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Results of the Modified Comprehensive Performance Evaluation of the South Sangamon Water Commission Water Treatment Plant Sangamon County, Illinois

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Acknowledgements

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South Sangamon Water Commission Commissioners Ruth Bottrell, Craig R. Hall, and Joel Sanders were helpful in furnishing information and assistance to the MCPE Team. Terry Burke's term as a Commissioner expired on 8 April 2016, and he was quick to be available and furnished considerable assistance to the MCPE Team. The Commissioners were diligent, prompt, and courteous each of the many times information was requested by the Team.

Village President Tom Gray, Chatham, and Village President Steve Frank, New Berlin assisted in arranging interviews and coordination with private citizens and their respective Water Departments. Patrick McCarthy, Interim Village Administrator and GIS/IT Manager, Village of Chatham, assisted in coordination of activities in Chatham, and Mary Pfeffer assisted in coordination of activities in New Berlin. Thanks to Chatham Water Dept. employees Dustin Patterson and J.D. Crawford, and to Tom Bliss, New Berlin Supt. of Water & Sewer, for sharing information about their respective water distribution systems.

Two citizens at Chatham and two citizens at New Berlin agreed to participate in private interviews to inform the MCPE Team about their concerns and complaints about water quality. These citizens were courteous and candid, and their participation contributed to the Team's understanding of problems being encountered.

The IEPA Division of Laboratories agreed to perform special testing for process control, and test results were not for compliance. Lead and Copper were analyzed in first-draw samples collected at two elementary schools in Chatham and one residence in Chatham and at the elementary school and two residences in New Berlin; bacteriological tests were performed on first-draw samples collected downstream from household filters and residences and Village Halls at Chatham and New Berlin. Kelly Turpin, Illinois EPA Quality Assurance Manager, Illinois EPA Division of Laboratories Quality Assurance Officer, was instrumental in arranging these tests. Julie Gebhardt assisted in coordinating the sampling and analyses.

Mary Reed, IEPA Division of Public Water Supplies, assisted by furnishing Consumer Confidence Reports (CCRs) for South Sangamon Water Commission, Village of Chatham, and Village of New Berlin.

Dave McMillan, P.G., Manager – IEPA Division of Public Water Supplies, and David Cook, P.E., Acting Manager – IEPA Division of Public Water Supplies Permit Section, and Regional Manager – IEPA Division of Public Water Supplies Springfield Regional Office, assisted in furnishing records for water quality and facilities – and unselfishly made themselves available for consultations during the entire MCPE endeavor, despite having to simultaneously deal with emergency conditions at other locations in the State. Anthony Dulka of the IEPA Division of Public Water Supplies furnished background information about the aquifer that supplies raw water to South Sangamon Water Commission.

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Abbreviations, Acronyms

CCR	Consumer Confidence Report
CCT	Corrosion Control Technology
CDA	Copper Development Association
CPE	Comprehensive Performance Evaluation
CPP	Composite Correction Program
CT	= mg/L chlorine residual x effective contact time (Aids in defining disinfection efficiency for inactivation or killing of potentially harmful organisms.)
CTA	Comprehensive Technical Assistance
Cu	Copper
CWS	Community Water System
DBPs	Disinfection By-Products, including THM_4 and HAA_5
DPWS	(IEPA) Division of Public Water Supplies
Fe	Iron
GWUDI	Ground Water Under Direct Influence (of surface water)
HAA_5	5 Haloacetic Acids that are regulated in drinking water.
HRT	Hydraulic Retention Time
IDPH	Illinois Dept. of Public Health
IEPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board (a)
LDB	Legionnaire's Disease Bacteria
MCL	Maximum Contaminant Level
MCPE	Modified Comprehensive Performance Evaluation
mg/L	Milligrams per Liter (interchangeable with ppm)
Mn	Manganese
OCCT	Optimal Corrosion Control Technology
Pb	Lead
ppb	Parts per Billion (by weight, interchangeable with ug/L)
ppm	Parts per Million (by weight, interchangeable with mg/L)
SSWC	South Sangamon Water Commission
TDS	Total Dissolved Solids
THM_4	4 Trihalomethanes that are regulated in drinking water.
TTHMs	Total Trihalomethanes (used interchangeably with THM_4)
ug/L	Micrograms per Liter (used interchangeable with ppb)
WTP	Water Treatment Plant

(a) Reference is made herein to the "Illinois Pollution Control Board regulations", which are at Illinois Administrative Code Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter I: Pollution Control Board.

Reference is made herein to "Ten State Standards", which is Recommended Standards for Water Works, Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Ontario, Pennsylvania, Wisconsin), 2012 edition. Adopted by the IPCB as a regulatory "design standard" applicable to Illinois CWS.

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Background

SSWC (South Sangamon Water Commission) supplies treated water to Village of Chatham, Village of New Berlin, and customers located along the treated water transmission mains between the water plant (located east of Rochester) and Chatham, and between Chatham and New Berlin. The Commission began delivering water to its customers in May 2012.

When SSWC operations commenced, water quality complaints developed, particularly in Chatham. New Berlin did not report significant problems, although customer complaints were received by the Village. Prior to obtaining water from SSWC, the Village of Chatham purchased treated water from the City of Springfield. Neither the SSWC system nor the City of Springfield have experienced drinking water violations from IEPA, but the chemical characteristics of the water changed at Chatham when they obtained water from SSWC, as shown below.

	Typical Value	
Parameter	SSWC	City of Springfield
Hardness, as $CaCO_3$	120 mg/L	120 mg/L
Alkalinity, as $CaCO_3$	280 mg/L	40 mg/L
pH	7.5-8	8.5-9
Total Dissolved Solids	400 mg/L	150-200 mg/L
Form of Chlorine Residual	Free	Monochloramine

The increased Alkalinity and Total Dissolved Solids in water from SSWC do not have any known adverse health effects, and the reduction in pH is not considered to represent an abnormal condition. The characteristics of SSWC water are very similar to many other community water supplies in Illinois. Nevertheless, some of the customers consider the water to be different and objectionable.
Water supplied by SSWC has complied with requirements of regulatory agencies and there have been no water quality violations.

Prior to connecting to the SSWC transmission main, the Village of New Berlin operated its own surface water-type treatment plant. Their plant had been in service for many years, and problems were sometimes encountered due to variations in the quality of raw water supplied from a side-channel reservoir.

A significant portion of the water mains in both New Berlin and Chatham utilize unlined cast iron pipe, and new water mains and replacement mains utilize PVC pipe. Apparently, the change in water characteristics upset the equilibrium in the older sections of cast iron pipe, and caused release of previously formed corrosion by-products (sometimes referred to as "tuberculation") and protective calcium carbonate scale that had accumulated over many years of service. The characteristics of each of the different water sources were individually considered to be acceptable, but even a minor change in water characteristics can disturb the interior surfaces of old, cast iron water mains, resulting in water quality complaints.

After customer complaints about presence of particulate matter and discoloration persisted, a product known as Oracle was purchased from Water Solutions Unlimited, and was applied for circulation in the water mains in Chatham from January to June 2014. Information furnished to the MCPE Team by Water Solutions Unlimited indicated that Oracle "… is created through an electrolysis process that creates hypochlorous acid as the primary product produced. This product acts primarily as a scale control product as the neutral charge attacks the biofilm and helps dislodge them from the distribution (interior water main) surfaces." A permit was obtained from IEPA to introduce this NSF-approved product into the water mains. During the period of treatment with Oracle, particulate matter was reportedly released from the interior surfaces of the water main pipes. Some of the particulate matter reportedly entered household plumbing systems and created problems for the residents, and at the same time the Village engaged in a water-main-flushing program with the goal of removing the particulate matter from the water mains.

After the interior water main treatment operations with Oracle were terminated at Chatham, customer complaints about scale formation in hot water heaters reportedly developed, and customer complaints about discoloration in the water increased. In retrospect, the reported hot water heater problems may have intensified because of (1) reported earlier inconsistencies in hardness reduction at SSWC's treatment plant during initial startup operations and (2) possibly due to some homeowners not being aware that manufacturers of hot water heaters recommend maintenance procedures that includes regularly-schedule draining of the tanks to remove accumulated solids released from the water due to changes in water characteristics at elevated temperature in hot water heaters. In the meantime, customer complaints were voiced about water faucets and metal sink drains being corroded by the water. And, complaints about "black spots and black water" in toilet tanks and toilet bowels persisted.

SSWC attempted to address some of these problems by feeding a polyphosphate blend, but complaints about corrosion and discoloration continued. In August 2015, SSWC switched to a phosphate blend corrosion inhibitor purchased from Water Solutions Unlimited; the blend was reportedly 50%

orthophosphate and 50% polyphosphate. Water Solutions Unlimited installed metal pipe coupons at the SSWC and at the Chatham ground storage reservoir to monitor the results of the phosphate blend for corrosion mitigation. The blend was later changed to 70% orthophosphate, 15% sodium tri-polyphosphate, 15% sodium hexametaphosphate. An IEPA permit was obtained to feed each of the phosphate blends, and each blend is NSF-approved for use in potable water applications.

During the last several months, additional customer complaints were received - alleging that hair loss and skin rashes were occurring because of the water. Other persons complained about gastrointestinal problems that they attributed to the water. These complaints are considered to be serious, and cause concern for everyone. The MCPE Team is not qualified to address medical concerns, and requested assistance from Illinois Dept. of Public Health and Center for Disease Control and Prevention, as described under the Inquiries section of this report.

The complaints about "black spots" and "black discoloration" in the water were being attributed to presence of Manganese in the water. Manganese was in fact present in the water at concentrations greater than the 0.05 mg/L USEPA Secondary Water Quality Standard. Presence of Manganese at concentration even less than 0.05 mg/L can lead to customer complaints about discoloration, because the Manganese can settle and accumulate in water mains during low flow conditions – and be re-suspended during increased flow, which carries the particles to the residents' plumbing system.

It was reported that a portion of the Manganese was being removed by the ion exchange water softeners at the SSWC water treatment plant. IEPA objected to use of the treatment plant water softeners for Manganese removal because the Manganese might eventually foul the ion exchange resin and cause operational and water quality problems. In February 2016, SSWC began feeding sodium permanganate to oxidize the Manganese that is present in the raw water from the wells.

As customer complaints persisted, citizens groups formed to present a united front for their complaints about water quality. News media coverage intensified, and the situation at Chatham came to the attention of Lisa Bonnett, Director, Illinois Environmental Protection Agency (IEPA). Subsequently, IEPA issued a directive to SSWC to proceed with a Comprehensive Correction Program (CCP), in a letter dated February 22, 2016.

On March 9, 2016, an informal "kickoff" meeting was held with representatives of IEPA, SSWC, Woodard & Curran (contractual Operators engaged by SSWC to manage the day to day operation of the water treatment plant), and Curry & Associates Engineers, Inc. to commence with arrangements for the CCP to proceed. On March 14, 2016, Andy Curry, P.E., submitted a proposal to SSWC outlining the proposed scope of services for proceeding with the first step of the CCP, with Curry & Associates Engineers, Inc. serving as coordinators. SSWC concurred with the proposal, and work commenced on the first step of the CCP, namely the Modified Comprehensive Performance Evaluation.

Composite Correction Program (CCP) Background

The CCP is an approach initially developed by the U.S. Environmental Protection Agency (U.S. EPA) to improve the performance of filtration plants and achieve compliance with the Surface Water Treatment Rule (SWTR). It is a systematic, comprehensive procedure to identify the unique combination of factors in the areas of design, operation, maintenance, and administration that are limiting performance. The CCP consists of two components: a Comprehensive Performance Evaluation (CPE), and a facilities correction procedure called Comprehensive Technical Assistance (CTA).

The CPE provides a comprehensive assessment of whether existing unit process capabilities, administrative support, and maintenance practices support a capable plant that, with proper operation, can provide safe and reliable drinking water. It also includes an assessment of the plant staff's ability to effectively apply process control principles that are critical to proper operation. The CPE provides an assessment of the plant's major unit treatment processes; and other design, operation, maintenance, and administrative factors that may be limiting performance.

IEPA has directed South Sangamon Water Commission to conduct a **Composite Correction Program (CCP)** pursuant to Section 611.160(a) of Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 611.160(a)). IEPA requested the CCP in light of ongoing consumer concerns expressed by residents within the Chatham community water supply distribution system. The Illinois EPA directed that the Commission engage the services of an outside third party contractor to conduct the CCP on behalf of the Commission.

Pursuant to 611.160(a), a CCP consists of two elements, namely a **Comprehensive Performance Evaluation (CPE)** and a **Comprehensive Technical Assistance (CTA).**

The Handbook, Optimizing Water Treatment Plant Performance Using the Composite Correction Program, ("Handbook") USEPA, Publication EPA/625/6-91/1027, revised August 1998, provides guidance for performing the CCP. The "Handbook" focuses on treatment of surface water. Since the Commission obtains raw water from wells and does not employ coagulation and clarification processes for turbidity removal, a **Modified Comprehensive Performance Evaluation (MCPE)** was deemed acceptable to IEPA as the first step of the CCP. The primary objective of the MCPE is to identify any performance limiting factors that may adversely impact compliance with regulatory drinking water standards and overall water quality. "A CPE is a performance-based evaluation and, therefore, factors should only be identified if they impact performance." (Ref. p. 35 of "Handbook")

The Team performing the MCPE consists of Andy Curry, P.E., and Capt. Michael D. Curry, P.E. of Curry & Associates Engineers, Inc.; Shane Hill - Public Utilities Manager and General Foreman, Village of Chatham; and John Bartolomucci with IEPA's Springfield Regional Office, Division of Public Water Supplies.

In addition to reviewing the South Sangamon Water Commission facilities, the MCPE includes a brief review of the water distribution and storage facilities owned and operated by the Village of Chatham and the Village of New Berlin. Since each Village has its own water storage and distribution system, their operation and maintenance procedures can affect water quality.

An objective of the MCPE is to provide direction for the plant to achieve optimized performance. IEPA will determine whether or not South Sangamon Water Commission must proceed to "step 2" of the CCP, namely the **CTA (Comprehensive Technical Assistance).**

Basis of Performance Assessment

A component of the MCPE is the assessment of the SSWC water treatment plant's ability to meet optimized performance goals. Optimized performance goals, for purposes of this MCPE, represent performance that exceeds the current minimum requirements for protection from microbial contamination and secondary drinking water standards. The recommended performance goals are listed below.

- "Drinking water professionals have long known that the most effective way to protect consumers from the risk of contamination and waterborne disease is through a multiple barrier approach. This approach sets up a series of technical and managerial barriers that ensure a safe drinking water supply and guard against waterborne disease outbreaks. The multiple barrier approach provides "defense in depth" against waterborne pathogens and chemical contaminants that can cause a variety of illnesses and conditions, some of them potentially fatal. By erecting barriers against these contaminants at each step in the process from raw, untreated source water to the delivery of treated finished water, system owners and operators can protect the health and well-being of the people who rely on them for potable water." (Ref: Sample Collector's Handbook, IEPA.)

  At present, SSWC's treatment plant is designed to utilize the following types of barriers against microbial contamination:

  1. Use of chlorine as a disinfectant, and maintenance of at least 0.2 mg/L free chlorine residual in all active parts of the system.
  2. Operation of the membrane filters to deliver filtered water turbidity less than 0.15 NTU (Nephelometric Turbidity Units), as required by the original operating permit issued by IEPA.
  3. Maintenance of membrane integrity based on the monitoring required by the original operating permit issued by IEPA.
  4. Bacteriological samples collected from SSWC, Chatham, and New Berlin.

- "National Secondary Drinking Water Standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. USEPA recommends secondary standards to water systems but does not require systems to comply." (Ref: Sample Collector's Handbook, IEPA).

  The National Secondary Drinking Water Standards include the following parameters considered to be of concern at SSWC:

Contaminant	Secondary Standard	Recommended SSWC Performance Goal	
Corrosivity	Noncorrosive	Note A.	
Manganese	0.05 mg/L	0.03 mg/L	Note B.
Iron	0.3 mg/L	0.02 mg/L	Note C.
pH	6.5-8.5	Note D.	
Total Dissolved Solids	500 mg/L	Note E.	

Note A

For first-draw samples collected from residences under the Lead and Copper Rule:

For Lead, the existing regulations indicate that the 90^{th} percentile cannot exceed the AL (Action Level) concentration of 15 ug/L (or, 0.015 mg/L). It is recommended that SSWC strive to not exceed the MCLG (Maximum Contaminant Level Goal) of 0 ug/L; and, as a minimum, it is recommended that SSWC strive to not exceed 15 ug/L in **100%** of the samples collected for compliance demonstration.

For Copper, the existing regulations indicate that the 90^{th} percentile cannot exceed the AL (Action Level) concentration of 1.3 mg/L. It is recommended that SSWC strive to not exceed the MCLG (Maximum Contaminant Level Goal) of 1.3 mg/L; and, as a minimum, it is recommended that SSWC strive to not exceed 1.3 ug/L in **100%** of samples collected for compliance demonstration.

Note B

The Secondary Standard and recommended goal for Manganese are based on aesthetic considerations to minimize customer problems with water discoloration and staining. Section 611.300 of the Illinois Pollution Control Board regulations establishes a 0.15 mg/L maximum Manganese concentration, but that standard is not considered to be applicable when full scale treatment is being provided, like at SSWC. Historically, the 0.15 mg/L Manganese concentration has typically been applied to unfiltered groundwater systems that add a sequestering agent to minimize precipitation of insoluble Manganese that would be a source of water discoloration and staining.

Note C

The Secondary Standard and recommended goal for Iron are based on aesthetic considerations to minimize customer problems with water discoloration and staining. During 2015, Iron concentration in the treated water typically did not exceed 0.02 mg/L concentration. Section 611.300 of the Illinois Pollution Control Board regulations establishes a 1.0 mg/L maximum Iron concentration. Historically, the higher concentration has typically been applied to unfiltered groundwater systems that add a sequestering agent to minimize precipitation of insoluble Iron that would be a source of water discoloration and staining.

Note D

If SSWC continues to use an orthophosphate corrosion inhibitor to optimize its corrosion control program, the recommended optimum pH and orthophosphate dosage will be verified after review by USEPA.
(See Request for Assistance from USEPA under Inquiries section.)

Note E

SSWC's water treatment plant does not include equipment or processes to reduce TDS (Total Dissolved Solids). The present TDS concentration of SSWC's treated water is approximately 400 mg/L. If homeowners elect to install privately owned and operated sodium-cycle cation exchange home water softeners, it is possible that the TDS concentration will be increased, which is beyond the control of SSWC.

> In the sodium-cycle cation exchange water softening process, two Sodium atoms (molecular weight = 2 x 22.99 = 45.98) replace one Calcium atom (molecular weight = 40.078) … which increases TDS (45.98 – 40.078 = 5.932 mg/L); two Sodium atoms (molecular weight = 2 x 22.99 = 45.98) replace one Magnesium atom (molecular weight = 24.305) … which increases TDS (45.98 – 24.304 = 21.675 mg/L).

Presence of Manganese in the treated water at concentrations above 0.05 mg/L is considered to be objectionable since it causes discoloration and the particulate residue has an objectionable appearance. Widespread consumer complaints have been received about discoloration and presence of "blackish" particulate matter. Manganese naturally occurs in surface water and groundwater, and is not harmful to public health at concentrations below the 0.3 to 1.0 mg/L range (A). SSWC water Manganese concentrations are far below the 0.3 to 1.0 mg/L range. When present above 0.05 mg/L concentration, consumer complaints about discolored water are reported and public confidence in the safety of the water is eroded. It is recommended that SSWC adopt a goal to consistently deliver treated water with Manganese concentration below 0.03 mg/L.

(A) Drinking Water Health Advisory for Manganese, USEPA, January 2004, EPA-822-R-04-003.

Customer complaints about "black water" can also be caused by sulfide corrosion of copper or iron piping. (Ref.: Tech Brief, Corrosion Control, National Drinking Water Clearinghouse.) In an aerobic environment in presence of chlorine residual, it is unlikely that sulfide corrosion could occur, which requires "reducing" conditions. On the other hand, if a home filtration unit contains carbon – it will remove (adsorb) chlorine residual and the potential exists for heterotrophic bacterial growth to occur … potentially to the point where dissolved oxygen could be depleted … which could result in conversion of sulfate (SO_4^{-2}) ion to sulfide (S^{-2}) . If copper piping would be exposed to these unusual conditions, then "black water" may be formed. Extensive testing in private residences would be required to determine if "black water" complaints are due to sulfide corrosion of copper pipe. It is further noted that routine Lead and Copper compliance samples are not collected from locations that utilize home water treatment devices, because the devices may alter water quality and not be representative of water quality from the CWS (Community Water System).

It is suspected that Manganese may have accumulated in the water mains in Chatham and New Berlin, as well as in the SSWC transmission mains. Even with treated water Manganese concentration of 0.03 mg/L, it is conceivable that a percentage of the Manganese may settle out in the water mains and be susceptible to re-suspension under increased flow conditions, causing "surges" or "spikes" of Manganese to enter household plumbing systems. To minimize customer complaints about Manganese discoloration and particulate matter in the water entering their homes, it is necessary to routinely and vigorously flush the water mains to "flush-out" the accumulated particles from the water mains on a regularly scheduled basis. Each community customer is responsible for its own flushing program, including design of the flushing pattern to utilize uni-directional flushing in order to improve overall water quality.

Data Review

Consumer Confidence Reports (CCRs)

The following background information is included about CCRs.

