BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In Re: Application for increase in water and wastewater rates in Alachua, Brevard, DeSoto, Highlands, Lake, Lee, Marion, Orange, Palm Beach, Pasco, Polk, Putnam, Seminole, Sumter, Volusia, and Washington Counties by Aqua Utilities Florida, Inc.	)))))))	DOCKET NO. 080121-WS Dated: November 19, 2008

REBUTTAL TESTIMONY

OF

PRESTON LUITWEILER

on behalf of

Aqua Utilities Florida, Inc.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

AQUA UTILITIES FLORIDA, INC.

REBUTTAL TESTIMONY OF PRESTON LUITWEILER

DOCKET NO. 08121-WS

Q. What is your name and business address:

A. My name is Preston Luitweiler. My business address is 762 W. Lancaster Avenue, Bryn Mawr, Pennsylvania 19010.

Q. Have you previously submitted testimony in this proceeding?

A. No.

Q. By whom are you employed and in what capacity?

A. I am Vice President and Chief Environmental Officer of Aqua Services, Inc.

Q. Please describe your education and business experience.

A. I have a B.S. degree in Civil Engineering from Drexel University and an M. S. in Environmental Engineering from Drexel University. I am a licensed Professional Engineer in Pennsylvania. I have worked for Aqua (and its predecessor, Philadelphia Suburban Water Company) for 24 years in various capacities, including Design Engineer, Research Engineer, Manager of Research, Vice President, Water Resources, and presently Vice President and Chief Environmental Officer.

Q. What are your duties as Vice President and Chief Environmental Officer?

A. I am responsible for water quality and environmental compliance for Aqua facilities in 13 states, including Florida. I supervise Aqua's corporate environmental compliance staff and central laboratory in Bryn Mawr, and provide indirect supervision to state and regional environmental compliance personnel who report to state and regional presidents.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to address and respond to water quality issues raised by Kimberly H. Dismukes who prefiled testimony in this case on behalf of the Office of Public Counsel.

Q. Are you sponsoring an exhibit to your rebuttal testimony?

A. Yes, I'm sponsoring Exhibit PL-1.

Q. Ms. Dismukes addressed water quality issues in Chuluota. Can you generally comment on the water quality issues that she raises?

A. Yes. Ms. Dismukes overlooks the fact that the raw water from the four wells in the Chuluota system is difficult to treat, and has presented treatment challenges for decades, long before AUF acquired the system in July 2004. The fact that AUF inherited these water quality issues when it acquired the Chuluota system was recognized by residents and State Officials in their testimony at the public input hearings.

Q. Before you address details of Ms. Dismukes' testimony regarding water quality, can you generally describe disinfectants and disinfection byproducts?

A. Disinfectants are an essential element of drinking water treatment because of the barrier they provide against waterborne disease-causing microorganisms. The most commonly used disinfectant for primary disinfection of drinking water is chlorine applied as gaseous chlorine or as liquid chlorine bleach. Either form of chlorine produces free chlorine in water. Another common disinfectant is a form of chlorine called combined chlorine, or chloramine. Both chlorine and chloramines are commonly used as residual disinfectants to maintain disinfection in a water utility's distribution system.

Disinfection byproducts (DBPs) form when disinfectants used to treat drinking water react with naturally occurring organic carbon in the water. Total trihalomethanes (TTHMs) are a type of disinfection byproduct formed during disinfection with chlorine and chloramine. As a general rule, free chlorine generally forms more of these DBPs than are formed with chloramines.

Q. Can you explain what chloramination is?

A. Chloramination is the use of chloramines as a disinfectant, usually to maintain a disinfectant residual in public water supply distribution systems. Ammonia and chlorine are added to water at carefully controlled levels to form chloramines, also referred to as combined chlorine residual. Chloramines are weaker than free chlorine as a primary disinfectant, but they are effective for maintaining a disinfectant residual in a distribution system and they do not continue to form DBPs in the distribution system.

