendation	Timeline	Reported Status	Estimated Completion Date
4	Training by staff on "Operations Parameters and Action Levels" document. Have staff sign off as they are being trained to maintain record of training.	Immediate	Implemented	
5	Define and document Roles and Responsibilities of Ops roles (Driver, Labs, Outs/Station Checks, and Leads) - once finalized, save in a location that can be used to onboard new staff and as reference for existing staff. Have staff sign off as they have reviewed to maintain record of acknowledgement.	Immediate	Implemented	
6	Roll out of Operations Knowledge Management / Knowledge Transfer training documents.	Immediate	Implemented	
7	Review of 4th operator possibility - roles/responsibilities - staffing needs.	Immediate	Implemented	
8	Review of revised organizational structure for Ops.	Immediate	Implemented	
9	Identify additional maintenance training (pumps; chlorinators/ammoniators; pump packing; lifting/rigging).	Immediate	Implemented	
10	Prepare updated formalized operations training plan that outlines training expectations for existing and new staff.	Near Term	Implemented	
11	Enable external notification (text and email) of alarms for clearwell turbidity exceedances.	Immediate	Implemented	
12	Confirm standardization of all turbidity alarms across process.	Immediate	Implemented	
13	Enable automatic backwashing and backwash anticipation of	Long Term	Underway	12/31/2025

Number	Recommendation	Timeline	Reported Status	Estimated Completion Date
	filters for turbidity trigger.			
14	Implement automatic shutdown of filter(s) for turbidity exceedances.	Long Term	Underway	12/31/2025
15	Review and update basin seeding improvements scope in upcoming Process Drain and Support Systems Capital Improvements Plan (CIP) project.	Immediate	Implemented	
16	Identify Supervisory Control and Data Analysis (SCADA) alarms that should be eliminated.	Immediate	Implemented	
17	Limit staff access to change trigger limits and setpoints.	Immediate	Implemented	
18	Identify alarms needed for elevated conditions.	Near Term	Implemented	
19	Disable manual operation of thickener pump to seed a basin to only allow for thickener pump to be on a 4-hour timer.	Immediate	Implemented	
20	Incorporate additional improvements with basin seeding in upcoming Process Drain and Support Systems Capital Improvements Plan (CIP) Project.	Long Term	Planned	12/31/2024
21	Add alarms or pop ups to continue to alarm staff if certain conditions exist - Identify items to add.	Near Term	Implemented	
22	Add pop up to Supervisory Control and Data Analysis (SCADA) computer to inform operators when seeding is occurring.	Near Term	Planned	12/31/2024
23	Review whether existing Supervisory Control and Data Analysis (SCADA) systems matches "state of the art" technology.	Near Term	Implemented	

Number	Recommendation	Timeline	Reported Status	Estimated Completion Date
24	Reinforcement of calling Supervision when issues arise.	Immediate	Implemented	
25	Provide remote Supervisory Control and Data Analysis (SCADA) read-only access for all WTP Superintendents, Supervisors, and process engineers.	Immediate	Implemented	
26	Purchase licenses to allow for additional access to Read-Only Supervisory Control and Data Analysis (SCADA).	Immediate	Implemented	
27	No manual seeding of basin is allowed. A pump timer must be set when you are seeding a basin.	Immediate	Implemented	
28	Set expectations for Superintendent/Supervisor monitoring of operations, especially during weather events.	Immediate	Implemented	
29	Communication of expectations for passdown time attendance and completeness of notes.	Immediate	Implemented	
30	Prepare, roll out, and monitor enhanced End of Shift Reports.	Immediate	Implemented	
31	Define limits of direction from Pumping for pump changes at all plants.	Near Term	Implemented	
32	Update Standard Operating Procedures to address basin seeding using a timer.	Immediate	Implemented	
33	Update format/presentation of all Electronic Operation & Maintenance manuals and Standard Operating Procedures.	Near Term	Underway	12/31/2023
34	Operations (process engineers and plant management) to gain access to Electronic Operation & Maintenance Manual and take responsibility for Standard Operating Procedure	Immediate	Implemented	

Number	Recommendation	Timeline	Reported Status	Estimated Completion Date
	updates.			
35	Conduct Advanced ICS training; ICS-400 for AW Executives and others.	Near Term	Implemented	
36	Increase IMT roster depth at select positions (IC/Dep. IC/LOFR) and maintain minimum staffing at 3 per IMT position.	Near Term	Implemented	
37	Obtain media streaming/cable access for local and national weather and news.	Long Term	Implemented	
38	Conduct ongoing ICS and VEOCI user training.	Long Term	Implemented	

Appendix 2-C Summary of Social Media Posts

LEGEND	
# Posts	The total number of individual posts on the account, one post may include several languages
# Post p/Language	The total number of messages per language, they were not necessarily published as standalone posts
E	English
S	Spanish
C	Chinese
F	French
B	Burmese
H	Hindi
V	Vietnamese
K	Korean
A	Arabic

Event	Date	Facebook		Twitter		Instagram	
		# Posts	# Post p/Language	# Posts	# Post p/Language	# Posts	# Post p/Language
Flooding - Boil Water Notice Date: 10/22/2018	10/21/2018	1	E:1	2	E:2	1	E:1
	10/22/2018	6	E:6	7	E:6|S:1	3	E:3
	10/23/2018	3	E:3	5	E:4|S:1	3	E:2|S:1
	10/24/2018	5	E:5	4	E:4	2	E:2
	10/25/2018	2	E:2	2	E:2	2	E:2
	10/26/2018	2	E:2	2	E:2	1	E:1
	10/28/2018	5	E:4|S:1	6	E:5|S:1	2	E:2
	10/30/2018	2	E:2	2	E:2	2	E:2
Totals		26	E:25|S:1	30	E:27|S:3	16	E:15|S:1
Zebra Mussels - Taste and Odor Date: 02/06/2019	2/7/2019	1	E:1	2	E:2	0	-
	2/8/2019	0	-	1	E:1	0	-
	2/9/2019	1	E:1	1	E:1	0	-
	2/10/2019	0	-	1	E:1	0	-
	2/11/2019	1	E:1	1	E:1	0	-
	2/12/2019	1	E:1	1	E:1	2	E:2
	2/13/2019	2	E:2	2	E:2	2	E:2
	2/14/2019	1	E:1	1	E:1	1	E:1
Totals		7	E:7	10	E:10	5	E:5
Uri Storm -	2/16/2021	4	E:3|S:1	2	E:2|S:1	1	E:1

Event	Date	Facebook		Twitter		Instagram	
		# Posts	# Post p/Language	# Posts	# Post p/Language	# Posts	# Post p/Language
Boil Water Notice Date: 02/17/2021	2/17/2021	6	E:5|S:1	8	E:6|S:2	5	E:5
	2/18/2021	8	E:7|S:2|V:1|C:1|A:1	5	E:4|S:1	2	E:1|S:1
	2/19/2021	9	E:9	11	E:11	4	E:4
	2/20/2021	9	E:9	6	E:6	7	E:7
	2/21/2021	10	E:9|S:1	8	E:8	7	E:7
	2/22/2021	4	E:4	6	E:6	4	E:4
	2/23/2021	3	E:3	7	E:6|S:2|V:1|C:1	8	E:7|S:2|V:1|C:1
Totals		53	E:49|S:5|V:1|C:1|A:1	53	E:49|S:6|V:1|C:1	38	E:36|S:3|V:1|C:1
Operational Error - Boil Water Notice Date: 02/05/2022	2/5/2022	7	E:1|S:1|H:1|B:1|C:1|F:1|K :1	2	E:1|S:1	7	E:1|S:1|H:1|B:1|C:1|F:1|K:1
	2/6/2022	10	E:10	7	E:7	6	E:6
	2/7/2022	3	E:3	3	E:3	3	E:3
	2/8/2022	11	E:6|S:1|K:1|A:1|V:1|B:1	11	E:6|S:1|K:1|A:1|V:1|B:1	11	E:6|S:1|K:1|A:1|V:1|B:1
	2/15/2022	1	E:1	1	E:1	1	E:1
Totals		32	E:21|S:2|V:1|C:1|A:1|H:1|K:2|B:2|F:1	24	E:18|S:2|K:1|A:1|V:1|B:1	28	E:17|S:2|V:1|C:1|A:1|H:1|K:2|B:2|F:1

Appendix 2-D Review of Water Quality Data

2-D.1 Review of Ullrich WTP Intake Water Quality

Drinking water plants are designed using processes that are best suited to treat the plant's water source. As designed, the lime softening/conventional filtration process used by Ullrich WTP is well chosen to treat the moderately hard, high alkalinity water of the Lake Austin source. However significant changes in raw water quality may create conditions which can challenge or exceed the capabilities of Ullrich WTP. Several raw water quality parameters are critical for the performance of Ullrich WTP. These include source (intake) water quality parameters:

- Turbidity measured as nephelometric turbidity units or NTU
- Total Organic Carbon or TOC, measured as mg/L C
- pH, measured as standard units
- Hardness, measured as mg/L $CaCO_3$
- Alkalinity, measured as mg/L $CaCO_3$

This evaluation covers a 22 plus year timespan ranging from January 2000 to May 2022 for turbidity or a 12 plus year timespan ranging from January 2011 to May 2022 for the other parameters. These timespans are sufficient to identify any ongoing changes in source water quality. The analysis is based on data files provided AW for Ullrich WTP intake (File names, Ullrich intake-Horizon LIMS and Ullrich-intake_old _LIMS). It should be noted that daily data were not available for every parameter evaluated.

Intake Water Turbidity

Data Summary

Figure 1 plots Ullrich WTP intake water turbidity from January 2000 to May 2022. During this period turbidity averaged 4.2 NTU with occasional turbidity spikes. Four spikes in the turbidity of 100 NTU or greater occurred since 2010. These spikes peaked on:

- 9/8/2010, 115 NTU
- 10/31/2013, 125 NTU
- 10/23/2018, 199 NTU
- 1/31/2019, 117 NTU

During the period between 2000 and the start of 2010, turbidity spikes never exceed 100 NTU and only one turbidity spike exceed 50 NTU (6/5/2003, 52.1 NTU).

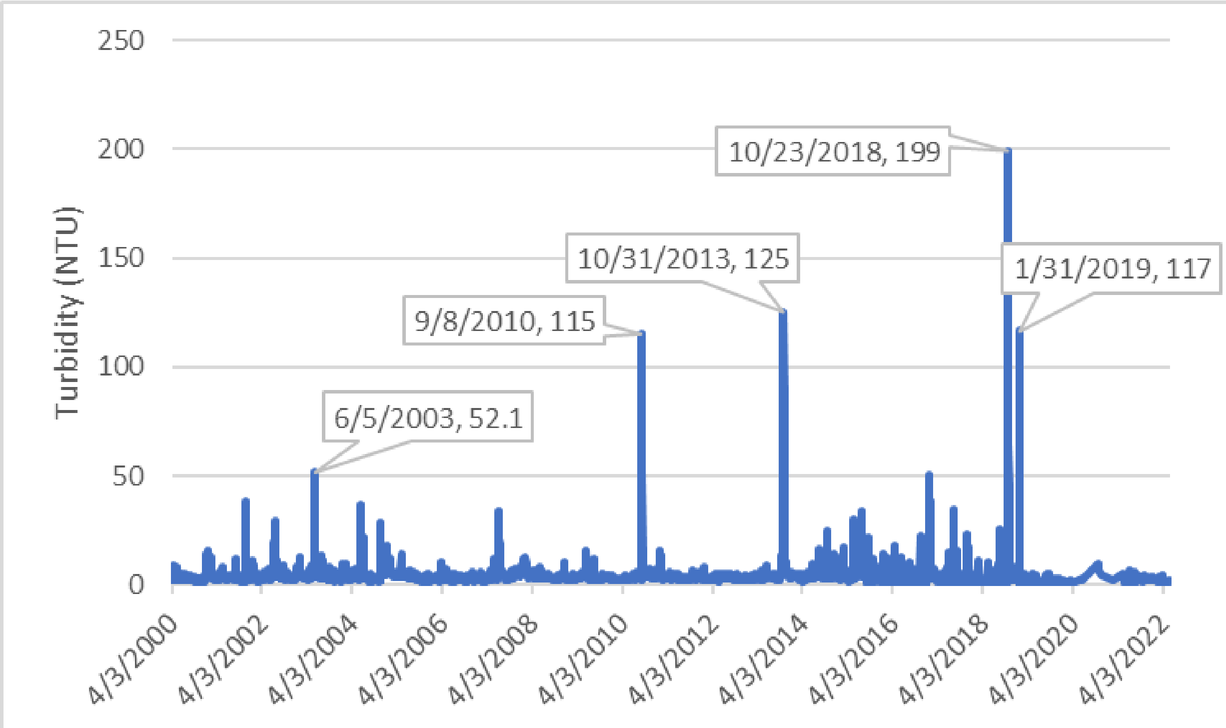


Figure 1 Ullrich Intake Turbidity

Data Assessment

Figure 2 is a cumulative probability distribution of all raw water turbidity values collected between January 2000 and May 2022. Note that the second graph in the figure provides a more detailed view of the left-hand portion of the distribution. A cumulative probability distribution defines the chance that a value in a distribution (in this case, the distribution is all measured turbidity values between 2000 and 2022) is at or less than a certain value. When derived from a large data set, a cumulative probability distribution can be assumed to predict the likelihood that that a water quality parameter will be a certain value in the future. Because water quality parameters naturally vary over a range of values, this type of analysis is useful in determining the frequency a particular water quality will need to be treated by a treatment plant. This knowledge is particularly valuable when evaluating the performance of Ullrich WTP because the softening process used at Ullrich WTP depends on water quality parameters remaining within a certain range for the process to be effective.

Referring to the upper graph in Figure 2, the exceptional nature of the October 2018 flood event is obvious. The turbidity value of 199 NTU was considerably greater than the next highest unrelated turbidity spike of 125 NTU in October of 2013. Because carbonate alkalinity was drastically depressed by the rain event, the chemical softening process at Ullrich WTP was circumvented, contributing to the raw water turbidity challenge.

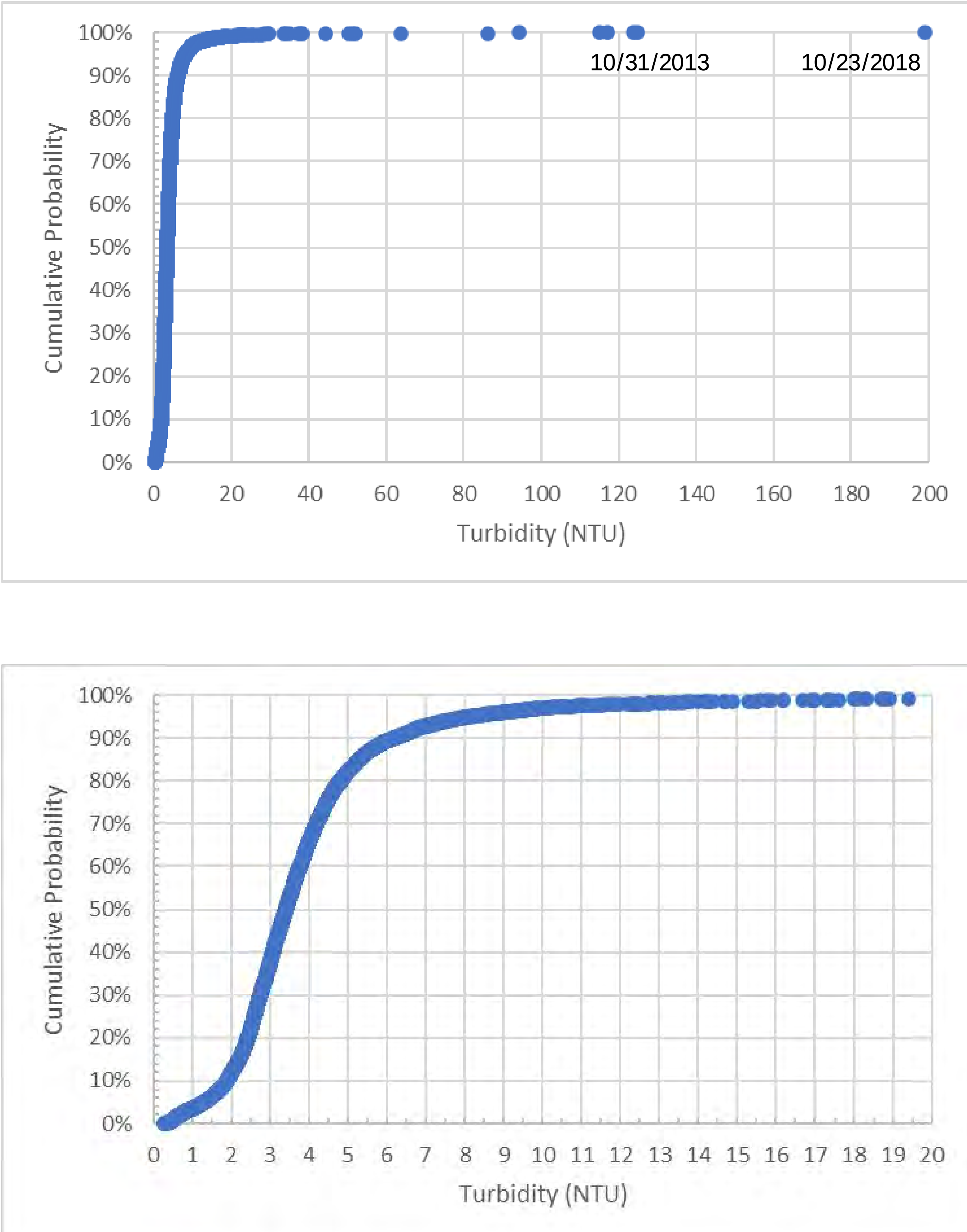


Figure 2 Cumulative Probability Diagrams for Ullrich Intake Turbidity

Referring to the lower graph in Figure 2, 99% of the turbidity readings were less than 20 NTU and 90% were less than 6 NTU. In other words, based on data collected since 2000, AW can anticipate that for 90% of the time, intake turbidity will not exceed 6 NTU and for 99% of the time it will not exceed 20 NTU. Conversely, for 1% of the time turbidity measured at the intake can be expected to exceed 20 NTU.

According to the *Water Forward* plan, the Austin climate is characterized by hot, humid summers, and mild winters, with occasional intense storms. These storms interact with the watershed to produce turbidity spikes and other changes in water quality which are challenging for Ullrich WTP. A statistical analysis, (t-test for two-sample sets assuming equal variance) comparing overall intake turbidity levels for 2000 - 2010 and 2010 - 2022 indicated that there was not a statistically significant difference in overall intake turbidity values between these two time periods at a 95% confidence level. However, as noted above all turbidity events exceeding 100 NTU (per Figure 2 with a probability of occurrence of approximately 0.1% of the time) have happened since 2010.