> "The guiding principle behind consumer confidence reports (CCRs) is that all people have the right to know what is in their drinking water and where it comes from. The CCR provides an opportunity for water suppliers to educate consumers about the sources and quality of their drinking water and to involve them in decisions about it. U.S. EPA has revised its public notification requirements to speed up notification of serious health threats, and simplify notification of other violations. Consumers who are familiar with the basic drinking water information in CCRs will be able to participate more effectively in these processes. The reports will not only help consumers to make informed choices that affect the health of themselves and their families, they will encourage consumers to consider the challenges of delivering safe drinking water. Educated consumers are more likely to help protect drinking water sources and to be more understanding of the need to upgrade the treatment facilities that makes their drinking water safe. … In 1996, the U.S. Congress and the President amended the Safe Drinking Water Act. They added a provision requiring that all community water systems deliver to their customers an annual water quality report. The law specifies certain contents for the reports, and requires water systems to distribute these reports to all of their customers. … The reports are based on calendar year data. Beginning in the year 2000, systems must deliver reports for the previous year by July 1."
>
> Ref.: http://www.epa.illinois/gov/topics/compliance-enforcement/drinking-water/consumer-confidence-reports/index

Exhibit 1 presents a summary of 2014 and 2015 water quality parameters from the CCRs for New Berlin, Chatham, and SSWC. There were no water quality violations reported, and MCL's (Maximum Contaminant Levels) were not exceeded for DBPs (Disinfection By-Products), Inorganic Chemicals, Radionuclides, and other parameters. And, Lead and Copper concentrations did not exceed the USEPA AL (Action Level) in SSWC, Chatham, and New Berlin. Lead and Copper results from the CCRs are repeated below for convenience of the reader.

Location	*90th Percentile*				*Sites Over AL*
	2014		*2015*		
	Cu	*Pb*	*Cu*	*Pb*	
SSWC	*0.752 ppm*	*7 ppb*	*0.803 ppm*	*4.04 ppb*	*0*
Chatham	*0.83 ppm*	*2.7 ppb*	*0.662 ppm*	*ND(a)*	*0*
New Berlin	*0.15 ppm*	*1.3 ppb*	*0.1 ppm*	*ND (a)*	*0*
AL	*1.3 ppm*	*15 ppb*	*1.3 ppm*	*15 ppb*	

(a) ND indicates non-detected. If the 90% value for lead is non-detected, it is not required to be included on the CCR.

AL Indicates "Action Level"; if 90th percentile Lead concentrations are below 15 ppb, no action is required; if 90th percentile Copper concentrations are below 1.3 ppm, no action is required.

ppb Indicates Parts per Billion; equivalent to ug/L (micrograms/Liter)

ppm Indicates Parts per Million; equivalent to mg/L (milligrams/Liter)

It is noted that the "draft" 2015 CCR documents for Chatham and New Berlin make no mention of Lead. This is because it is not "required" to report results for Lead if it was non-detected in samples collected during the reporting period. Absence of CCR information about Lead in Chatham's water apparently contributed to a citizen complaint that the Village was "withholding" Lead results, which unfortunately has contributed to erosion of public confidence. It is recommended that both Chatham and New Berlin consult with IEPA to seek permission to add to their CCRs information for all "non-detected" parameters, including Lead. Since neither Chatham nor New Berlin are directly responsible for monitoring source water parameters included with SSWC's CCR, the SSWC CCR information has apparently not reached the consumers at Chatham and New Berlin. Expanding the contents and distribution of CCR information is recommended.

It is further noted that the actual 2014 and draft 2015 CCR documents for SSWC make no mention of other non-detected parameters such as Cyanide, VOCs (Volatile Organic Compounds), SOCs (Synthetic Organic Chemicals including herbicides and pesticides), and other non-detected potential drinking water contaminants that are regulated. The IEPA test results for these parameters were reviewed, and they all were "non-detected".

Bacteriological Results

IEPA spreadsheet summaries of bacteriological results for 2012-2015, inclusive, for SSWC, Chatham, and New Berlin were reviewed. No violations were noted, and no violations were reported for either SSWC, Chatham, or New Berlin. And, all reported water distribution system chlorine residual tests were in compliance for the same period for each of the entities.

IEPA Water Quality Monitoring

IEPA furnished copies of spreadsheets showing water quality monitoring results for raw water from the SSWC wells, treated water delivered by SSWC, and samples from the Chatham and New Berlin distribution systems. Review of that information indicated that no water quality violations have occurred. It is noted that Nitrite and Nitrate levels are far below their MCLs (Maximum Contaminant Levels). Water from the wells has not contained VOCs, SOCs (herbicides, pesticides), Mercury, Chromium, MTBE, or other contaminants. DBPs (TTHM, HAA5) have been below their MCLs in all samples collected from the SSWC transmission main service area, Chatham, and New Berlin. Lead and Copper have been below the USEPA Action Level (AL) in all samples collected from the SSWC transmission main service area, Chatham, and New Berlin.

The SSWC water treatment plant has a primary objective to remove Iron and Manganese to levels below 0.3 mg/L and 0.05 mg/L, respectively. It is noted that the MCPE recommends that the SSWC treatment process goals should include reduction of Iron and Manganese to below 0.02 mg/L and 0.03 mg/L, respectively.

Raw water Iron and Manganese concentrations were measured by IEPA in samples collected from the SSWC wells in January 2016, and results are shown as follows, along with private laboratory results from 2012 when the wells were originally constructed.

Raw Water Iron and Manganese Concentrations

	IEPA Data, January 2016		Original Data, 2012	
Well No.	Fe, mg/L	Mn, mg/L	Fe, mg/L	Mn, mg/L
1	2.43	0.235	2.3	0.139
2	1.71	0.272	2.1	0.181
3	1.38	0.17	1.56	0.0992
4	1.73	0.235	2.58	0.14
5	0.279	0.19	0.557	0.146
6	0.607	0.261	0.916	0.233
7	1.01	0.123	1.35	0.132
8	0.53	0.074	1.01	0.139
9	0.668	0.375	1.20	0.286
10	0.183	0.0591	0.256	0.0953

The variations in Iron and Manganese concentrations from the individual wells are naturally-occurring, and may vary day to day, week to week, etc. as indicated on the SSWC Water Treatment Plant Monthly Operating Reports discussed below.

IEPA test results for Iron and Manganese in samples collected from the SSWC Plant Tap are shown below.

Treated Water Iron and Manganese Concentrations, IEPA Testing

	SSWC Plant Tap (Treated Water)	
Date	Fe, mg/L	Mn, mg/L
25 Jan 2016	0	0.0287
12 Oct 2015	0	0.0175
9 July 2015	0	0.0213
20 Jan 2015	0	0.0227

The IEPA testing results shown above indicated that Iron (Fe) was not detected and Manganese (Mn) was below the 0.05 mg/L secondary MCL.

SSWC Water Treatment Plant Monthly Operating Reports

Like all water treatment plants in Illinois, SSWC records information on water production, chemicals used and dosages, testing results for controlling water quality parameters, and related information. The MCPE Team reviewed the SSWC monthly reports for each month in the year 2015. Areas of interest are summarized below.

Operating Report Review – Treatment Plant Effluent Chlorine Residual

Month	Chlorine Residual, Reported Range, mg/L	Calculated/Reported Sodium Hypochlorite Dosage Range, mg/L
January	0.8-1.4	1.69-3.62
February	1.0-1.3	2.13-3.56
March	0.5-2.0 (a)	1.45-3.55
April	0.8-1.3	2.36-3.58
May	0.9-1.5	1.84-3.77
June	1.0-1.5	2.36-3.65
July	1.0-1.8	0.35-4.81
August	1.1-1.4	1.57-4.20
September	1.2-1.3	2.25-3.69
October	1.2-1.3	2.22-3.55
November	1.0-1.7	1.67-4.02
December	1.2-1.6	2.07-3.94

(a) The 2.0 mg/L chlorine residual reading was recorded on March 10, 2015. On the previous day, the recorded chlorine residual was 0.5 mg/L, and on the next day the recorded chlorine residual was 1.2 mg/L. This variability suggests that there may be a physical process limitation since the chlorine dosage was 2.95 mg/L on March 10, 2015, and the dosage was 3.33 mg/L on the previous day and 3.36 mg/L on the next day.

The range of chlorine residual variability suggests the possibility that the sodium hypochlorite feed rate into the high service pump suction line has not been consistently proportional to high service pump flow rate? The reported dosage range variations seem to be extreme for treatment of groundwater normally expected to have fairly consistent water quality and low chlorine demand following the membrane filters and softeners.

Operating personnel are aware that liquid sodium hypochlorite loses strength when stored onsite for long periods of time, especially during warm temperature periods, and operating personnel reported that their goal is to assure that sodium hypochlorite dosage is sufficient to provide the desired chlorine residual leaving the treatment plant. The variability in the treatment process appears to be due to equipment limitations beyond the control of the Operators.

The 250 gpm high service pumps are not in service due to unconfirmed problems, and the 1150 gpm high service pump flow rate is expected to vary from 1150 gpm down to very low flows when Chatham is not receiving water and during night-time hours when customer usage along the transmission main is low. See additional discussion under Chemical Feed Paced by High Service Pump Flow Rate from Clearwell to Transmission Main in **Major Unit Process Evaluation and Performance Description.**

Operating Report Review – Raw Water Iron and Manganese Variations

Month	Reported Range, Raw Water	
	Fe, mg/L	Mn, mg/L
January	0.6-1.1	0.15-0.22
February	0.4-1.6	0.16-0.32
March	0.5-1.3	0.17-0.38
April	0.5-1.5	0.16-0.25
May	0.6-1.17	0.202-0.228
June	0.5-1.1	0.16-0.22
July	0.5-1.3	0.18-0.21
August	0.52-1.51	0.187-0.22
September	0.67-0.88	0.210-0.231
October	0.48-0.89	0.193-0.254
November	0.64-1.57	0.208-0.251
December	0.59-0.93	0.222-0.238

The daily raw water Iron and Manganese variability poses a process control challenge when using sodium permanganate as an oxidant fed into the detention/reaction basin influent line.

Operating Report Review – Treated Water Manganese Concentration Range, 2015

Month	Reported Range, Treated Water Concentration, mg/L	
January	0.005-0.049	
February	0.017-0.501	0.501 reading on 11 February 2015, abnormal?
March	0.018-0.060	
April	0.016-0.044	
May	0.017-0.048	
June	0.023-0.068	
July	0.021-0.063	
August	0.032-0.056	
September	0.035-0.055	
October	0.037-0.045	
November	0.036-0.061	
December	0.036-0.060	

It is desired that Manganese concentration in the treated water not exceed 0.05 mg/L, but this concentration was exceeded on several occasions. It is recommended that SSWC adopt a goal for treated water Manganese concentration not to exceed 0.03 mg/L. Information on the Manganese removal process is presented in the section for **Major Unit Process Evaluation and Performance Description.**

The 2015 Operating Reports indicate that Iron concentration in the treated water is typically below 0.02 mg/L, which is below the 0.3 mg/L secondary MCL concentration range that should not be exceeded to avoid discoloration problems associated with presence of Iron in the treated water. If "reddish" water complaints are lodged, the cause is usually associated with release of iron from the interior surfaces of old, unlined cast iron pipe, and flushing is normally required to resolve the problem until it occurs again. Communities have a goal to replace old, unlined cast iron water mains, but economic constraints slow the replacement process.

During 2015, the raw and treated water hardness concentration range is shown below.

Operating Report Review – Raw and Treated Water Hardness Concentrations

Month	Reported Range, Raw Water mg/L Hardness (a)	Reported Range, Treated Water mg/L Hardness (a)
January	348-370	114-140
February	342-366	116-130
March	340-380	116-128
April	260-368	118-138
May	248-366	104-130
June	348-372	112-122
July	246-378	106-174
August	356-372	110-126
September	356-370	114-166
October	360-370	116-130
November	358-368	114-126
December	360-370	112-136

(a) Expressed as equivalent $CaCO_3$.

Values in ...... are significantly different from the values for the previous and following days for unknown reasons. Determining total hardness by titration method does not necessarily yield "precise" results, and a significant variation in an individual raw water hardness test suggests that it be re-tested. Similarly for any significant variation in treated water hardness, and if the re-test results are still significantly different from the "120 mg/L" treated water hardness goal, then the cause should be investigated. Presence of hardness in the treated water does not pose any particular concern about "safety of the water", but the customers expect a consistent hardness concentration in the treated water.

Operating Report Review - Chemical Feed

Calculated/reported Fluoride and Phosphate dosages varied considerably during 2015, as indicated in the following summary.

	Calculated/Reported Dosage Feed Range, mg/L	
Month	Fluoride	Phosphate
January	0.11-0.70	0.35-2.09
February	0.38-0.79	0.31-2.04
March	0.37-0.99	0.22-1.99
April	0.29-0.98	1.05-2.13
May	0.12-1.43	0.7-2.27
June	0.22-2.40	0.52-2.13
July	0.39-1.44	0.61-2.47
August	0.80-1.79	0.41-2.32
September	0.44-2.01	0.90-1.66
October	0.47-1.80	0.57-1.57
November	0.09-1.58	0.74-1.15
December	0.03-1.10	0.43-1.49

Each of these chemicals is fed in liquid form using a metering pump that discharges into the high service pump suction line supplied from the clearwell. Each pump is "paced" to feed proportional to high service pump discharge flow rate. The high service pumps are VFD (Variable Frequency Drive), and pump into a closed system to maintain a constant pressure with downstream variable demand and flow rate. At times, the high service pump flow rate drops to very low levels, and at other times the flow rate is much higher. Control of metering pump flow rate with the existing configuration is (1) not working and (2) potentially cannot be made to work.

The dosage/feed rate for Fluoride and Phosphate should be consistent, but the dosages have varied considerably. Additional information about these feed systems is presented in **Major Unit Process Evaluation and Performance Description** under "Chemical Feed".

Inconsistent Fluoride readings have been experienced in the treated water. It is now required to maintain Fluoride ion concentration between 0.65 to 0.74 mg/L. Fluoride concentration was reportedly measured at 0.79 mg/L at the plant, and was reportedly measured at 0.462 mg/L by IDPH, on 23 February 2016. SSWC treatment plant Fluoride readings have consistently been different from IDPH readings. State and treatment plant ("Site") Fluoride test results are shown on Exhibit 2, and inconsistencies are evident. Additional information about the Fluoride feed arrangement is presented in **Major Unit Process Evaluation and Performance Description** under "Chemical Feed".

Water "Stability" Monitoring

"Water stability" refers to the tendency for treated water to either have tendency to form scale or to be corrosive. Current IEPA regulations do not require water treatment plants in Illinois to perform any specific tests to monitor water stability, and SSWC (like many plants in Illinois) does not perform process control tests pertaining to water stability.

It is recommended that SSWC monitor water stability conditions since it is important to understand the characteristics of water delivered to the customers. (See item 5 under Performance Limiting Factors, South Sangamon Water Commission section.

Filtered Water Turbidity and Particle Count Monitoring

The original construction permit for the SSWC, dated December 23, 2010, includes requirements for "indirect integrity testing" for the membrane filters. Monitoring requirements set forth in that permit are stated as follows:

1. "Continuous monitoring of the membrane filtrate quality shall be done through the use of turbidimeters and particle counters."
2. "Monitoring must be conducted at a frequency of at least one reading every 15 minutes."
3. "If the continuous indirect integrity monitoring results exceed the specified control limit for any membrane unit for a period greater than 15 minutes, direct integrity testing (pressure decay) must be immediately conducted on that unit."
4. "The control limit for turbidity monitoring is 0.15 NTU."
5. The control limit for particle counters shall be established within 6 months of start of operation of the membranes, utilizing procedures recommended in the USEPA Membrane Filtration Guidance Manual or an alternative method approved by the Agency."

Turbidimeters and particle counters are provided, but results are not reported to IEPA. Additional information is presented in the **Major Unit Process Evaluation and Performance Description** section below under "Membrane Filters".

Inquiries

Private Citizen Interviews

The MCPE Team conducted private interviews with citizens residing in Chatham and New Berlin. The Team explained the purpose of the MCPE and indicated that the reason for the interview was to gain information about consumer complaints about water quality. It was emphasized that the MCPE procedure is intended to identify any performance limiting factors that may interfere with SSWC's goal to provide high quality water to all persons served from their water treatment plant, and it is not the Team's objective to "find fault or place blame". Citizens were notified that their identify would remain confidential, but that their complaints would be summarized in the MCPE findings.

The MCPE Team conducted private interviews with two (2) citizens residing in Chatham, via telephone and speaker phone. This interview procedure was requested by the individual citizens. Findings from the interviews are summarized as follows:

<u>Chatham Citizen 1</u>

When Chatham started receiving water from SSWC in 2012, gray rings were noticed in the toilet bowls, and there were black spots present in the toilet water tanks. Toilet bowl flush valves had to be replaced, and the toilet water tank contained red/black sediment with persistent black streaks. A plumber informed the citizen that mold was present in the toilet water tank. In 2012, calcium buildup was observed on plumbing fixtures, and the sink faucets and metal sink drain corroded; the hot water heater made a "banging" noise. Kitchen sink faucets have been replaced due to corrosion three times since 2012. In 2012, the customer started experiencing hair thinning and hair breaking. The customer did not consult with a Dermatologist because there was no medical insurance coverage for that type of medical consultation. The customer indicated that hair loss has continued and the customer is experiencing scalp pain. The customer indicated that tap water cannot be used for cooking and the customer started using bottled water for cooking and bathing in January 2016. The customer reported experiencing itching skin since the first week in February 2016.

<u>Chatham Citizen 2</u>

The customer's family moved into this location 2.5 years ago. One year ago, "black crud" appeared in the toilet bowl and toilet water tank; yellow rings are also observed in the toilet bowl. The customer and a child have experienced dry hair and hair strands breaking off. The customer installed a "whole house filter". A water softener was installed about a month ago at the recommendation of a family member that is a Doctor specializing in internal medicine. The family stopped drinking the water (including the 3 children), and this has "helped".
The customer reported a "greenish ring" in the dish washer and washing machine. The customer reported continuing hair loss and considers the water to be "hard" and objects to presence of chlorine taste and odor.

The MCPE Team conducted "in-person" private interviews with two (2) citizens residing in New Berlin. Findings from those interviews are summarized as follows:

<u>New Berlin Citizen 1</u>

"Brownish" water color has been experienced. The customer indicated that a "whole house filter" was installed, and it is "clogged" with brown to black color sediment within a few months, necessitating frequent filter replacements.

New Berlin Citizen 2

> This residence had a "whole house filter" in place when New Berlin still operated its own water treatment plant. The "whole house filter" could remain in service for about 6 months, but now it has to be completely replaced every 1 to 1.5 months. The customer reported that the hot water heater had to be replaced, and the kitchen sink faucets had to be replaced due to corrosion. (The reason for the hot water heater replacement was not stated; the customer's spouse handled the replacement.) The customer reported that "debris" is present in the water … such as "lime" and "dirty, muddy river color". The customer indicated that previously the water was sometimes "blackish" color, but now it is "dark brown" color.

Prior to and after conducted citizen interviews, the MCPE Team requested assistance from Center for Disease Control and Prevention, Illinois Dept. of Public Health, and Illinois EPA to seek information about potential water-related health problems that may be causing hair loss, skin rash, and other problems reported by citizens. See subsequent sections below for additional information about requests for outside assistance.

Chatham Water Dept. Interview

The MCPE Team conducted an onsite interview with Chatham Water Dept. employees involved with the day to day operation of the Chatham water distribution system. Findings are summarized as follows:

- Chlorine residual in the Village's distribution system is reportedly above the minimum 0.2 mg/L free residual required in all active parts of the distribution system. *(The MCPE Team did not undertake spot checks of chlorine residual in the distribution system.)*
- No bacteriological water quality violations have been received.
- The Village's cross connection control program is reportedly in compliance with regulatory requirements.
- Customer complaints have been received from all portions of the distribution system, and complaints have not been isolated to small areas in the system.
- Approximately 30% of the water distribution mains are unlined cast iron pipe, and the remainder is primarily PVC pipe. Unlined cast iron mains are subject to leaching of iron into the water, which can cause customer complaints about water discoloration. Regularly scheduled flushing is required to minimize customer complaints about water discoloration, and in past instances the flushing primarily occurred in response to customer complaints about water discoloration.
- When Chatham switched to using water from SSWC, previously deposited calcium carbonate protective scale was reportedly released from the interior surfaces of water mains, which resulted in customer complaints about presence of debris in the water and clogging of plumbing fixtures. A "de-scaling" chemical was introduced into the water with the intention of accelerating release and dispersal of the scale, and customer complaints occurred simultaneously with the "de-scaling" operation. The Village accelerated and expanded its water main flushing program in hopes of "flushing out" particulate solids.
- When Chatham switched to using water from SSWC, customer complaints about "black water" were widespread, and continue to this day although the number of complaints is decreasing.
- Widespread customer complaints have been received about presence of scale in residential hot

water heaters, after Chatham switched to using water from SSWC. The Village responded by having scale analyzed to determine the chemical composition at several locations, and responded by furnishing information about recommended maintenance practices to extend the life expectancy of hot water heaters. Hot water heater manufacturers typically recommend annual draindown to remove accumulated solids, but the majority of homeowners are apparently not aware of the recommended maintenance procedures.

- Customer complaints have been received about whole house filters clogging due to presence of "black deposits". The Village had an independent laboratory analyze deposits on a few filters, and the deposits consisted of Manganese.
- Customer complaints have been received about corrosion and scale formation on household faucets and sink drains. The Village had an independent laboratory analyze deposits on some of the fixtures, and the scale was mostly Calcium Carbonate but Lead and Copper particulate matter was present, apparently from corrosion of the metal fixtures.
- System water main flushing may have been sporadic in the past, but flushing frequency and coverage is being increased to cover the entire distribution system. The Village has engaged the services of a consulting engineering firm to assist in designing a "uni-directional flushing program" to improve water main flushing efficiency and results.
- The Village discovered that several water main valves were in the closed position when they were supposed to be in the open position, which in essence created two dead-ends at each valve that was inadvertently in the close position. Water quality can deteriorate on dead-end mains where water age increases due to lack of circulation, which can lead to leaching of iron into the water from unlined cast iron mains that can contribute to water discoloration problems for the customers. The Village has increased efforts to verify that all valves are fully open and functional, but specific records are not maintained for each individual valve.
- The Village is not aware of the presence of any private lead service lines in the community.
- Chatham utilizes GIS for all water system mapping, including valve and hydrant locations.