Q. Has AUF implemented chloramination at Chuluota?

A. Yes. The FDEP issued a consent order in December 2006 requiring AUF to implement chloramination. As I've stated, chloramination typically reduces levels of certain by-products of chlorination.

Q. Can you briefly describe the challenges in treating the raw water in Chuluota?

A. Yes. The water in Chuluota contains high levels of hydrogen sulfide. This must be removed by air stripping or oxidized by chlorination to control "rotten egg" taste and odor in the distribution system. The tray aerators at both of the water treatment plants in Chuluota remove about 20% of the hydrogen sulfide at the prevailing operating conditions and pH of the water from the Chuluota wells.

The remaining hydrogen sulfide requires high doses of free chlorine to treat. This high dose of chlorine also reacts with moderate levels of natural organic carbon in the water and produces TTHMs. The TTHMs continue to be formed in the distribution system unless the disinfectant is changed to chloramines after primary disinfection. This is what Florida Water Service tried to do in the treatment process prior to Aqua's acquisition of the system. Unfortunately, in Florida's climate, and with residual elemental sulfur in the treated water, the distribution system became very vulnerable to nitrification – a condition where all chlorine residual is lost and where metal sulfides can be formed and released in the system creating "black water." These were the prevailing conditions in the Chuluota system in July 2004 when Aqua acquired the system. At that time, the primary water quality issues were a loss of residual disinfectant, discolored water, and taste and odor. Aqua quickly addressed these conditions with reversion to free chlorine. However, free chlorine also caused higher levels of a chlorine disinfection by-products in the system. As you can see, it is somewhat of a balancing act.

Q. Are there other challenges in treating the raw water quality in Chuluota that Ms. Dismukes overlooks?

A. Yes. One very important system management tool to control nitrification, and to respond to "black water" conditions, is aggressive and extensive flushing of the distribution system. AUF is limited in the amount of water it has access to. The Consumptive Use Permit (CUP) from the St. Johns River Water Management District restricts the amount of water that can be withdrawn from the Chuluota wells, limiting the frequency, duration and volume of flushing that can be done to manage and maintain the distribution system.

Q. Does Ms. Dismukes take those treatment challenges into account in her prefiled testimony?

A. No.

Q. Please explain what method the Company is currently using to disinfect the Chuluota raw water.

A. The Company is utilizing free chlorine in the ground storage tanks for primary disinfection, and combined chlorine, or chlormination, in the distribution system to minimize the formation of TTHMs in the distribution system. Sufficient chlorine, in the form of bleach (sodium hypochlorite) must be fed into the ground storage tanks after the tray aerators so that a minimum free chlorine residual can be measured at the outlet of the tank. This residual value is the value FDEP requires utilities to use to monitor and calculate primary disinfection effectiveness. If the chlorine residual is lost in the tank, there is also a risk of nitrification occurring in the tanks.

After the ground storage tank, the chlorine residual is boosted and then immediately "quenched" with ammonia to form chloramines. This process must be carefully controlled to prevent overfeeding of chlorine or ammonia. In the system Aqua had designed and installed in 2007, this is done automatically with residual analyzers that continuously measure free chlorine and total chlorine levels, and chemical dosing pumps that are adjusted continuously to meet flow and chemical demand.

Q. Can you briefly explain how a water system becomes out of compliance for TTHMs?

A. Yes. All water systems are required to test their water initially at least once a year for TTHMs at locations in the distribution system that have been selected to represent potential worst case conditions for the formation of TTHMs. Results are compared with the U.S. Environmental Protection Agency drinking water standard, or Maximum Contaminant Level (MCL) of 80 micrograms per liter (or parts per billion). If initial annual testing shows elevated levels of TTHMs, then samples are collected and tested quarterly. When the Running Annual Average (RAA) of all quarterly test results exceeds the MCL, the system is in violation of the standard. In Chuluota's case, when AUF converted the system to free chlorine, a sample for TTHMs tested above the MCL, and in subsequent quarterly sampling, the RAA exceeded the MCL.