Intake Total Organic Carbon

Data Summary

Figure 3 plots Ullrich WTP intake TOC from January 2011 to May 2022. During this period TOC averaged 3.9 mg/L C with occasional TOC spikes, which coincide with turbidity spikes in the intake water. Four spikes in TOC of 7 mg/L C or greater occurred since 2011. These spikes peaked on:

- 1/8/2014, 12.7 mg/L C (questionable value)
- 5/18/2020, 8.1 mg/L C
- 10/24/2018, 7.8 mg/L C
- 11/1/2013, 7.6 mg/L C

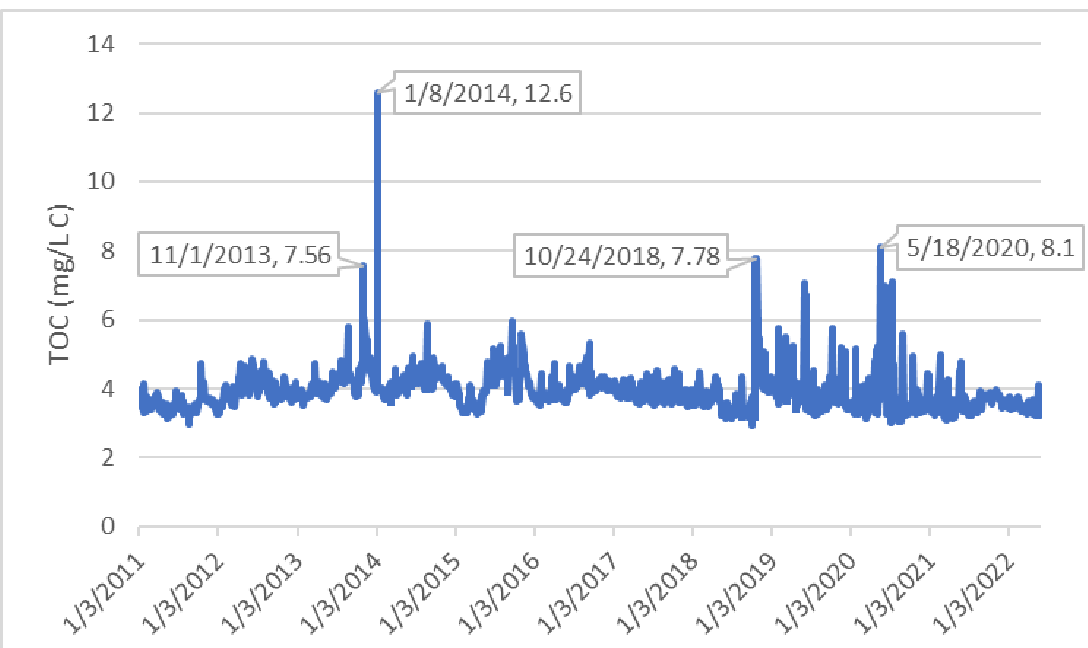


Figure 3 Ullrich Intake Total Organic Carbon

Data Assessment

Total organic carbon (TOC) measure of the amount of organic carbon contained in a water sample. In drinking water sources, TOC almost exclusively consists of natural organic matter (NOM). NOM is formed from the natural decomposition of plant material, algae and bacteria in the watershed and water column.

In reviewing Figure 3, it is important to note the increased variability in TOC values following the October 2018 flood event. Despite this increased variability, the average TOC concentration before and after the flood has remained the same (3.9 vs. 3.8 mg/L C). It is possible the flood impacted portions of the watershed, changing surface overflow rates and consequently how NOM entered the source water without changing the total amount NOM entering the water.

Referring to Figure 4, TOC in the intake water is fairly constant, remaining within the range of 3 to 4.5 mg/L C for approximately 95% of the time. A TOC concentration of 3-5 mg/L C is typical for surface waters. Also note that given other raw water quality parameters were nominal on 1/8/2014, it is likely that the 100% cumulative probability value of 12.7 mg/L C ivalue observed during this period. As a point of comparison, the turbidity on 5/18/2202 was 8.1 NTU, which is a 95th percentile turbidity water.

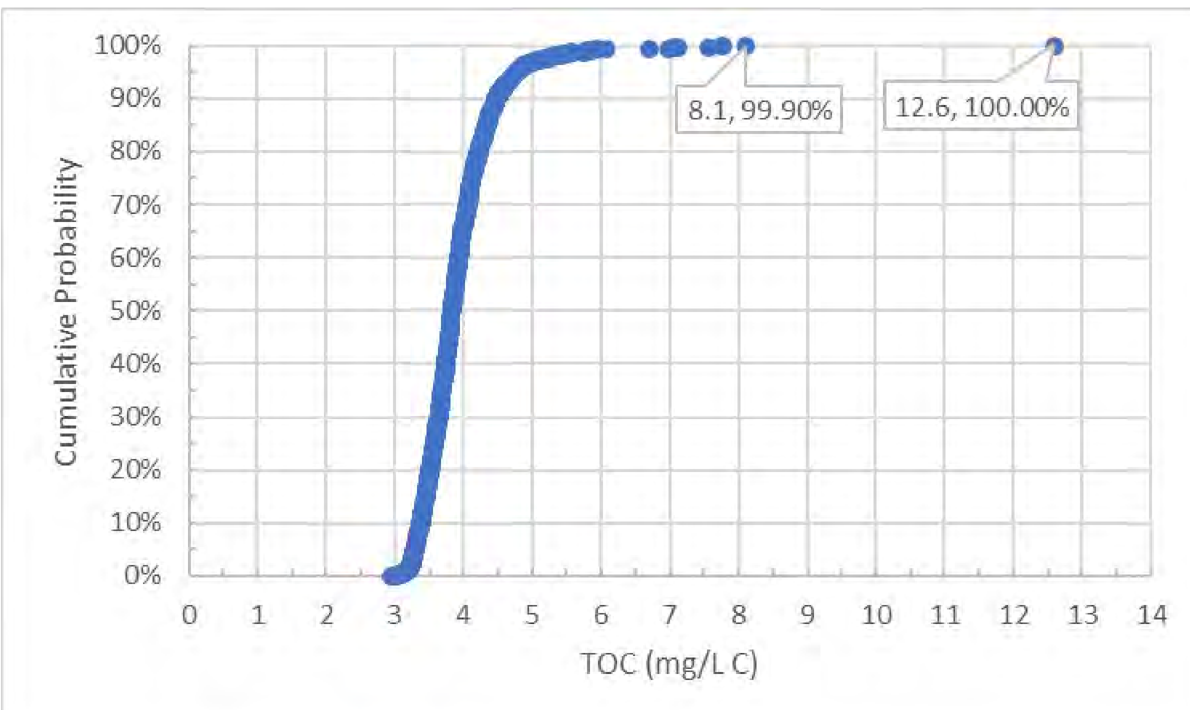


Figure 4 Cumulative Probability Diagram for Ullrich Intake TOC

Intake pH

Data Summary

Figure 5 plots Ullrich WTP intake pH from January 2011 to May 2022. During this period pH averaged 8.15 pH units.

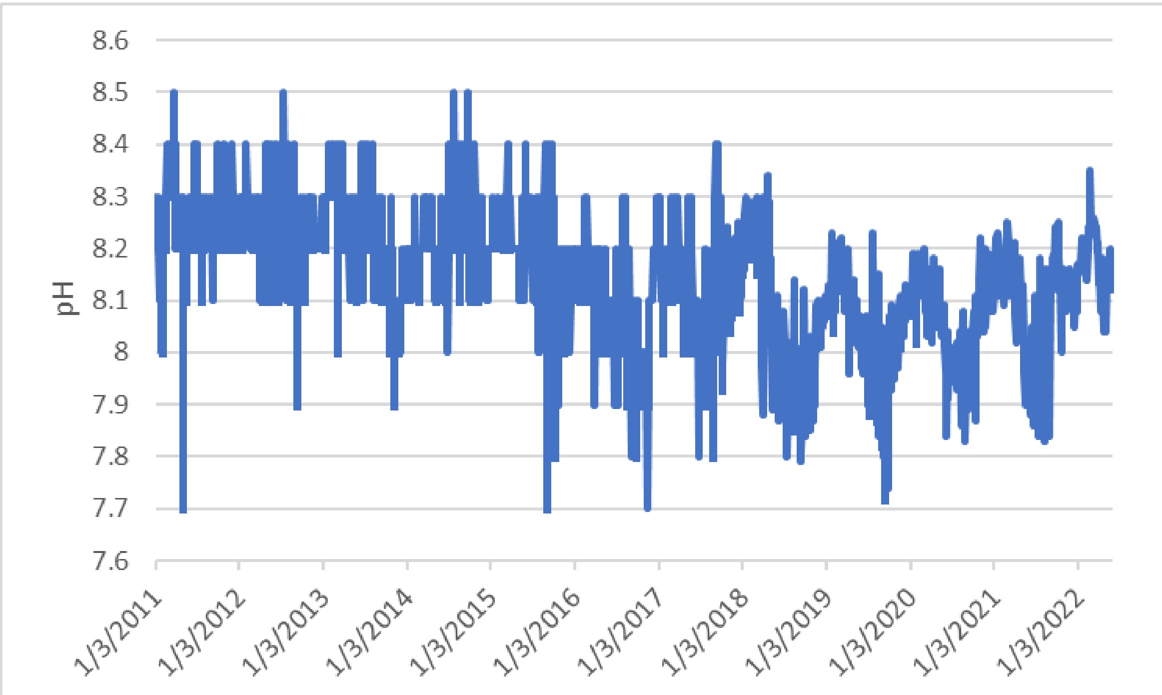


Figure 5 Ullrich Intake pH

Data Assessment

Although the intake pH looks quite variable in Figure 5, the difference between minimum and maximum pH measured during this period was only 0.8 pH units. Given pH will naturally vary both seasonally and diurnally, a range of 0.8 pH units is not exceptional. However, in mid-2018 average pH dropped suddenly by about 0.2 pH units and has been slowly increasing since that time. However, this small change in pH is inconsequential relative to the operation of Ullrich WTP.

Intake Hardness

Data Summary

Figure 6 plots Ullrich WTP intake hardness from January 2011 to May 2022. During this period hardness averaged 199 mg/L $CaCO_3$ with occasional hardness spikes above 250 mg/L $CaCO_3$. Of greater concern are the 'dips' when hardness decreases. Three dips are dramatic:

- 11/1/2013, 144 mg/L $CaCO_3$
- 10/22/2018, 88 mg/L $CaCO_3$
- 1/31/2019, 98 mg/L $CaCO_3$

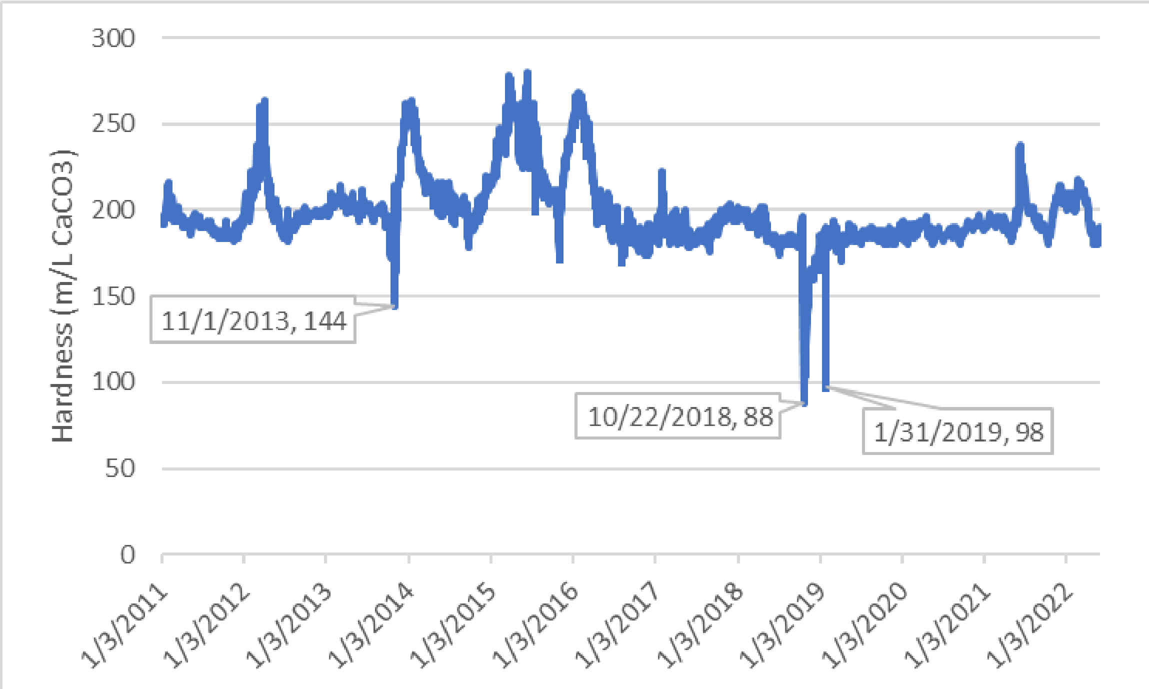


Figure 6 Ullrich Intake Hardness

Data Assessment

The Ullrich treatment process is designed to remove hardness from the Lake Austin source through a lime softening process. As described in the main body of this report, the softening process removes hardness by precipitating calcium from the source water to form solids which are then removed from the water using up-flow clarifiers and filters. In other words, the treatment process depends on the intentional precipitation of solids in the clarifiers. The primary source of these solids is the calcium removed from the water. Although counterintuitive, Ullrich WTPs *needs* a certain level of hardness in its raw water to function effectively.

The dips in intake hardness, with minimum values on 10/22/2018 and 1/31/2019 of less than 100 mg/L $CaCO_3$ are conditions that are inherently difficult for a softening process to treat. This is particularly true in systems with up-flow clarifiers because effective operation is closely tied to solids production.

Figure 7 provides the cumulative probability diagram for hardness at the Ullrich intake. The long ‘tail’ on the left of the diagram are all low hardness values recorded between October 2018 and January 2019, presumably related to the 2018 flood event. The figure clearly indicates the uniqueness of the 2018 flood event in terms of water hardness. It also raises the question of if events like this will recure in the future.

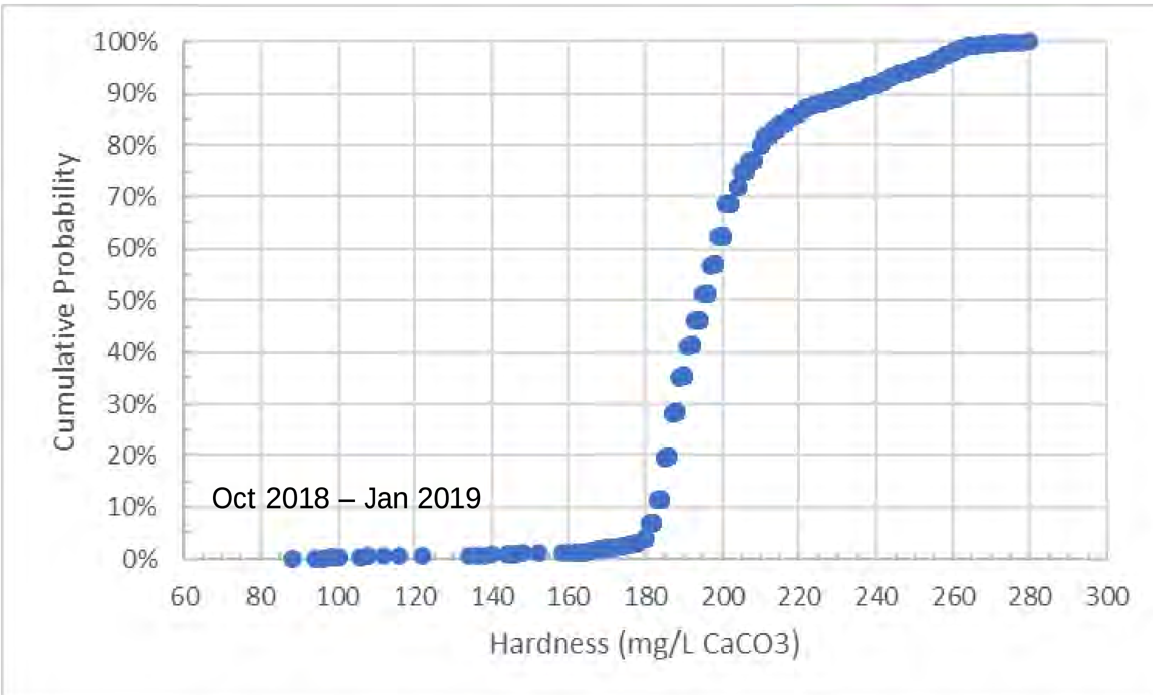


Figure 7 Cumulative Probability Diagram for Ullrich Intake Hardness

Intake Alkalinity

Data Summary

Figure 8 plots the Ullrich intake alkalinity from January 2011 to May 2022. During this period intake alkalinity averaged 170 mg/L $CaCO_3$. As would be expected, the trend in the alkalinity levels at the Ullrich intake track hardness levels, with dips in alkalinity at the same time. The lowest values occurred on:

- 11/4/2013, 139 mg/L $CaCO_3$
- 10/26/2018, 101 mg/L $CaCO_3$
- 1/31/2019, 102 mg/L $CaCO_3$

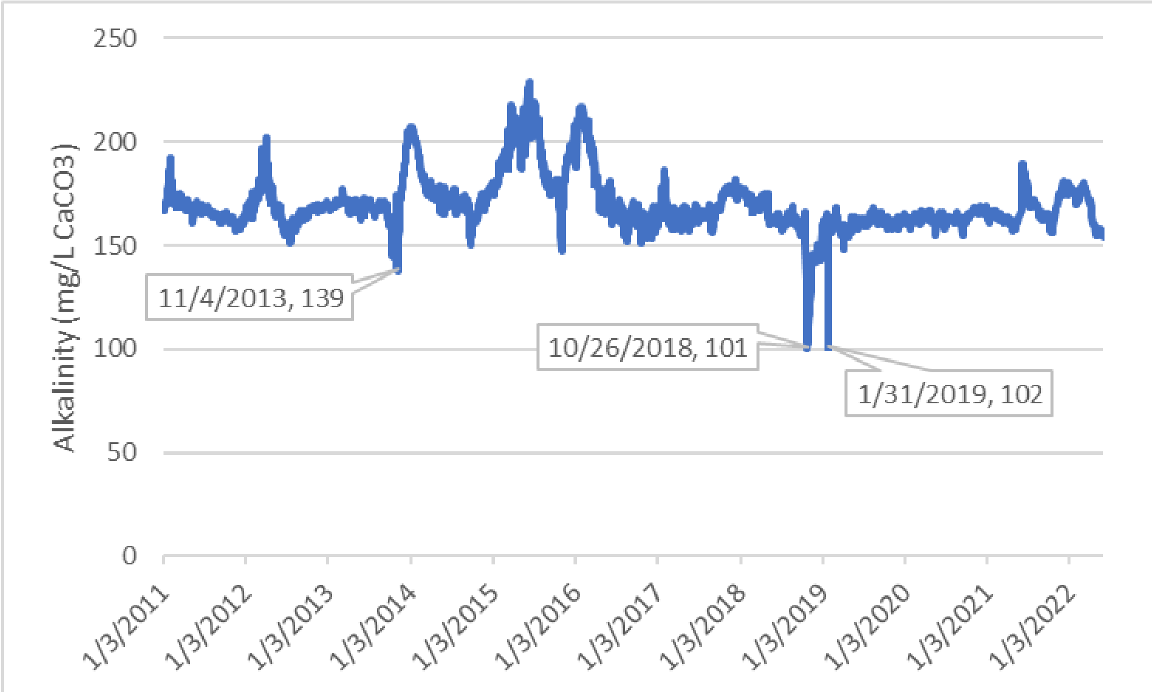


Figure 8 Ullrich Intake Alkalinity

Like hardness, the Ullrich treatment process depends on using alkalinity in the raw water to contribute carbonate to the precipitation reaction which softens the water. Also, like hardness, Ullrich WTPs *needs* a certain level of alkalinity in its raw water to function effectively.

Figure 9 provides the cumulative probability diagram for alkalinity at the Ullrich intake. The long ‘tail’ on the left of the diagram are all alkalinity values recorded between October 2018 and January 2019. Again, this figure clearly indicates the uniqueness of the 2018 flood event.