The Chatham Water Dept. records chlorine residual readings on a daily basis on the "Monthly Distribution Reports" that are submitted to IEPA. Chlorine residual information for 2015 is summarized below.

Chatham Chlorine Residual Readings, Range During 2015, mg/L

Month	At Ground Storage Reservoir (1)	At Shop Behind 116 E. Mulberry
January	0.63-0.81 F	0.63-0.81 T
February	0.68-0.78 F	0.69-0.84 T
March	0.69-0.81 F	0.73-0.84 T
April	0.47-0.94 F	0.6-0.96 T
May	0.59-0.86 F	0.72-0.99 T
June	not reported	0.69-1.08 F
July	not reported	0.58-0.89 F
August	not reported	0.52-0.67 F
September	not reported	0.53-0.71 F
October	not reported	0.53-0.71 F
November	not reported	0.1 -0.96 F
December	not reported	0.65-0.76 F

(1) Ground storage reservoir is SSWC delivery point to Chatham.
F Indicates "free chlorine residual".

T Indicates "total chlorine residual".

The 0.1 mg/L chlorine residual during November 2015 was less than the minimum required 0.2 mg/L free chlorine residual.

Up until June 2015, the free chlorine residual readings were measured at the Chatham ground storage reservoir pump house (the point of water delivery from SSWC to Chatham) using a Hach chlorine residual analyzer, and the total chlorine residual reading at Village Hall was measured with a DPD test kit ("color wheel"). At the request of SSWC, the Village moved the Hach chlorine residual analyzer to the Village's shop behind 116 E. Mulberry where Village Hall is located, because SSWC wanted to monitor the chlorine residual near the center of the Village's water distribution system.

Absence of at least a once daily chlorine residual reading at the entrance to the Village's 1,500,000 gallon ground storage reservoir that is filled by SSWC is potentially not responsive to maintaining the desired chlorine residual concentration throughout the Village's distribution system. If for some reason the chlorine residual would be too low at the point of entry into Chatham's system, the problem may not be detected until the water with the potentially low residual has passed through the ground storage reservoir and passed through the distribution system mains to the point where chlorine residual is being measured in the shop behind Village Hall at 116 E. Mulberry. While it is desirable for SSWC to be able to monitor the chlorine residual near the center of Chatham's water distribution system, it is at least equally important for SSWC and/or the Village of Chatham to monitor the chlorine residual entering the Chatham ground storage reservoir to assure that it is at high enough concentration to sustain at least 0.2 mg/L free chlorine residual in all active parts of the Chatham water distribution system.

The "total" chlorine residual reading represents the sum of "free chlorine residual reading" and "combined chlorine residual reading". "Combined" chlorine residual is formed by reactions between Ammonia and Chlorine. A spot check was made to determine whether or not any Ammonia is present in the raw water, and none was detected. On that basis, the "total" chlorine residual should equal the "free" chlorine residual unless there are unknown interferences in the tests. Manganese can interfere with the DPD colorimetric test for chlorine, and presence of Manganese at low levels (less than 0.05 mg/L) may cause interference with the test accuracy.

The Chatham Water Dept. employees have made concerted efforts to respond to citizen complaints about corrosion and scale formation on household plumbing fixtures, hot water heater scale problems, discoloration and staining, etc. A significant amount of testing by independent private laboratories has been paid for by the Village of Chatham. The MCPE Team considers these efforts to be conscientious and commendable, but the Team is unsure whether or not the public-at-large recognizes the level of concern demonstrated by the Village Officials and Employees. Improving openness of communications appears to be desirable, but not easily accomplished in an environment of mistrust.

New Berlin Water Dept. Interview

The MCPE Team conducted an onsite interview with the New Berlin Water & Sewer Supt. involved with the day to day operation of the New Berlin water distribution system. Findings are summarized as follows:

- ❖ Chlorine residual in the Village's distribution system is reportedly above the minimum 0.2 mg/L free residual required in all active parts of the distribution system. The range of chlorine residual at the 200,000 gallon elevated water storage reservoir (point of delivery of water from SSWC) was reported by the Supt. as follows during the February and March of 2016.

Month	mg/L Chlorine Residual Range
March 2016	0.32 to 0.62
February 2016	0.41 to 0.79

The cause of the chorine residual variations was not investigated, and historic records were not reviewed during the onsite visit.

(The MCPE Team did not undertake spot checks of chlorine residual in the distribution system.)

- ❖ No bacteriological water quality violations have been received.
- ❖ The Village's cross connection control program is reportedly in compliance with regulatory requirements.
- ❖ Customer complaints have been received from all portions of the distribution system, and complaints have not been isolated to small areas in the system. Most of the complaints have been about "blackish staining" in toilet bowls and tanks, and clogging of whole house filters with "blackish material". It is suspected that the "blackish staining and material" may be Manganese.
- ❖ Customer complaints have been received about accumulation of scale in hot water heaters.
- ❖ A large portion of the Village's water distribution mains are unlined cast iron pipe, and new additions and water main replacements utilize PVC pipe. Unlined cast iron mains are subject to leaching of iron into the water, which can cause customer complaints about water discoloration. Regularly scheduled flushing is required to minimize customer complaints about water discoloration, and in past instances the flushing primarily occurred in response to customer complaints about water discoloration. The Village flushes mains when needed to assist in responding to customer complaints about water discoloration.
- ❖ One customer complaint has been received about presence of "air in the line causing the water to be cloudy".
- ❖ The Village is not aware of the presence of any private lead service lines in the community.
- ❖ There have been a small number of water main breaks, primarily on the older sections of unlined cast iron pipe.
- ❖ A few service line failures have occurred, associated with either presence of pin hole leaks in the underground copper service line or corrosion of galvanized iron service saddles.

- ❖ The Village's water distribution system map does not include recent system additions, but separate maps of the system additions (new subdivisions) are available.

New Berlin customers have voiced various complaints to the Village Board, but the number of complaints has not been as many as received at Chatham, probably due to the difference in population between the two communities. This does not diminish the importance of any individual complaint.

Special Water Samples: Lead & Copper

Special process control "first-draw" samples (not for compliance) for Pb/Cu analyses were obtained by the Chatham Water Dept. on 29 March 2016 from drinking fountains at Chatham Elementary Schools. A private residence also obtained a "first-draw" sample for Pb/Cu analyses, using Pb/Cu "first-draw" sampling procedures. It is noted that the schools were not in session at the time of sampling, and the drinking water fountains were thoroughly flushed on the day preceding sample collection in order to follow customary Pb/Cu sampling protocol. The following results were furnished by Illinois EPA Division of Laboratories on 7 April 2016.

Village of Chatham

Location	Lead (ug/L)	Copper (ug/L)
Elementary West	ND	712
Elementary East	ND	727
Private Residence (522)	ND	522
USEPA Action Level (AL)	15 ug/L	1300 ug/L

ND Indicated "Not Detected"
Note: ug/L indicates micrograms/Liter, which is equivalent to ppb (parts per billion).

Three additional Lead and Copper "first-draw" samples were collected by homeowners at private residences in Chatham on 29 March 2016, but could not be analyzed by the IEPA Laboratory due to inadequate sample volume. Each resident cooperated by collecting "resample" samples, and the results are reported as follows by IEPA Division of Laboratories on 14 April 2014.

Village of Chatham Resamples (Results Reported 14 April 2014)		
Location	Lead (ug/L)	Copper (ug/L)
Private Residence (R208)	ND	618
Private Residence (R301)	ND	227
Private Residence (R49)	ND	524
USEPA Action Level (AL)	15 ug/L	1300 ug/L

ND Indicated "Not Detected"
Note: ug/L indicates micrograms/Liter, which is equivalent to ppb (parts per billion).

Special process control "first-draw" samples (not for compliance) for Pb/Cu analyses were obtained by the New Berlin Water Dept. on 1April 2016 from drinking fountains at New Berlin Elementary School, using Pb/Cu sampling procedures. Private residences at New Berlin also obtained "first-draw" Lead and Copper samples. The following results were furnished by Illinois EPA Division of Laboratories on 7 April 2016.

Village of New Berlin		
Location	Lead (ug/L)	Copper (ug/L)
New Berlin Elementary School (Off Multi-Use Room)	ND	454
New Berlin Elementary School (200 Hallway)	ND	396
Village Hall	ND	229
Private Residence 1 (305)	ND	168
Private Residence 2 (406)	ND	ND
USEPA Action Level (AL)	15 ug/L	1300 ug/L

ND Indicated "Not Detected"
Note: ug/L indicates micrograms/Liter, which is equivalent to ppb (parts per billion).

These were one-time sampling events to check Lead and Copper levels at the elementary schools and at private residences, and results indicate that Lead and Copper were below the USEPA Action Level (AL). The MCPE Team forwarded these individual results to the Village of Chatham and Village of New Berlin, and requested that the Villages forward the results to the respective locations.

Special Water Samples: Bacteriological, Chatham

At the request of the MCPE Team, the Chatham Water Dept. arranged for residents to collect process control (not for compliance) "first-draw" bacteriological samples on 29 March 2016 at three locations that utilize point of use filters for their household water use, and at Chatham Village Hall where no type of filter is present. The individual home owners collected the samples from their residences, and the Chatham Water Dept. collected the Village Hall sample. Samples were analyzed by the Illinois EPA Division of Laboratories, using membrane filter technique for coliform analysis, and results are shown below based on the April 7, 2016 laboratory report.

Location	*Point of Use Filter*	*Total Coliform*
Village Hall	*none*	*Absent*
Private Residence (407)	*refrigerator filter*	*Absent*
Private Residence (402)	*"whole house filter"*	*Present*
Private Residence (1219)	*"whole house filter"*	*Present*

A representative of SSWC reviewed these results with a Microbiologist with USEPA at Cincinnati, and the following review comments were received on 5 April 2016.

> The Microbiologist said that the way the sampling was done did not provide validity to the sample results. The line should have been flushed, chlorine residual determined, and the sample collected at a suitable tap by a properly trained collector. The Microbiologist said that the homeowners should be told that the sample results contained bacteria. However, it is possible that the sample was contaminated during sampling. The homeowner should contact the representative of the whole house (filter) system and request assistance. Suggest that after any corrective maintenance the taps be flushed, then a sample sent to an accredited lab for additional testing. The homeowner should be assured that the water entering the home meets all regulations and the Commission has never received a violation for bacterial water monitoring.

The MCPE Team forwarded the individual results to the Village of Chatham and requested that the Village forward the results to the homeowners, along with the comments by the USEPA Microbiologist.

Special Water Samples: Bacteriological, New Berlin

At the request of the MCPE Team, the New Berlin Water Dept. arranged for residents to collect process control (not for compliance) "first-draw" bacteriological samples on 4 April 2016 at one location that utilizes a point of use filter for its household water use, and at New Berlin Village Hall where no type of filter is present. The individual home owner collected the sample from its residence, and the New Berlin Water Dept. collected the Village Hall sample. Samples were analyzed by the Illinois EPA Division of Laboratories, using membrane filter technique for coliform analysis, and results are shown below based on the April 7, 2016 laboratory report.

Location	*Point of Use Filter*	*Total Coliform*
Village Hall	*none*	*Absent*
Private Residence (505)	*whole house filter*	*Absent*

A representative of SSWC reviewed these results with a Microbiologist with USEPA at Cincinnati, and the following review comments were received on 5 April 2016.

> The Microbiologist said that the way the sampling was done did not provide validity to the sample results. The line should have been flushed, chlorine residual determined, and the sample collected at a suitable tap by a properly trained collector. ... The homeowner should be assured that the water entering the home meets all regulations and the Commission has never received a violation for bacterial water monitoring.

The MCPE Team forwarded the individual results to the Village of New Berlin and requested that the Village forward the results to the homeowner, along with the comments by the USEPA Microbiologist.

Request for Assistance: Center for Disease Control & Prevention

The MCPE Team learned that there have been numerous complaints about hair loss and skin rashes, allegedly caused by the water. The MCPE Team sent a written request to the Center for Disease Control & Prevention, requesting assistance in identifying any water-related causes for hair loss and/or skin rashes. A response has not yet been received. When a response is received, it will be forwarded to IEPA, SSWC, Village of Chatham, and Village of New Berlin. Followup should include submittal of the findings to individual customers that have reported hair loss and skin rash problems. It is recommended that IEPA assist in coordination of the reports to the customers and/or public sector.

Request for Assistance: Illinois Dept. of Public Health

As stated above, the MCPE Team learned that there have been numerous complaints about hair loss and skin rashes, allegedly caused by the water. The MCPE Team sent a written request to the Illinois Dept. of Public Health, requesting assistance in identifying any water-related causes for hair loss and/or skin rashes. A response has not yet been received. When a response is received, it will be forwarded to IEPA, SSWC, Village of Chatham, and Village of New Berlin. Followup should include submittal of the findings to individual customers that have reported hair loss and skin rash problems. It is recommended that IDPH assist in coordination of the reports to the customers and/or public sector.

Request for Assistance: Illinois EPA

A citizen interviewed by the MCPE Team reported presence of mold in the residence's toilet water tank. The MCPE Team requested that IEPA assist in investigating the reported presence of mold. It is the Team's understanding that IEPA may consult with Sangamon County Health Department to investigate the reported mold condition. A response has not yet been received. It is assumed that either IEPA or Sangamon County Health Department will report findings to the individual customer that reported concern about mold.

Request for Assistance: U.S. EPA

SSWC has been feeding a blended phosphate for corrosion control. It is noted that the Action Level (AL) for Lead and Copper has not ever been exceeded in the SSWC system, Village of Chatham, and Village of New Berlin since SSWC commenced operations in 2012. Copper concentrations are typically less than 50% of the 1.3 mg/L AL, but SSWC desires to optimize its corrosion control program to (1) help to assure continuing compliance with Lead and Copper regulations and (2) to further minimize concentrations of Copper detected in future compliance monitoring samples.

Corrosion control technology is complex, and in this instance the MCPE Team requested technical review and assistance from USEPA personnel at Cincinnati, in order to seek-out the best recommendations for SSWC's corrosion control program.

Michael Schock and Darren Lytle with USEPA are recognized for their expertise in corrosion control technology and many other aspects of drinking water quality and treatment, and either Mr. Schock or Mr. Lytle will respond to the SSWC assistance request in the order of priority among the many other demands on their time. When a response is received, it will be forwarded to IEPA and SSWC for followup review.

After the original request was sent to USEPA for assistance in reviewing corrosion control, USEPA published Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primary Agencies and Public Water Systems, EPA 816-B-16-003, March 2016. This document became available to the MCPE Team in early April 2016. Due to the updated information in that document, the request for technical assistance from USEPA will be revised to reflect acknowledgement of the updated information. In the meantime, SSWC, Chatham, and New Berlin have been in complete compliance with the Lead and Copper regulations, and SSWC should continue with its present corrosion control treatment methods with refinements in controlling and monitoring orthophosphate dosage and residual in the system described under item 6 of the Performance Limiting Factors, South Sangamon Water Commission section.

Request for Assistance: CDA

The MCPE Team contacted the CDA (Copper Development Association) to inquire if there are different types of copper pipe metallurgy that might affect corrosion rates, and to ask for their input regarding corrosion control treatment to minimize copper pipe corrosion. The email containing the Team's questions and CDA's full response has been furnished to IEPA and SSWC. Some key points are summarized as follows:

> Is Type M copper pipe less susceptible to corrosion than Type L, or Type K, etc.?
> *CDA response: There is no difference in composition of copper tube of either Type K, L, or M, they are identical materials with the only difference being wall thickness. Therefore, Type M copper tube is no more susceptible to corrosion than Type L or K. A corrosive situation would be expected to have similar effects on all of the tube types, however should such a situation be encountered it would be expected that simply due to its thinner wall that a trough wall leak would appear in Type M tube more quickly than Type L, and in turn Type K. This does not indicate an increase (in) susceptibility to corrosion, only a decreased time to failure should the tube be installed in a corrosive situation.*
>
> Visually, are there any markings on copper pipe for residential service that indicates the Type of copper?
> *CDA response: Yes. Hard drawn copper tube is marked with an ink/paint stripe and with an incised mark stamped on the copper surface. Both of these are required by the standard to indicate the tube type. In addition, the ink stripe indicates the type of tube by color, with red signifying Type M, blue signifying Type L, and green signifying Type K. At a minimum, both the ink/paint marking and the incise marking will indicate the tube type every 18 inches along the length of the tube.*
>
> Does CDA make recommendations for treatment of drinking water to mitigate corrosion of copper pipe?
> *CDA response: CDA does not make specific recommendations for treatment of drinking water as this would be considered consulting, and should be developed in conjunction with a qualified water treatment engineer/specialist. In reviewing the water chemistry information sent below* (SSWC water quality parameters were furnished to CDA) *there is nothing show(n) from our experience*

that would lead us to believe that this water would be especially corrosive to copper from either a pitting standpoint, or a copper leaching standpoint and the low level of copper leaching being shown would not indicate a situation where accelerated corrosion would be of concern. Generally, to minimize copper leaching in waters where alkalinity is greater than 151-250, pH should be kept in the range of 8 or slightly above. With the alkalinity (of SSWC water) *being ... 268, this system may consider water treatment to control alkalinity to below 250 however the water already shows that it is not prone to excessive copper leaching so this incremental change may not result in significant change. Alternatively, if the system is seeking to further minimize copper levels it could consider treatment with orthophosphate. At the alkalinity level shown, orthophosphate dosage would need to be greater than 3.3 mg/L to possibly deliver any effect.*

This (SSWC) system does not violate the "Action Level for Copper", but nevertheless desires to reduce corrosion of copper pipe.

From USEPA Ref. 1, an option to mitigate copper pipe corrosion is to lower pH to the 7.2 to 7.8 range and feed an orthophosphate corrosion inhibitor with initial dose >0.5 mg/L orthophosphate as P, either orthophosphate or blend.

Ref. 1: Revised Guidance Manual for Selecting Lead and Copper Control Strategies, (EPA-816-R-03-001); March 2003; prepared by Catherine M. Spencer, P.E., Black & Veatch, Pownal, ME 04069, U.S. Environmental Protection Agency, Washington, D.C. 20460.

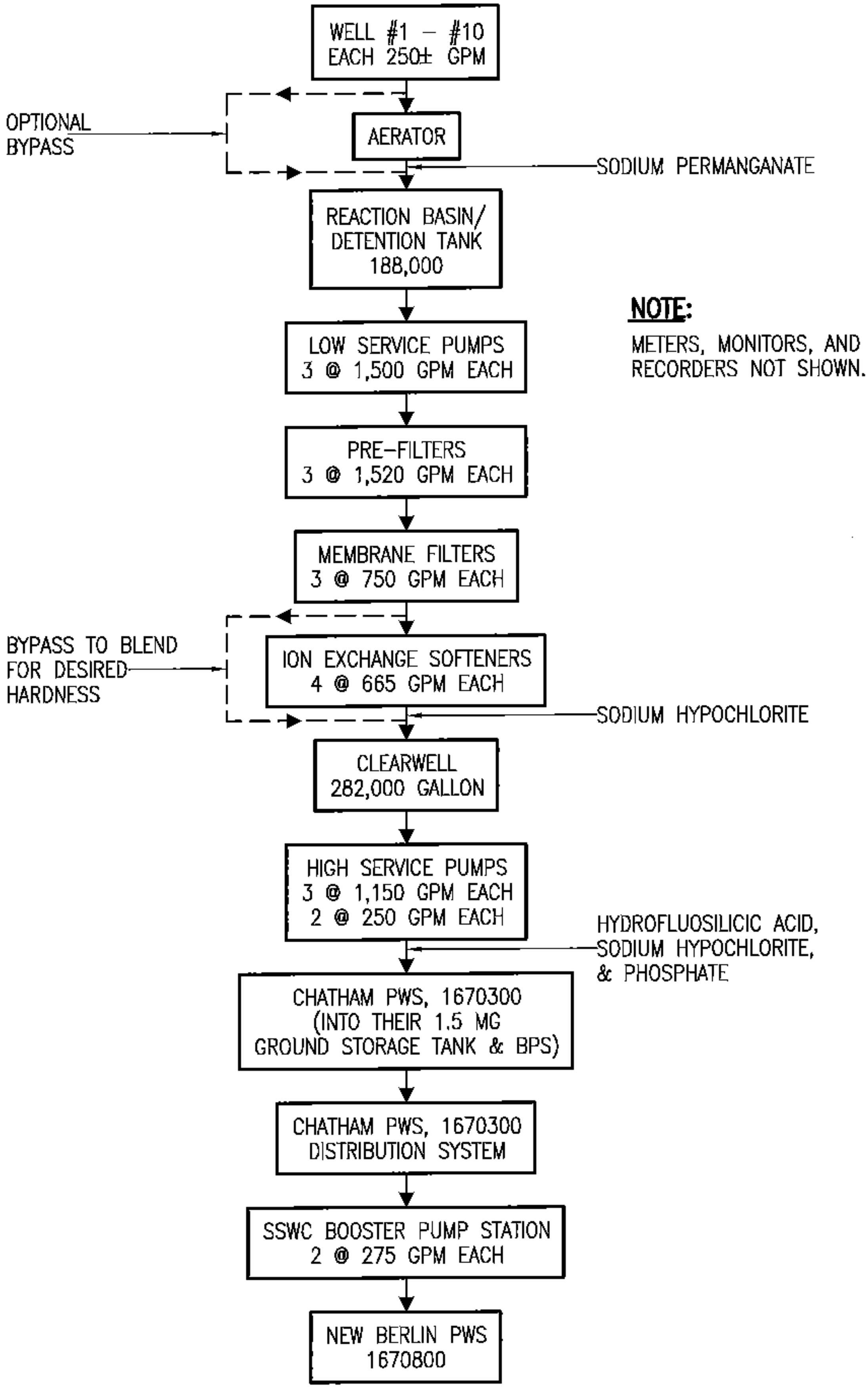
USEPA published an updated guidance document in March 2016, which became available to the public after the MCPE Team inquiry was sent to CDA. Questions and comments in this section could not take into account the most recent information from USEPA. See item 6 in the Performance Limiting Factors, South Sangamon Water Commission section.