Q. What is the current status of the water quality in Chuluota?

A. TTHM results in the distribution system have been below the MCL for two successive quarters. The RAA is still slightly above the MCL.

Q. How does a system come back into compliance?

A. To return to compliance, the RAA must fall below the MCL. In Chuluota's case, TTHM results in the distribution system have been below the MCL for two successive quarters, but the RAA remains slightly above the MCL.

Q. What other tests have been taken since the public input hearings?

A. On August 4, 2008, Florida DEP and Florida Rural Water Association took samples at six sites throughout the Chuluota distribution system monitoring for nitrate, nitrite, *E. coli*, total coliform, and Heterotrophic Plate Count. All samples were negative for all parameters tested. The purpose of this sampling was to ensure that disinfection was being maintained in the distribution system and nitrification was being controlled while the system was being prepared to return to chloramination.

On August 5, 2008, the Florida Department of Health collected samples of raw water at the four Chuluota production wells. The purpose of that testing was to determine whether or not there was any contaminant heretofore untested present in the raw water. All samples came back negative for a wide array of analytes for which testing was done.

Q. Has AUF conducted tests at Chuluota subsequent to the public input hearings?

A. Yes. On July 25, 2008, AUF collected similar raw water samples from the wells and sent them to Aqua's central laboratory in Bryn Mawr. Sensitive broad-range screening tests were done for a wide array of potential possible contaminants, and nothing was found to suggest any kind of contamination of the wells except for naturally occurring sulfides.

I would also note that AUF has retained Dr. James Taylor, a renowned scientist and researcher in water treatment chemistry, processes and technology. AUF has engaged Dr. Taylor to assist in evaluating the challenges of water treatment at Chuluota.

On September 5 and September 10, 2008, students from the University of Central Florida (UCF) under Dr. Taylor's supervision conducted raw water and process control tests at the Chuluota wells and water plants. The testing provided a baseline for levels of naturally occurring hydrogen sulfide in the raw well water, and performance of the tray aerators.

In September, Dr. James Taylor recommended an extensive protocol for testing distribution samples to monitor for early signs of nitrification. Since September 25, sampling and testing has been conducted weekly at seven locations in the distribution system by Aqua personnel.

Q. Can you report on any updated progress for the Chuluota water system

since filing Mr. Franklin's supplemental direct testimony?

A. Yes. As mentioned in Mr. Franklin's supplemental direct testimony, AUF purchased new analyzers for the chloramination system. The analyzers are testing instruments that provide continuous feedback on the levels of disinfectant at critical points in the treatment process. The analyzers provide a signal that is used by the process control computer to adjust the chemical doses to achieve optimum levels for maintaining disinfection and controlling TTHM formation. Because of the challenging raw water quality at Chuluota, the treatment processes are a delicate balancing act, and must be adjusted frequently to react to changes in raw water quality, water temperature, and system demand that all affect the levels of disinfectant residual at various points in the process. Too much chlorine, or excessive detention time in the presence of free chlorine can result in elevated TTHMs. Too little chlorine in the ground storage tank, too little chloramine or too much ammonia at the point of entry can lead to nitrification in the distribution system and episodes of "black water."

Q. Has AUF taken other proactive steps to address the quality of water in and around Chuluota?

A. As I previously stated, AUF has engaged Dr. James Taylor to assist in addressing the challenges of water treatment at Chuluota. Dr. Taylor reviewed the work that had been done by AUF's staff, our consulting engineer, Boyd Environmental, and other consultants. He recommended special sampling, and arranged for graduate students at UCF to conduct thorough baseline sampling at both Chuluota water plants. He prepared a report summarizing his findings (ASR1), a copy of which is attached to this testimony as Exhibit PL-1. That report was reviewed with FDEP on October 31, 2008. Dr. Taylor has also evaluated data when the system was returned to chloramination in September, and made recommendation on process changes such as the target chlorine to ammonia ratio at the treatment plants.

Dr. Taylor continues to advise AUF and has established an extensive distribution system sampling protocol to evaluate the treatment process and distribution system operation, guide distribution system flushing, and provide early warning of nitrification conditions.