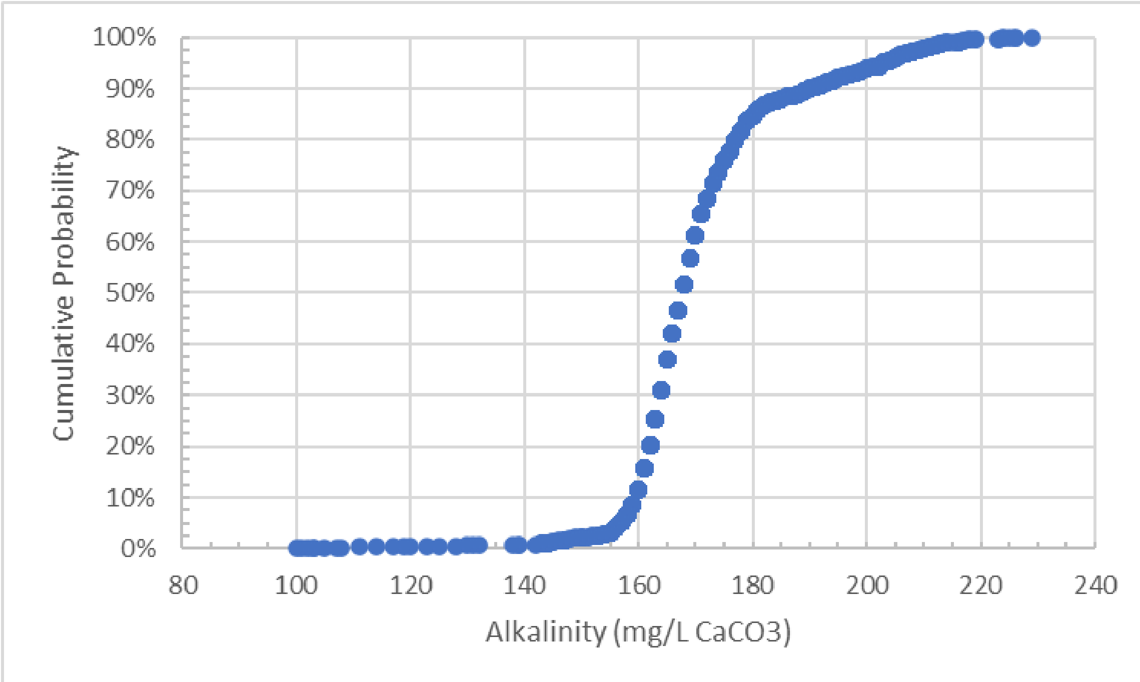


Figure 9 Cumulative Distribution Diagram for Ullrich Intake Alkalinity

The implications of low alkalinity levels on the functionality of Ullrich WTP are discussed in Appendix 2-F.

Appendix 2-D.2 Assessment of Ullrich WTP Treated Water Quality

Ullrich WTP must meet TCEQ imposed requirements in order to produce water whose quality is considered safe for the public to consume. These requirements are designed to protect the public from acute and chronic health risks associated with the consumption of treated water. Acute risks are those that are associated with a single or limited number of exposures. Acute risks typically make consumers sick within a short period of time from that exposure. From a drinking water perspective, exposure to microbial pathogens, including pathogenic viruses, bacteria and protozoa in untreated water is the primary concern. Failure to remove, disinfect or inactivate these pathogens will cause sickness and death among consumers. (This is why boil water orders must be rapidly issued). Chronic risks are those that are associated with a repeated number of exposures over an extended period. Sickness from chronic exposure may not occur until after many years of exposure. Treated water quality levels are set to manage both of these risks.

Several regulatory and non-regulatory parameters measuring treatment performance and treated water quality were used to evaluate the performance of Ullrich WTP. These included the following treated water parameters:

- Turbidity
- Microbial inactivation ratios
- TOC removal
- Disinfectant residual
- pH
- Hardness/Alkalinity
- Daily pumpage

The performance evaluation covers more than a decade of time, ranging from January 2011 to March 2022. This timespan encompasses all the events considered by this review. The bulk of the data for this analysis was derived from utility supplied Monthly Operating Reports (MORs), which AW is required to summit to TCEQ. This data was supplemented by water quality data provided to the project team by AW (File name T3 water quality data). It should be noted that daily data were not available for every parameter evaluated.

Turbidity

Data Summary

Figure 10 plots Ullrich WTP treated water turbidity as measured by the daily average of four-hour combined filter effluent (CFE) turbidity readings. Note that the two figures are identical, except the turbidity excursions are cut off in the lower graph to provide a more detailed plot of turbidity levels. With the exception of the 2019 Flood Event and 2022 Boil Water Event, turbidity levels are consistently well below regulatory requirements.

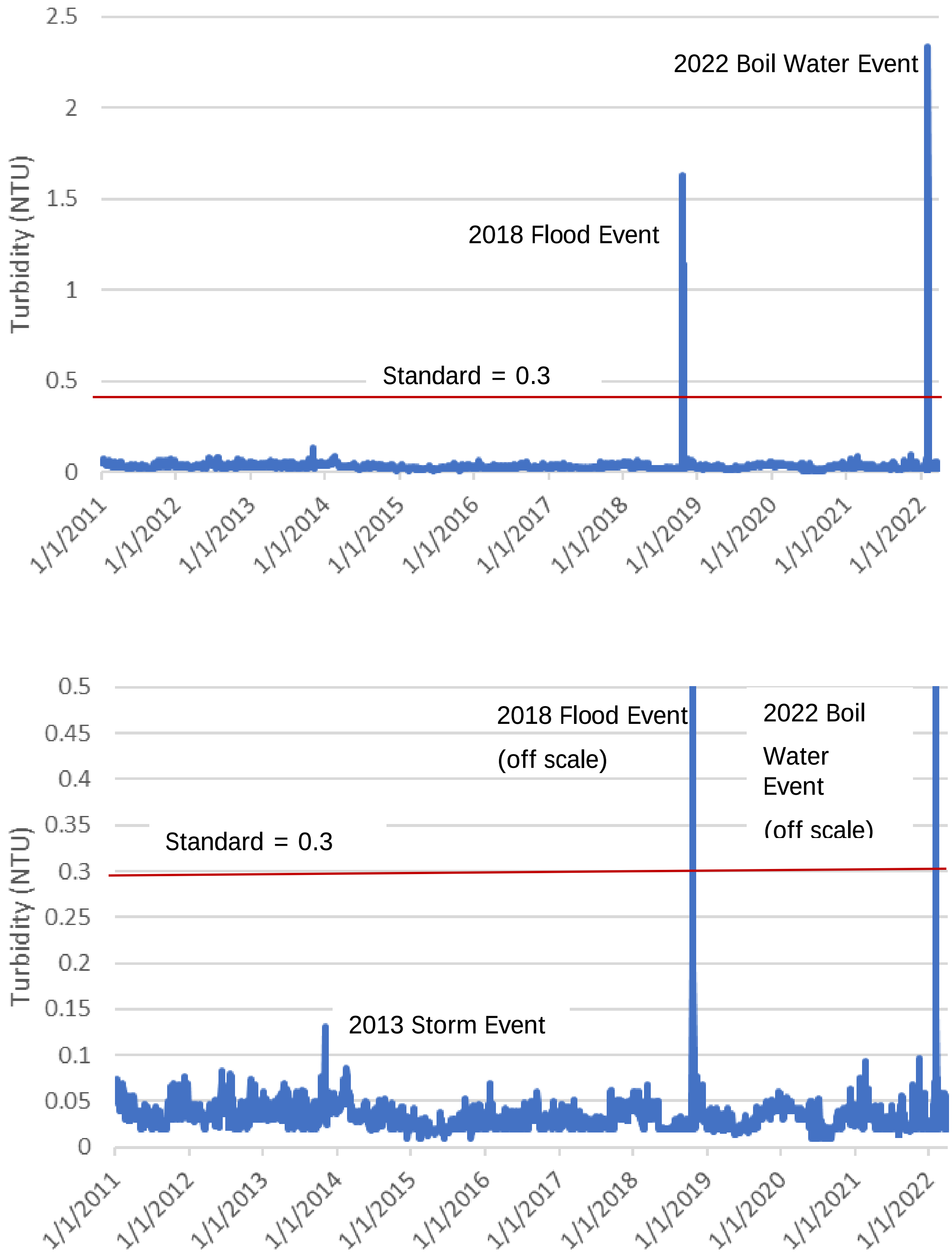


Figure 10 Ullrich WTP Daily Average Treated Water Turbidity

Figure 11 provides a histogram of the distribution of daily treated water turbidity between January 2011 and March 2022. As seen in the figure, for 3822 of 4108 days (93%) for which data is available, treated water turbidity was below 0.05 NTU, and for 4097 or 99.7% of the days during this period treated water turbidity was less than 0.1 NTU. However, there were seven days when treated water turbidity exceeded 0.3 NTU. These were October 21-25, 2018, during the 2018 flood event and February 2-3, 2022, during the 2022 Boil Water event.

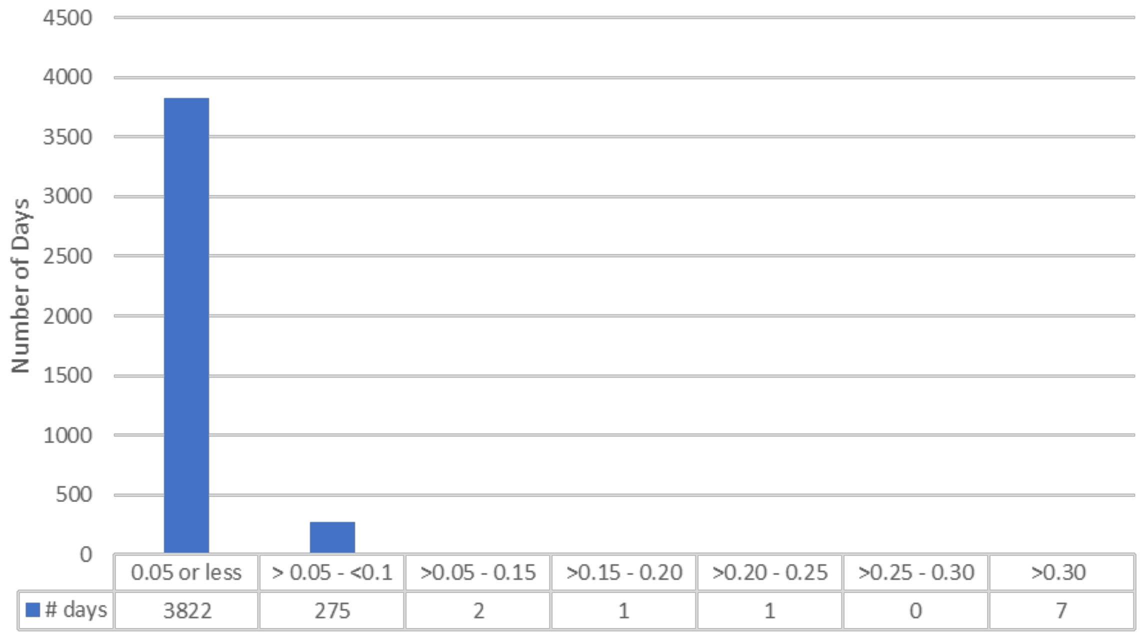


Figure 11 Distribution of Daily Combined Filter Effluent Turbidity (Bins are turbidity range in NTU)

Data Assessment

Combined Filter Effluent (CFE) turbidity, which in the context of this report is considered representative of treated water turbidity, is one of the key indicators of microbial pathogens removal and overall treatment plant performance. For this reason, treated water turbidity levels are closely regulated by TCEQ. The details of the regulation are complex; the following three conditions summarize requirements:

1) CFE turbidity must be less than or equal to 0.3 NTU for 95% of readings averaged over a four-hour period. If exceeded, at minimum public notice is required.
2) CFE turbidity averaged over a four-hour period cannot exceed 1.0 NTU. If exceeded, at minimum public notice is required.
3) CFE turbidity can never exceed 4.0 NTU. If exceeded, a mandatory boil water order is required.

In addition, AW has an internal goal of not exceeding individual filter turbidity of 0.1 NTU. Outside of the 2018 Storm and 2022 Boil Water Events, the turbidity levels produced by Ullrich WTP are excellent and far exceed TCEQ requirements. Figure 12 plots the raw water turbidity for January 2011 – March 2022 and Figure 12 and Figure 13 summarizes this data in a histogram.

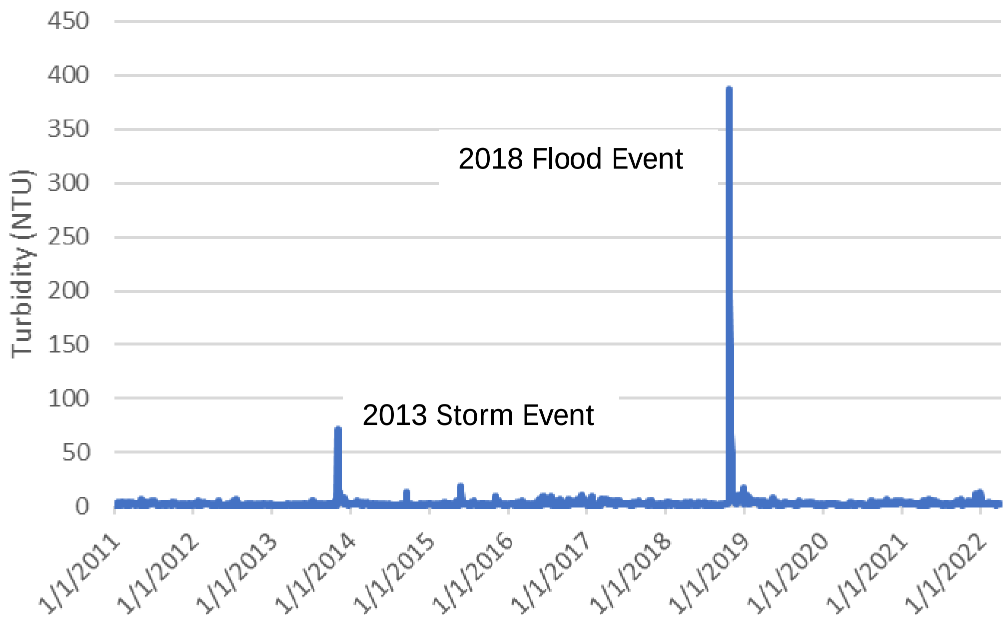


Figure 12 Ullrich WTP Average Daily Raw Water Turbidity (from MOR)[9]

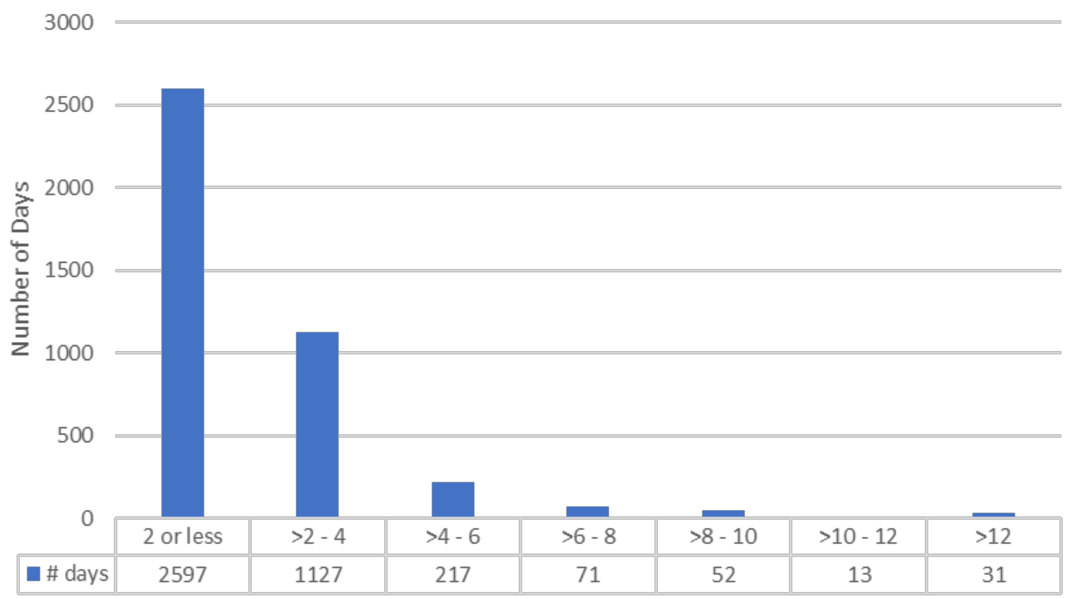


Figure 13 Distribution of Ullrich WTP Daily Average Raw Water Turbidity (Bins are turbidity range in NTU)

[9] Note that turbidity values in this section were taken from MORs submitted to TCEQ. These values may not exactly match values raw water values analyzed in Appendix 2-D, which were collected under different circumstances.

As seen in Figure 12, raw water turbidity is generally consistent with only two excursions in the past eleven years - a storm event in late October 2013 and the October 2018 flood. Otherwise, turbidity is low, with 2597 of 4108 or 63% of the days with raw water turbidity 2 NTU or less and 99% of the days in this period 12 NTU or less. Of the 31 days when turbidity exceeded 12 NTU, 27 days were associated with two events in October - November 2013 and October -November 2018:

- October - November 2013: 7 days exceeding 12 NTU
- October - November 2018: 20 days exceeding 12 NTU

As seen in Figure 10, Ullrich WTP was able to handle the October 2013 storm event, but unable to handle the October 2018 flood event. As discussed elsewhere in the report, the 2018 Flood Event conditions, with a maximum turbidity of 387 NTU, were truly unprecedented and would be challenging for any water treatment plant utilizing up-flow clarifiers. Conversely, raw water turbidity during the October 2017 storm event, with a maximum of 72 NTU, was within the treatment capability of the plant. It should also be noted that raw water turbidity during the 2022 Boil Water Event was 2 NTU and was not a contributing factor to this event.

Microbial Inactivation Ratio (IR)

Data Summary

Figure 14 and Figure 15 respectively are plots of Ullrich WTP microbial inactivation ratios (IR) for virus and protozoa (*Giardia*) on a monthly basis from January 2017 – March 2022. These figures plot both the average monthly IR and the minimum daily IR calculated during each month.