Does CDA concur with this type of approach?

CDA response: While the water quality shown above does not indicate an issue with copper corrosion/leaching, orthophosphate treatment is common for systems looking to further control copper leaching. Whether it is warranted here should be carefully considered and not be undertaken without perhaps bench scale or pipe loop experiments with copper in this specific water to see if the expense and maintenance of orthophosphate dosing would provide a meaningful result. In the specific recommendation box above, these are general recommendations and a qualified water treatment specialist should be consulted as to the applicability of these recommendations to the subject water quality. From our standpoint there is no inherent reason that the pH of the above water needs to be modified from the 7.9 shown to the range in the recommendation. In addition, these recommendations do not take into consideration the alkalinity of the water, which may be more informative as to the orthophosphate dosage necessary. As indicated in the previous answer, at the alkalinity cited for this system it is likely that a higher orthophosphate dosing might be necessary to achieve any effect. Treatment to lower the alkalinity of the system may prove to be more beneficial. Also, at these high alkalinities a water treatment specialist should also be considering natural organic matter (NOM) or dissolved organic carbon (DOC) levels as they can have an impact on leaching.

It is noted that Water Solutions Unlimited, SSWC's phosphate blend supplier, has been monitoring metal coupon corrosion for SSWC for several months and their evaluations are reportedly ongoing at the present time.

One of the first steps that the MCPE Team took was submittal of a request for corrosion control technology assistance submitted to Michael Schock with USEPA on 23 March 2016. The MCPE Team feels that input from recognized corrosion control experts employed by USEPA will be in the best interest of SSWC and its customers. On 31 March 2016, Mr. Schock responded and advised that the request for assistance should be forwarded to Samuel L. Hayes, Ph.D., Associate Division Director, NRMRL/WSWRD, USEPA. A formal request for corrosion control technology assistance was forwarded to Dr. Hayes on 2 April 2016. USEPA has indicated that Michael Schock and his colleague Darren Lytle are the persons that respond to corrosion control inquiries, and one of those gentlemen will respond to the SSWC request for assistance in the order of priority of other nationwide requests.



WASTEWATER FROM THE MEMBRANE FILTERS AND ION EXCHANGE SOFTENERS IS DISCHARGED TO TWO LAGOONS AND ONE WASTEWATER TANK.

SCHEMATIC PROCESS FLOW DIAGRAM
SSWC FACILITIES (1670080)

APRIL 2016
2016.20

FIGURE 1

Major Unit Process Evaluation and Performance Description

Capacity Rating

The capacity rating of a water treatment plant is based on the individual unit capacities, with the largest unit out of service due to unforeseen malfunction or for maintenance/repair. The Schematic Process Flow Diagram for the SSWC treatment plant is shown on Figure 1, and unit capacities are summarized as follows. Size information is from the IEPA Inventory.

Unit	Size	Criteria	Capacity Rating with Largest Unit Out of Service
Wells	10 @ 250 gpm	9 in service.	2250 gpm/3.24 mgd
Aerator	10 trays @ 144 SF = 1440 SF	1 to 5 gpm/SF	1440 gpm/2.073 mgd to 7200 gpm/10.368 mgd (Note 1)
Reaction Basin	188,000 gallons	Minimum 30 min. detention time	Maximum 6266 gpm/9.023 mgd (Note 2)
Low Service Pumps	3 @ 1500 gpm	1 out of service	3000 gpm/4.32 mgd (Note 3)
Pre-Filters	3 @ 1520 gpm	1 out of service	3040 gpm/4.377 mgd
Membrane Filters	3 skids @ 750 gpm each	2 in service	1500 gpm/2.16 mgd (Note 4)
Cation Exchange Softeners	4 @ 665 gpm	1 out of service	1995 gpm/2.872 mgd
Clearwell	282,000 gallons	(Note 5)	
High Service Pumps	3 @ 1150 gpm 2 @ 250 gpm	1 out of service (not in service)	2300 gpm/3.312 mgd (Note 3)

Note 1: A bypass is provided around the aerator as required by Ten State Standards and standards of good practice.

Note 2: It is common practice to provide >30 minute hydraulic retention time in a reaction basin for iron removal. Mention was made about this basin serving as a "settling basin". It is 50 ft. diameter with total surface area of 1962.5 SF.

Settling basins are normally provided when Iron and Manganese concentrations are "high". Between 1982 and 2012, each edition of Ten State Standards stipulated: "Sedimentation basins shall be provided when treating water with high iron and/or manganese content, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made." Ten State Standards do not identify the iron and/or manganese concentration that would be considered to be "high".

John T. O'Connor, Ph.D., is recognized as an expert in water treatment matters, and in Water Quality and Treatment, A Handbook of Public Water Supplies, 3rd ed., 1971, American Water Works Association (p. 394), he stated: "Sedimentation is rarely specifically provided unless the concentration of iron and manganese in the raw water is quite high (>10 mg/L). Little sedimentation occurs in most detention tanks. Instead, the detention tanks may be considered to be quiescent reaction basins."

During 2015, the maximum raw water Iron and Manganese concentrations were 1.6 and 0.38 mg/L, respectively. These concentrations are not considered to be "high" and would normally not justify construction of settling basins.

If settling basins would be needed, a mixing or "flocculation" step would be necessary to agglomerate the Iron and Manganese precipitates into "settleable solids", and a coagulant may be required to achieve meaningful solids removal in settling basins.

As indicated with the "Membrane Filter" information in a later portion of this section, the membrane filter manufacturer's specifications for filter influent water limit the Iron to 2.6 mg/L and the Manganese to 0.60 mg/L.
In the opinion of the MCPE Team, the existing raw water Iron and Manganese concentrations in the 1.6 and 0.38 mg/L range, respectively, do not represent a high solids loading since they are less than the specification limits for the membrane filters.

Note 3: The actual capacity of pumps operating in parallel depends on the performance curve characteristics, and the individual unit capacities may not be "additive" when operating in parallel.

Note 4: The actual "production capacity" would be less than indicated since the filters are intermittently out of service for backwashing, maintenance-backwashing, and CIP (Clean in Place).

Note 5: As a "groundwater" treatment plant, there are no specific criteria for sizing the clearwell. The clearwell supplies softener and filter backwash water and equalizes suction supply to the high service pumps. "IF" the wells are determined to be GWUDI, then the treatment plant will be subject to surface water treatment requirements, including at least 60 minute HRT as required by IEPA Technical Policy Statements , and the capability to provide sufficient CT value to attain at least 0.5 log Giardia and at least 2.0 log Virus inactivation with disinfection, at low water level in the clearwell.

Raw Water Source

The SSWC raw water source consists of ten (10) wells developed in unconsolidated formations north of the water treatment plant. The wells are within the Sangamon River alluvial aquifer system, based on information furnished by Anthony Dulka with IEPA. The well casings extend above ground level to platforms that house electrical equipment and well access fittings, so that they are above the flood stage elevation.

Submersible well pumps are provided, and are equipped with VFD motors. Individual flow meters are provided on the discharge line from each well, and piping is arranged to permit "pumping to waste" during well maintenance operations. Transducers are utilized to monitor non-pumping ("static") and pumping water levels in the wells, and levels are reported through the SCADA system. An outside well contractor reportedly monitors specific capacity and overall well performance capability. An air line with connections for a pressure source and pressure gage is reportedly provided at each well to permit individual onsite water level measurements. Each well is equipped with a separate sample tap, and the sample piping is disinfected with sodium hypochlorite prior to sample collection. Well capacity evaluations were not undertaken as part of the MCPE.

It is noted that raw water quality from the wells has been in compliance with regulatory requirements for VOCs, SOCs, Nitrite/Nitrate, and other parameters, based on a review of IEPA water quality records.

In a letter dated 29 December 2014, IEPA informed SSWC that it is required to demonstrate whether or not the *(raw water)* sources are utilizing "groundwater under the direct influence of surface water (GWUDI)." The 29 December 2014 IEPA letter supersedes another letter dated 30 December 2011, which stated that "… the ten wells … are not under the direct influent of surface water." This change-in-status was triggered by unfavorable bacteriological results from well samples. SSWC has not undertaken the sampling and other tasks needed to comply with IEPA's request to demonstrate whether or not the SSWC raw water sources are to be classified as GWUDI.

IEPA has not issued a current opinion whether or not the SSWC wells are classified GWUDI. If it is eventually classified as GWUDI, additional disinfection monitoring practices will be needed to demonstrate that 0.5 log Giardia inactivation and 2.0 log Virus inactivation are being achieved.

A separate raw water master meter measures raw water flow into the water treatment plant from the wells. The original meter was designed to be located in overhead piping, and was not reasonably accessible for maintenance. A separate meter was subsequently installed in an underground vault at the water treatment plant site.

Disinfection Process

Liquid sodium hypochlorite (NaOCl) is utilized as a source of chlorine for disinfection of the water. The original arrangement included provisions to feed sodium hypochlorite after the aerator, after the membrane filters, after the ion exchange softeners, and into the high service pump discharge line delivering water to the customers. Prior to initiation of sodium permanganate feed between the aerator and reaction basin, SSWC fed sodium hypochlorite into the reaction basin influent as an oxidant and for disinfection of the water. Sodium hypochlorite feed into the reaction basin was discontinued when the sodium permanganate feed commenced in February 2016.

At the time of the MCPE Team site visit, sodium hypochlorite was being fed into the high service pump discharge line. It is common practice to maintain a chlorine residual in the clearwell following filtration to provide contact time for the disinfection process as part of the multi-barrier approach for protecting water quality. A chlorine residual was not maintained in the SSWC water treatment plant clearwell because water from the clearwell is used to backwash the membrane filters. The membrane filter manufacturer's original specifications required that any water entering the membrane filters was <u>not</u> to have chlorine residual >0.1 mg/L continuously below pH 9.5. No provisions were included with the original plant design to dechlorinate the membrane filter backwash water supplied from the clearwell.

On 30 March 2016 when SSWC was informed of the importance of using the water plant clearwell to provide onsite disinfection contact time with chlorine, SSWC representatives immediately consulted with IEPA and the membrane filter manufacturer, and subsequently initiated sodium hypochlorite feed into the ion exchange softener effluent/clearwell influent in order to improve disinfection contact time. This process modification (piping changes, changes to the SCADA controls, etc.) was reportedly completed on 5 April 2016. See additional information under item 1 of the Performance Limiting Factors, South Sangamon Water Commission section.

The metering pump that delivers sodium hypochlorite into the softener effluent line is "paced" to deliver chlorine proportional to flow rate into the clearwell. The metering pump that delivers sodium hypochlorite into the high service pump discharge line is also "paced" to deliver flow proportional to flow rate from the high service pump.

SSWC officials and operating personnel are to be commended for expeditiously modifying the chlorination system to improve in-plant disinfection contact time in the clearwell.

Iron and Manganese Removal

The SSWC water treatment plant is equipped with an induced draft aerator that (1) introduces oxygen into the water pumped from the wells to the treatment plant, which can readily oxidize soluble Iron in the raw water from the wells, and (2) helps to remove dissolved gases such as Hydrogen Sulfide (which if present, can cause customer complaints about "rotten egg" odor), methane (if present), and carbon dioxide. Release of carbon dioxide into the atmosphere helps to lower pH, and the Iron oxidation rate is more rapid at higher pH values. Manganese, on the other hand, is not easily oxidized with oxygen introduced with the aeration process.

Immediately following the aerator, a reaction basin is provided. This basin is sometimes referred to as a "detention basin", and its function is to allow sufficient time for the oxidation reactions to go to completion.

Reducing Iron and Manganese concentrations to less than 0.3 mg/L and 0.05 mg/L, respectively, is usually considered to be acceptable. SSWC has consistently reduced Iron concentration to less than 0.02 mg/L in the treated water, but Manganese sometimes exceeded the 0.05 mg/L concentration. As indicated in the Data Review section, under SSWC Water Treatment Plant Monthly Operating Reports, there are variations in raw water Iron and Manganese concentrations.

At the present time, sodium permanganate is being fed into the aerator effluent line leading to the reaction basin, in order to oxidize both Iron and Manganese. Iron can be "air oxidized", but the Iron is not likely being oxidized immediately ahead of the sodium permanganate feed point, so the permanganate is most likely oxidizing both Iron and Manganese. Normally, at least 30 minutes reaction time is required for oxygen (introduced by aeration) to oxidize Iron, and only a few seconds reaction time is available in the pipe from the aerator ahead of the sodium permanganate feed point.

The daily variations in concentrations of Iron and Manganese in the raw water from the wells pose difficult operational process control challenges when relying on chemical oxidation of these constituents. The following discussion illustrates the complexity of this process. The CCP approach was initially developed by USEPA to improve performance of water treatment plants, and the following information is included in the MCPE report to furnish plant operating staff with information that may be useful for process control. An objective of the MCPE is to provide direction for the plant to achieve optimized performance. This information is not intended to supplant a CTA, and other approaches may be needed for SSWC to meet its objectives with respect to Iron and Manganese removal. This level of process control is not routinely included with water operator education classes and is not covered on water operator certification examinations. The SSWC operating personnel have not received the desired level of administrative and technical support necessary to monitor and control portions of the process.

Important Permanganate Relationships

mg/L Permanganate Demand = mg/L Permanganate Dosage - mg/L Permanganate Residual

Desired mg/L Permanganate Dosage = mg/L Permanganate Demand

mg/L Permanganate Residual = mg/L Permanganate Dosage - mg/L Permanganate Demand

mg/L Permanganate Residual = mg/L Permanganate Over-feed

When feeding sodium permanganate, it is preferable that the dosage concentration be sufficient to satisfy all sodium permanganate demand. Sodium permanganate demand is caused by oxidation of the following:

Ferrous Iron (un-oxidized/soluble Iron, Fe).
0.85 mg/L sodium permanganate, dry equivalent $NaMnO_4$, is required to oxidize 1 mg/L soluble Fe. The "neat" liquid chemical dosage depends on the % $NaMnO_4$ purchased.

Manganous Manganese (un-oxidized/soluble Manganese, Mn).
1.72 mg/L sodium permanganate, dry equivalent $NaMnO_4$, is required to oxidize 1 mg/L soluble Mn. The "neat" liquid chemical dosage depends on the % $NaMnO_4$ purchased.

Arsenic (III^+).
1.26 mg/L sodium permanganate, dry equivalent $NaMnO_4$, is required to oxidize 1 mg/L As(III^+) Arsenite to As(V^+) Arsenate. The "neat" liquid chemical dosage depends on the % $NaMnO_4$ purchased.

Hydrogen sulfide … "rotten egg" odor.
2.78 mg/L sodium permanganate, dry equivalent $NaMnO_4$, is required to oxidize 1 mg/L H_2S to S^0. The "neat" liquid chemical dosage depends on the % $NaMnO_4$ purchased.
(Other treatment techniques may be preferable for hydrogen sulfide ... such as aeration, iron salts, hydrogen peroxide.)

Phenol (C_6H_5OH, or similarly C_6H_6O, also known as carbolic acid; usually an algae cell by-product)…which can react with chlorine and intensify objectionable odor in drinking water. 14.07 mg/L sodium permanganate, dry equivalent $NaMnO_4$, is required to oxidize 1 mg/L phenol. The "neat" liquid chemical dosage depends on the % $NaMnO_4$ purchased.

Organics with unknown demand that are associated with formation of objectionable taste and odor, and associated with formation of DBPs (Disinfection By-Products, including THM_4 and HAA_5).

For purposes of this discussion, it is assumed that oxidation of only Iron and Manganese is creating "sodium permanganate demand".

Sodium permanganate is supplied in liquid form from Carus Chemical Company. Assume the following properties:

Specific gravity	1.15 to 1.17, say assume 1.16
Weight of neat chemical	(1.16 x 8.34) = 9.674 pounds/gallon
% $NaMnO_4$	Carusol is 19.5 to 21.5% $NaMnO_4$ (Carusol C is 39.5 to 41% $NaMnO_4$)

In this document, it is assumed that Carusol is being used, and it is assumed that it contains 20.5% $NaMnO_4$. If the % concentration is different in the product purchased, adjustments will need to be made for the calculation examples in this document.

Pounds $NaMnO_4$/gallon 20.5% liquid neat chemical = 9.674 (0.205) = 1.983 pounds/gallon

For illustrative purposes, hypothetical sodium permanganate feed scenarios are shown below.

<u>Case 1, Sodium Permanganate Feed</u>

0.4 mg/L Fe x 0.85 mg/L dry equiv. $NaMnO_4$	=	0.34 mg/L dry equiv. $NaMnO_4$
0.15 mg/L Mn x 1.72 mg/L dry equiv. $NaMnO_4$	=	<u>0.26 mg/L dry equiv. $NaMnO_4$</u>
Total	=	0.60 mg/L dry equiv. $NaMnO_4$

Assume 800 gpm flow rate, 1.152 mgd rate.

PPD dry equiv. $NaMnO_4$ = (1.152 mgd) (0.60 mg/L) (8.34) = 5.76 PPD dry equiv. $NaMnO_4$

GPD liquid sodium permanganate = 5.76 PPD $\left(\frac{1\ \text{gallon}}{1.983\ \text{pounds}}\right)$ = 2.90 GPD feed rate

Case 2, Sodium Permanganate Feed

1.2 mg/L Fe x 0.85 mg/L dry equiv. $NaMnO_4$	=	1.02 mg/L dry equiv. $NaMnO_4$
0.22 mg/L Mn x 1.72 mg/L dry equiv. $NaMnO_4$	=	0.38 mg/L dry equiv. $NaMnO_4$
Total	=	1.40 mg/L dry equiv. $NaMnO_4$

Assume 800 gpm flow rate, 1.152 mgd rate.

PPD dry equiv. $NaMnO_4$ = (1.152 mgd) (1.40 mg/L) (8.34) = 13.45 PPD dry equiv. $NaMnO_4$

GPD liquid sodium permanganate = 13.45 PPD $\left(\frac{1 \text{ gallon}}{1.983 \text{ pounds}}\right)$ = 6.78 GPD feed rate

Compared to Case 1, this represents a (6.78/2.90) x 100 = 233% feed rate change that might be required from one day to the next based on the potential variability in raw water concentrations of Iron and Manganese.

Case 3, Sodium Permanganate Feed

Keeping in mind that it is desired to lower Mn concentration to 0.03 mg/L in the treated water, what would be the necessary sodium permanganate dosage change if the raw water Mn concentration increases by 0.05 mg/L?

Assume 800 gpm flow rate, 1.152 mgd rate.

0.05 mg/L Mn x 1.72 mg/L dry equiv. $NaMnO_4$ = 0.086 mg/L dry equiv. $NaMnO_4$

PPD dry equiv. $NaMnO_4$ = (1.152 mgd) (0.086 mg/L) (8.34) = 0.826 PPD dry equiv. $NaMnO_4$

GPD liquid sodium permanganate = 0.826 PPD $\left(\frac{1 \text{ gallon}}{1.983 \text{ pounds}}\right)$ = 0.417 GPD feed rate change

0.417 GPD $\frac{(3785 \text{ ml})}{(1 \text{ gal.})} \frac{(1 \text{ day})}{(1440 \text{ min.})}$ = 1.096 ml/minute feed rate change

This is a relatively "minute" feed rate change, which would require that time be set aside to calibrate and re-check the metering pump feed rate. A 0.05 mg/L change in raw water Mn concentration requires considerable operational time and effort in order to make necessary adjustments in order to attain desired results.

The point is … a considerable amount of Operator time is required to perform raw water testing, testing of water following addition of the sodium permanganate to assure that oxidation is being accomplished, testing of the water following the filters to be sure that sufficient removal is being accomplished, and adjusting/"fine tuning" the chemical feed rate. Further complicating the process control, if over-feed of sodium permanganate occurs, then soluble Mn from the permanganate can pass through the membrane filters.

The molecular weight of sodium permanganate is 141.924 and the molecular weight of manganese is 54.938. Therefore:

To calculate the amount of manganese added based on the sodium permanganate dosage, use the following relationship:

$$\frac{54.938 \text{ mg/L Mn}}{141.924 \text{ mg/L } NaMnO_4} = 0.387, \text{ say } 0.39$$

mg/L Mn increase from $NaMnO_4$ = (mg/L $NaMnO_4$ dosage) x (0.39)

($NaMnO_4$ dosage based on actual dry equivalent dosage.)

How much would the dosage need to be "off" to add 0.03 mg/L soluble Mn into the water?

$$\frac{(1 \text{ mg/L } NaMnO_4 \text{ dosage})}{(0.39 \text{ mg/L Mn added})} (0.03 \text{ mg/L Mn increase}) = 0.077 \text{ mg/L}$$

Then, based on 800 gpm flow rate or 1.152 mgd rate:

(1.152 mgd) (0.077 mg/L) (8.34) = 0.74 PPD dry equiv. $NaMnO_4$

$$\text{GPD liquid sodium permanganate} = 0.74 \text{ PPD} \left(\frac{1 \text{ gallon}}{1.983 \text{ pounds}}\right) = 0.373 \text{ GPD feed rate change}$$

$$0.373 \text{ GPD } \frac{(3785 \text{ ml})}{(1 \text{ gal.})} \frac{(1 \text{ day})}{(1440 \text{ min.})} = 0.98 \text{ ml/minute feed rate change}$$

Again, this is a small value and considerable Operator time would be required to perform calibration changes for the metering pump output.

An onsite monitoring program is needed to assist operating personnel in meeting objectives for Manganese removal, and the following factors will need to be considered in designing the program:

- Additional laboratory apparatus is needed to test for soluble (unoxidized) Mn. For process control, filtrate from a 0.2 micron membrane filter is considered to be soluble. If soluble Mn is present in the sample filtrate, it could be caused by:

  - Presence of unoxidized Mn due to deficient sodium permanganate dosage, or
  - Presence of excess sodium permanganate ("pink water") caused by overfeed.