Dr. Taylor is also collaborating with Boyd Environmental in evaluating additional treatment process alternatives to improve removal of sulfides in the raw water and reduce chlorine demand and disinfection by-product formation.

I also note that since July 2004, AUF has added 14 automatic flushing valves in the distribution system. These automatic valves flush predetermined amounts of water from the dead ends during hours of low use to keep the water from stagnating in the mains. These are critical for maintaining water quality at dead ends and extremities of the distribution system where nitrification would otherwise first occur.

AUF has also designed, bid, and awarded a contract to provide new water mains to loop some of the dead ends of the distribution system to avoid stagnation of water in the system and improve flows.

AUF has also applied and received Florida DEP approval for a carbon dioxide (CO2) system at the Chuluota water plant #2. Because of the unique water quality in Chuluota, everything we can do to improve the raw water quality ahead of the disinfection processes gives us greater flexibility in the chemical balancing act required to meet the multiple competing goals of water treatment in this system. As stated previously, the raw water in Chuluota contains high levels of hydrogen sulfide. Adding CO2 ahead of the tray aerators at water plant #2 will lower the pH of the water in the aerators and in this way greatly improve the removal of hydrogen sulfide in the aerators. With less hydrogen sulfide in the raw water, less chlorine will have to be added to react with the sulfides that remain. Lowering the chlorine dose will lower the TTHM formation.

Q. Can you comment on Ms. Dismukes' reference to coliform bacteria in Chuluota?

A. Yes. As is standard procedure for any water utility company, AUF tests for coliform bacteria. There was one instance where we received a positive sample for coliform bacteria. I agree with Mr. Prather's testimony that it is not uncommon for samples to test positive for bacteria [Oviedo Service Hearing Transcript Page 134]. I also agree with Mr. Prather that further tests were done and the samples came back negative. We have not had any further problems with this issue.

Q. Can you please provide an update on AUF's negotiations with the City of Oveido?

A. I have not been directly involved in the negotiations with the City, but I understand that Mr. Franklin will be providing an update in his rebuttal testimony.

Q. Finally, can you please give a brief update on the MCL violation in The Woods?

A. The Woods is a small system with one well that a previous owner had equipped with an unconventional iron removal filtration system constructed of precast concrete tanks. The configuration of the system resulted in highly variable detention times and operational challenges for controlling chemical doses and disinfection. These factors along with raw water quality, variability of system demand, and the configuration of the distribution system, resulted in occasional high levels of DBPs in water samples from the distribution system. In the first quarter of 2006, the Running Annual Average of test results for TTHMs exceeded the MCL.

In 2007, Aqua designed a new, more conventional pressure greensand filter treatment system. Construction of the new system was completed in June 2008. Samples collected in September 2008 tested below the MCL for TTHMs at 39.4 ppb.

Q. Does that conclude your rebuttal testimony at this time?

A. Yes.

James S. Taylor, Ph.D.
1630 Wood Duck Drive
Winter Springs, FL 32708
Email: taylor@mail.ucf.edu
Phone: 407-366-36561
Cell: 407-701-5314

Kimberly Joyce, Esq.,
Manager, Rates and Regulatory Relations
Aqua Services, Inc.
762 W. Lancaster Avenue
Bryn Mawr, PA 19010

October 25, 2008

Reference: Chuluota Water Distribution Water Quality Review

Dear Ms Joyce,

Please find my initial Activity and Status Report (ASR1) following this letter in the corresponding efile.

The ASRs will provide a summary of my activities and interpretation of my work in the Chuluota Project. Please contact me if there are any questions regarding these reports.

Sincerely

Chuluota WTP and DS Project

Introduction

This document is the initial Activities and Status Report (ASR-1) on the activities and interpretation of J. S. Taylor, Ph.D. for evaluating the Chuluota Water Treatment Plant (WTP) and Distribution System (DS) project.