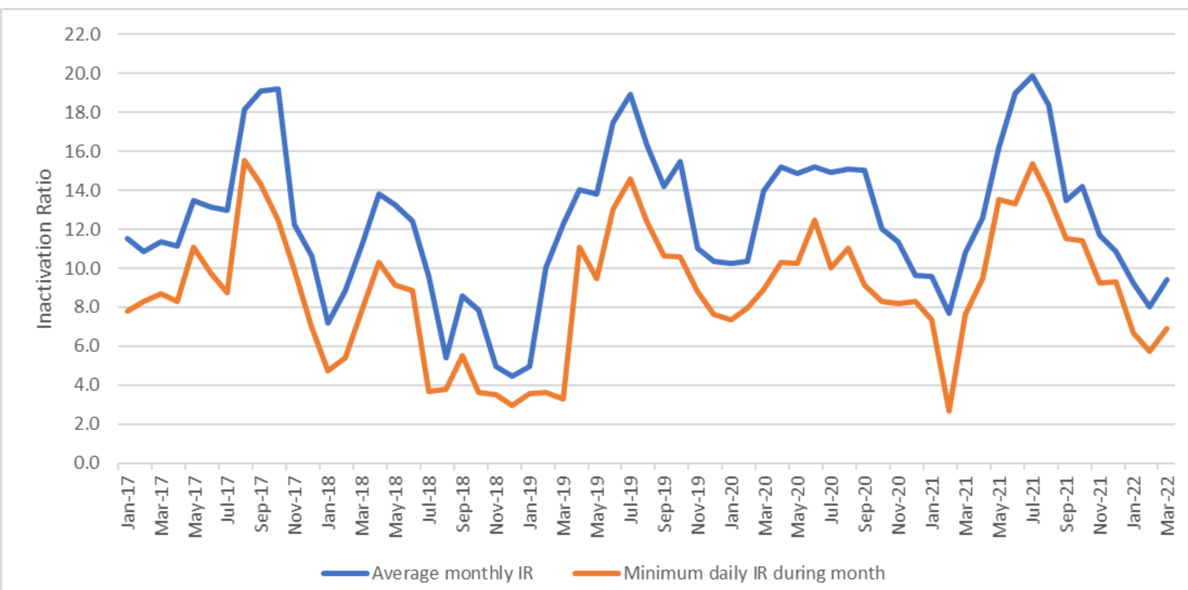


Figure 14 Ullrich WTP Viral Inactivation Ratio

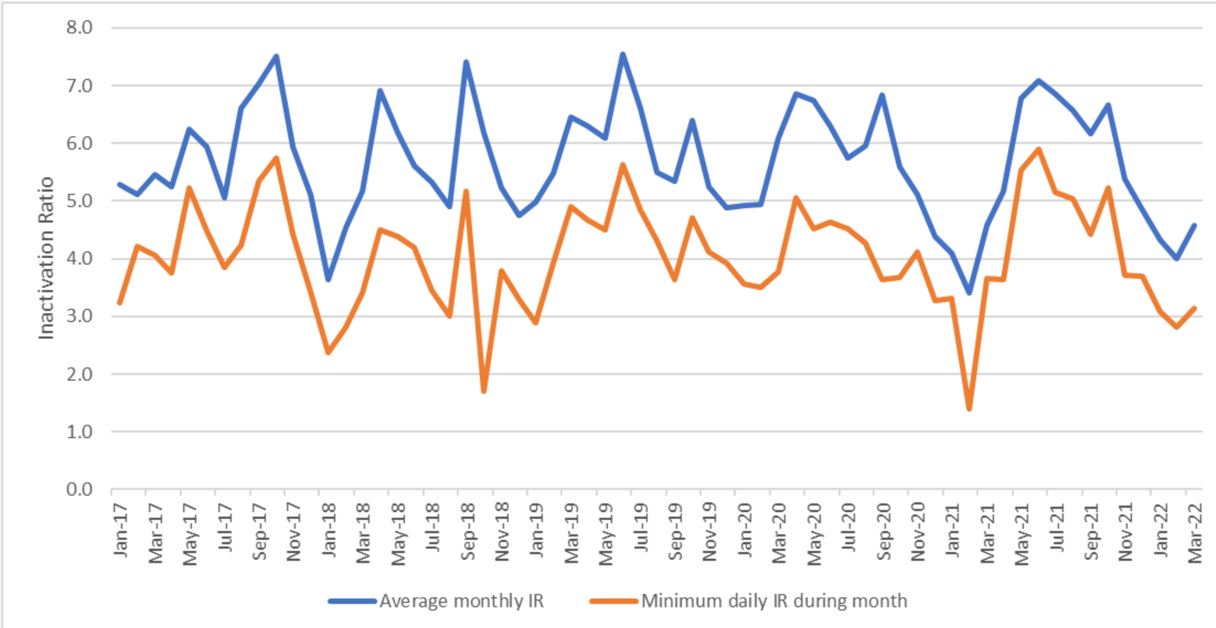


Figure 15 Ullrich WTP Giardia Inactivation Ratio

Data Assessment

Inactivation Ratio (IR) is another indicator of microbial pathogen control at drinking water plants. Specifically, the IR is a mathematical calculation of the microbial disinfection or inactivation achieved in the plant, compared to the level of disinfection or inactivation required of the plant by TCEQ. An IR of 1.0 means the plant is exactly meeting its disinfection requirement, an IR of less than 1.0 means the plant is not achieving its required level of disinfection, while an IR of greater than 1.0 means the plant's level of disinfection is exceeding the required level of disinfection. Obviously, drinking water plants want to maintain IRs greater than 1.0 to provide a margin of safety for disinfection. In addition, different microbial pathogens require different levels of exposure to disinfectants for successful disinfection or inactivation. For this reason, IRs are calculated for the general categories of both viruses and for protozoa (based on the organism *Giardia lamblia*). IRs are not calculated for bacteria, because an IR of 1.0 or greater for viruses is more than sufficient to achieve bacterial disinfection.

It is common for variations in IRs to be observed during the operation of drinking water plants. This is because many factors, most notably disinfectant dose, water temperature, pH and water production rate influence the actual level of disinfection achieved by a plant at any given time.

AW has set a goal to maintain an IR of greater than 2.0 at Ullrich WTP. As seen in Figure 14, over the period evaluated, Ullrich WTP met this goal with an average monthly viral IR of 12.4 and lowest daily IR during this period of 2.7. Ullrich WTP also maintained IRs greater than 2.0 for *Giardia* over the period evaluated with two exceptions. Referring to Figure 15, the average monthly IR over the period for *Giardia* was 5.7. The minimum daily IR fell below 2.0 in October 2018 and in February 2021 with a lowest daily IR of 1.4 in February 2021. In summary, over the period evaluated, Ullrich WTP consistently provided microbial pathogen disinfection/inactivation with a comfortable margin of safety.

Total Organic Carbon

Data Summary

Figure 16 plots the raw and treated TOC values for Ullrich WTP for January 2017 – December 2021. During this period the average raw water TOC was 3.8 mg/L C and average treated water TOC was 2.5 mg/L C, average TOC removal was 33%.

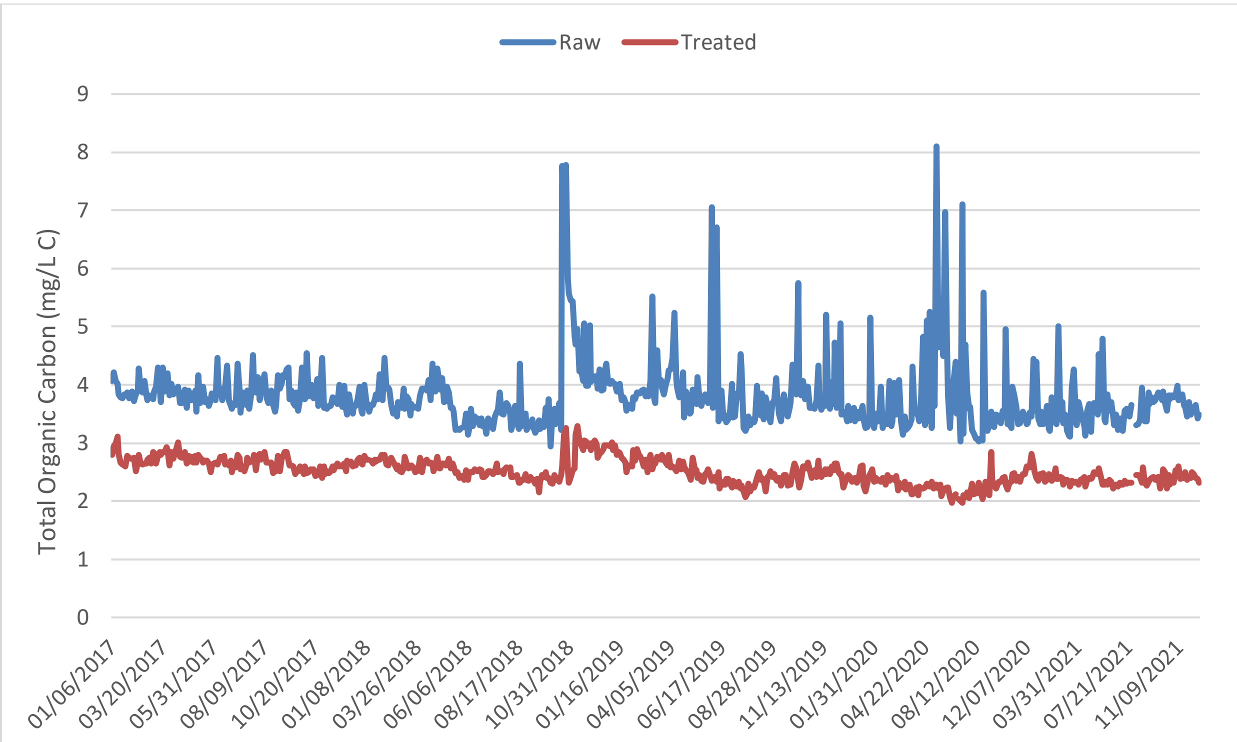


Figure 16 Ullrich WTP Raw and Treated Water TOC

Figure 17 plots the percentage TOC removal during this period. Figure 18 presents the percentage TOC removal in the form of a histogram. As indicated in both figures TOC removal was less than 20 % on two occasions, September 16 and December 16, 2020, but in general TOC removal exceeds 25%.

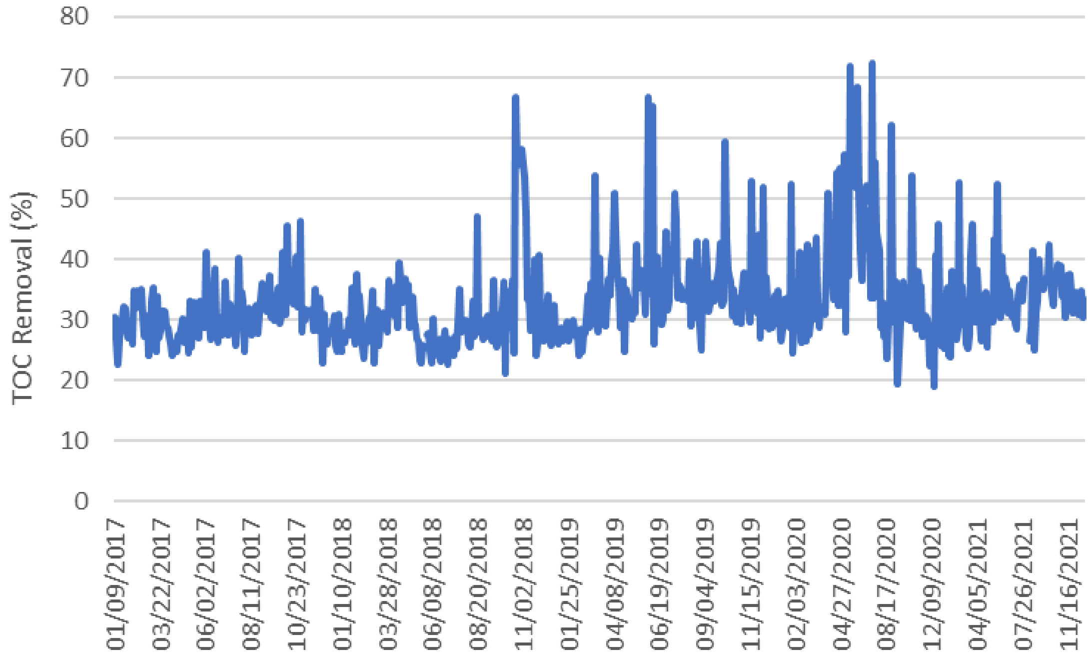
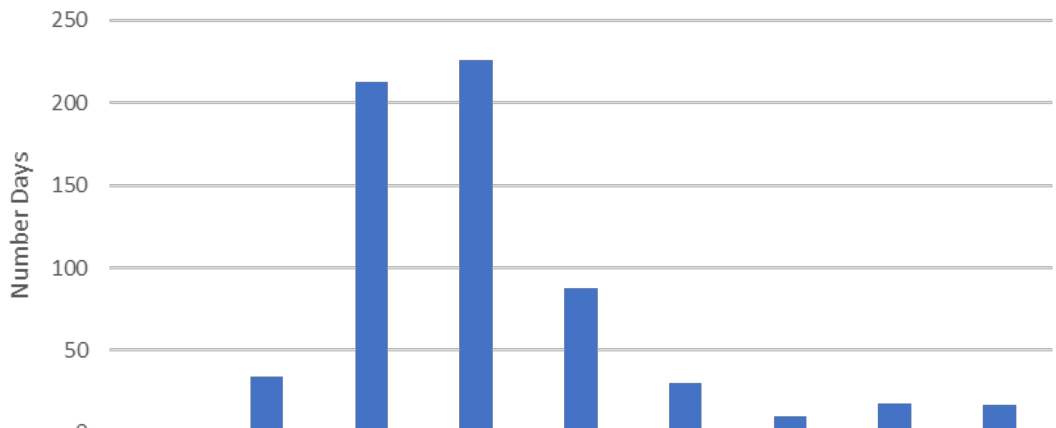


Figure 17 Ullrich WTP TOC Removal



	20 or less	>20 - 25	>25 - 30	>30 - 35	>35 - 40	>40 - 45	>45 - 50	>50 - 55	>55
# days	2	34	213	226	88	30	10	18	17

Figure 18 Distribution of Percentage TOC Removal (Bins are TOC removal in percent)

Data Assessment

Disinfection byproducts (DPBs) are a chronic contaminant regulated by TCEQ. DPBs are formed by the interaction of TOC with drinking water disinfectants. Utilities are required to reduce the level of TOC in their treated water in order to minimize the formation of DPBs. The percentage reduction in TOC that is required depends on the plant's raw water quality. Because Ullrich WTP is a precipitative softening facility, the facility qualifies for alternative compliance criteria as defined by TCEQ, specifically in 30 Texas Administrative Code 290.112. Ullrich WTP meets the Texas TOC removal requirements.

Disinfectant Residual

Data Summary

Figure 19 plots the daily water disinfectant residual produced by Ullrich WTP for the period January 2017 – December 2021. During this period total chlorine residual averaged 2.7 mg/L, although since 2020 the total chlorine concentration increased to an average of 2.8 mg/L.

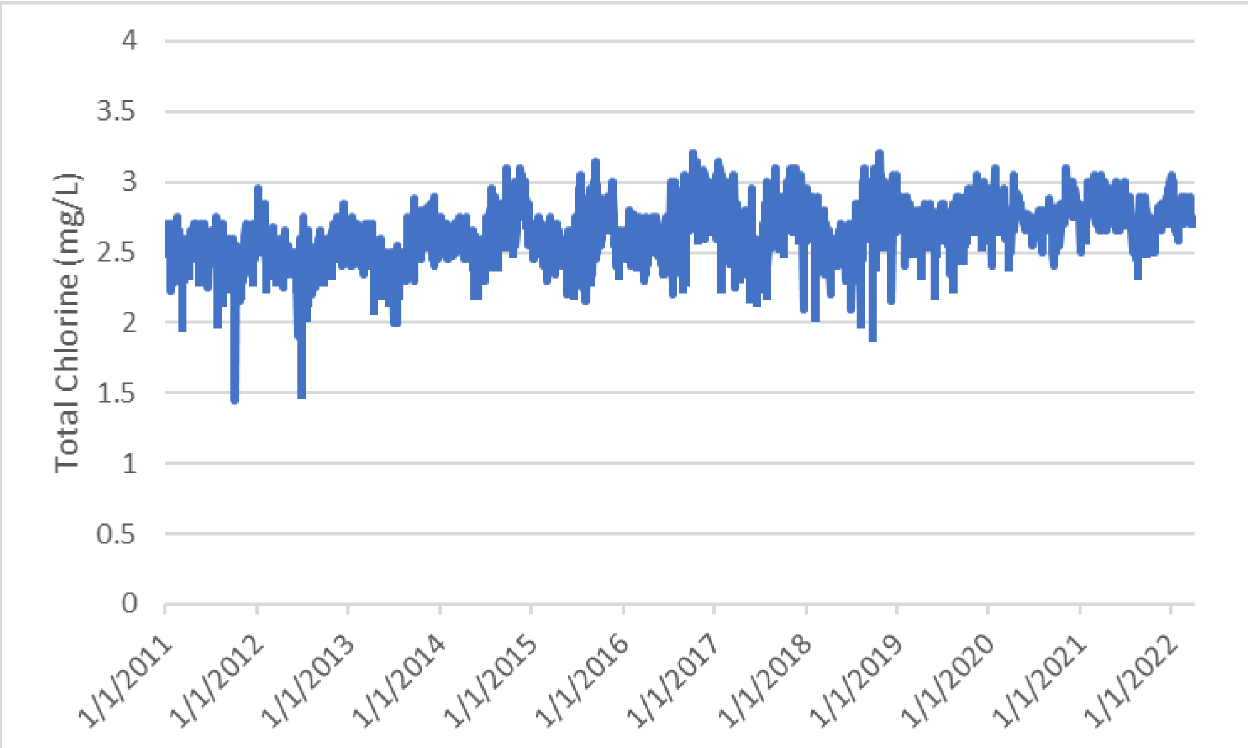


Figure 19 Ullrich WTP Daily Disinfectant Residual

Figure 20 provides a histogram of total chlorine concentration during this time period. Ullrich WTP produced treated water with a total chlorine residual between 2.25 mg/L and 3.0 mg/L for 96% of this period. For the remainder of this time the residual was either less than 2.25 mg/L or greater than 3.0 mg/L for approximately 2% of the time.

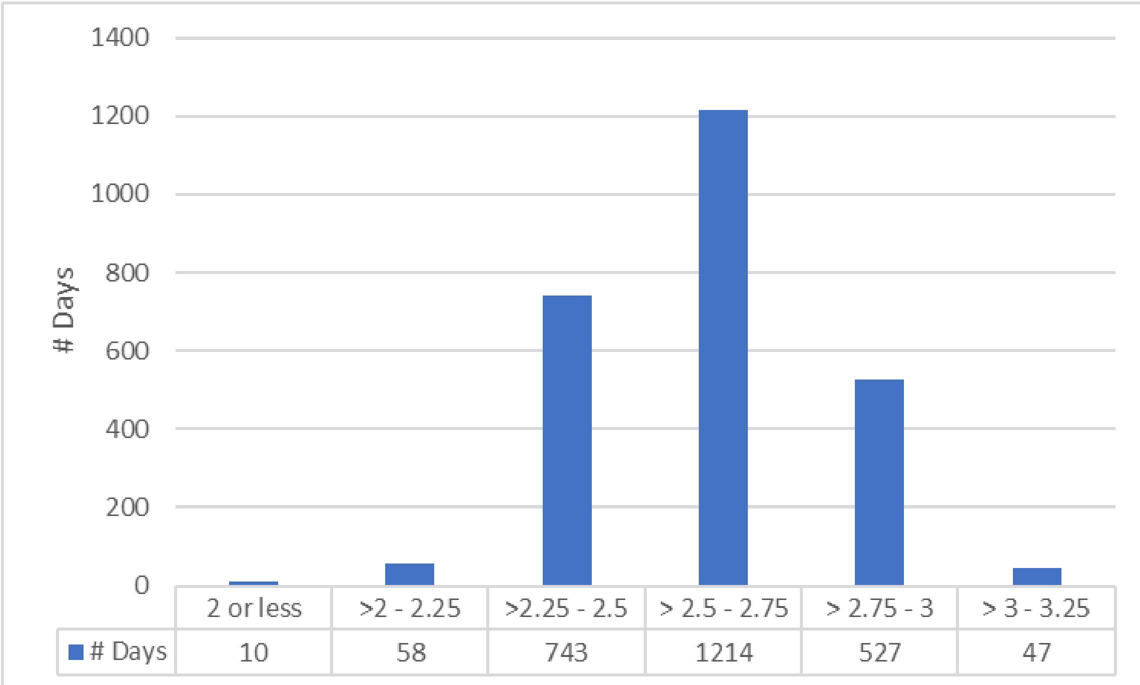


Figure 20 Distribution of Disinfectant Residual for Ullrich WTP (Bins are total chlorine concentration in mg/L)

Figure 21 plots the minimum daily disinfectant residual in Ullrich WTP treated water. During this period the minimum residual was greater than 2.0 mg/L for 99% of the time. Also, during this time, the residual never fell below 1.0 mg/L.