A white styrofoam cup is useful in detecting unreacted permanganate ("pink water").

Hach can furnish reagents to test for both total Iron and Ferrous Iron (soluble, unoxidized) using the existing spectrophotometer, which makes process control testing easier for oxidation of Iron. Reagents are available for testing total Mn, but are not available for testing soluble (unoxidized) Mn, which necessitates use of the onsite laboratory filter.

(Information for the laboratory filter devices has been forwarded to SSWC's plant.)

- If sodium permanganate overfeed is occurring, the residual can be measured using a DPD chlorine residual test kit. If "pink water" is present, signifying presence of unreacted permanganate, the dosage should be reduced equivalent to the amount of residual present in the filtered or unfiltered sample.

  (Information for testing permanganate residual has been forwarded to SSWC's plant.)

- Routine testing of filter effluent and plant effluent to determine Mn (and Fe) concentration is required for quality assurance. But, process control is more responsively exercised if soluble Mn (and Fe) measurements are made as early as possible in the treatment process. In other words, if an adjustment in permanganate feed rate needs to be made, it is best to not wait until excess Mn and/or Fe have passed all the way through the treatment process. Optional monitoring points might include:

  - Test for soluble Mn and Fe in a sample from the reaction basin influent, after allowing the sample to sit for … say 15 minutes … to simulate the permanganate oxidation process in the reaction basin. The 15 minute reaction time should be sufficient, but the actual reaction time in this laboratory testing procedure will need to be verified based on actual experience at this location.

  - Test for soluble Mn and Fe in a sample from the reaction basin effluent. If soluble Mn and Fe are present, it signifies the need for a permanganate dosage adjustment based on the stoichiometric amount required for oxidation. (See earlier examples.)

- A gross estimation of required sodium permanganate dosage can be determined using a "Sodium Potassium Demand Test", where an excess amount of unreacted sodium permanganate remains in the sample after … say 15 minute … reaction time.

  (Information for the "Demand Test" has been forwarded to SSWC's plant.)

There are undoubtedly additional "shortcut" process control techniques available, and plant operating personnel should feel free to exercise their own ingenuity.

While not directly applicable to the MCPE, it is noted that SSWC has expressed a desire to utilize greensand filters (or equivalent) for removal of Iron and Manganese. That process would still require use of permanganate to oxidize the Mn, but the process is "more forgiving" since the catalytic media can absorb excess permanganate if a slight overfeed would be occurring. If SSWC decides to utilize greensand filters, it may be beneficial to review (March 1990) Removal of Soluble Manganese by Water from Oxide-Coated Filter Media, William R. Knocke, Suzanne Occiano, Robert Hungate – Dept. of Civil Engineering, Virginia Polytechnic Institute and State University, prepared for AWWA Research Foundation. Appendix A of that document contains useful information about procedures for conditioning filters for manganese removal, and it is noted that some companies have developed proprietary formulations and procedures for conditioning anthracite to serve in a role similar to manganese greensand, potentially at less cost than greensand. The treated anthracite particle size can be larger than natural greensand, which promotes longer filter runs.

Membrane Filters

The pressure membrane filters are provided to remove oxidized Iron and Manganese, and to physically remove certain types of bacterial organisms. Three "skids" are provided, and operate in parallel. Pre-filter devices precede the membrane filters and are intended to prevent entry of debris that could damage the membranes. The membrane filters are AltaFilter™ ultrafiltration system designed by WesTech for SSWC WTP, project no. 21038A. The following information is from the WesTech documents available at the SSWC water treatment plant.

> "The system has been designed to treat well water, 2 mg/L chlorine, forced draft aerator, 30 minute detention time to precipitate Fe and Mn, pump through the pre-filters to the UF system. Provided that the membrane feed water quality does not change from or exceed:

10 to 20°C	Design Temp
1 ntu	Turbidity, low value
20 ntu	Turbidity, peak value
7.0 – 8.0	Raw water pH
210-280 mg/L	Raw water alkalinity
230-250 mg/L	Raw water hardness
0.1 – 2.6 mg/L	Raw water Iron
0.05 – 0.60 mg/L	Raw water Manganese
< 0.1 ppm	Chlorine residual, continuously below pH 9.5

> "The UF system will be capable of producing a net daily flow of 1.98 million gallons, while achieving a recovery ratio [net/gross] of 95% or higher and a minimum CIP (Clean in Place) interval of 30 days. The maximum daily flow is 3.44 mgd net production." (with all 3 skids in service)

Actual raw water characteristics exceed the above-listed design parameters for the membrane filters, as follows:

Raw water alkalinity is sometimes slightly above the 280 mg/L (as $CaCO_3$) limit. Raw water hardness is typically in the 360 mg/L (as $CaCO_3$) range.

The potential "harm" or "process interference" that might affect the membranes because the hardness is higher than stated for the membrane filter design condition was not investigated. Hardness is caused by divalent metallic cations, predominantly Calcium and Magnesium, and since these parameters are soluble, the reason for this limitation is not clear. If the potential exists for scale formation to be deposited within the membrane filters, it would be necessary to lower pH of the water entering the membrane filters. If minor scale formation would occur, the CIP should be effective for removing it from the membranes.

Based on a review of 2015 raw water quality, the maximum Iron and Manganese concentrations in raw water were 1.6 and 0.38 mg/L, respectively. These concentrations are below the manufacturer's limits and do not represent a high solids loading to the filters.

Presence of "air bubbles" was observed in the membrane filter influent sight tubes, which is not considered to be normal for membrane filters. The source of the "air bubbles" needs to be identified so that corrective action can be taken. The air scour cycle for backwashing the membrane filters utilizes air from a compressor and receiver, and it was reported that some of the valves leak. Malfunctioning valves need to be repaired or replaced.

The original construction permit issued by IEPA (No. 0658-FY2010, dated December 23, 2010) contains several provisions pertaining to operation of the membrane filters and conditions that the membrane filter effluent are to meet. A copy of that permit is included as Exhibit 3.

The membrane filter integrity testing has reportedly not been performed since approximately August 2015. Valve malfunctions, valve seat deterioration, membrane breakage, air-scour rotameter flow rate failure, and other equipment failure problems reportedly caused the integrity testing to be discontinued. Replacement and repair procedures have not been authorized, apparently due to financial constraints.

Results of continuous monitoring of the membrane filtrate quality, through the use of turbidimeters and particle counters, are not being reported with the monthly operating report submitted to IEPA. This is apparently due to an administrative misunderstanding, since the operational personnel have not been informed of these reporting requirements. SSWC should consult with IEPA to verify the extent of any calibration, monitoring, and reporting requirements for the turbidimeters and particle counters.

Since membrane integrity testing is not being performed and effluent quality results are not being reported, the performance of the membrane filters is in question.

Operating personnel routinely monitor TMP (Trans-membrane Pressure) and permeability for operation of the membrane filters. Interviews with operating personnel did not indicate any unusual problems with these parameters.

Ion Exchange Softeners

Four (4) sodium-cycle cation exchange water softeners are provided downstream from the membrane filters. One of the water quality objectives adopted by SSWC before the plant was designed and constructed was to supply water with hardness of approximately 120 mg/L as $CaCO_3$, which would be similar to water that Chatham received from Springfield and to minimize the amount of hardness in the water for all customers including the Village of New Berlin.

Each ion exchange unit consists of an 11 ft. diameter steel pressure vessel with 8 ft. side shell height. The IEPA inventory indicates that each is equipped with 12 in. of support gravel, 3 in. layer of torpedo sand, and a 4 ft. layer of cation exchange resin with exchange capacity of 20,000 grains per cu. ft. when regenerated with 6 pounds of salt per cu. ft. of resin. Two brine tanks are provided to receive the salt for the saturated brine solution used to regenerate the resin. Two brine transfer pumps are provided to deliver brine to the individual unit being regenerated. (One brine pump is in service and the other is standby and can be alternated in service.) Operating personnel utilize a Salameter to determine brine solution concentration used for regeneration. The backwash cycle, brine application cycle, slow rinse cycle, and fast rinse cycle are automatically controlled, but can be altered. The backwash water is supplied from the clearwell.

The softeners are considered to be conventional, and a bypass is provided to blend un-softened water with the "zero-hardness" softener effluent to deliver a treated water hardness of 120 mg/L as $CaCO_3$.

Treated water samples collected on March 4, 2016 indicated an unusual variation in Chloride concentration, as follows:

29.5 mg/L	Raw Water
29.1 mg/L	Treated Water at Plant
60 mg/L	Chatham Reservoir
59.6 mg/L	New Berlin

Chloride concentration is not routinely tested at the SSWC. A review of original 2012 well construction records indicated that the typical raw water Chloride concentration was in the 20 mg/L range, although Well No. 2 had a 2012 Chloride concentration of 49 mg/L. Both Chloride and Sulfate are "salts" that can contribute to corrosion of metal pipes, so it is desirable to avoid any inadvertent concentration increase of those parameters. Sodium Chloride is used to regenerate the water softeners. "If" all of the Chloride is not removed during the slow and fast rinse cycles, it will increase the Chloride concentration in the treated water. The Salameter is not effective for checking Chloride content of the rinse water and treated water, but the plant laboratory has a spectrophometer than can be used to test for Chloride. SSWC operating personnel ordered reagents for testing Chloride immediately after learning of the need to monitor Chloride concentration.

Chemical Feed Equipment

All water treatment chemicals used by SSWC are in liquid form, and are fed with metering pumps from separate day tanks. Duplicate pumps are provided for redundancy. The individual chemical feed systems are categorized below, based on how they are controlled. It is necessary that each individual chemical be fed proportional to the flow rate in the sector being treated with the particular chemical.

Chemical Feed
Paced by Raw Water Flow Rate from Wells to Aerator, to Reaction Basin

Raw water flow rate into the aerator from the wells can be controlled at a fairly constant rate using "setpoints" for the VFD well pump motors. Flow rate can be consistently controlled with careful monitoring. At present, the plant has the option to feed sodium hypochlorite between the aerator and reaction basin, but this feed point is not being utilized since initiation of sodium permanganate feed for oxidation of Iron and Manganese. When sodium hypochlorite was added ahead of the reaction basin, the water leaving the reaction basin and being pumped to the membrane filters had to be dechlorinated with sodium bisulfite to protect the membranes from potential damage from the chlorine, as originally required by the membrane filter manufacturer. No particular problems have been reported with this sodium hypochlorite feed point. When in service, this sodium hypochlorite metering pump is "paced" to feed proportional to flow entering the reaction basin.

Sodium permanganate is fed into the aerator effluent line ahead of the reaction basin. The metering pump is "paced" to feed proportional to flow entering the reaction basin. It is noted that Iron from the wells can be oxidized by oxygenation of the water passed through the aerator, but with the limited option for the sodium permanganate feed point, the Iron is mostly likely being oxidized by the permanganate, with accompanying increase in cost vs. using the oxygen introduced through the aerator. The present plant configuration "might" be altered to move the permanganate feed point to a different location in the reaction basin, but that option was not investigated as part of the MCPE.

Chemical Feed
Paced by Low Service Pump Flow Rate from Reaction Basins to Membrane Filters, to Softeners, to Clearwell

Flow rate through this portion of the process is dependent upon the flow rate delivered by the VFD motors on the low lift pumps. Flow rate can be controlled fairly consistently with careful monitoring, but variations will occur as membrane filter "Trans-Membrane Pressure (TMP)" varies (due to increased pressure drop as the membranes remove solids from the process flow stream), and as membrane filters and/or softeners are taken off –line for backwashing and regeneration, respectively. Sodium hypochlorite feed into the softener effluent commenced on 5 April 2016 to provide a chlorine residual in the clearwell. The metering pump is "paced" to feed proportional to low service pump flow rate. No problems are known to exist with this arrangement.

Chemical Feed
Paced by High Service Pump Flow Rate from Clearwell to Transmission Main

The metering pumps delivering sodium hypochlorite, hydrofluosilicic acid, and phosphate blend into the high service pump suction line are all "paced" to feed each chemical with dosages proportional to flow rate out of the high service pump. The high service pump flow rate varies considerably, sometimes down to very low flow rates during night-time hours when no water is being delivered into the Chatham ground storage reservoir. It is difficult to control chemical feed "pacing" when process water flow drops to very low levels due to lack of demand for water along the transmission main between the plant and the Chatham ground storage reservoir.

As indicated in the Data Review section, under SSWC Water Treatment Plant Monthly Operating Reports, there is considerable variability in the calculated sodium hypochlorite dosage and in the recorded plant effluent chlorine residual. It is suspected that these variations are due to wide-ranging process flow variations down to very low flow rates that potentially interfere with achieving proportional feed rates. The sodium hypochlorite feed point into the high service pump suction line was the only feed point prior to

April 7, 2016 when sodium hypochlorite feed was initiated into the clearwell. The high service pump suction line feed point should continue to be used "as needed" to make adjustments to the chlorine residual concentration leaving the treatment plant, but there does not appear to be an immediate solution to improving consistency of feed rate and residual due to the non-use of the 250 gpm high service pumps during low flow conditions and due to the wide range in flow rate when pumping into the "closed system" transmission main when Chatham is not receiving water into its ground storage reservoir.
As indicated in the Data Review section, under SSWC Water Treatment Plant Monthly Operating Reports, there is considerable variability in hydrofluosilicic acid feed rates and Fluoride ion concentration in the treated water, and there is considerable variability in phosphate feed rates. It is suspected that these variations are due to wide-ranging process flow variations down to very low flow rates that potentially do not allow truly proportional feed rates. Operating personnel reported that periodic "off-gasing" problems are experienced with the hydrofluosilicic acid metering pump. This should be confirmed and equipment modifications undertaken to eliminate the problem.

The variations in feed rate for sodium hypochlorite, hydrofluosilicic acid, and phosphate blend may be due to potential equipment limitations, and the existing configuration makes it difficult for the operating personnel to control chemical feed consistency.

The phosphate solution day tank volume is oversized for this application, and does not comply with the requirement for the day tank to contain no more than a 30 hour supply of chemical. Some latitude in the 30 hour supply requirement "might" be possible in consultation with IEPA, but the existing tank capacity greatly exceeds this requirement. Ten State Standards contains the following requirement for phosphate solutions:

> (4.8.6.b.)
> "Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 mg/L free chlorine residual unless the phosphate is not able to support bacterial growth and the phosphate is being fed from the covered shipping container. Phosphate solutions having a pH of 2.0 or less may also be exempted from this requirement by the reviewing authority."

Since the phosphate solution is not being fed from the "covered shipping container", it is recommended that SSWC take steps to verify whether or not it is required to maintain a 10 mg/L free chlorine residual in the phosphate solution tank.

- Inquire whether or not the phosphate supplier has evidence that the solution will not support bacterial growth if fed from the covered shipping container.
- Measure pH of the solution to determine whether or not it is 2.0 or less.

After completing these steps, SSWC should consult with IEPA to confirm whether or not a 10 mg/L free chlorine residual needs to be maintained in the phosphate solution tank. At the same time, SSWC should consult with IEPA to confirm the acceptable day tank capacity needed to comply with the "30 hour supply" requirement vs. the shipping container volume.

Prospective Chemical Feed Modifications

If the hydrofluosilicic acid and phosphate solution feed points would be located to the softener effluent (clearwell influent), the metering pumps for those chemicals could be "paced" with flow from the low service (transfer) pumps that deliver water from the reaction basin through the process to the clearwell. The low service pumps are VFD driven, but are operated at selected "set points" to maintain consistent flow rate. The metering pumps should be able to operate at more consistent feed rates with this arrangement, which could produce more consistent treatment results.

A "downside" of feeding hydrofluosilicic acid and phosphate solution into the clearwell is that membrane filter backwash water and softener backwash water are supplied from the clearwell. So, chemicals added to the water lost to backwash would increase operating costs. Under the circumstances, the slight increase in operating expense should be more than offset by the benefit of gaining consistent feed rates and improved effluent quality.

If the 250 gpm high service pumps could be restored to service for use during low flow periods, the post sodium hypochlorite feed consistency, and accompanying plant effluent chlorine residual, should be improved.

High Service Pumps

Two sets of high service pumps are provided:

> 2 pumps each rated 250 gpm, which have been removed from service due to "overheating" and control problems; these pumps were originally intended to meet on-line water demand during low flow periods when Chatham's ground storage reservoir is not being re-filled.
>
> 3 pumps each rated 1150 gpm, VFD; at least one of these pumps is in operation at all times to maintain pressure on the transmission main between the treatment plant and Chatham; during periods of near-zero demand, these pumps cycle down to very low rpm possibly not intended in the original design?

These pumps deliver water from the treatment plant clearwell into the treated water transmission main that delivers water to Chatham, New Berlin, and customers along the transmission main.

An evaluation was not performed to determine potential corrective action that may be needed to re-activate the 250 gpm pumps; an evaluation was not performed to review low flow operating conditions for the 1150 gpm pumps. It is noted that SSWC received a violation notice from IEPA because neither an elevated nor a hydropneumatic storage tank is provided to sustain pressure on the transmission main between the treatment plant and Chatham. The IEPA 1985 Technical Policy Statements require that either an elevated or hydropneumatic storage tank be provided to maintain pressure at all times, including in event of a pump failure. The original design should have addressed this. SSWC is considering installation of an hydropnuematic pressure tank.

The water in the suction line from the clearwell to the high service pumps was supersaturated with oxygen during the MCPE Team site visit, and operating personnel indicated that this has been a persistent occurrence. Allowing a sample of the water to sit in a jar open to the atmosphere allows the excess oxygen to escape. The cause of the supersaturated condition was not investigated as part of the MCPE, but further investigations should be undertaken by SSWC operating staff and/or with its consulting engineer. If excess air is entering the system through piping systems that are intended to be "closed", the condition should be eliminated. The number, size, and location of air release valves should be reviewed.

Treated Water Transmission Main

The treated water transmission main delivers water from the treatment plant to all of the SSWC water customers. A 20 in. diameter DR 25 PVC main leaves the plant and other sizes are used in the system. An evaluation of the transmission main was not performed. The MCPE Team installed pressure gages in order to evaluate Hazen-Williams c factor for the transmission main, but the section tested was not long enough to realistically measure pressure drop at low flow, and no further testing was done.

In order to maintain at least 2 ft./second scouring velocity in the 20 in. section of transmission main, the flow rate would need to be at least 1942 gpm (2.796 mgd flow rate). Based on current water customer usage, flow rate in the transmission main does not reach the 1900 to 2000 gpm range. If Manganese would be present in the treated water, potential exists for some of the Manganese to "settle-out" in the transmission main and periodically be re-suspended when flow rate increases, causing it to be moved further down the line where it could potentially enter the Chatham and New Berlin systems. Flushing of the transmission main to remove any accumulated Manganese and/or Iron has not been performed, primarily because of flow velocity capability limitations. SSWC has reportedly given consideration to installing "polypig" launching and exit stations, but the cost is a major issue.

The locations of valves and hydrants along the transmission main are available to SSWC operating personnel via GIS.

Standby Power

A standby generator is provided to supply electrical power for the wells and treatment plant in event of a power outage from the electric utility.

Water Treatment Plant Process Wastewater Disposal

Water used for backwashing the filters and ion exchange softeners is supplied from the clearwell, and the spent backwash water is discharged to a pump station that transfers these flows into two parallel earthen process wastewater treatment basins. The effluent from the basins is discharged to a public waterway, and SSWC reportedly has an NPDES permit covering this discharge. Review of the permit and discharge records was not within the scope of the MCPE.

At the end of the regeneration cycle for the sodium-cycle ion exchange water softeners, the individual softeners are subjected to a slow rinse cycle and a fast rinse cycle to flush out any Chlorides that may remain in the softener vessels. These waste streams are transferred to an above-ground storage tank that is routinely pumped out and trucked to Chatham where it is discharged into a sanitary sewer manhole that outfalls to the City of Springfield wastewater treatment plant. This liquid has Chloride concentration too high for discharge into public waterways.

Process wastewater disposal practices and facilities were not evaluated, and NPDES DMRs (Discharge Monitoring Reports) were not reviewed since these facilities do not directly affect treated water quality.

Treatment Plant Sewage Disposal

Wastewater from the water treatment plant rest rooms and laboratory is disposed of with an onsite treatment system. Operating personnel indicated that the sanitary sewer lines have adequate horizontal separation from the underground potable water mains. These facilities were not evaluated.

PERFORMANCE LIMITING FACTORS
SOUTH SANGAMON WATER COMMISSION

Areas of design, operation, maintenance, and administration were evaluated in order to identify factors which limit performance, in the opinion of the MCPE Team. These evaluations are based on information obtained from the plant tour, interviews, performance and design assessments, and the judgement of the CPE Team.

The identification of factors that may be limiting performance is provided to support the SSWC water treatment plant in achieving the optimization performance goals.

1. Disinfection

Prior to February 2016, sodium hypochlorite was fed into the reaction basin as an oxidant and as a disinfectant, and disinfection contact time was being provided in the reaction basin. When SSWC initiated sodium permanganate feed ahead of the reaction basin, sodium hypochlorite feed ahead of the reaction basin was discontinued. Prior to April 6, 2016, onsite disinfection was not provided in the clearwell following the membrane filters, and chlorine contact time within the clearwell was not provided. SSWC indicated that water from the clearwell is used to backwash the membrane filters, and historically it was SSWC's understanding that chlorine must not be present in water entering the membrane filters or in the water used for backwashing the membrane filters, based on the membrane filter manual on file at the treatment plant (see p. 48 herein for membrane filter influent water quality limitations).

Upon learning of the desirability to maintain a chlorine residual in the clearwell (the source of backwash water for the membrane filters and softeners and suction supply for the high service pumps), SSWC operating personnel immediately contacted the membrane filter manufacturer on March 30, 2016 and requested clarification of the previously understood requirement that water containing chlorine residual could not enter the membrane filters. The manufacturer responded by stating:

> "Chemicals used during backwash – Chlorine
> The recommended chemical to prevent biological fouling and organics adsorption is chlorine at a concentration of 5 to 10 ppm in the backwash water. If required the chlorination may be used during every backwash or only periodically."