When Aqua acquired the Chuluota system in 2004, the primary water quality issue was nitrification in the distribution system resulting in loss of residual disinfectant, discolored water, and taste and odor. Aqua quickly addressed these conditions with reversion to free chlorine. Aqua also subsequently made improvements to the plants and distribution system.

Free chlorine, high chlorine demand of the raw water, and long retention times in the storage tanks and distribution system continued to result in formation of disinfection by-products (DBPs) which exceeded the THM MCL. Results for HAAs have always been below the MCL. Reduction in THMs to achieve compliance with the MCL while simultaneously maintaining distribution system water quality are the primary focuses of current work.

Statement of Work

The statement of work is to provide the following services with regard to the specific bulleted tasks.

Consulting services to evaluate operations and alternatives that address the water quality issues of the distribution system including hydrogen sulfide, DBP formation, system discolored water, odor complaints, low chlorine residuals and nitrification in the storage tanks and distribution system. Some of the specific items included in this work include:

- Evaluate water quality testing data; recommend additional testing or monitoring if appropriate
- Evaluate operational data and records
- Visit and inspect the existing facilities; review plans, processes and operations; assess performance of facilities and treatment
- Obtain and review information on water quality and treatment system design and performance for water systems in the area that might have faced similar challenges
- Provide advice to one or more engineering consultants on the design of additional facility improvements if appropriate
- Provide written and verbal reports to Aqua or their designee as requested.

Activities

Activities to date have focused on control of DBPs and problems associated with nitrification. Initial investigations revealed no other immediate treatment or distribution system issues. The following activities were completed:

Plant Investigation

Plant investigation consisted of review of existing plant and distribution system water quality. These reviews found WTPs 1 and 2 were essentially fundamental Florida groundwater (GW) plants in that the plants were designed to pump and treat GW by aeration, chlorination and storage. Raw water quality typically consists of 3 meq/L of alkalinity and calcium hardness, and 400 mg/L of TDS. Low or no HPCs have been reported in the raw water. The two WTPs are similar in that both are equipped with Tray Aerators and initially added free chlorine in the down stream following tray aeration. Hydraulic retention time (HRT) in the storage tanks was estimated to vary from 8 hours to 2 or more days based on consumer demand. Free chlorine coupled with the dissolved organic content (DOC) measured at 1.4 to 2.4 mg/L as C resulted in formation of disinfection by-products (DBPs) which exceeded the stage 1 THM MCL. Results for HAAs were below the stage 1 MCL.

THM formation in WTPs 1 and 2 led to the installation by Aqua earlier this year of a chloramination system utilizing automated pre- and post-chlorine and post-ammonia feeds with continuous monitoring of chlorine residuals at multiple points in the process. The system was initially set to operate at a 4/1 Cl_2/NH_3 ratio. TTHM results in the distribution system were below the MCL following the start-up of the system. Difficulties were encountered with the combined chlorine analyzers. Long detention times with free chlorine in the storage tanks, particularly at WTP 2, remained a challenge. After a few months of operation, an episode of nitrification occurred in the distribution system which required a temporary reversion to free chlorine.

New analyzers were installed and chloramination was started again in September. The target Cl_2/NH_3 ratio was adjusted to operate as closely as possible to 5/1 Cl_2/NH_3 to reduce nitrification in the DS. The control system could be modified to control Cl_2 feed on both chlorine residual and ammonia concentration; however such modifications may not be necessary if the free ammonia concentration leaving the plants can be controlled to less than 0.05 mg/L as N. This level of free ammonia is used by utilities in FL and CA, and has been recommended in the literature (Taylor et al., AwwaRF 2009), and lower (0.025 mg/L as N) by Fleming et al. (JAWWA, Oct. 08). The nitrification process has also been modeled by Liu et al., JAWWA 2005 using a similar approach based on intermediate formation of complexes in microbiological processes. (Liu et al., Aqua, 2005).