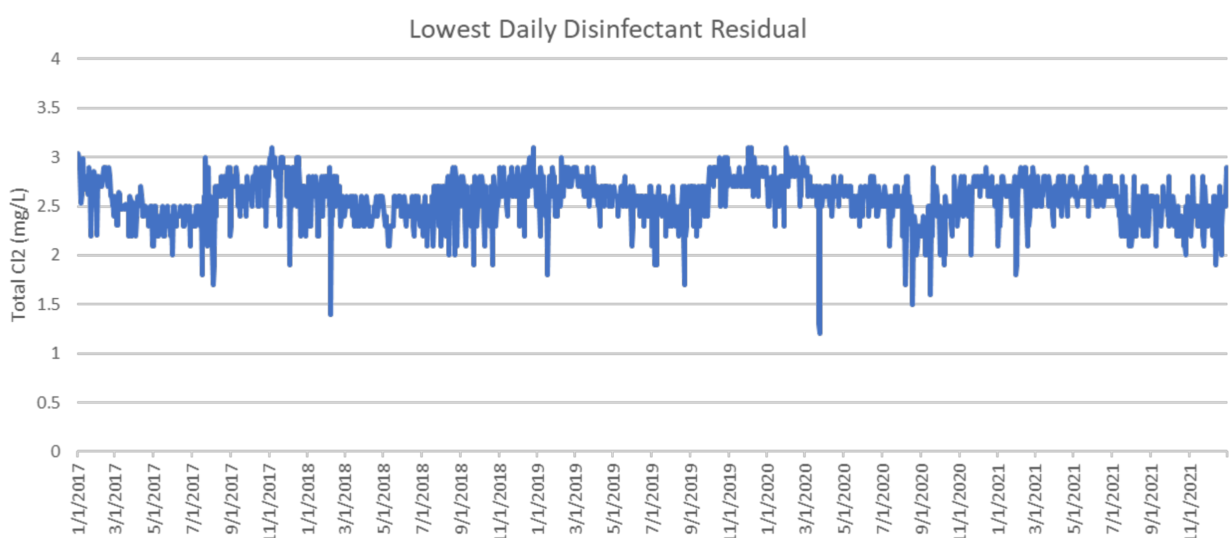


Figure 21 Minimum Daily Disinfectant Residual for Ullrich WTP

Data Assessment

Maintaining a residual disinfectant in distribution system water helps prevent microbial pathogen regrowth. Ullrich WTP uses monochloramine as a residual disinfectant. The concentration of this chemical is measured by the parameter total chlorine. TCEQ requires water systems using chloramine as a residual disinfectant to maintain a minimum total chlorine concentration of 1.0 mg/L. Typically, utilities must provide a higher initial concentration of disinfectant residual in their treated water to assure the minimum concentration of 1.0 mg/L is maintained in all parts of their distribution systems. The actual residual disinfectant value targeted by a utility varies depending on water quality and physical design of its distribution system.

AW has set a target range for total chlorine residual at Ullrich WTP of 2.35 – 2.9 mg/L, which was met 89% of the time during this period. In addition, as seen in Figure 21, minimum daily residual never fell below the TCEQ requirement of 1.0 mg/L. Ullrich WTP maintains the regulated levels of disinfectant residual in its treated water.

pH

Data Summary

Figure 22 plots the treated water pH values for Ullrich WTP for January 2011 – June 2022. During this period the average treated water pH was 9.61.

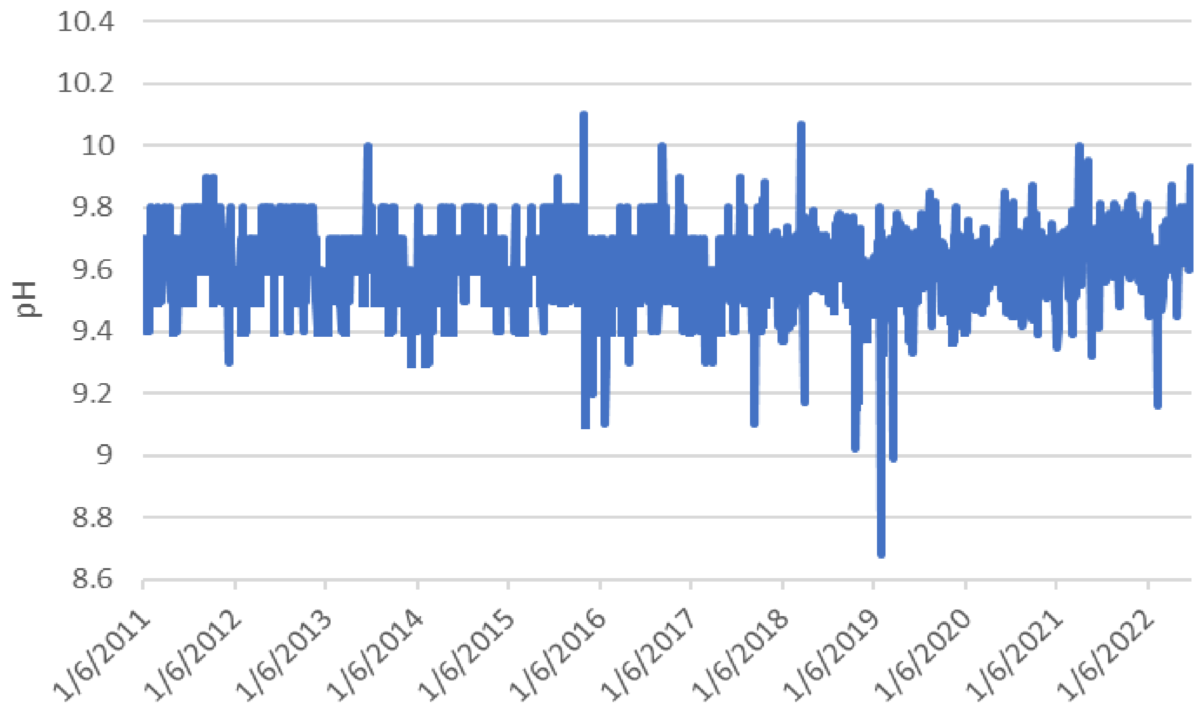


Figure 22 Ullrich WTP Treated Water pH

Figure 23 presents a histogram the number of days at specific treated water pH values. As seen in the figure, the most frequent daily pH was 9.6.

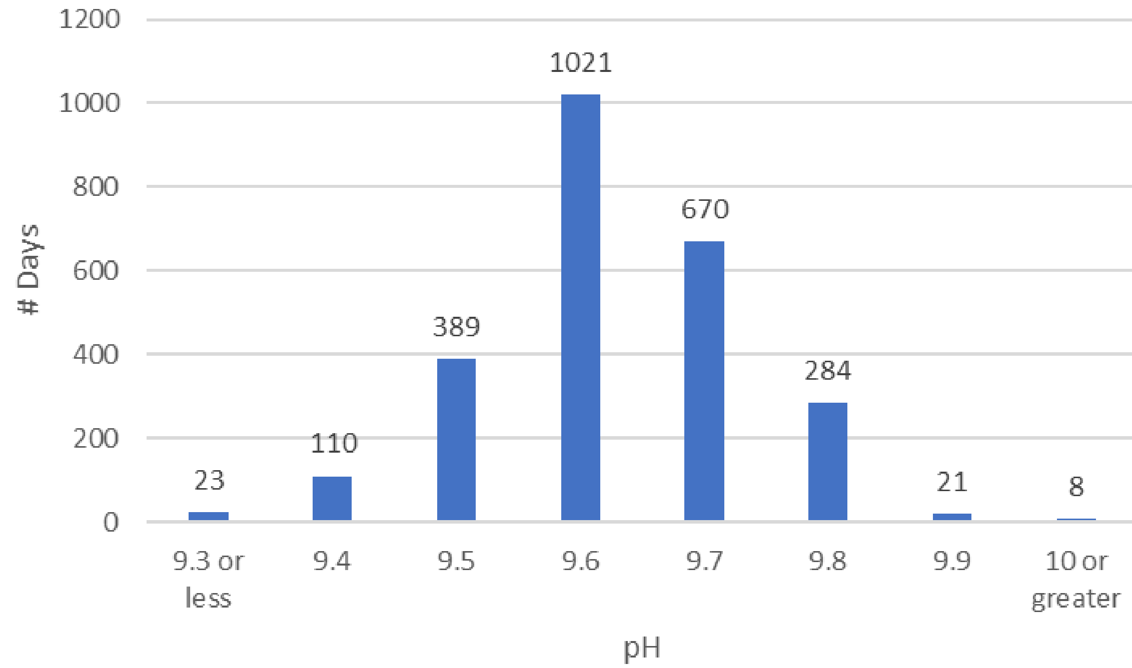


Figure 23 Number of Days at Indicated Treated Water pH Value

Data Assessment

TCEQ has not set a binding treated water pH standard. As a result, utilities can set a treated water pH goal best suited to the specific needs of their system. AW has set an internal treated water pH goal of 9.6. In general, the ability to maintain treated water pH within a narrow range is more important than providing water at a specific pH. From a water quality perspective, maintaining treated water pH within +/- 0.2 of the target pH value is desirable. Treated water pH values outside of this range are acceptable, if they are infrequent and of short duration.

For the period evaluated, Ullrich WTP did a very good job producing treated water at the pH goal of 9.6. It also did a good job of limiting the treated water pH variability, with 98% of the daily treated water pH values being within the range of 9.6 +/- 0.2 pH units.

Hardness/Alkalinity

Data Summary

Figure 24 plots the treated water total hardness and alkalinity values for Ullrich WTP for January 2011 – June 2022. During this period the average treated water hardness was 97.3 mg/L as $CaCO_3$. The average treated alkalinity was 60.8 mg/L as $CaCO_3$.

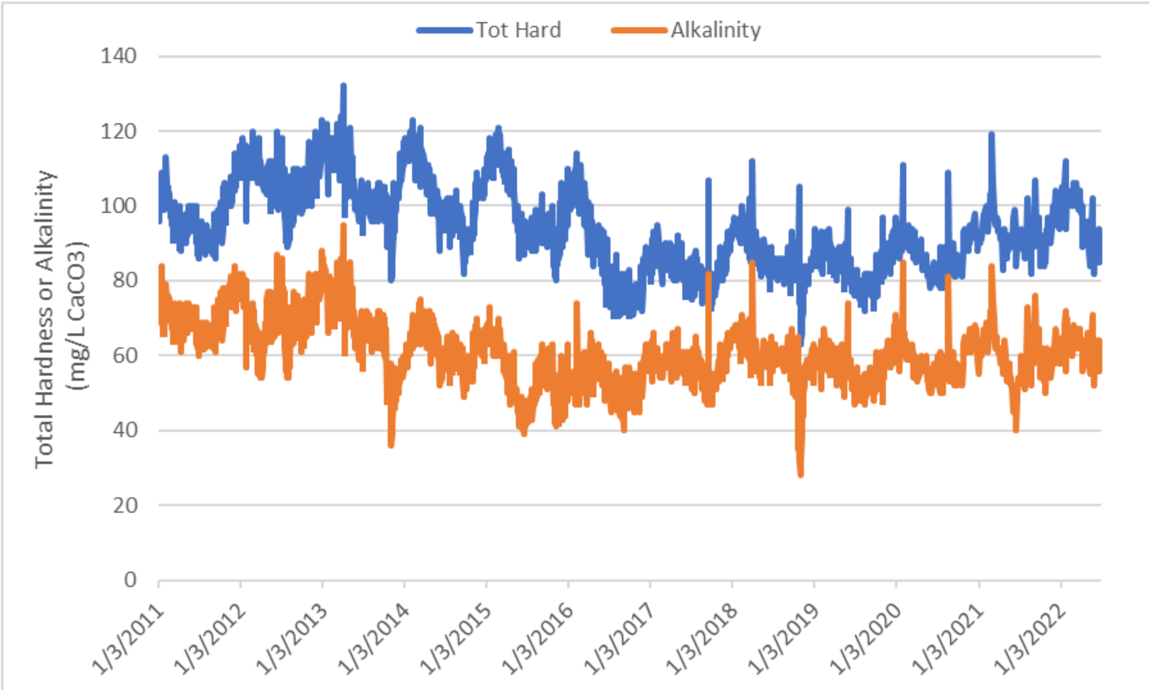


Figure 24 Treated Water Total Hardness and Alkalinity

Figure 25 provides a histogram of the number of days at various hardness concentrations. For 99% of the days treated water hardness was between 70 and 120 mg/L $CaCO_3$. As would be expected for the treatment process used at Ullrich WTP, treated water hardness and alkalinity concentrations tend to track each other.

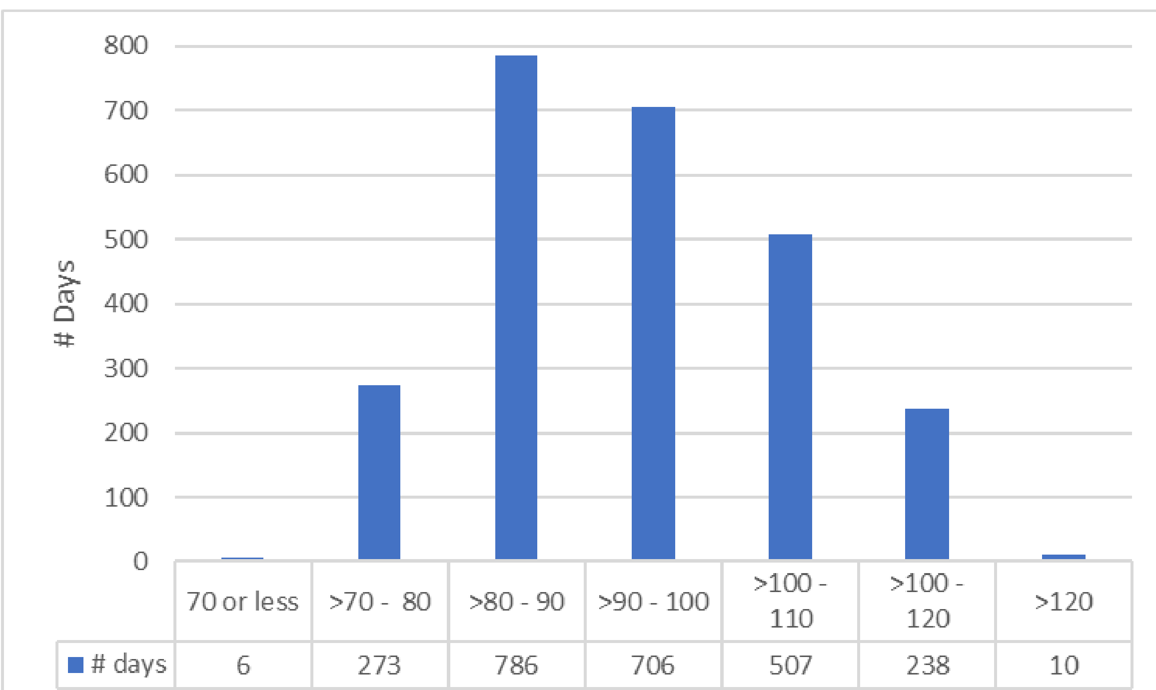


Figure 25 Number of Days at Indicated Total Hardness (Bins are hardness range in mg/L $CaCO_3$)

Figure 26 provides a histogram of the number of days at various alkalinity concentrations. For 95% of the days treated alkalinity was between 45 and 80 mg/L $CaCO_3$.

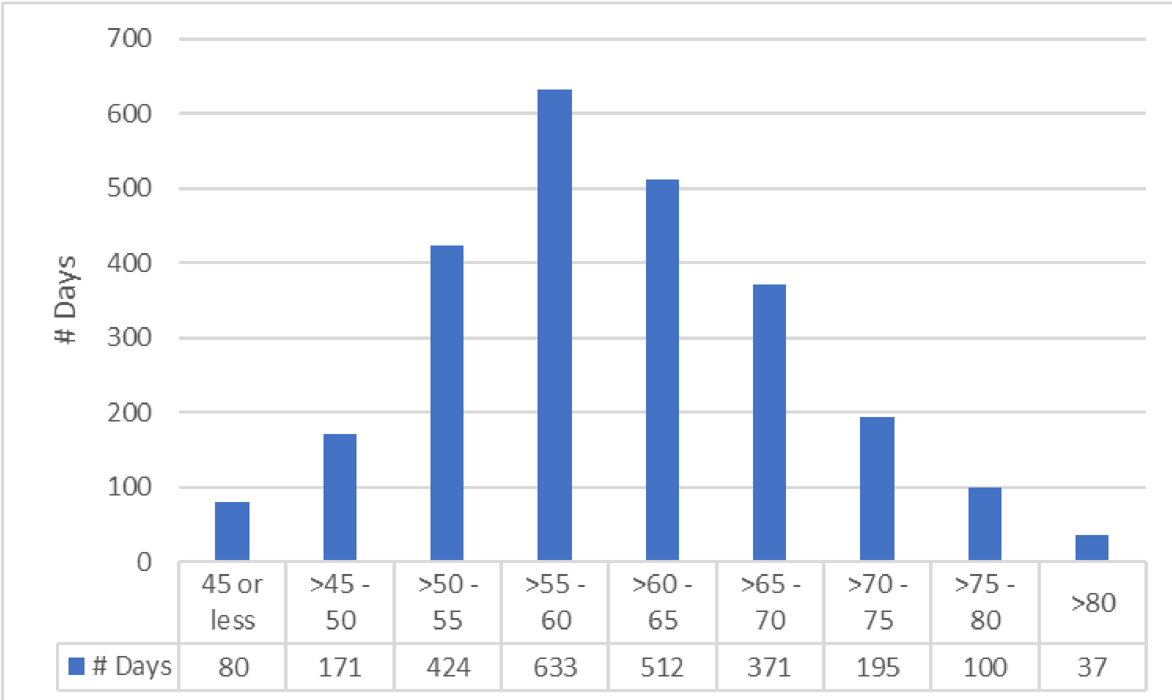


Figure 26 Number of Days at Indicated Alkalinity (Bins are alkalinity range as mg/L $CaCO_3$

Data Assessment

TCEQ does not regulate the hardness of drinking water. Chemically, hardness is caused by the presence of dissolved calcium and magnesium in water. While not determinantal to human health, hardness will react with soaps to form insoluble curds that float in water and deposit on sinks and bathtubs. Laundry soaps are less effective in hard water, causing clothes to look less 'clean' after washing. In addition, hardness can cause scales to form on the interior of pipes. Tolerance of hard water is a matter of personal preference; some consumers are not troubled by hard water, but many consumers find it undesirable.

There are several different ways to express the measurement of hardness in water. The unit of measure mg/L as calcium carbonate (mg/L $CaCO_3$) is typically used by drinking water utilities. Using the unit mg/L $CaCO_3$, the hardness of water is classified by the following scale:

Table 1 Hardness Classifications

Hardness (mg/L $CaCO_3$)	Classification
0 - 75	Soft
75 - 150	Moderately hard
150 - 300	Hard
> 300	Very hard

Using this system of classification, the raw water treated by Ullrich WTP is classified as 'hard' while the treated water is classified as 'moderately hard'.

Figure 27 presents the raw and treated water hardness measured at Ullrich WTP for the period January 2011 – March 2022. As is discussed in detail in Appendix 2-F, the single stage or straight lime softening process used at Ullrich WTP is intended to only remove the calcium portion of hardness. Given the background level of magnesium in Ullrich water, and the inherent limitations of the lime softening process, a treated water in the range of 100 +/- 20 mg/L $CaCO_3$ is to be expected. As in seen in Figure 25 and Figure 27, Ullrich WTP typically produces water in this hardness range.