On 30 March 2016, immediately upon being informed of concern about absence of chlorine disinfection contact time within the treatment plant processes and receipt of updated information from the membrane filter manufacturer regarding presence of chlorine residual in the backwash water, SSWC representatives contacted IEPA and the decision was made to make modifications necessary to introduce chlorine into the softener effluent which flows into the clearwell. The modifications (piping, SCADA control to "pace" the sodium hypochlorite metering pump to feed proportional to low service pumping rate through the membrane filters and softeners) were completed and placed into service on April 6, 2016. SSWC is to be commended for its responsive action.

"Ten State Standards" requires that plants treating groundwater include provisions for applying the disinfectant to the detention basin inlet and water entering the distribution system. This capability is provided at SSWC's plant, but addition of chlorine to the detention basin inlet was discontinued when sodium permanganate feed was initiated in February 2016. It is implied that disinfection contact time can be provided in the detention basin. If chlorine residual could be maintained in the clearwell, it would be at least equally as beneficial as maintaining chlorine residual in the detention basin. "Disinfection for groundwaters shall be determined by the reviewing authority (ie., IEPA Technical Policy Statements)."

Without hesitation, SSWC took the appropriate steps to seek concurrence from IEPA with regard to disinfection procedures, and initiated chlorine feed into the softener effluent/clearwell influent on April 6, 2016.

Sodium hypochlorite dosages at the high service pump suction feed point have varied, and plant effluent chlorine residual has varied. It is suspected that these variations are due to the potential inability of the metering pump to cover the feed rate range to be proportional to the wide variation in high service pump flow rate. These inconsistencies pose concern because delivery of a consistent chlorine residual to the customers is a necessity. Resolution of this potential problem warrants consideration of the following steps:

- ✓ Review and confirm laboratory procedures for measuring chlorine residual.
- ✓ Review and confirm accuracy of spreadsheet dosage calculations used for the operating reports.
- ✓ Restore to service the 250 gpm high service pumps for operation during low flow periods, hopefully to achieve more consistent post sodium hypochlorite feed rates during those low flow periods. In absence of this step, it will be difficult for operating personnel to improve the consistency of sodium hypochlorite feed rate and chlorine residual leaving the plant when using the post sodium hypochlorite feed point into the high service pump suction line.

Liquid sodium hypochlorite "loses strength" during storage, and the aging process accelerates as temperature increases. Bulk storage of large volumes of sodium hypochlorite is more susceptible to loss of strength. SSWC utilizes a bulk storage tank to have a backup supply on hand at all times, and to take advantage of cost savings when purchased in bulk quantities. SSWC operating personnel are aware of this limitation, and the need to adjust sodium hypochlorite dosage based on chlorine residual readings since the hypochlorite may not always deliver exact chlorine residual desired.

2. Membrane Filter Integrity

Integrity testing for the membrane filters was reportedly discontinued in August 2015 due to various membrane filter equipment problems. The original construction permit issued by IEPA included requirements for membrane filter integrity testing, turbidity monitoring, and particle count monitoring. Assuring membrane integrity, coupled with monitoring and reporting filtered water turbidity levels and particle counts, would provide additional assurance that treated water quality is acceptable. Membrane integrity testing is a condition of the original construction permit issued by IEPA (see Exhibit 2), and testing must be re-instituted.

SSWC should consult with IEPA to verify the extent of any calibration, monitoring, and reporting requirements for the turbidimeters and particle counters.

3. Membrane Filter Maintenance

Reported membrane filter equipment failures are limiting the ability of the membrane filters to perform properly, including:

- ✓ Valves that are used to control the air-scour step in backwashing have reportedly become operationally unreliable.
- ✓ "Air bubbles" were observed to be present in the membrane filter influent sight tubes, and the source of the air needs to be identified so that corrective action can be taken.
- ✓ There are reportedly not any air release or pressure relief valves on the air-scour piping system, even though the air-scour pressure may be exceeding the 30 psi limit recommended by the membrane filter manufacturer.
- ✓ The rotameter that is to indicate rate of air flow during the air-scour step in backwashing has reportedly become inoperable.
- ✓ Valve seats have reportedly become worn, which interferes with integrity of valve closures.
- ✓ PDT (Pressure Decay Tests) failed, but the units remain in operation.

SSWC needs to authorize Woodard & Curran and plant operating personnel to proceed with maintenance and repairs to restore full operational functions of the membrane filters. Hesitation to proceed with steps to maintain all equipment in optimal operating mode because of financial constraints will need to be addressed now and in the future. The MCPE Team recognizes that all CWS systems have financial constraints that are increasingly difficult to overcome in the midst of public criticism originating from complaints about water quality, but CWS systems must nevertheless expend funds to assure that equipment and processes are fully operational.

4. Manganese Removal

There have been widespread customer complaints about blackish particles, dirty water, and discoloration in the treated water, and Manganese has been present above the 0.05 mg/L secondary standard. Low concentrations of Manganese are not harmful to public health (A), but its presence causes decreased public confidence in the safety of the water. Performance limiting factors that may be affecting manganese removal at the treatment plant include:

> (A) The ten-day HA (Health Advisory) for a child is 1 mg/L, and this level should also be protective of adults. It is advised that for infants less than 6 months, the lifetime exposure of 0.3 mg/L may be used for an acute exposure of ten days. (Ref. Drinking Water Health Advisory for Manganese, USEPA, January 2004; EPA-822-R-04-003.) *The Manganese in treated water from SSWC has been far below the HA limits.*

- ✓ The day tank for sodium permanganate is not equipped with a scales, which is required by the IEPA construction permit and standards of good practice for the sodium permanganate feed system. Monitoring permanganate usage and close tolerance dosage control is not attainable without a scales.
- ✓ Soluble manganese that might be remaining in the water is not measured after oxidation with sodium permanganate, which restricts the ability to monitor effectiveness of the sodium permanganate treatment. If soluble manganese remains in the water entering the membrane filters, it is likely that it will pass through the membrane filters and remain in the water delivered to the system. Total manganese measurements are being recorded, and they have been variable and sometimes higher than the 0.05 mg/L secondary standard.
- ✓ Due to variabilities noted, the Manganese testing procedures and dosage calculation procedure warrant the following steps:
- ✓

Review and confirm laboratory procedures for measuring Manganese (total and soluble).

Review and confirm accuracy of spreadsheet dosage and feed calculations used for the operating reports.

Confirm that the sodium permanganate usage and feed rate (dosage) are being reported on the basis of dry equivalent sodium permanganate. This method of control is recommended since the dry equivalent sodium permanganate dosage has a direct relationship to the amount of Iron and Manganese to be oxidized.

- ✓ The water treatment plant Operators have not received sufficient technical support and education on process control techniques for oxidation and removal of manganese using sodium permanganate.
- ✓ Ten wells are operated simultaneously with variable Manganese concentrations in the water entering the treatment plant. For process optimization, consideration should be given to evaluating different combinations of wells in operation, rotated in service, which might deliver more consistent raw water quality that could help to stabilize the treatment process and improve treatment results.

5. Monitoring of "Water Stability" (Tendency to form scale or tendency to be corrosive.)
There have been customer complaints about the water corroding household plumbing fixtures (faucets, sink drains, etc.). And, there have also been customer complaints about scale formation on household plumbing fixtures. Despite these complaints, SSWC water treatment plant Operators have not received sufficient technical support and education on techniques for monitoring water stability (ie., tendency to be either corrosive or scale forming). Present water quality monitoring does not include tests and procedures for assessment of water stability.

SSWC personnel collected samples for analysis so that the MCPE Team could evaluate water quality characteristics using the "RTW" Model, and results are contained in Exhibit 4. Application of the "RTW Model" to assess the tendency of the water to exhibit either scale-forming or corrosive tendencies suggest that the water has slight to moderate scale-forming tendency. Despite the results of this one-time "RTW Model" analysis, the matter of customer complaints about corrosion affecting household plumbing fixtures remains.

Continuous monitoring of water stability should be instituted in consultation with IEPA. Additional investigations should be undertaken to hopefully identify the cause of corroded plumbing fixtures. If the corroded fixtures are downstream from home water softeners, potential adverse effects associated with alteration of water quality by ion exchange softening may need to be investigated by the affected homeowners. The following techniques for monitoring water stability should be considered:

1 With respect to corrosivity, SSWC must continue to deliver water to Chatham and New Berlin that maintains compliance with the Lead and Copper Rule. Compliance with the Lead and Copper Rule has been maintained at all times by SSWC, Chatham, and New Berlin.

2 Continue to investigate the cause(s) of corrosion of household plumbing fixtures.

3 Update control techniques and monitoring to maintain desired orthophosphate residual in the water distribution systems, summarized under item 6 of this section.

4 Utilize the "RTW Model" (see Exhibit 4 for additional information and an example

analysis) to evaluate water stability on a weekly basis. The software is available from AWWA. *(Tetra Tech (RTW) Model for Water Process & Corrosion Chemistry, AWWA Catalog No. 53052, authored by Tetra Tech, Inc.)*

Input parameters for the "RTW" Model include:
Temperature (a laboratory thermometer is available)

Total Dissolved Solids (relatively inexpensive meters are available and of sufficient accuracy for this purpose)

pH (a meter is available)

Alkalinity (test is now being performed)

Calcium hardness, as $CaCO_3$ (a spectrophotometer is available, but reagents would be needed)

Chloride (a spectrophotometer is available, but reagents would be needed)

Sulfate (a spectrophotometer is available, but reagents would be needed)

Additional investigations to assess scale-forming tendencies of the water might include hydraulic gradient testing for the transmission main – assuming that if a Hazen-Williams c factor that would be much lower than "new pipe" values might be attributable to presence of scale formation on the interior pipe walls, and close inspection of household plumbing fixtures at residences along the transmission main to determine if scale formation can be detected. If scale formation is occurring, it cannot be allowed to continue indefinitely, and pH adjustment may be necessary. Any adjustment of pH must take into account possible interference with the orthophosphate corrosion control program.

6. Phosphate Blend and Corrosion Control Program

SSWC feeds a blended phosphate chemical to inhibit corrosion of metals in the distribution system and in residential plumbing systems. It is noted that the AL (Action Level) for Lead and Copper has never been exceeded in routine monitoring samples from SSWC, Chatham, and New Berlin systems. Nevertheless, the water treatment being applied for corrosion control may not be at optimum levels due to the following factors.

✓ The orthophosphate residual is not routinely monitored through the system, including in the Chatham and New Berlin distribution systems. There appears to be uncertainty about monitoring responsibility. The Operators have not received appropriate technical guidance regarding monitoring procedures for the corrosion treatment being employed. Monitoring requirements should be confirmed in consultation with IEPA, taking into account regulatory requirements (A).

(A) IPCB regulations stipulate the following at 611.352.f.1).c): "If a corrosion inhibitor is used, a minimum concentration or a range of concentrations for the inhibitor, measured at each entry point to the distribution system and *in all tap samples* (emphasis added), that the Agency determines is necessary to form a passivating film on the interior walls of the pipes in the distribution system." In consultation with IEPA, SSWC, Village of Chatham, and Village of New Berlin, a determination needs to be made to identify the entity (or entities) responsible for monitoring in the respective Village distribution systems. In any event, all results must be reported and recorded at the WTP for process monitoring and control.

Recent guidance from USEPA (B) recommends:

Monitor at least one sample from the entry point for the dosage rate of the inhibitor and the concentration of orthophosphate at least once every two weeks. <u>For process control at the treatment plant, the MCPE Team recommends that daily readings be recorded for the orthophosphate dosage and residual at the plant effluent.</u>

Monitor at least two sets of samples from a specified number of taps at maximum 6 month intervals to record orthophosphate residual; based on the SSWC service area population, 10 sample sites are required and 20 sample sites are recommended. If concentrations of Lead and/or Copper increase above background levels, the sampling frequency may need to be increased to once monthly rather than every 6 months.

(B) <u>Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems,</u> USEPA Office of Water (EPA 816-16-003), March 2016.

Clear guidance has not been provided to SSWC operating personnel with respect to who is responsible for monitoring orthophosphate residual in the Chatham and New Berlin water distribution systems. The water purchase contracts between SSWC and the Villages of Chatham and New Berlin do not contain any provisions identifying monitoring responsibility. IEPA requires that each Village monitor chlorine residual, and the Villages reportedly communicate these results to SSWC. It is recommended that SSWC and the Villages of Chatham and New Berlin jointly determine who is to perform orthophosphate residual monitoring in each system, and results need to be communicated between SSWC and each Village.

✓ The phosphate feed rate is inconsistent, and the measured phosphate residuals are inconsistent. The phosphate feed metering pump feeds into the high service pump suction, and the metering pump is paced to provide feed proportional to the high service pump discharge flow rate. The high service pump(s) is VFD (Variable Frequency Drive) and flow rate varies considerably due to varying demands in the system. The option to move the phosphate feed point to the clearwell influent should be evaluated, since the flow rate into the clearwell should be more stable, which could improve feed rate stability. In addition, the following steps are recommended:

Review and confirm laboratory procedures for measuring orthophosphate residual.

Review and confirm accuracy of spreadsheet dosage and feed rate calculations used for the operating reports.

Confirm that the phosphate blend usage and feed rate (dosage) are being reported on the basis of dry equivalent orthophosphate. This method of control is recommended since the dry equivalent orthophosphate dosage represents the active ingredient for corrosion control. Reporting total "P" would not be responsive since other phosphate-based chemicals, in addition to orthophosphate, are present in the current blend.

✓ Since the phosphate solution is not being fed from the "covered shipping container", it is recommended that SSWC take steps to verify whether or not it is required to maintain a 10 mg/L free chlorine residual in the phosphate solution tank.

- ➢ Inquire whether or not the phosphate supplier has evidence that the solution will not support bacterial growth if fed from the covered shipping container.
- ➢ Measure pH of the solution to determine whether or not it is 2.0 or less.

After completing these steps, SSWC should consult with IEPA to confirm whether or not a 10 mg/L free chlorine residual needs to be maintained in the phosphate solution tank. At the same time, SSWC should consult with IEPA to confirm the acceptable day tank capacity needed to comply with the "30 hour supply" requirement vs. the shipping container volume.

✓ The blended phosphate corrosion inhibitor is being fed into water with pH near 8 units, which is outside the pH range 7.2 to 7.8 recommended by USEPA's 2003 guidance document *(Revised Guidance Manual for Selecting Lead and Copper Control Strategies, (EPA-816-R-03-001); March 2003; prepared by Catherine M. Spencer, P.E., Black & Veatch, Pownal, ME 04069, U.S. Environmental Protection Agency, Washington, D.C. 20460.)* The MCPE Team was initially concerned that "optimum"corrosion control technology was not being utilized because the pH was outside the range recommended in 2003.

Regardless, during 2015, Lead was "non-detected" at Chatham and New Berlin, and Copper concentrations did not exceed the "action level". Lead and Copper in SSWC's separate monitoring area were also below the "action level". SSWC, Chatham, and New Berlin have never exceeded the Lead and Copper "action level".

During the MCPE study timeframe, updated information became available from USEPA regarding optimal corrosion control technology in the following publication:

Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primary Agencies and Public Water Systems, EPA 816-B-16-003, March 2016.

The following excerpts from that publication are considered to be applicable to SSWC.

- If DIC (Dissolved Inorganic Carbon) concentration is >25 and pH is above 7.8, orthophosphate addition is recommended as Optimum Corrosion Control Technology for Copper. (p. 38) The DIC at SSWC is >25 and the pH is in the 8 range.
- For Copper, orthophosphate effectiveness is not strongly affected by pH when pH is between 7 and 8; dose is much more important. The effectiveness of orthophosphate for Copper control increases with increasing pH above 8. While the pH range of 7.2 to 7.8 is still considered optimal,

systems **should not** automatically reduce the pH of their water if it is 8 or higher when starting orthophosphate treatment. (p. 46)

- "Conventional wisdom is that orthophosphate treatment for controlling Lead and Copper should target residual concentration of **0.33 to 1.0 mg/L as P** (1.0 to 3.0 mg/L as PO_4) at the tap when pH is within the range of **7.2 to 7.8.** ***Higher orthophosphate doses*** (1.0 – 1.2 mg/L as P, or 3-3.5 mg/L PO_4 and higher) may be needed under the following circumstances:

    - To control lead release from LSLs (Lead Service Lines). (a)
    - To control Copper corrosion from new Copper pipe.
    - If the system has aluminum carry-over from alum coagulation and/or presence of iron, manganese, and/or magnesium in finished water." (b)

    (p. 46 of referenced document)

(a) Lead service lines are reportedly not present at either Chatham or New Berlin.
(b) Alum is not used in the SSWC treatment process; iron and manganese may be present in the treated water, preferably at low concentrations; magnesium will be present in the treated water.

Because SSWC is feeding a phosphate blend (70% ortho, 15% hexameta, 15% poly), it is recommended that dosage control and monitoring be based on PO_4, since total P includes the other forms of Phosphorus. The following relationships establish a starting point.

Formula weight, PO_4

$$\begin{aligned} P &= 1 \times 30.794 = & 30.794 \\ O &= 4 \times 15.999 = & \underline{63.996} \\ & & 94.79 \end{aligned}$$

$$\% P = \frac{(30.794)}{(94.79)} \times 100 = 32.49\%$$

$$\frac{1\ PO_4}{0.3249\ P} \times 0.33\ P = 1.02 \text{ as } PO_4 \text{ (round to 1 to agree with USEPA value)}$$

$$\frac{1\ PO_4}{0.3249\ P} \times 1\ P = 3.08 \text{ as } PO_4 \text{ (round to 3 to agree with USEPA value)}$$

SSWC should consult with the supplier of the phosphate blend to verify the exact formulation in order to establish the correct procedure for accurately calculating the orthophosphate dosage.

The MCPE Team has requested that USEPA (Michael Schock and/or Darren Lytle) review the Optimal Corrosion Control Technology to be utilized by SSWC, but it is uncertain when they will be able to complete their review due to other nationwide commitments. The original request for assistance from USEPA will be modified based on Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primary Agencies and Public Water Systems, EPA 816-B-16-003, March 2016, becoming available after the initial request was submitted.

The MCPE Team did not consult with Water Solutions Unlimited, the supplier of the phosphate blend, about application conditions and dosages, since it was the Team's desire to maintain its status as independent, third party inquirers. And, the Team desired to receive USEPA input prior to evaluating specific recommendations for the corrosion control program. When the USEPA input is received for the use of the phosphate blend for corrosion control, it is recommended that Water Solutions Unlimited (or the specific company that SSWC chooses to supply the phosphate blend) be brought into the full circle of communications, to (1) assure that there is a clear understanding of USEPA's input and (2) for the SSWC to avail itself of input from the water treatment specialists employed by the supplier. A "team" effort will be beneficial to SSWC and its customers, and the experience of the phosphate blend manufacturer should be taken into consideration.

Since Lead was undetected in 2015 at Chatham and New Berlin, and recognizing that Copper is below the USEPA Action Level, the objectives of optimization of corrosion control treatment are (1) continue to maintain low levels of Lead in compliance samples and (2) improve Copper control by confirming that orthophosphate residual is 1 to 3 mg/L as PO_4 as recommended in the referenced 2016 USEPA publication. Until additional information is available from the USEPA review, this guidance is considered to be applicable. The "bottom line" will be actual Lead and Copper Rule sampling results.

6. CCRs

There have been reports of public distrust about potential presence of Lead and/or Copper in the drinking water. Some complaints have been voiced about absence of results for mandatory Lead and Copper monitoring results at Chatham. The draft 2015 CCRs (Consumer Confidence Reports) for Chatham and New Berlin do not mention Lead monitoring results. It is reportedly "standard procedure" to exclude Lead results from the CCRs if Lead was non-detected in monitoring samples. Lead monitoring results should preferably be reported to the public, including non-detected results. Consumer trust is eroded by absence of full reporting.

It is recommended that SSWC, Village of Chatham, and Village of New Berlin consult with IEPA to confirm that CCR content can be modified to assure full disclosure about compliance with all water quality parameters, including those that are "non-detected". It is desired to improve public confidence in the water supply by eliminating the need for citizens to "question whether or not results are being hidden".

7. Additional Chloride Monitoring

A limited number of special raw and treated water samples were collected during the MCPE. It was noted that Chloride content varied in the treated water samples. Chloride can contribute to metal corrosion. Sodium Chloride is used to regenerate the cation exchange water softeners. If the slow rinse and fast rinse cycles do not remove all of the Chloride before returning the softeners to service, the Chloride content of the water will increase. Chloride is not tested in the softener effluent, and routine Chloride testing in individual softener effluent lines is recommended – especially at the end of the rinse cycle to assure that all excess Chloride has been rinsed out, with all results recorded in plant operating records. It is the MCPE Team's understanding that operational personnel have already addressed this item.

8. Fluoridation

Inconsistent Fluoride readings have been experienced in the treated water. It is now required to maintain Fluoride ion concentration between 0.65 to 0.74 mg/L. Fluoride concentration was measured at 0.79 mg/L at the plant, and was measured at 0.462 mg/L by IDPH, on 23 February 2016. Similar inconsistencies were reported throughout 2015. These inconsistencies may be due to any one of the following factors, or a combination of the factors:

- ✓ The hydrofluosilicic acid feed rate is inconsistent, and the measured Fluoride residuals are inconsistent. The hydrofluosilicic acid feed metering pump feeds into the high service pump suction, and the metering pump is paced to provide feed proportional to the high service pump discharge flow rate. The high service pump(s) is VFD (Variable Frequency Drive) and flow rate varies considerably due to varying demands in the system. The option to move the hydrofluosilicic acid feed point to the clearwell influent should be evaluated, since the flow rate into the clearwell should be more stable, which could improve feed rate stability.
- ✓ The metering pump feed range may not be compatible with actual, required feed rates.
- ✓ A different, potentially more accurate Fluoride testing method may be required.
- ✓ Operators reported "off-gasing" problems with the hydrofluosilicic acid metering pump, which can occur due to temperature variations. Installation of a "de-gassing valve" could help to alleviate this problem; peristaltic pumps reportedly do not experience "off-gasing" problems so switching from diaphragm-type metering pump to peristaltic should be considered.
- ✓ Undertake additional quality assurance steps:

    Review and confirm laboratory procedures for measuring Fluoride ion.