In September, DBP formation in the storage tanks was reduced by reducing the HRTs. Modeling of the effect of time on THM formation indicated the Chuluota DS HRT averaged from 24-48 hours and reduction of the storage tank to 4-16 hours would reduce THM formation by 10 to 50 %. The THM reduction achieved has been approximately 30% under the current water temperature conditions (27 °C). Water temperature will drop and water demand will increase during the winter months, both of which should help reduce THM formation. However, THM control will remain a challenge during at least six months of the year.

Another treatment challenge at Chuluota is the presence of sulfides in the raw water. The tray aerators at both WTPs intended to remove hydrogen sulfide have only a limited effect on sulfides at Chuluota. Addition of free chlorine after aeration forms sulfur from the remaining sulfides. Colloidal elemental sulfur contributes to turbidity in the treated water and can form iron and copper sulfide when exposed to either metal in distribution systems. This process has been described in the literature, (Lyn and Taylor, JAWWA, 1993). The resulting sulfide films are not hard and provide an opportunity for biofilm growth. These deposits can be released into the bulk water resulting in occurrence of "black water" in distribution systems. This process is almost impossible to avoid if free chlorine is used for removal of sulfides and chloramines are used for residual maintenance in the distribution system in a setting like Chuluota where nitrification can occur in the distribution system.

Distribution System

Distribution system maintenance is essential in a system like Chuluota that uses chloramination for residual disinfection in the distribution system in order to anticipate and respond to potential episodes of nitrification and to maintain DS water quality. A draft monitoring and action plan has been developed for the Chuluota system. The plan recommends specific distribution system monitoring and corresponding actions if certain triggers are reached.

Water Quality Testing

Extensive water quality analyses were conducted at both WTPs by Aqua and graduate students from UCF under my direction. Levels of DOC were relatively low, as previously noted. Levels of sulfides were high (2-4 mg/L as S) in all four wells at the two WTPs. Measurement of sulfides in the raw water and throughout the trays at WTP 2 found approximately 20% sulfide removal through tray aeration for normal operation. Reducing flow through the aerator from 600 to 300 gpm increased the sulfide removal to approximately 33%. Total removal of sulfides is possible with very high HRTs in aeration; however very high HRTs are not feasible in Tray Aerators. The remaining sulfide levels were between 1.4 and 2.7 mg/L. The remaining sulfides had to be oxidized by chlorine in the ground storage tanks, leaving colloidal elemental sulfur in the water, which is detrimental to distribution system water quality.

The results of water quality testing have guided the operation of the existing treatment plants and distribution system, the monitoring and action plan for the distribution system, and recommendations for additional treatment improvements.

Treatment System Investigation

Implementation of chloramination, reduction in storage tank HRT and trimming of the Cl_2/NH_3 ratio have resulted in TTHM results in the distribution system below the MCL for two successive quarters. Careful operation of treatment and the distribution system has maintained disinfectant residual and DO, low HPCs and good water quality at all points in the Chuluota DS. These achievements are significant accomplishments by Aqua operations personnel. It might be possible to sustain these efforts without additional treatment, but this will require a continued high level of staffing and operating costs long term. Extensive flushing and periodic reversion to free chlorine disinfection would be necessary under this scenario. There is no guarantee that this approach would reliably achieve compliance with DBP MCLs and avoid occurrences of nitrification, with accompanying episodes of "black water" and taste and odor.

Alternatively, treatment improvements to improve sulfide removal before chlorination and to reduce HRT under free chlorine should reliably achieve compliance with DBP MCLs and avoid episodes of nitrification in the distribution system.

Aqua was already pursuing a full-scale pilot implementation of a CO_2 injection system at WTP 2 to enhance removal of sulfides through the aerator at this plant. In the course of evaluating and designing the process, additional alterations have been proposed that will reduce the HRT in the ground storage at WTP 2. A construction permit was received from FDEP in late September for the proposed system improvements. The process is summarized below:

- CO_2 Tray Aeration

  CO_2 adjustment of pH is used with aeration for removal of sulfides and offers the advantage compared to pH adjustment using mineral acids that it does not destroy alkalinity (an important factor for control of copper corrosion). The efficacy of CO_2 addition prior to tray aeration is unknown. The current aeration pH is near 7.6. Reducing the pH to ~6.7 prior to aeration will significantly increase the percentage of sulfides in the H_2S form that can be removed in the aerators. Some sulfides may remain following CO_2 addition and tray aeration, which would be converted to elemental sulfur by chlorination.'' Since sulfides are lower in water from the wells at WTP 2, this process has the best chance of working at WTP 2, especially in conjunction with the other process changes proposed.