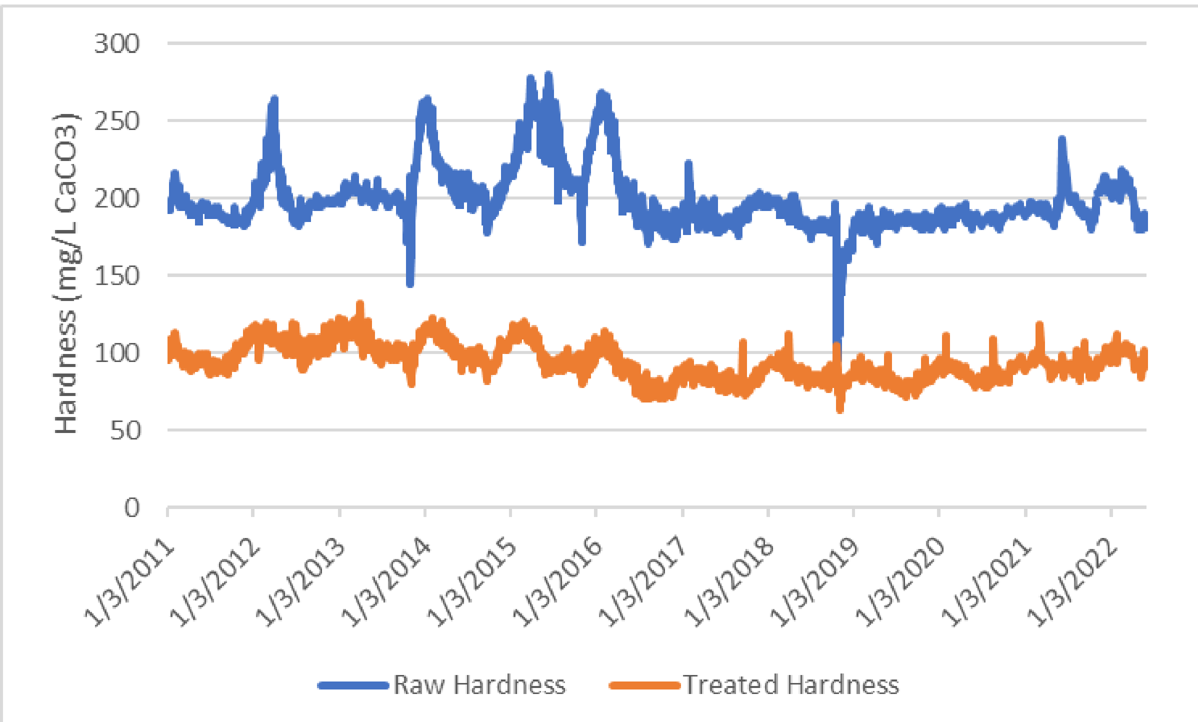


Figure 27 Comparison of Ullrich WTP Raw and Treated Hardness

TCEQ also does not regulate the alkalinity of drinking water. Chemically alkalinity is a measure of the amount of bicarbonate, carbonate and hydroxide in water. Like hardness, alkalinity is not detrimental to human health. Also, like hardness, alkalinity is measured in units of mg/L $CaCO_3$. There is no set value for an optimum amount of alkalinity in drinking water, although low levels of alkalinity (< 20-30 mg/L $CaCO_3$) are less desirable because of their ability to promote corrosion. As seen in Figure 26, the treated water alkalinity produced by Ullrich WTP is acceptable.

Although, alkalinity is not regulated in treated water, its presence in raw water is critical to the successful operation of Ullrich WTP. The importance of alkalinity on the performance of Ullrich WTP are discussed in detail in Appendix 2-F.

Pumpage

Data Summary

Pumpage, or the volume of treated produced per day by Ullrich WTP for the period January 2017 – March 2022 is plotted in Figure 28. During this period average production for Ullrich WTP was 62.7 million gallons per day (MGD). The maximum pumpage was 110.7 million gallons on 8/2/2018 and the minimum pumpage was 25.2 million gallons on 1/29/2019. Ullrich WTP produced water on every day during this period. As can be seen in the figure, peak production occurs during the summer and minimum production during the winter.

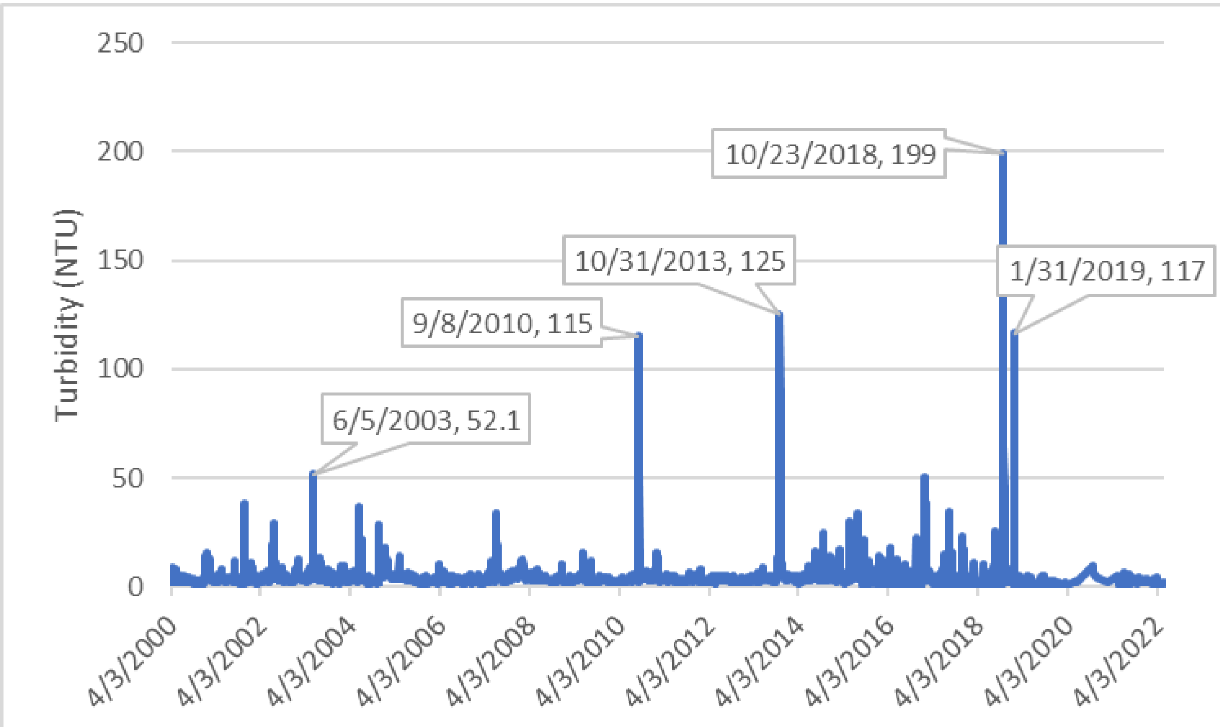


Figure 28 Daily Pumpage from Ullrich WTP

Figure 29 is a histogram of Ullrich WTP distribution of daily pumpage rates. During this period the Ullrich WTP seldom operated at less than 30 MGD or more than 100 MGD.

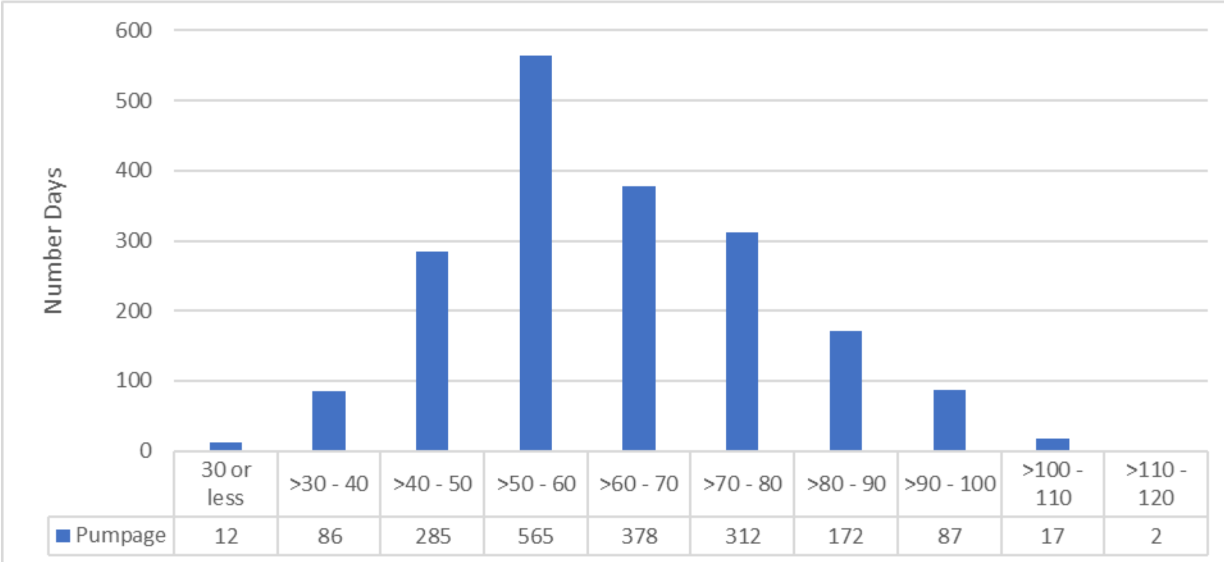


Figure 29 Distribution of Ullrich WTP Pumpage (Bins are pumpage range in MGD)

Data Assessment

Ullrich WTP has a rated capacity of 167 MGD. However, the plant was not operated at more than 110.7 MGD or 66% of its rated capacity during this period. Average pumpage was 38% of rated capacity. Hence during the period evaluated, Ullrich WTP has not operated near its rated capacity.

Appendix 2-E Ullrich Water Treatment Process Review Supplement

Appendix 2-E
Ullrich Water Treatment Plant
Process Review Supplement*

Prepared for
The University of Texas at Austin
Center for Water and the Environment

December 29, 2022

STATE OF TEXAS
CHAD D. BARTRUFF
91688
LICENSED
PROFESSIONAL ENGINEER
12/29/2022

** This Appendix 2-E provides supplemental, supporting information regarding the Section 2.6 process review completed for the associated report *External Review of Austin Water Quality Events*, January 2023 (the Report). The process review included examination of available design documentation, historical operating data, and primary regulatory rules applicable to the Ullrich WTP water treatment processes as referenced in the Report and this Appendix 2-E. The process and regulatory review conducted for the Report was not, and should not be considered, a complete, line-by-line review and verification of regulatory rule compliance for the Ullrich WTP. It was assumed that the existing Ullrich WTP facilities and treatment processes designs were developed under the supervision of and submitted by the respective engineers of record for review and acceptance to the Texas Commission on Environmental Quality at time of design. The information and engineering review included in this Appendix 2-E was used for development of the Section 2.6 summary and identification of process observations and the associated issues and recommendations.

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Brown and Caldwell
8522 Broadway # 109,
San Antonio, TX 78217
T: 210.642.2728

Appendix 2-F The Role of Alkalinity in Treatment Plant Performance

The basis of Ullrich WTP design, a lime softening process using up-flow clarification followed by conventional filtration, is a mature and well established technology. This treatment train is well suited to treat hard or moderately hard waters where calcium is the major contributor to the water hardness and there is sufficient alkalinity in the water source to sustain the chemical reactions upon which softening is based.

As discussed in Appendix 2-D, hardness is caused by the presence of calcium and magnesium in water. In the context of drinking water treatment, the term softening means to reduce hardness by removing either calcium, magnesium or both from the water. Because there tends to be more calcium in water than magnesium, and since calcium is easier and less costly to remove from water than magnesium, drinking water utilities like AW that soften generally on only target calcium removal.

There are many processes that can soften water by removing calcium, but most of these processes are not cost effective when treating the large volumes per day needed by Austin. When dealing with a plant the size of Ullrich, lime softening is the industry standard and the most cost effective and practical process to perform softening.

The lime softening process is based on adding lime to raise the pH of the water to the point will where the calcium in the water precipitates to form the solid calcium carbonate ($CaCO_3$). At Ullrich WTP, pH is increased to pH 10 – 10.4 S. U., forcing the precipitation of calcium carbonate. Once formed, calcium carbonate is removed from the water by the clarifiers and filters. But precipitation of calcium carbonate also removes other contaminants from the water. Turbidity, TOC and microbial pathogens are caught up in the calcium carbonate precipitates as they form and removed from the water along with the calcium. Hence, even though softening at Ullrich WTP is designed to remove calcium, it also removes a suite of regulated and unregulated contaminants from the water. Precipitation of calcium carbonate is at the heart of Ullrich WTP's treatment process and the plant will perform poorly if the precipitation process doesn't work well.

Chemically, the calcium carbonate precipitation reaction governing operation of Ullrich WTP is:

$$Ca^{2+} + Ca(OH)_2 + 2HCO_3^- \Rightarrow 2CaCO_3(s) + 2H_2O$$

In summary, calcium naturally in the water (Ca^{2+}) and lime ($Ca(OH)_2$) added to the water reacts with bicarbonate (HCO_3^-) naturally in the water to form the calcium carbonate solid ($CaCO_3(s)$) which is removed from the water while creating more water (H_2O). At Ullrich WTP, bicarbonate is not added but supplied from alkalinity in the water.

Relationship Between Turbidity Spikes and Alkalinity

As discussed in Appendix 2.7.3.A, storm events in the watershed will generate turbidity spikes. In many cases raw water alkalinity will drop during the turbidity spikes. Figure 30 compares raw water alkalinity values to raw water turbidity using Ullrich MOR data for the period January 2011 – March 2022. As seen in the figure, the lowest alkalinity values observed in the raw water occurred when turbidity levels were elevated. At the same time, raw water turbidity levels were never elevated at alkalinity greater than approximately greater than 150 mg/L CaCO3. Hence when raw water alkalinity falls below 150 mg/L $CaCO_3$ there is a greater chance Ullrich WTP will experience a turbidity spike. Conversely, if Ullrich WTP experiences a turbidity spike, there is a reasonable likelihood it will also experience a drop in alkalinity.

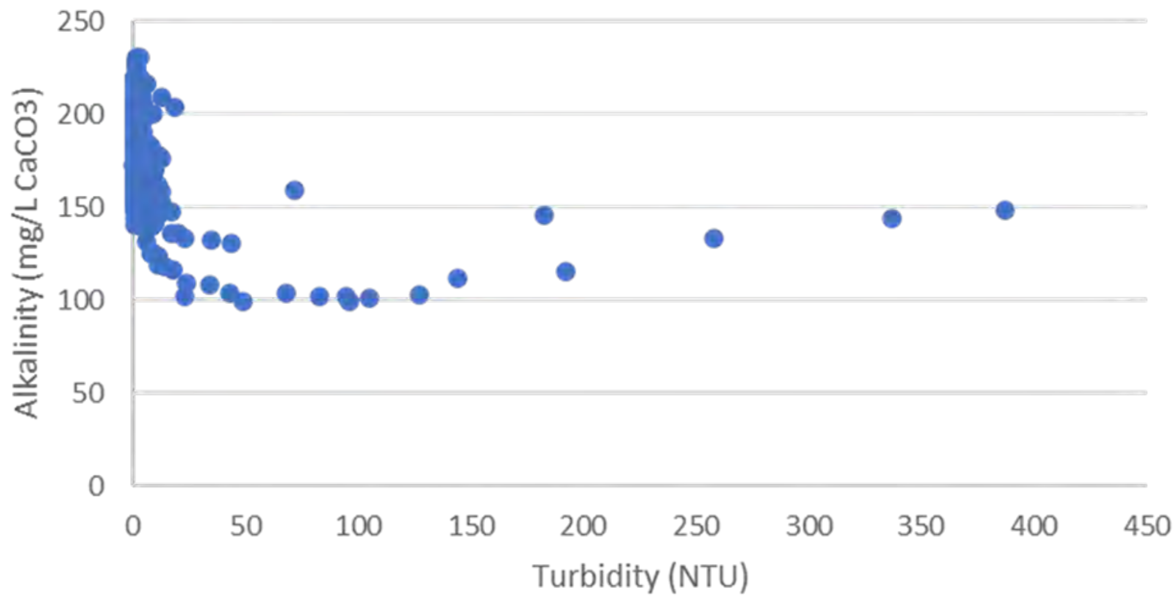

Figure 30 Relationship Between Raw Water Turbidity and Alkalinity

The impact of lower raw water alkalinity can be seen in turbidity removal by Ullrich WTP. Figure 31 plots raw water alkalinity versus treated water turbidity. As can be seen in the figure, all the treated water turbidity events also occurred when raw water alkalinity was below approximately 150 mg/L $CaCO_3$, inferring Ullrich WTP may be more difficult to operate below this threshold.

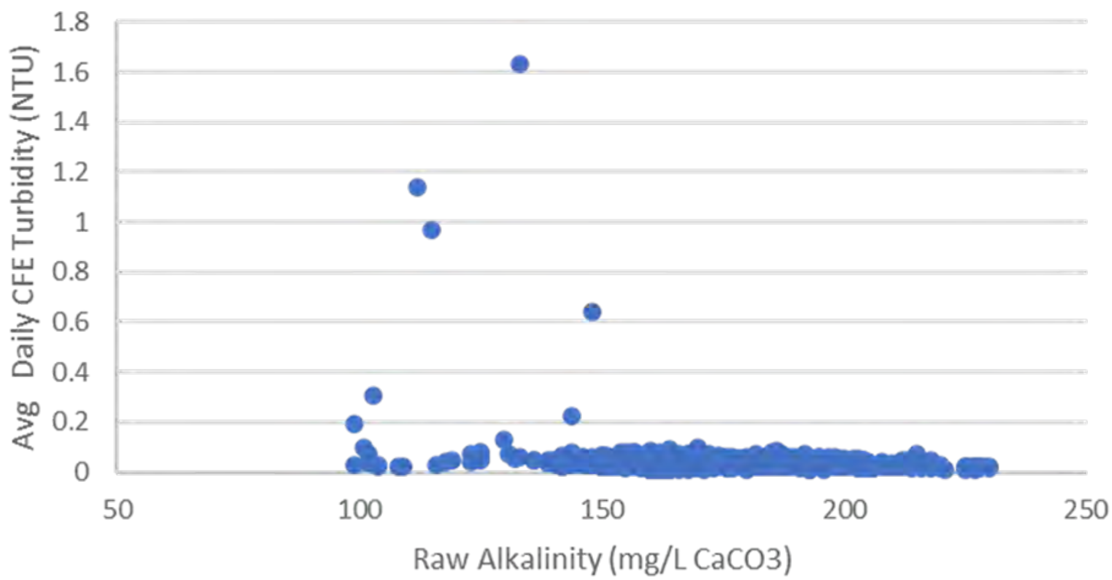

Figure 31 Relationship Between Raw Water Alkalinity and Treated Water (CFE) Turbidity

<u>Potential for Failure of the Ullrich Straight-Lime Softening Process at Low Alkalinity Conditions</u>

The straight-lime softening (or lime softening)[10] process used by Ullrich WTP depends on having sufficient alkalinity in the raw water to:

- Precipitate calcium naturally contained in the raw water
- Precipitate calcium added by using lime
- Account for the alkalinity consumed by the ferric coagulant

Straight-lime softening refers to a lime softening process used when both calcium and magnesium hardness is present but there is little noncarbonate hardness in the water. The straight-lime process is designed to remove calcium hardness through the addition of a single chemical (lime) and avoids the need to add a second chemical (soda ash) to soften the water. Lime-soda softening refers to this alternative lime softening process in which lime and soda ash are provided.