    Review and confirm accuracy of spreadsheet calculations for dosage and feed rate used for the operating reports.

    Confirm that the hydrofluosilicic acid and feed rate (dosage) are being reported on the basis of dry equivalent Fluoride ion. This method of control is recommended since the process objective is to assure that the treated water Fluoride ion concentration is within the regulatory range of 0.65 to 0.74 mg/L, taking into account adjustments for Fluoride ion present in the raw water from the wells.

9. Administrative and Financial Support of Operations

The existing water treatment processes, equipment, instrumentation, and electrical controls are complex. Equipment failures have been reported, but repairs and replacements have not been undertaken due to concerns about cost. Administrative and financial support of the water treatment plant operation may be limiting plant performance efficiency and may result in continuing malfunctions. Arrangements need to proceed to complete repairs to all equipment.

10. Flow Meter Calibration

Chemical feed must be proportional to actual flow rate in order to be effective. The water plant meters have not been calibrated or checked for accuracy. If flow meters are inaccurate, inconsistent treatment results may be experienced. (Raw water meter accuracy may be checked by comparing the meter reading to the computed change in volume in the reaction basin, during a period of zero flow out of the basin; finished water meter accuracy may be checked by comparing the meter reading to the computed change in volume in the clearwell during a period when zero flow is entering the clearwell.)

11. GWUDI

In a letter dated 29 December 2014, IEPA informed SSWC that it is required to demonstrate whether or not the *(raw water)* sources are utilizing "groundwater under the direct influence of surface water (GWUDI)." SSWC has not undertaken the sampling and other tasks needed to fulfill this requirement.

Since issuance of the 20 December 2014 letter to SSWC, IEPA has not issued an opinion whether or not the SSWC wells are classified GWUDI. If it is eventually classified as GWUDI, additional disinfection monitoring practices will be needed to demonstrate that 0.5 log Giardia inactivation and 2.0 log Virus inactivation are being achieved.

Until the GWUDI demonstration has been completed by SSWC, questions will remain about suitability of the treatment and disinfection processes. Administrative decisions are required to address this matter and move forward with the determination.

12. Administrative/Technical Support

The water treatment plant process and equipment configurations are "above average complexity". There are two major unit processes (membrane filters and ion exchange softeners) that utilize numerous valves, meters, monitors (including for turbidity and particle counting), and control functions, but a comprehensive process flow diagram is not available for operating personnel. Overall process control and monitoring could benefit from a comprehensive process control diagram.

Administrative support is necessary to assure that operating personnel can purchase replacement parts and make repairs necessary to keep all equipment and processes in continuous operation and in compliance with regulatory requirements and standards of good practice. Sufficient funds need to be available to allow operating personnel to make repairs to essential components in a timely manner. The facility must be maintained to consistently deliver high quality water in compliance with regulatory requirements.

Technical support of operating personnel is needed to establish water stability monitoring procedures, and to establish procedures to monitor and control the oxidation of Iron and Manganese with sodium permanganate followed by removal of those minerals using the membrane filters. Laboratory procedures and operating report calculation procedures need to be confirmed, which will assist operating personnel in updating any procedures that may be necessary. Technical assistance should be provided to operating personnel in verifying that orthophosphate chemical feed control is based on the actual amount of orthophosphate being fed for corrosion control, since orthophosphate is the "active ingredient".

Operating personnel are subject to stressful working conditions. Since a Water Operator is not present at all times when the treatment plant is in operation, personnel must leave their homes and go to the plant any time an "alarm" condition exists, such as can occur with the membrane filters or with the SCADA system. With just two Operators familiar with the treatment plant, it is difficult for the Operators to schedule time off for vacations, sick leave, and any family emergency that may arise.

POTENTIAL PERFORMANCE LIMITING FACTORS – COMMUNITY WATER CUSTOMERS

Illinois EPA directed SSWC to undertake the CCP (Composite Correction Program), the first step of which is this MCPE (Modified Comprehensive Performance Evaluation). In the interest of achieving water quality optimization goals, the MCPE Team respectfully recommends that community water customers participate as "team members" and address the following potential performance limiting factors and to take "extra" steps to assure water quality maintenance in their respective distribution systems.

Village of Chatham

- ✓ Resume daily chlorine residual measurements and records at the point of where SSWC delivers water into the Chatham system, and continue with daily in-Village chlorine residual monitoring in the central part of the system. Continue to perform spot-check chlorine residual measurements throughout the system as required to assure that at least 0.2 mg/L free chlorine residual is maintained in accordance with regulatory requirements and standards of good practice.
- ✓ Establish a minimum acceptable chlorine residual concentration at the point where SSWC delivers water into the Chatham system, in consultation with SSWC operating personnel. Establish procedures for notifying SSWC if the chlorine residual is below the acceptable concentration at the point where SSWC delivers water into the Chatham system.
- ✓ Proceed with uni-directional flushing, and repeat on an annual basis. The Village of Chatham is to be commended for recognizing the need for a uni-directional flushing program and for taking steps to establish a well-designed program being planned by its consulting engineer.
- ✓ Undertake a formalized "chlorine residual check" procedure during the summer months when chlorine residual depletion might be more severe, by spot checking and recording the chlorine residual in each sector of the Village's service area. The number and location of individual sectors will need to be determined by the Water Dept. employees most familiar with the system, and will require the administrative support of the Village Officials. This "check" is intended to serve as a quality-assurance measure.

Village of New Berlin

- ✓ Continue daily chlorine residual measurements and records at the point of where SSWC delivers water into the New Berlin system, and continue with daily in-Village chlorine residual monitoring in the central part of the system. Continue to perform spot-check chlorine residual measurements throughout the system as required to assure that at least 0.2 mg/L free chlorine residual is maintained in accordance with regulatory requirements and standards of good practice.
- ✓ Establish a minimum acceptable chlorine residual concentration at the point where SSWC delivers water into the New Berlin system, in consultation with SSWC operating personnel. Establish procedures for notifying SSWC if the chlorine residual is below the acceptable concentration at the point where SSWC delivers water into the New Berlin system.
- ✓ Develop and proceed with uni-directional flushing, and repeat on an annual basis.
- ✓ Undertake a formalized "chlorine residual check" procedure during the summer months when chlorine residual depletion might be more severe, by spot checking and recording the chlorine residual in each sector of the Village's service area. The number and location of individual sectors will need to be determined by the Water Dept. employees most familiar with the system, and will require the administrative support of the Village Officials. This "check" is intended to serve as a quality-assurance measure.
- ✓ An overall map of the Village water system should be prepared, and maintained in an up-to-date condition.

PROJECTED IMPACT OF COMPREHENSIVE TECHNICAL ASSISTANCE (CTA)

The MCPE Team believes that the South Sangamon Water Commission water treatment plant could benefit from Comprehensive Technical Assistance (CTA), which is defined in greater detail in the "CCP Handbook". A CTA is a formal and comprehensive program that systematically addresses the factors identified as limiting the plant's performance during the CPE. A CTA typically is initiated when significant performance problems are identified during the CPE. It normally focuses on improving plant performance through Operator training, and improved process control. Administrative factors are also resolved as they relate to their impact on performance problems. All changes during a CTA are implemented by local personnel under the guidance of a facilitator external to the plant staff. The facilitator can be a consultant or other qualified person. Clearly, achieving optimization requires time and effort. Therefore, the staff and management of the water treatment plant must be committed to those goals for a CTA to be successful.

The MCPE Team respectfully acknowledges that the South Sangamon Water Commission management and operating personnel showed concern and dedication to protection of public health during the onsite evaluation and all MCPE-related contacts. The MCPE Team has confidence that the Commission's staff will continue to demonstrate a professional and fully dedicated commitment during all followup activities.

Unrelated to MCPE, but Included for Informational Purposes

Chlorine Residual

Citizen complaints have been received about taste and odor caused by presence of chlorine in the water. Some residences have reportedly installed home treatment devices with the intention of removing chlorine from the water. Over the years, public mistrust has existed about chlorine in the water because of publicity about reactions between free chlorine residual and NOM (Natural Organic Material) forming objectionable compounds, including Total Trihalomethanes, Haloacetic Acids, and Total Organic Halides ("TOX"). The public has a right to know about the presence of these compounds in drinking water.

SSWC, Village of Chatham, and Village of New Berlin water have always been in 100% compliance with regulations governing the concentration of Total Trihalomethanes and Haloacetic Acids, yet there are reports of public mistrust about chlorine being present in the water.

U.S. EPA and Illinois EPA regulations allow up to 4 mg/L chlorine residual in the water based on an annual average of concentrations measured when bacteriological samples are collected at approved-sampling sites. Illinois EPA regulations require that at least 0.2 mg/L free chlorine residual or at least 0.5 mg/L combined chlorine residual be present in the water at all times to protect bacteriological integrity in the water mains delivering water to the customers. The chlorine residual in the SSWC service area has typically been less than 1.6 mg/L, well below the average maximum permissible concentration.

If chlorine residual were to be absent in the water, it would signify that the microbial quality of the water is unknown, since harmful organisms cannot survive in presence of chlorine residual. Like the "singing canary in the coal mine", presence of chlorine signifies that the water is bacteriologically safe.

All water customers have the right to exercise personal choice with respect to presence of chlorine as a disinfecting agent in their household drinking water, but SSWC, Chatham, and New Berlin have a legal obligation to assure that chlorine residual is present in the water supplied to customers.

Chlorine Residual Testing

SSWC, Village of Chatham, and Village of New Berlin measure free chlorine residual with the "DPD method" using Hach test kits and reagents. One section of the Hach test procedure instructions states that the free chlorine residual is to be read "immediately", and in another section of the instructions it states that the free chlorine residual is to be read "within 1 minute" after 20 seconds of vigorous shaking of the sample vial with sample and reagents.

<u>Standard Methods for Examination of Water and Wastewater</u> states that the free chlorine residual must be read "immediately" and makes no reference to a delay up to 1 minute. It is recommended that free chlorine residual readings be taken <u>immediately</u>, since delay in taking the reading may introduce errors.

Communications

There is a need for improved communications between SSWC and its customers, particularly the Villages of Chatham and New Berlin. Citizen complaints have been voiced about the public not being notified about "changes in the water treatment process that may alter water quality". It is the MCPE Team's view that it would be reasonable for SSWC to notify customers of pending major changes, such as incorporation of sodium permanganate feed into the treatment process, and when appropriate - prospective changes in pH and/or significant dosage changes for corrosion control optimization. This could be accomplished with written notification to each community, and an informational note submitted to the local news media. This is "do-able", and will hopefully be rewarded with increased public confidence in South Sangamon Water Commission. Notification of minor, routine changes in chemical dosages is not considered to be necessary.

The MCPE Team received positive, unsolicited comments that Mark Thomas with Woodard & Curran "… always responded to information requests in a prompt and courteous fashion". It is the MCPE Team's view that all representatives of SSWC have a strong desire to address public concerns, but it is sometimes difficult to respond to technical questions about the water when the answer is not readily available. It is not practical for lay persons to be expected to respond to questions about potential water-related health problems. Outside assistance needs to be sought, and assistance from IDPH may be the logical entity to assist in addressing potential widespread water-related health issues. If citizens consult with their personal physicians, the physician's confidential report(s) should be made available to IDPH and/or IEPA.

Customer and citizen complaints should be responded to, even if it requires a delay to seek assistance in getting the answers to those questions. As a public entity, SSWC should not hesitate to request assistance from State agencies, including but not limited to Illinois EPA and Illinois Dept. of Public Health, who employee talented professionals whose goals include "public service".

It may be preferable for SSWC to designate one person to serve as spokesperson for the Commission in responding to public inquiries.

Non-Approved Sampling Sites for Monitoring Lead and Copper Compliance

Section 611.356.a).1).D) of the Illinois Pollution Control Board regulations states the following for sampling site locations for tap water monitoring for Lead and Copper:

> "The supplier must not select as sampling sites any faucets that have point-of-use or point-of-entry treatment devices designed to remove or capable of removing inorganic contaminants."

Initial 1992 IEPA guidance for selecting sample sites required that the sampling sites must not have point-of-entry (water conditioning or softening or treatment equipment) or point-of-use devices (filters attached to the tap or sink plumbing) attached to the plumbing system.

Residences that have point-of-use or point-of-entry treatment devices cannot be included in the routine Lead and Copper monitoring program. Residences that utilize in-home treatment devices may alter water quality and create potentially corrosive conditions. It is respectfully recommended that those residences undertake their own Lead and Copper testing using the services of a certified independent laboratory, utilizing the USEPA sampling protocol for Lead and Copper.

Privately Owned and Operated Home Filtration Devices

The MCPE did not include a survey to determine the number and type of home filtration devices installed by homeowners at Chatham and New Berlin, but reports indicate that these devices have been installed by some of the residents. Neither IEPA, SSWC, the Village of Chatham, nor the Village of New Berlin have jurisdiction over privately installed home water treatment devices.

The Illinois Pollution Control Board regulations (611.280) stipulate specific guidelines for "point-of-entry" treatment devices (home treatment units) if they must be installed in private homes to comply with a MCL (Maximum Contaminant Level) for a particular contaminant that is not being removed in a CWS (Community Water System). These regulations do not apply to home treatment units voluntarily installed by residents unless they are needed to comply with a MCL. IPCB requirements for home filtration devices installed to comply with a MCL for a contaminant include:

d) Effective technology must properly be applied under a plan approved by the Agency, and **the microbiological safety of the water must be maintained**. (emphasis added)

1) The Agency must require adequate certification of performance, field testing, and if not included in the certification process, a rigorous engineering design review of the point-of-entry devices.

2) **The design and application of the point-of-entry devices must consider the tendency for increase in heterotrophic bacteria concentrations in water treated with activated carbon. The Agency may require, by a SEP issued pursuant to Section 611.110, frequent backwashing, post-contactor disinfection and HPC monitoring to ensure that the microbiological safety of the water is not compromised.** (emphasis added)

Privately installed home treatment devices are not required to follow these guidelines. The homeowners are "on their own", and it is not known if (1) the residential filters are being replaced at necessary intervals or (2) if microbial water quality is being tested or maintained in absence of disinfection after filtration. If a homeowner question bacteriological integrity of water treated with a home filtration device, it is recommended that the homeowner seek assistance from a trained-sample collector to collect a bacteriological sample to be analyzed by an accredited independent laboratory engaged by the homeowner.

The MCPE Team neither condemns nor endorses use of home filtration systems and it is the responsibility of the individual homeowners utilizing home treatment devices to assure that their in-home water quality meets their needs.

Home Water Softeners

Typical home water softeners are sodium-cycle cation exchange softeners, and remove Calcium and Magnesium from the water. Calcium and Magnesium are the primary constituents of "hard water". This process replaces each Calcium ion with two Sodium ions and each Magnesium ion with two Sodium ions. The TDS (Total Dissolved Solids) concentration is increased with ion exchange water softening, which can contribute to presence of "residue" on some surfaces after the water has evaporated.

Neither Calcium nor Magnesium cause adverse health effects at concentrations present in SSWC water, but

SSWC utilizes the cation exchange softening process to reduce total hardness to the 120 mg/L range (as $CaCO_3$) for aesthetic reasons, and for the water at Chatham to have hardness similar to the water previously supplied to Chatham from the City of Springfield. Aesthetic benefits of soft water in household use include reduction of "spots" on glassware since Calcium and Magnesium are removed by the softening process. (If hard-to-remove spots remain on glassware even with soft water, they "might" be caused by naturally occurring silica in some water sources.) Other potential benefits of additional home water softening for household use are based on personal preference.

Some home owners elect to utilize home water softeners so that there is "zero" hardness remaining in the water. "Softened water is made potentially aggressive to metallic piping, a properly sized and maintained softener will produce a water with zero hardness that can be corrosive to home plumbing. Water with zero hardness will also attack glassware resulting in a hazy surface sheen or "rainbow etching". (Ref: "Private Drinking Water in Connecticut", State of Connecticut Department of Public Health; adapted from "Healthy Drinking Waters for Rhode Islanders, University of Rhode Island Cooperative Extension", April 2003.)

The following is from "Corrosion, Saturation Index, Balanced Water in Drinking Water Systems – Corrosion Control Training for Professionals", Water Research Center, Brian Oram, P.G.

> "It is important to keep in mind that the corrosiveness of water can be increased by the installation of water softeners, aeration devices, increasing hot water temperatures, chlorinating the water, turbid or fine sediment, and improper matching of metals. Some water treatment equipment such as softeners and aeration systems can aggravate corrosion. Softeners remove the protective calcium and magnesium and introduce the highly conductive sodium into the water."

The following is from Culligan, a manufacturer/supplier of home water softeners:

> "Trouble Shooting Blue-Green Staining and Copper Corrosion
>
> The complex issue of corrosion of copper water pipes is a frequent complaint. Primary concerns include deterioration of metallic plumbing, potentially harmful levels of copper in drinking water and aesthetic problems such as blue green stains or bitter taste. Addressing the concerns (about corrosion of copper pipe) is often difficult due to the variety of corrosion mechanisms and limited data on evaluating remediation techniques."

Residences that elect to utilize home water softeners may wish to engage the services of a certified independent laboratory to test their water for Lead and Copper using the services of a certified independent laboratory, utilizing the USEPA sampling protocol for Lead and Copper. Periodic testing could potentially be beneficial to these residences since their homes cannot be included in the routine Lead and Copper sampling program required for compliance with the Lead and Copper Rule.

The MCPE Team neither condemns nor endorses use of home water softeners and it is the responsibility of the individual homeowners utilizing home treatment devices to assure that their in-home water quality meets their needs. It is noted, however, that softening only the hot water supply for residential use might be acceptable to some homeowners, since it is not necessary to use softened water for flushing toilets and some other residential water uses.

Hot Water Heaters

Customer complaints have been reported about scale formation in hot water heaters at Chatham and New Berlin. Hot water heater manufacturers typically recommend draining to remove accumulated solids at least once a year.

Most manufacturers suggest a 120-125° F temperature setting for hot water heaters. If the water temperature is above 140°F, increased scale formation may result. Homeowners should be made aware that the U.S. Department of Labor, Occupational Safety & Health Administration, has published the following cautions:

- Scale and sediment in domestic hot water heaters supply the environment needed for growth of Legionnaire's disease bacteria (LDB) and other microorganisms.
- Dead legs and non-recirculating plumbing lines that allow hot water to stagnate also provide areas for growth of the LDB organism.
- Temperatures maintained below 140°F encourage growth of LDB and other organisms.
- Maintain domestic water heaters at 140°F and water delivered at the faucet at a minimum of 122°F. Where these temperatures cannot be maintained, control LDB growth with a safe and effective alternate method.
- Proper insulation of hot water lines and heat tracing of lines can help maintain distribution and delivery temperatures at 122°F.
- Hot water heaters should be drained periodically to remove scale and sediment.
- Periodically chlorinate the system at the tank to produce 10 ppm free residual chlorine and flush all taps until a distinct odor of chlorine is evident as a means of control. (Or, flush until a free chlorine residual can be measured.) The tank should be thoroughly rinsed to remove excess chlorine before reuse.

Also, refer to https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html.

Reducing hot water temperature may lessen scale formation, but this would not be prudent if there is a potential danger of developing LDB. There is concern about "scalding" with hot water, and use of "mixing valves" should be considered to lessen concern about "scalding".

A scale sample from a hot water heater collected by the Chatham Water Dept. employees indicated presence of a "bluish tint" with some of the scale, which suggests potential presence of particulate Copper, and analyses by a private laboratory (paid for by the Village) did indicate presence of a relatively small amount of Copper with the scale. Hot water is more corrosive than cold water, but it is not known if the source of the Copper in the scale sample was from the piping or the hot water heater. The scale sample also indicated presence of a high concentration of Aluminum, likely originating from an Aluminum anode? Aluminum hydroxide can form on the anode and it has a "jelly bead" appearance, or a green, blue or gray gel-like substance in the heater drain or at faucet aerators. The majority of the scale was composed of Calcium and Magnesium.

Due to low solubility of Calcium and Magnesium in the temperature range used in hot water heaters, it is likely that nearly 100% of these minerals will "drop out" in the form of scale in the hot water heaters. In-depth investigations regarding scale formation in hot water heaters is not within the scope of the MCPE.

It is noted, however, that the circumstances at Chatham involved a change in water quality when the switch was made from the City of Springfield to SSWC. Springfield water reportedly has alkalinity in the 40 mg/L range (as $CaCO_3$), and SSWC water has alkalinity in the 280 mg/L range (as $CaCO_3$), which "might" explain the complaints about increased formation of scale in Chatham residential hot water heaters, based on the following:

> "… it is commonly assumed that the solubility of $CaCO_3$ decreases with increase in temperature. This is not true for waters with low alkalinity (less than 50 ppm). In such waters, the greater temperature decreases the pH at a rate which is greater than the rate of decrease in solubility of $CaCO_3$. This decrease in pH (as water temperature increases) actually increases the *solubility* of $CaCO_3$…" (Ref: From T. E. Larson, Water Quality and Treatment, A Handbook of Public Water Supplies, American Water Works Association, 3rd ed. 1971 (p. 305).
>
> Since the SSWC alkalinity is higher than water previously supplied to Chatham by the City of Springfield, the solubility of $CaCO_3$ decreases with increased in temperature within the hot water heater causing it to precipitate in the form of "Calcium scale". Perhaps this explains the reason for increased customer complaints about scale formation in hot water heaters. The higher alkalinity of SSWC water is naturally-occurring with the groundwater supply and is not in itself considered to be harmful to public health.
>
> Through an independent analysis, the "bottom line" is: the reason for increased scale formation in hot water heaters, particularly at Chatham, is the Calcium Carbonate Precipitation Potential (CCPP, from "RTW Model") is much higher in SSWC than in water from Springfield, especially at elevated temperatures used in hot water heaters. The reason for the increased CCPP in SWWC is the much different alkalinity in the two waters. Reiterating, alkalinity in itself is not harmful to public health.