At Aqua's request, I have been working with their consulting engineer, Jim Boyd, and Aqua water quality staff in Leesburg, FL and Bryn Mawr, PA to evaluate additional treatment options for sulfide removal should the CO_2 tray aeration pilot prove ineffective at WTP 2 or inappropriate for implementation at WTP 1. Review of a preliminary assessment of process alternatives resulted in identification of three potential additional processes for sulfide treatment at Chuluota listed below:

- Thermax Ion Exchange

  Thermax ion exchange is specific for sulfide and DBP precursor removal. This process appears to be well-suited for Chuluota and has the efficiency advantages of counter current column application. This system is used at Lantana FL and Pembroke Pines FL for color and DOC removal.
- Miex Ion Exchange

  Miex ion exchange is also specific for sulfide and DBP precursor removal, and is well-suited for Chuluota. This process utilizes a fluidized bed and hence the resulting co-current application is less efficient than column applications. This system is used at Wedgefield FL for color and DOC removal.
- Adedge

  Adedge makes several different medias that offer catalytic oxidation and removal of sulfides. They specifically have recommended a MnO_2 media preceded by chlorination. This process is somewhat similar to a GAC/Cl_2 process that was developed by OUC for sulfide removal in the late 80s and later abandoned in favor of ozonation.

Other alternatives including forced draft packed tower aeration, ozone, UV, RO/NF membrane filtration and GAC/Cl_2 were considered and rejected as ineffective or inappropriate for application at Chuluota.

Summary

Aqua has proceeded diligently and prudently in addressing the water quality challenges in the Chuluota system. Aqua has achieved two quarters of TTHM results below the MCL. Careful operation of treatment and the distribution system has maintained disinfectant residual and DO, low HPCs and good water quality at all points in the Chuluota DS.

The following tasks in my scope of work have been accomplished:

- Review of the WTP processes and confirmation of DBP and elemental S formation as immediate treatment needs.
- Interaction with Aqua concerning chloramination protocols and needs
- Measurement of existing water quality at WTP 1 and 2; evaluation of existing tray aerator performance for sulfide removal.
- Development of a DS monitoring and action protocol
- Evaluation of proposed CO_2 sulfide removal treatment system for WTP 2 and additional alternatives for further evaluation.

References

Suibing Liu, J. S. TAYLOR, and David Webb, “Water Quality Profiles during Nitrification in a Pilot Distribution System Study”, *Journal of Water Supply: Research & Technology – AQUA,* vol.54 (2005) pp. 133-145.

Suibing Lui, J.S. TAYLOR, A.A. Randall, and John Dietz, “Nitrification Modeling in Chloraminated Distribution Systems”, *JAWWA*, vol. 97 no. 10 (2005) pp. 98-108

Taylor, J.S. et. Al, “Control of Distribution System Water Quality in a Changing Water Quality Environment Using Inhibitors”, *AWWARF Report*, Scheduled for Publication Jan, 2009

Fleming K. K., Harrington G. W., Noguera, D. R., Using Nitrification potential curves to evaluate full-scale drinking water distribution systems, JAWWA, 100:10, Oct., 2008

Carrico, B. A., Digiano, F. A., Love, N. G., Vikesland, P., Chandran, K, Fiss, M and Zaklikowsi A., Effectiveness of switching disinfectants for nitrification control. JAWWA, 100:10, Oct. 2008

Lyn, T. L. and TAYLOR, J.S., "Turbidity Control Following Hydrogen Sulfide Chlorination", *JAWWA*, vol. 84 no. 1 (1993) pp. 68-78.