When predicting the performance of softening, bar diagrams can be used to illustrate the contributions of chemical species important for the softening process. The bar diagram provides a visual representation of the levels of calcium, (Ca) magnesium (Mg) and other

[10] Straight-lime softening refers to a lime softening process used when both calcium and magnesium hardness is present but there is little noncarbonate hardness in the water. The straight-lime process is designed to remove calcium hardness through the addition of a single chemical (lime) and avoids the need to add a second chemical (soda ash) to soften the water

cations compared to bicarbonate (HCO_3) and other anions in the water. Since alkalinity in the Ullrich raw water consists primarily of bicarbonate, the terms alkalinity and bicarbonate can be used interchangeably. For all practical purposes, having sufficient alkalinity means having enough bicarbonate in the raw water to complete the reactions listed above. For the straight-lime softening process used by Ullrich WTP to function effectively, the amount of bicarbonate must always exceed the amount of calcium in the water.

Figure 32 compares the bar diagrams for three different water quality conditions at Ullrich WTP. The three conditions are:

- Operating at average levels of calcium, magnesium and bicarbonate in the raw water
- Operating under conditions measured during the October 2013 storm event (discussed in Appendix 2.7.3.B) when alkalinity levels were much lower than average
- Operating under conditions measured during the October 2018 flood event when the lowest ever alkalinity level was recorded at Ullrich WTP

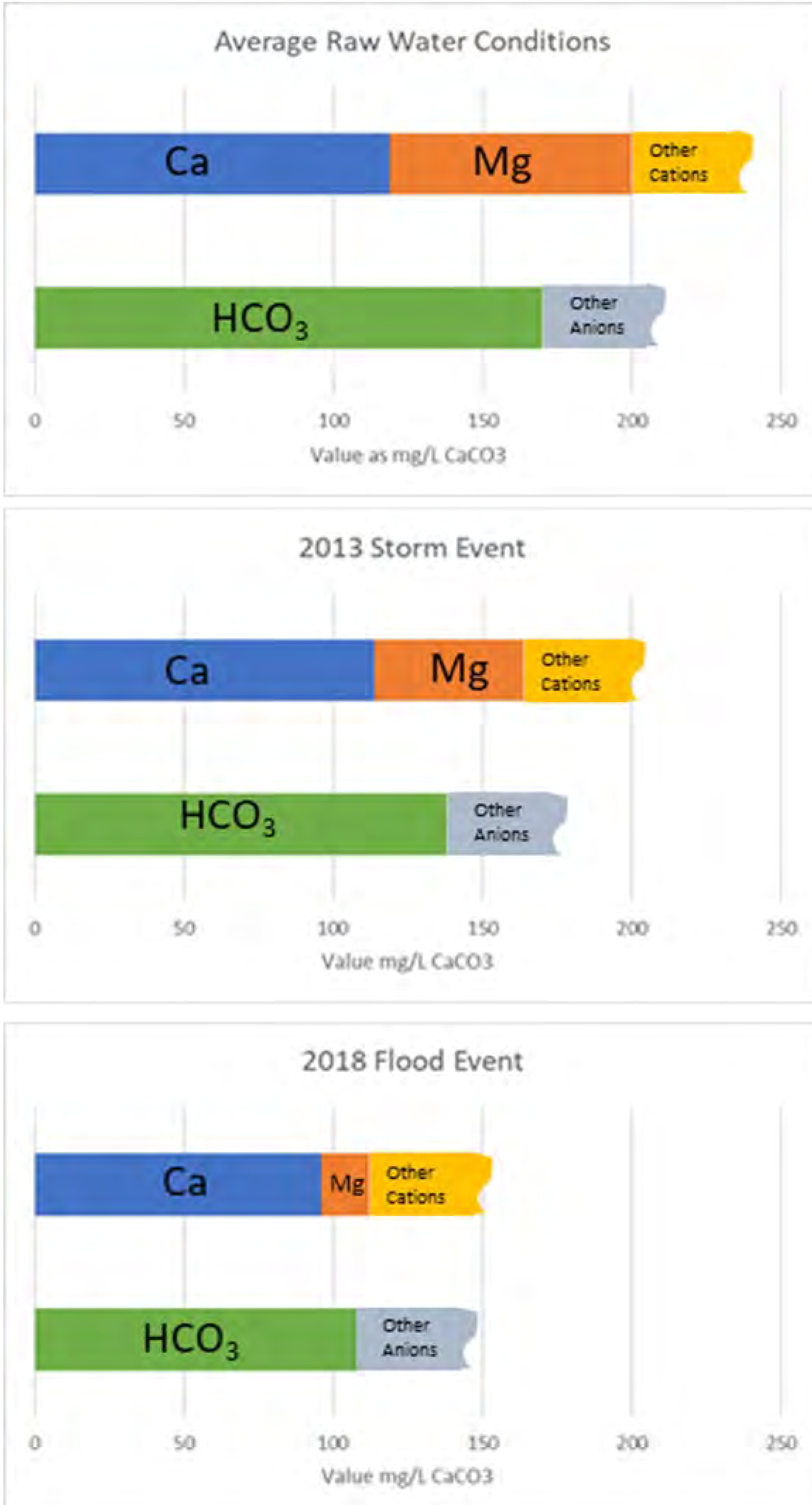

Figure 32 Bar Diagrams Comparing Average to Storm Event Ullrich Raw Water Quality

The figure clearly shows that levels of calcium, magnesium and bicarbonate drop during storm events. But it is also important to compare the excess amount of bicarbonate available to the amount of calcium which is to be removed from the water. For the three conditions compared in the figure the amount of excess bicarbonate is:

- Average condition: 43% excess
- 2013 Storm Event: 21% excess
- 2018 Flood Event: 13% excess

This trend is consistent with the prior observation that Ullrich WTP becomes more difficult to operate at lower alkalinity values. It is likely that a root cause of the failure of Ullrich WTP during the 2018 Flood Event was insufficient alkalinity (bicarbonate) to support the straight-lime softening process upon which treatment at the plant is based. It is possible that the addition of a soda ash feed could compensate for the loss in alkalinity if such an event were to recur.

As previously noted, the water quality conditions experienced by Ullrich WTP during the 2018 storm event were unprecedented. The addition of the polymer feed system and reduced levels of production will mitigate the sensitivity of Ullrich WTP to similar storm events. However, if storm events with comparable conditions become more frequent, the facility may be at risk for similar issues.

Appendix 2-G External Review Recommendations and Management Response

MEMORANDUM

TO: Mayor and Council Members

FROM: Shay Ralls Roalson, P.E., Austin Water Director

THROUGH: Gina Fiandaca, Assistant City Manager, Mobility

DATE: January 11, 2023

SUBJECT: **External Review of Austin Water**

This memo acknowledges receipt of the draft External Review of Austin Water Quality Events that will be presented and discussed at the January 18, 2023 Audit and Finance Committee meeting. I, along with our collective organization, am committed to rebuilding public trust by elevating the values central to Austin Water's 100+ year history. Safety, integrity and trust, excellence, sustainability and resilience, equity, and customer service will remain pillars of our commitment to the Austin community and will guide decision-making to the services we provide.

The External Review provided 53 recommendations, which could be bracketed into the following themes: Hiring and Compensation; Organizational Structure; Operations and Staff Training; Culture and Internal Communications; and Emergency Management. Of the 53 recommendations, Austin Water agrees or partially agrees with 49; implementation of 19 of those are already underway. Some of the key findings from this extensive review:

- Treatment processes performed by Austin Water to serve its more than 1 million customers are appropriate.
- The Ullrich Water Treatment Plant infrastructure is adequately designed with sufficient capacity.
- Austin Water has taken steps to mitigate water quality risks and improve operational resiliency at its water treatment plants.
- Austin Water's power resiliency and Emergency Preparedness Plan sufficiently address hardening of electrical transmission and distribution, additional auxiliary power generation, adequate water storage, and implementation of emergency water demand rules.
- Austin Water's emergency management structures are well thought out and suitably structured; the Incident Management Team and Department Operations Center align with FEMA standards.

While Austin Water is well positioned in many ways to respond to risks and threats, we certainly have felt the impacts of staffing shortages and employee retention. We agree with many of the recommendations within this report, and I am committed to collaborating across the City organization to address and resolve the issues raised to support the needs of Austin Water employees and our community.

Included herein is our response to each recommendation. I plan to discuss these matters in more detail at the Austin Water Oversight Committee meeting on February 15, 2023, or sooner, if requested.

I would like to thank the Office of the City Auditor and UT's Center for Water and the Environment for their efforts. I'd also like to thank Robert Goode for his service as Austin Water's Interim Director while this review was underway.

Please contact me at shay.roalson@austintexas.gov if you have any questions or need more information.

CC: Spencer Cronk, City Manager
Robert Goode, Incoming Interim Assistant City Manager, Mobility
Veronica Briseno, Assistant City Manager, Government that Works for All
Corrie Stokes, City Auditor

Attachments:
External Review Recommendations and Management Response

External Review Recommendations and Management Response

2.2-1 Establish a position for a single person to be in charge of Ullrich WTP and provide that person with guidance and training regarding leadership, goal setting, holding staff accountable, and other assistance as requested. The objective should be to have a leader with a well communicated message for staff that is promoted and enforced.

Management Response: Agree

Proposed Implementation Plan: Ullrich Water Treatment Plant (WTP) is staffed with two superintendents: one oversees maintenance activities, the other oversees daily operations. Both superintendents report to a Division Manager, who also oversees similar positions at other WTPs. Austin Water will dedicate the current Division Manager solely to Ullrich WTP. A new leadership position over the remainder of the WTPs will be proposed for approval through the City's annual budget process. Priority will be placed on filling existing vacancies for operations and maintenance technician positions as noted in Recommendation 2.3-1.

Proposed Implementation Date: January 2023

2.2-2 Establish reporting requirements and accountability of the plant superintendents to a single treatment manager. Investigate ways to better support managers in the plants with their conflict management skills, and team building efforts, potentially providing external support for developing all leaders at the plants.

Management Response: Agree

Proposed Implementation Plan: See our response to Recommendation 2.2-1 for our plan to streamline reporting and accountability for plant superintendents. Austin Water's Employee & Leadership Development staff will provide additional training and consulting resources related to conflict management, team building, and leadership development.

Proposed Implementation Date: January 2023

2.2-3 Engage a management consultant to review, evaluate and make recommendations regarding changes in the management structure to best support the water plant operations and maintenance staff.

Management Response: Partially Agree

Proposed Implementation Plan: Austin Water will conduct the Partnership for Safe Water Self-Assessment for Water Treatment Plant Operations at Ullrich WTP. Findings from this assessment will be used to evaluate options to properly support operations and maintenance requirements. The

Self-Assessment (published in 2016) provides industry guidance for administration best practices, as well as recommendations for appropriate adjustments to staffing and organizational structure.

Proposed Implementation Date: December 2024

2.2-4 Teach all O&M staff how to access SOPs. Emphasize that they are expected to follow SOPs. Continue the program/process for updating existing SOPs and assign staff to participate as soon as time is available. Provide staff time to develop any new SOPs needed.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will continue efforts to update the electronic Operations & Maintenance (O&M) platform for ease of navigation by staff (funding for this was approved by Council in May of 2022). Once updates are complete, we will provide refresher SOP training by dedicated WTP Training Instructors.

Proposed Implementation Date: February 2023

2.2-5 Continue regular team-building exercises and require attendance by all staff. To be successful, all management levels from the superintendent to the director should provide tangible and visible support for these efforts.

Management Response: Agree and Underway

Proposed Implementation Plan: See our response to Recommendation 2.2-2. Austin Water's Employee & Leadership Development staff will continue to incorporate regular team-building exercises in coordination with WTP leadership.

Proposed Implementation Date: Ongoing

2.2-6 Communicate to the operations staff and let them know what is and is not going to change regarding compensation and other significant HR decisions.

Management Response: Agree and Underway

Proposed Implementation Plan: The first phase of market study recommendations was implemented in September of 2022, and the results were communicated to employees. Communication is underway to impacted employees who are part of Phase 2 compensation changes. Austin Water will continue to provide supporting data to the City's Human Resources Department (HRD), as well as advocate additional compensation changes and recruitment/retention strategies.

Proposed Implementation Date: Ongoing

2.2-7 Continue to advocate strongly for increased operator/mechanic salaries so that the utility can hire and retain qualified and interested people.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will continue to provide data to HRD to support additional compensation increases and enhanced recruitment/retention strategies.

Proposed Implementation Date: Ongoing

2.2-8 Partner with other utilities or with the Texas Section of AWWA (TAWWA) to develop a pipeline for young people to learn about water treatment, water operations and get some basic training. Some utilities have helped to set up 2-year programs at community colleges to give young people basic training as operators. TAWWA currently is working on training modules that will be used in high schools to teach high school students about water operations, and_AW has participated in the creation of one of these training modules. AW should make an effort to continue and to expand participation in this and similar activities that foster the development of future operators.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will continue to partner with TAWWA and other similar professional organizations in our industry to develop new talent resources. Austin Water is currently evaluating a similar program with the Water Environment Association of Texas.

Proposed Implementation Date: March 2023

2.2-9 Support the ability for all the utility divisions to hire above the starting level when a candidate is qualified.

Management Response: Partially Agree

Proposed Implementation Plan: Austin Water has a career progression plan in place for the Operations & Maintenance job family. While we typically post openings at entry levels, this does not typically result in an external hire. Austin Water is reviewing hiring results from FY22 to determine the effectiveness of posting at higher levels for attracting qualified candidates outside of Austin Water.

Proposed Implementation Date: Quarter 2 of FY23

2.2-10 Establish greater autonomy for AW Human Resources, distinct from the City Human Resources, to better define job requirements and job qualifications. Encourage AW HR to find new ways to recruit potential hires, look in new places for talent and screen candidates differently. Refer to the Rocky Mountain Section of AWWA, Utility Management Committee's workforce program.

Management Response: Do Not Agree

The City of Austin strives to be an employer of choice and recognizes that employees are its most valuable resource. Compensation packages (including cash compensation, benefits, and work/life balance) are one of the primary tools used to attract and retain employees. The City frequently uses market studies to evaluate how our compensation packages match up to comparable employers. The City seeks to maintain a target market match philosophy at the 50th percentile in cash compensation and a high market match philosophy in group benefits while also factoring in the balance needed to maintain tax/rate payer affordability.

The City of Austin is a complex organization with more than 40 departments. Centralized functions, with high level overview and authority to guide departments in regard to Human Resources, Finance, Purchasing, etc., help develop and maintain consistent operations across the enterprise. A centralized Human Resources Department is required by the City Charter and necessary to develop and maintain consistent operations across the enterprise. HRD places great importance on coordinating with individual departments to ensure to successful operations across the entire organization.

Proposed Implementation Plan: Not Applicable

Proposed Implementation Date: Not Applicable

2.2-11 Continue incorporation of the new trainer positions completely into the plant and push them to develop or find training tools that significantly increase the training quality, quantity, and effectiveness for both new hires and existing operators. Promote consistency of training for all O&M staff. Emphasize in-person training. Re-educate staff regarding their reporting options when they notice discipline or safety violations.

External Review Recommendations and Management Response

Management Response: Agree and Underway

Proposed Implementation Plan: An initial enhanced staffing plan to support WTPs was approved by Council in May 2022. This includes having dedicated technical trainers at WTPs that focus on in-person training. The trainer positions have been filled and an initial training program has been developed and approved by Austin Water's Operations and Employee Leadership & Development Programs. The enhanced training program will begin in February 2023 for new hires and existing operators.

Proposed Implementation Date: Initiated May of 2022 with anticipated completion this FY

2.2-12 **Engage an expert in staffing evaluations to complete a detailed staffing evaluation of all three water treatment plants. Utilize the study results to inform staffing levels, training programs, and job descriptions. Results could also inform the processes utilized by human resources to screen new hire candidates.**

Management Response: Partially Agree

Proposed Implementation Plan: As detailed in our response to Recommendation 2.2-3, Austin Water will utilize results from the Partnership for Safe Water Self-Assessment to provide recommendations on staffing levels, training programs, and job descriptions. As is standard practice, these results will inform the screening processes utilized by Austin Water and HRD.

Proposed Implementation Date: December 2024

2.2-13 **Develop a plan to manage the impacts of cross-training between operations and maintenance, particularly in the training program for new O&M staff. Cross training and broad knowledge of a facility has been shown to be very valuable, reducing plant risks during times of stress. An effort should be made to set up the program in a way that those who want to specialize in one area can do so.**

Management Response: Agree

Proposed Implementation Plan: Austin Water will review our existing Operations & Maintenance cross-training program to determine if any changes are required. Austin Water will create new job descriptions focused on specialized areas of operations or maintenance to complement the existing Austin Water career progression for Operations & Maintenance positions.

Proposed Implementation Date: September 2023

External Review Recommendations and Management Response

2.2-14 Develop a regulatory and water quality training program and a CIP progress update that occurs on a more frequent basis to teach plant staff in person to address this need to know.

Management Response: Agree

Proposed Implementation Plan: Austin Water will develop an informational and technical training program for facility engineers, process engineers, Operations support staff, and the Regulatory and Water Quality Manager. The training will be focused on regulatory requirements, water quality impacts, and capital improvement progress updates.

Proposed Implementation Date: September 2023

2.2-15 AW should report directly to the City Manager due to its criticality for both public health and safety as a critical infrastructure.

Management Response: Do Not Agree

Only recently did Austin Water return to the historical reporting relationship of reporting through an Assistant City Manager. Multiple variables inform the decisions of whether a department reports directly or indirectly to a City Manager, who must constantly evaluate the appropriateness of the entire organizational structure and make adjustments as necessary. While Austin Water is a critical infrastructure institution, its status and operations as such is not affected by whether it reports directly to the City Manager. If that were the case, all the municipalities across the country whose utilities report either through an ACM or Utilities Director would not meet that “requirement”. Regardless of direct reporting structure, it is important to note that ultimately all city operations report through, and are accountable to, the City Manager. There are many different organizational structures for municipal utilities across the country. Typically, water utilities in a Council-Manager form of government report to an Assistant City Manager. Different structures can be effective, depending on the people, standard operating procedures, delegation of authority, and communication protocols; the structure by itself doesn’t dictate success.

Proposed Implementation Plan: Not Applicable

Proposed Implementation Date: Not Applicable

2.3-1 Continue to recruit and retain skilled workforce across organization; prioritize filling vacant positions.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will continue to prioritize hiring in FY23, focusing on operational positions. We currently utilize 100+ recruiting sources, including industry and professional sites, job fairs, second chance hiring venues, veteran's organizations, and a variety of nationwide trade schools, colleges, and universities. We offer a generous referral bonus and new hire incentives. Austin Water has also promoted hiring opportunities through non-traditional methods, utilizing QR codes on fleet vehicles linked directly to job postings, as well as a large marketing banner facing I-35 on the side of our headquarters building.

Proposed Implementation Date: Ongoing

2.3-2 Replace existing protocol and have AW directly report to the City Manager. Similar recommendation found in section 2.4.

Management Response: Do Not Agree

As noted in in the response to Recommendation 2.2-15, only recently did Austin Water return to the historical reporting relationship of reporting through an Assistant City Manager. Multiple variables inform the decisions of whether a department reports directly or indirectly to a City Manager, who must constantly evaluate the appropriateness of the entire organizational structure and make adjustments as necessary. While Austin Water is a critical infrastructure institution, its status and operations as such is not affected by whether it reports directly to the City Manager.

Proposed Implementation Plan: Not Applicable

Proposed Implementation Date: Not Applicable

2.3-3 Train personnel for plant-specific knowledge. Employ at higher certification levels where necessary.

Important to note, the recommendation for this item was initiated by AW in March 2022 with the approval of technical trainers at each WTP. Staff were recently hired and an Onboarding program is being developed by the AW Ops/Certification Training team.

Management Response: Agree and Underway

External Review Recommendations and Management Response

Proposed Implementation Plan: Development of a training program focused on plant-specific information was initiated last year. This program will complement several other training initiatives, including certification and safety training, as well as our knowledge transfer program.

Proposed Implementation Date: March 2022

2.3-4 Enforce training on VEOCI for all personnel who need to work in the system.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will continue implementing an annual reporting and accountability process to ensure full compliance with our training and response requirements. This project began with the launch of a training tracking dashboard in 2021 and a quarterly training report in 2022. In 2023, additional accountability measures will be developed and implemented to enforce training requirements.

Proposed Implementation Date: September 2023

2.3-5 Continually exercise VEOCI system on small low-stakes or no consequence events to enable its effective and efficient use during high-profile or high-consequence events.

Management Response: Agree

Proposed Implementation Plan: Austin Water will finalize a new SOP for utilization of VEOCI for situational awareness. The revised SOP will be communicated to the organization through employee newsletters, staff meetings, and VEOCI training sessions. Austin Water's Emergency Management Division will collaborate with Operations and Engineering Services to identify a sample of low-stakes events in which employees' utilization of VEOCI will be evaluated.

Proposed Implementation Date: September 2023

2.3-6 Evaluate the current emergency planning and training available at each plant. Develop scenario challenges for training plant staff so that staff are engaged in the planning and become aware of expectations during emergency events.

Management Response: Agree

Proposed Implementation Plan: Austin Water's Emergency Management Division will work with Operations to evaluate current emergency planning and training at each plant. Scenario challenges will be developed to train water and wastewater operations staff. On-site scenario exercises will be included in Austin Water's annual training calendar beginning in FY 24.

Proposed Implementation Date: September 2023

2.3-7 **In advance of no-notice events, establish notification thresholds that are documented and understood by all staff to ensure effective response. These thresholds need to be applicable at all organizational levels (e.g., when is it appropriate to enter into VEOCI, escalate to top organizational levels).**

Management Response: Agree

Proposed Implementation Plan: Austin Water has well-documented notification thresholds in our Risk Guidance Criteria (which were developed across all business units), as well as the Decision Matrices for General Operations Conditions and Extreme Cold Conditions. Austin Water will train staff to promote understanding of notification thresholds at all levels of the organization. This training will be conducted in coordination with training on the SOP for utilization of VEOCI for situational awareness (see our response to Recommendation 2.3-5).

Proposed Implementation Date: September 2023

2.3-8 **In advance of no-notice events, establish notification thresholds that are documented and understood by all staff to ensure effective response. These thresholds need to be applicable at all organizational levels (e.g., when is it appropriate to enter into VEOCI, escalate to top organizational levels).**

Management Response: Agree

Proposed Implementation Plan: Austin Water already has well-documented notification thresholds in our Risk Guidance Criteria (which were developed across all business units), as well as the Decision Matrices for General Operations Conditions and Extreme Cold Conditions. Austin Water will train staff and promote understanding of notification thresholds at all levels of the organization. This training will be conducted in coordination with training on the SOP for utilization of VEOCI for situational awareness (see our response to Recommendation 2.3-5).

Proposed Implementation Date: September 2023

2.3-9 **Emergency incidents can be confusing, and it is important to communicate roles and responsibilities (beyond Executive Leadership) prior to events and immediately upon activating for incidents. Continued training for broad understanding across AW is** important.

Management Response: Agree

Proposed Implementation Plan: Austin Water will revise the Standard Operating Procedure for Incident Command and the Department Operations Center to clarify roles and responsibilities of the Incident Management Team (IMT). Roles and responsibilities in the revised SOP will be communicated through employee newsletters, staff meetings, and position-specific training for the Incident Management Team. Upon activating for incidents, roles and responsibilities will be communicated through position-specific checklists in VEOCI and through a standardized email to all Austin Water employees.

Proposed Implementation Date: July 2023

2.3-10 Reduce span of control to allow for more responsive organizational actions during emergencies. Recommended to have no more than 3-5 direct reports for the Director and all ADs.

Management Response: Do Not Agree

Austin Water's Department Operations Center (DOC) emergency management structures are well thought out and suitably structured to handle events that deviate from standard operations. Incident Management Team (IMT) roles and responsibilities have been adapted from lessons learned following activations, and the IMT closely follows FEMA's guidance and leadership structure. Austin Water's daily organizational structure, outside of emergency operations, has taken steps to enhance and elevate customer satisfaction, employee and leadership development, and emergency management. The Austin Water Director will continue to evaluate the appropriateness of the entire organizational structure to make adjustments as necessary.

Proposed Implementation Plan: Not Applicable

Proposed Implementation Date: Not Applicable

2.3-11 There need to be strong messages around the importance of bringing potential issues forward and prioritizing safety, and the training should be at the level expected of an HRO. There must be consequences for noncompliance, and corrective actions should be a norm. Recommendations in Section 2.3 discuss this as well.

Management Response: Agree

Proposed Implementation Plan: Remedial training for management of personnel focused on safety, conflict management, employee relations, goal setting, performance management, and performance reviews is planned for the entirety of FY23.

Proposed Implementation Date: Beginning Quarter 2 of FY23

2.3-12 AW should find avenues to increase purchasing capability and authority at the operations level to expedite rapid purchasing when not in an emergency for impending emergencies (e.g., purchasing pumps).

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water has authority to declare emergency purchasing conditions pursuant to Texas Local Government Code 252.022 a (2), which specifically exempts purchases necessary to preserve or protect the public health and safety of the municipality's residents. Austin Water has not hesitated to declare emergency purchasing conditions in response to recent emergency conditions. We used emergency purchasing conditions during the 2018 Colorado River Flood, during Winter Storm Uri, and in early 2022 to address a critical equipment failure at Ullrich. Austin Water will continue to work with Central Purchasing to utilize all available procurement avenues to expedite emergency purchases.

Proposed Implementation Date: Ongoing

2.4-1 Leaders and staff communicating on social media or press-conferences should be trained and coordinate efforts with the PIO staff at all times, but especially during non-routine events.

Management Response: Agree and Underway

Proposed Implementation Plan: Following recommendations from our Winter Storm Uri After Action Report, Austin Water worked with two local industry experts, Marjorie Clifton of Clifton Consulting and Jenifer Sarver of Sarver Strategies, to conduct Communications and Media Training workshops for the entire Executive Team and other managers throughout the organization. Workshop participants were selected based on their required interactions with media, or requests to provide regular briefings to Commissions and Council. The interactive training workshops have provided participants with a strong foundation of critical communications skills – especially in challenging environments. Two workshops were completed in 2022. Additional workshops are planned for 2023.

Proposed Implementation Date: Training will continue throughout 2023

External Review Recommendations and Management Response

2.4-2 The team needs to make conscious decisions concerning how they approach publishing information in languages other than English. Standard practices should be established.

Management Response: Agree and Underway

Proposed Implementation Plan: Required regulatory language for Boil Water Notifications has been translated into multiple languages, as well as standard guidance to Frequently Asked Questions. During an emergency event, translations for event-specific particulars are coordinated through the City's Communications & Public Information Office and teams on hand to support the City's Emergency Operation Center with services as needed. During normal operations, Austin Water works directly with City-approved contracted vendors to provide translation services of materials. Additional emergency notifications for Warn Central Texas and the My ATX Water customer portal are underway.

Proposed Implementation Date: September 2023

2.4-3 The Director and ADs, working with the PIO team during emergencies, should: (a) notify the City Manager of an emerging crisis or situation, (b) brief the City Manager of the immediate actions necessary and required to protect the public, (c) immediately move forward with decisions related to public communications. This is similar to the recommendation made in Section 2.2.

Management Response: Partially Agree

Emergency communication protocols should be regularly reviewed, especially after a significant event, to ensure processes are seamless and allow for timely and effective communication with the public. Equally important is ensuring that in all emergency incidents, the City communicates across all affected departments in one consistent voice. The City's processes will be reviewed to support this outcome.

Proposed Implementation Plan: The emergency communications protocols with the City Manager's Office will be reviewed to confirm a seamless, efficient, process is in place.

Proposed Implementation Date: February 2023

2.4-4 As AW continues to implement the My ATX Water program and its customer portal, AW should continue to plan and hire staff to handle more water (and wastewater) concerns.

Management Response: Agree and Underway

Proposed Implementation Plan: The My ATX Water program and customer portal is on target for full implementation and staffing by the close of Fiscal Year 2025. The portal has been successfully deployed for emergency notifications and communications, initially during Winter Storm Uri, and again during the February 2022 event. The customer portal will continue to play a significant role within Austin Water's public communication and plans and is identified as part of the emergency notifications process in the Incident Management Team Mobilization Plan for Austin Water's Public Information Office.

Proposed Implementation Date: September 2025

2.4-5 Allow AW to easily develop its own titles as appropriate for a critical infrastructure institution; or develop a process through the AW HR team to manage its titles, pay, and job scope.

Management Response: Partially Agree

The City of Austin is a complex organization with more than 40 departments. Centralized functions, with high level overview and authority to guide departments in regard to Human Resources, Finance, Purchasing, etc., help develop and maintain consistent operations across the enterprise. A centralized Human Resources Department is required by the City Charter and necessary to develop and maintain consistent operations across the enterprise. HRD places great importance on coordinating with individual departments to ensure to successful operations across the entire organization.

Proposed Implementation Plan: Austin Water will streamline roles, responsibilities, and timelines for improved service delivery through and with HRD according to the Charter.

Proposed Implementation Date: October 2023

2.4-6 Issue initial generic language (that is, template/pre-determined) to the public in all languages and then post detailed information after updates are made pertaining to that emergency.

Management Response: Agree

Proposed Implementation Plan: The Texas Commission for Environmental Quality has templates for required notifications specific to the circumstances of each event. For example, mandatory regulatory language for the 2018 Flood Boil Water Notice related to turbidity is different than the Winter Storm Uri Boil Water Notice regulatory language related to low system pressure/water loss.

Boil Water Notices can also be issued for identified contaminants, which require different regulatory notifications from other scenarios. While Austin Water attempts to prepare for all likely potential situations, it is important to recognize that timing issues may arise should specificity be needed for an unforeseen issue. Required regulatory language for Boil Water Notifications has been translated into multiple languages, as well as standard guidance to Frequently Asked Questions.

Proposed Implementation Date: September 2023

2.5-1 Review oil spill response plan and update it where needed, particularly with respect to current flow requirements, treatment plant facilities, suppliers of temporary equipment and costs.

Management Response: Agree

Proposed Implementation Plan: Austin Water will continue to review and update plans for spill responses as required, on a 5-year cycle. Our next update is scheduled for 2023.

Proposed Implementation Date: December 2023

2.5-2 AW should sponsor a study looking at the risks of more frequent and intense storms. Include an evaluation of LCRA's approach to management of the watershed during major storms and whether changes in their approach could positively impact water treatment challenges.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water will include surface water quality considerations in the planned 2024 update to the Water Forward Integrated Water Resource Plan.

Proposed Implementation Date: December 2024.

2.6-1 a) Align clarifier operations with distribution system demands and balance hydraulic load variation across on-line units.

b) Increase/improve communication between Pumping and Plant Operations.

Management Response: Agree and Underway

Proposed Implementation Plan: VEOCI allows enhanced communication between Pumping and Treatment Plants to document pump change requests and responses. Austin Water also is implementing a training program about pump change requests and associated implications to increase communication between these work groups.

Proposed Implementation Date: January 2023

2.6-2 a) Verify operational range of primary processes (UFCs) to enhance operational flexibility. Update SOPs based on findings.

b) Validate performance of primary processes over confirmed operational range via stress-testing. Update SOPs based on findings.

c) Concurrent with stress-testing, evaluate related process systems and complete condition assessments for PM and CIP planning.

d) Evaluate operational staffing (numbers and experience) requirements for operational range of process systems inclusive of normal and emergency conditions.

Management Response: Agree

Proposed Implementation Plan: Austin Water will develop a plan to test unit process equipment such as Upflow Clarifiers and modify any SOPs necessary based on test results. Additionally, any staff resource needs identified during testing will be incorporated into the Partnership for Safe Water Self-Assessment report for future planning requirements.

Proposed Implementation Date: September 2023

2.6-3 a) Conduct a seasonal backwash performance evaluation.

b) Define and implement a routine filter media monitoring program.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water continues to conduct filter performance assessments and monitoring programs as recommended by the Partnership for Safe Water or American Water Works Association Standards. As a result of ongoing evaluation, filter media were replenished or topped off to Ullrich WTP filters in Summer 2022.

Proposed Implementation Date: Ongoing

2.6-4 Centrifuge replacement recommended in the Ullrich Water Treatment Plant Solids Handling System Improvements, May 2020 report should be prioritized.

Management Response: Agree

Proposed Implementation Plan: Austin Water will evaluate the May 2020 report and prioritize recommendations related to the renewal of centrifuge equipment.

Proposed Implementation Date: February 2023

2.6-5 a) Engage AW teams to review coordination of operations for system flow changes with consideration of current staffing situations.

b) Consider internal/external resources to facilitate review of staffing assignments, action levels, communication protocols, and SOPs

c) Conduct simulations to train and maintain staff familiarity with assignments and procedures.

d) Conduct a post event debriefing with participating AW teams. Update SOPs and staffing assignments to reduce operational risk.

Management Response: Agree

Proposed Implementation Plan: Much of this recommendation relates to current staffing constraints for startup and online operations at higher production rates. Austin Water will continue to coordinate system operations and review protocols with internal support teams, including simulation of a planned peak load testing. Lessons learned from these simulations will be incorporated into SOPs.

Proposed Implementation Date: Summer 2023

2.6-6 a) Implement short-term assistance measures to remedy the PM backlog.

b) Verify staff training and identify to staff the position/role-specific benefits that the CMMS provides.

c) Evaluate long-term staff planning considerations; verify the current staff resource plan to confirm that defined positions, including current staff and proposed hires, are comparable to the facility needs.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water continues to address PM backlog by identifying priorities based on critical equipment and processes. Where there are staffing shortfalls, we identify internal and/or external services for preventative maintenance projects. Preventative maintenance staffing requirements are included during annual business needs planning and will incorporate any recommendations from the Partnership for Safe Water Self-Assessment for Water Treatment Plant Operations (see response to Recommendation 2.2-3).

Proposed Implementation Date: January 2023

2.6-7 Enhance understanding of the CIP process throughout the organizational levels so that critical projects are identified as soon as possible and are given priority to minimize operational risks.

Management Response: Agree

Proposed Implementation Plan: Austin Water will incorporate an enhanced plan to communicate priority projects based on operational risk.

Proposed Implementation Date: September 2023

2.6-8 Remediate Upflow Clarifier No. 5 launder and verify launder elevation uniformity for all units.

Management Response: Agree

Proposed Implementation Plan: Austin Water will evaluate Upflow Clarifier No. 5 and provide a corrective action to launder elevation uniformity. Additionally, basin inspections will continue to include this task as they are taken down for annual preventive maintenance.

Proposed Implementation Date: February 2023

2.6-9 Review prior lime feed and delivery system condition assessment(s) and their findings with plant staff to confirm their stated concerns. Identify remaining issues, if any, and determine response actions.

Management Response: Agree

Proposed Implementation Plan: Austin Water's plant management staff will coordinate with Engineering to review prior lime feed and delivery system conditions assessments to determine if any issues are outstanding. The resulting action plan to address these issues will be communicated with plant staff and any immediate concerns related to mechanical, electrical, or instrumentation will be captured in Austin Water's work order management system.

Proposed Implementation Date: March 2023

2.6-10 The disinfection process is critical for water treatment; continue Ullrich WTP Conversion project as currently scheduled, with efforts taken to minimize any delays.

Management Response: Agree

Proposed Implementation Plan: Austin Water continues to evaluate and implement inherently safer chemical technologies to protect our employees and the community. Austin Water will work to identify areas that will improve the quality of the conversion project to enhance delivery of a reliable and safe system.

Proposed Implementation Date: December 2025

2.7-1 Establish a consistent backwash procedure and teach it to all staff, impressing on them the need to be consistent in treatment operations. Develop appropriate, readily accessible SOPs for backwashing and other critical operations.

Management Response: Agree

Proposed Implementation Plan: An established backwash procedure for Ullrich WTP is available for staff within Austin Water's electronic Operations & Maintenance platform, which was excerpted and published in the G100 standard for Water Treatment Plant Operations and Management (2011). A review and update of the SOP is underway and SOP navigation training will be performed as described in our response to Recommendation 2.2-4.

Proposed Implementation Date: February 2023

2.7-2 Evaluate the cost of continual polymer feed and compare to the cost of extra training for staff on how to start up polymer feed when needed. Implement extra training if the latter is found to be cost efficient.

Management Response: Agree

Proposed Implementation Plan: Austin Water will evaluate the cost and efficiency of operating polymer on an intermittent versus continuous basis to achieve priority water quality goals.

Proposed Implementation Date: September 2023

External Review Recommendations and Management Response

2.7-3 Identify possible future scenarios, study such scenarios, identify possible solutions, and plan implementation programs for possible and probable future water quality and treatment challenges. Include all subsequent effects from decisions that are being made regarding water quality and treatment. Recommended scenarios include:

- **PFAS occurrence in finished water**
- **Oil spill into the lakes**
- **Climate change impacts (cold and hot)**
- **Flood water management**

Management Response: Agree

Proposed Implementation Plan: Future risk scenarios will be incorporated into the Risk and Resilience Assessment and Emergency Response Plan required by America's Water Infrastructure Act. Harmful Algal Blooms and cyanotoxin risk assessment and response plans were recently completed and will be incorporated into annual emergency response plan updates.

Proposed Implementation Date: October 2023

2.7-4 Re-evaluate the scope and status of capital projects at the plant based on more comprehensive condition assessments and communication with plant staff.

Management Response: Agree

Proposed Implementation Plan: Austin Water reevaluates capital projects as new condition assessments are performed, including communicating to plant staff, and incorporating results into the annual capital planning process.

Proposed Implementation Date: March 2023

2.8-1 Confirm that all level monitors and controls in storage tanks in the distribution system are working properly. If not, repair and/or replace.

Management Response: Agree and Underway

Proposed Implementation Plan: Austin Water performs station checks throughout the distribution system on a routine basis to determine if level monitors or controls are out of service. Work orders are generated in Austin Water's maintenance management system to perform corrective actions.

Most recently, the December 2022 freeze generated corrective work orders, which have already been completed.

Proposed Implementation Date: December 2022

2.8-2 Increase/improve communication between Pumping and Plant Operations, especially with regard to flow changes.

Management Response: Agree and Underway

Proposed Implementation Plan: VEOCI allows enhanced communication between Pumping and Treatment Plants to document pump change requests and response. Austin Water also is implementing a training program about pump change requests and associated implications to increase communication between these work groups.

Proposed Implementation Date: January 2023

2.8-3 Develop additional pathways for water supply to reach south pressure zones.

Management Response: Agree

Proposed Implementation Plan: Austin Water is updating our Water Distribution Long-Range Plan and will explore opportunities to enhance water supply to south pressure zones.

Proposed Implementation Date: Initiate January 2023

2.8-4 Continue to implement plans for communicating ways to manage water loss in premise plumbing during freeze events.

- Consider taking advantage of Advanced Metering Infrastructure technology
- Implement recommendations from upcoming consultant review of water loss programs

Management Response: Agree

Proposed Implementation Plan: Following Winter Storm Uri, Austin Water enhanced our winter messaging to help the community prepare for and respond to extreme freeze events. Additionally, Austin Water recognizes the role Advanced Metering Infrastructure can play in situational awareness and disaster resiliency and has developed a winter analysis dashboard to track leaks, bursts, and zero consumption. This will play a vital role in how we analyze customer impacts during winter weather. Austin Water will also evaluate and implement recommendations through the Water Loss Program Review.

Proposed Implementation Date: Evaluation of Water Loss Program begins in FY23

The Office of the City Auditor was created by the Austin City Charter as an independent office reporting to City Council to help establish accountability and improve City services.

Support from the Office of the City Auditor Provided by:

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