Sodium concentration is higher in SSWC water than in water previously purchased from Springfield by Chatham, due to use of the sodium-cycle cation exchange water softeners used at the SSWC treatment plant to lower hardness to the 120 mg/L range (as $CaCO_3$). Sodium is a component of TDS (Total Dissolved Solids), but in hot water heaters the majority of the Sodium likely remains in solution due to its high solubility, so Sodium is not expected to be a significant component of scale within hot water heaters.

Lead and Copper

Action Level Goal (ALG): The level of a contaminant in drinking water below which there is no known or expected risk to health. ALGs allow for a margin of safety.
Action Level (AL): the concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

New Berlin	Date Sampled	MCLG	Action Level (AL)	90^{th} Percentile	# Sites Over AL	Units	Violation
Copper	2014	1.3	1.3	0.15	0	ppm	N
	2015	1.3	1.3	0.1	0	ppm	N
Lead	2014	0	15	1.3	0	ppb	N
	2015	(If the 90% value for lead is non-detected it is not required to be included on the CCR.)					

Disinfectants & Disinfection By-Products

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Chlorine	12/31/2014	0.9	0.5-1.3	4	4	ppm	N
	2015	0.8	0.58-1.09	4	4	ppm	N
HAA_5	2014	12	11.1-12.3	none	60	ppb	N
	2015	4	4.34-4.34	none	60	ppb	N
TTHM	2014	36	35.45-37.28	none	80	ppb	N
	2015	28	28.4-28.4	none	80	ppb	N

Inorganic Contaminants ***... Sampled prior to connection to South Sangamon Water Commission***

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Barium	5/16/2011	0.051	0.051-0.051	2	2	ppm	N
Fluoride	5/16/2011	0.84	0.84-0.84	4	4.0	ppm	N
Iron (1)	5/16/2011	0.051	0.051-0.051		1.0	ppm	N
Manganese (1)	5/16/2011	2.1	2.1-2.1	150	150	ppb	N
Nitrate-N	5/16/2011	4.1	4.1-4.1	10	10	ppm	N
Sodium	5/16/2011	8.1	8.1-8.1			ppm	N

(1) Not regulated by USEPA. Regulated by State.

Lead and Copper
Action Level Goal (ALG): The level of a contaminant in drinking water below which there is no known or expected risk to health. ALGs allow for a margin of safety.
Action Level (AL): the concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

Chatham	Date Sampled	MCLG	Action Level (AL)	90th Percentile	# Sites Over AL	Units	Violation
Copper	2014	1.3	1.3	0.83	0	ppm	N
	2015	1.3	1.3	0.662	0	ppm	N
Lead	2014	0	15	2.7	0	ppb	N
	2015	(If the 90% value for lead is non-detected it is not required to be included on the CCR.)					

Disinfectants & Disinfection By-Products

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Chlorine	12/31/2014	0.8	0.6-1	4	4	ppm	N
	12/31/2015	0.8	0.55-0.87	4	4	ppm	N
HAA_5	2014	12	7.8-19	none	60	ppb	N
	2015	22	14.95-28.8	none	60	ppb	N
TTHM	2014	30	24.11-47.22	none	80	ppb	N
	2015	25	20.98-24.5	none	80	ppb	N

Inorganic Contaminants … ***no data reported since supplied from South Sangamon Water Commission***

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Barium							
Fluoride							
Iron (1)							
Manganese (1)							
Nitrate-N							
Sodium							

(1) Not regulated by USEPA. Regulated by State.

Lead and Copper

Action Level Goal (ALG): The level of a contaminant in drinking water below which there is no known or expected risk to health. ALGs allow for a margin of safety.
Action Level (AL): the concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

SSWC	Date Sampled	MCLG	Action Level (AL)	90th Percentile	# Sites Over AL	Units	Violation
Copper	2014	1.3	1.3	0.752	0	ppm	N
Lead	2014	0	15	7	0	ppb	N
Copper	2015	1.3	1.3	0.803	0	ppm	N
Lead	2015	0	15	4.04	0	ppb	N

Disinfectants & Disinfection By-Products

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Chlorine	12/31/2014	1.2	0.3-1.3	4	4	ppm	N
HAA_5	2014	10	9.9-9.9	none	60	ppb	N
TTHM	2014	29	29.25-29.25	none	80	ppb	N
Chlorine	12/31/2015	1	0.5-1.01	4	4	ppm	N
HAA_5	2015	21.8	21.8-21.8	none	60	ppb	N
TTHM	2015	19.64	19.64-19.64	none	80	ppb	N

Inorganic Contaminants

	Date Sampled	Highest Detected	Range Detected	MCLG	MCL	Units	Violation
Barium	7/19/2012	0.0204	0.0204-0.0204	2	2	ppm	N
	2015	0.019	0.019-0.019	2	2	ppm	N
Fluoride	7/19/2012	0.79	0.79-0.79	4	4.0	ppm	N
	2015	0.886	0.886-0.886	4	4.0	ppm	N
Iron (1)	no report						
	2015	1.7	0-2.83		1.9	ppm	N
Manganese (1)	7/19/2012	17.8	17.8-17.8	150	150	ppb	N
	2015	259	0.0175-429	150	150	ppb	N
Nitrate-N	2014	0.41	0.41-0.41	10	10	ppm	N
	2015	0.343	0.343-0.343	10	10	ppm	N
Sodium	7/19/2012	116	116-116			ppm	N
	2015	122	122-122			ppm	N
Zinc (1)	7/19/2012	0.115	0.115-0.115	5	5	ppm	N
Combined Radium	2014	1	0.59-1.25	0	5	pCi/L	N
	2015	1	0.91-1.53	0	5	pCi/L	N
Gross alpha excluding radon & uranium	2014	3	2.01-2.96	0	15	pCi/L	N

(1) Not regulated by USEPA. Regulated by State.

wsName	WSID	Site Result	SITE_NO	LabResult	Date
SOUTH SANGAMON WATER COMMISSION	1670080	1.2	01	0.871	1/13/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1	01	0.642	1/20/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1	01	0.897	2/3/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1	01	1.09	3/10/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.02	01	0.825	4/1/2014
SOUTH SANGAMON WATER COMMISSION	1670080	0.97	01	0.664	4/23/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.11	01	1.04	5/29/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1	01	0.836	6/9/2014
SOUTH SANGAMON WATER COMMISSION	1670080	0	01	0.82	6/26/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.04	01	0.984	7/10/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.03	01	0.856	8/11/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.03	01	0.901	9/24/2014
SOUTH SANGAMON WATER COMMISSION	1670080	0.9	01	0.842	10/6/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.1	01	0.663	11/10/2014
SOUTH SANGAMON WATER COMMISSION	1670080	1.3	01	1.04	12/1/2014
SOUTH SANGAMON WATER COMMISSION	1670080	0.99	01	0.99	1/26/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.05	01	0.864	2/10/2015
SOUTH SANGAMON WATER COMMISSION	1670080	0.95	01	0.636	3/31/2015
SOUTH SANGAMON WATER COMMISSION	1670080	0.98	01	0.76	4/6/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.16	01	1.39	5/12/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.2	01	0.995	6/2/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.18	01	0.936	7/6/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.19	01	1.07	8/22/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.21	01	1.11	9/10/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.27	01	1.05	10/16/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.15	01	1.01	11/23/2015
SOUTH SANGAMON WATER COMMISSION	1670080			1	12/1/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.14	01	0.986	12/15/2015
SOUTH SANGAMON WATER COMMISSION	1670080	1.02	01	1.06	1/26/2016
SOUTH SANGAMON WATER COMMISSION	1670080	0.79	02	0.462	2/23/2016

EXHIBIT 2 SSWC FLUORIDE TEST RESULTS FROM IDPH

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 North Grand Avenue, East; Post Office Box 19276; Springfield, IL 62794-9276

Division of Public Water Supplies — Telephone 217/782-1724

PUBLIC WATER SUPPLY CONSTRUCTION PERMIT

SUBJECT: SOUTH SANGAMON WATER COMMISSION (Sangamon County-1670080)

RECEIVED
SPRINGFIELD REGION
JAN 05 2011
Environmental Protection Agency
STATE OF ILLINOIS

Permit Issued to:
Chairman and Board of Trustees
South Sangamon Water Commission
P.O. Box 83
New Berlin, IL 62670

PERMIT NUMBER: 0658-FY2010

DATE ISSUED: December 23, 2010
PERMIT TYPE: Plant Improvement

The issuance of this permit is based on plans and specifications prepared by the engineers/architects indicated, and are identified as follows. This permit is issued for the construction and/or installation of the public water supply improvements described in this document, in accordance with the provisions of the "Environmental Protection Act", Title IV, Sections 14 through 17, and Title X, Sections 39 and 40, and is subject to the conditions printed on the last page of this permit and the ADDITIONAL CONDITIONS listed below.

FIRM: Donohue & Associates, Inc.
NUMBER OF PLAN SHEETS: 172
TITLE OF PLANS: "Contract C Water Treatment Plant and Contract E Procurement"

PROPOSED IMPROVEMENTS:

***The proposed project shall consist of an aerator, 188,000 gallon detention tank, a membrane filterations system, four (4) ion exchange vessels, a brine system, an aqua ammonia feed system, a fluoride feed system, a polyphosphate feed system, a sodium hypochloride feed system, 282,000 gallon clearwell, three (3) high service pumps, (each with a capacity of 1,150 gpm @ 263 ft TDH), three (3) low service pumps (each with a capacity of 1,500 gpm @ 117 ft TDH), a back-up generator, piping, controls and necessary appurtenances.

The aerator shall include a raw water header/lateral distribution system incorporating low head hollow cone pattern spray nozzles. There shall be ten (10) tiers of trays and two (2) blowers (each with a capacity of 10,800 cfm). Each Tier shall be 12 feet by 12 feet or 144 square feet with a total of 1440 square feet provided. The proposed membrane system, WesTech AltaFilter-UF120 S2, shall be a three skid system and shall be complete with a clean in place (CIP) system, piping, controls and necessary appurtenances. The CIP system shall be complete with an 800 gallon heated tank, two (2) feed pumps (capacity of 240 gpm), chlorine feed system, citric acid feed system, caustic feed system, neutralization system, sodium bisulfate feed, system, ammonium sulfate feed system, hydrofluosilicic acid feed system, piping, controls and necessary appurtenances. Each of the ion exchange vessels shall be 11 feet in diameter with a side shell height of 8 feet. Each unit shall have 12 inches of support gravel, three inches of torpedo sand supporting four feet of resin. The brine system shall have two (2) brine tanks, two (2) brine pumps, piping, controls and necessary appurtenances.

The aqua ammonia feed system shall be complete with two (2) chemical feed pumps (each with a capacity of 2 gph), anti-siphon valves, bulk storage tank (capacity of 6,300 gallons), day tank (capacity of 120 gallon), scale, feed lines, controls and necessary appurtenances. The fluoride feed system shall be complete with two (2) chemical feed pumps

EXHIBIT 3 ORIGINAL IEPA CONSTRUCTION PERMIT FOR SSWC WTP

Rcd 29 Mar 2016

(each with a capacity of 1 gph), anti-siphon valves, tankage, scale, feed lines, controls and necessary appurtenances. The polyphosphate feed system shall be complete with two (2) chemical feed pumps (each with a capacity of 2 gph), anti-siphon valves, tankage, scale, feed lines, controls and necessary appurtenances. The sodium hypochlorite feed system shall be complete with two (2) chemical feed pumps (each with a capacity of 8.4 gph), anti-siphon valves, bulk storage (capacity of 5,500 gallons, day tank (capacity of 175 gallons), scale, feed lines, controls and necessary appurtenances.***

ADDITIONAL CONDITIONS:

1. The hatches on the brine storage tank must be famed at least four inches above the roof at the opening. They shall be fitted with a solid water tight cover which overlaps the famed opening and extends down around the fame and at least two inches. Shall be hinged on one seide and shall have a locking device.

2. Only those chemicals used in the pretreatment process prior to the membranes during the pilot study are acceptable for use.

3. Any changes in chemicals used in the pretreatment process prior to the membrane units must have a certification from the membrane supplier that is acceptable to use and will not negatively impact the efficiency or agreed upon life of the membranes. A construction permit must be obtained from the Agency prior to any chemical feed changes.

4. The DPWS requires that an integrity test be performed at no longer an interval than every eights hours.

   For Integrity Testing the Agency shall require:

   1. The direct integrity test resolution must be such that, at a minimum, the test can respond to a breach of 3 um or less. The direct integrity test sensitivity in terms of log removal value (LRV) must be demonstrated to the Agency by testing on site and by calculation. The USEPA Membrane Filtration Guidance Manual (EPA 815-R-06-009) should be used as general guide with regard to complying with this general condition. The established sensitivity and the procedure used to establish it shall be submitted to the Agency and approved prior to South Sangamon being issued an Operating Permit. Though the direct integrity test based on a resolution of 3 um and it associated sensitivity the Agency recommends that if an integrity breach of any magnitude exists the unit should be taken out of service for diagnostic testing and repair.
   2. An upper and lower control limit must be established within the sensitivity limits of the pressure decay test that shows the membrane unit capable of achieving the LRV. The control limit and the procedure used to establish it shall be submitted to the Agency and approved prior to South Sangamon being issued an Operating Permit.
   3. The sensitivity and frequency of the pressure decay test must be demonstrated to the Illinois EPA for all of the membrane units prior to an operating permit being issued.
   4. If the pressure decay test results exceed the control limit for any membrane unit, that unit must be removed from service.
   5. Any unit taken out of service for exceeding pressure decay test (PDT) control limits cannot be returned to service until a corrective action is taken including repairs, if required. The unit shall not be place back in service until the corrective actions including repairs are confirmed by subsequent direct integrity test within the control limit.
   6. Any pressure decay test results exceeding the control limit, as well as the corrective action taken in response, must be reported to the Illinois EPA no later than 10 days after the end of the month.
   7. The membrane used by South Sangamon Water Commission must undergo challenge testing to evaluate removal efficiency, and the results must be reported to the Agency. Challenge Testing must be conducted in accordance with the LT2 Enhanced Surface Water Rule and establish a quality control release valve (QCRV) for the PDT that demonstrates the removal capabilities of the membrane filtration module and that can be applied to all modules used. The Agency reserves the right to approve the method for determining

the QCRV.

For Indirect Integrity Testing the Agency shall require:

1. Continuous monitoring of the membrane filtrate quality shall be done through the use of turbidimeters and partical counters.
2. Monitoring must be conducted at a frequency of at least one reading every 15 minutes.
3. If the continuous indirect integrity monitoring results exceed the specified control limit for any membrane unit for a period greater than 15 minutes, direct integrity testing (pressure decay) must be immediately conducted on that unit.
4. The control limit for turbidity monitoring is 0.15 NTU.
5. The control limit for particle counters shall be established within 6 months of start of operation of the membranes, utilizing procedures recommended in the USEPA Membrane Filtration Guidance Manual or an alternative method approved by the Agency.

JHK:CLK: dsa

cc: Donohue & Associates, Inc.
Springfield Region

Jerry H. Kuhn, P.E.
Manager Permit Section
Division of Public Water Supplies

South Sangamon County Water Commission

Tetra Tech (RTW) Model Results*

Curry & Associates Engineers, Inc. 2016.20

Prepared by MDC on 11 March 2016

Sample Location	Finish Water	Chatham Reservoir	New Berlin
Sample Date	3/4/2016	3/4/2016	3/4/2016
Model Inputs			
Total Dissolved Solids, mg/L	428	484	482
Temperature, °C	13.1	14	14.7
pH	7.83	7.83	7.9
Alkalinity (as mg/L CaCO3)	268	280	274
Calcium (as mg/L CaCO3)	64.5	62.9	67.4
Chloride, mg/L	29.1	60	59.6
Sulfate, mg/L	68.9	68.9	68.9
Model Outputs			
Precipitation Potential mg/L	(+4.07)	(+4.51)	(+7.66)
(Desired + 4 to 10 mg/L with variations)			
Negative indicates corrosive tendency			
Positive indicates scale forming tendency			
Langelier Index	(+0.12)	(+0.13)	(+0.23)
(Desired >0)			
Negative indicates corrosive tendency			
Positive indicates scale forming tendency			
Aggressiveness Index	(+12.07)	(+12.08)	(+12.17)
<12.0 indicates corrosive tendency			
>12.0 indicates scale forming tendency			
Ryznar Index	7.59	7.57	7.44
>6.8 indicates corrosive tendency			
6.2 to 6.8 indicates "stable"			
<6.2 indicates scale forming tendency			
alkalinity / (Cl + SO4)	2.7	2.2	2.1
<5.0 indicates corrosive tendency			
>5.0 indicates scale forming tendency			

* Tetra-Tech (RTW) Model for Water Chemistry, Process, and Corrosion Control; Michael R. Rothberg, Hong-Chang "H.C." Liang, Sarvin Tabatabaie, and Joseph R. Tamburini; available from American Water Works Association (AWWA); originally "Rothberg Tamburini Winsor" model.

The RTW Model Ver. 3.0 ID: **Finished Water @ Plant, Sampled 4 March 2016**

STEP 1: Enter initial water characteristics.

Measured TDS	**428**	mg/L
Measured temperature	**13.1**	deg C
Measured pH	**7.83**	
Measured alk, as CaCO3	**268**	mg/L
Measured Ca, as CaCO3	**64.5**	mg/L
Measured Cl	**29.1**	mg/L
Measured SO4	**68.9**	mg/L

For CT and TTHM functions enter current:

Treated water pH	
Chlorine residual	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.

Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L
Ctrl+C to add to list	**0**	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	268	mg/L	> 40 mg/L	Interim pH	7.83		6.8-9.3
Interim Ca, as CaCO3	65	mg/L	> 40 mg/L	Precipitation potential	4.07	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.7		> 5.0	Langelier index	0.12		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	286	mg/L
Initial Ca sat, as CaCO3	49	mg/L
Initial DIC, as CaCO3	554	mg/L

Theoretical interim water characteristics

Interim acidity	286	mg/L
Interim Ca sat, as CaCO3	49	mg/L
Ryznar Index	7.59	
Interim DIC, as CaCO3	554	mg/L
Aggressiveness Index	12.07	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	264	mg/L
Final Ca	60	mg/L
Final acidity	286	mg/L
Final pH	7.75	
Final DIC, as CaCO3	550	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

The RTW Model Ver. 3.0 ID: **Chatham Reservoir, Sampled 4 March 2016**

STEP 1: Enter initial water characteristics.

Measured TDS	**484**	mg/L
Measured temperature	**14**	deg C
Measured pH	**7.83**	
Measured alk, as CaCO3	**280**	mg/L
Measured Ca, as CaCO3	**62.9**	mg/L
Measured Cl	**60**	mg/L
Measured SO4	**68.9**	mg/L

For CT and TTHM functions enter current:

Treated water pH	
Chlorine residual	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.

Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L
Ctrl+C to add to list	**0**	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired
Interim alkalinity	280	mg/L	> 40 mg/L
Interim Ca, as CaCO3	63	mg/L	> 40 mg/L
Alk/(Cl+SO4)	2.2		> 5.0

Theoretical interim water characteristics			Desired
Interim pH	7.83		6.8-9.3
Precipitation potential	4.51	mg/L	4-10 mg/L
Langelier index	0.13		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	298	mg/L
Initial Ca sat, as CaCO3	47	mg/L
Initial DIC, as CaCO3	578	mg/L

Theoretical interim water characteristics

Interim acidity	298	mg/L
Interim Ca sat, as CaCO3	47	mg/L
Ryznar index	7.57	
Interim DIC, as CaCO3	578	mg/L
Aggressiveness Index	12.08	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	275	mg/L
Final Ca	58	mg/L
Final acidity	298	mg/L
Final pH	7.74	
Final DIC, as CaCO3	573	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

The RTW Model Ver. 3.0 ID: **New Berlin, Sampled 4 March 2016**

STEP 1: Enter initial water characteristics.

Measured TDS	**482**	mg/L
Measured temperature	**14.7**	deg C
Measured pH	**7.9**	
Measured alk, as CaCO3	**274**	mg/L
Measured Ca, as CaCO3	**67.4**	mg/L
Measured Cl	**59.6**	mg/L
Measured SO4	**68.9**	mg/L

For CT and TTHM functions enter current:

Treated water pH		
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.

Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L
Ctrl+C to add to list	**0**	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	274	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	67	mg/L	> 40 mg/L	Precipitation potential	7.66	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.1		> 5.0	Langelier index	0.23		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	288	mg/L
Initial Ca sat, as CaCO3	40	mg/L
Initial DIC, as CaCO3	562	mg/L

Theoretical interim water characteristics

Interim acidity	288	mg/L
Interim Ca sat, as CaCO3	40	mg/L
Ryznar index	7.44	
Interim DIC, as CaCO3	562	mg/L
Aggressiveness Index	12.17	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	266	mg/L
Final Ca	60	mg/L
Final acidity	288	mg/L
Final pH	7.74	
Final DIC, as CaCO3	554	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

Mike Curry

From: Dan Held <dheld@woodardcurran.com>
Sent: Wednesday, March 09, 2016 9:51 AM
To: Mike Curry; Marc Thomas
Cc: Andy Curry; Paul Roux; Keith Sommers
Subject: RE: Initial Water Stability Information

Gentlemen:

New set of results became available to me today. See the table below:

Analysis	RAW	Finished	Chatham Reservoir	New Berlin
Calcium Hardness (as CACO3)	164	64.5	62.9	67.4
Calcium	79.0	25.8	25.2	27.0
Chloride	29.5	29.1	60.0	59.6
Sulfate	69.2	68.9	68.9	68.9
Total Alkalinity (as CACO3)	279	268	280	274
Bicarbonate Alkalinity (as CACO3)	279	268	280	274
Carbonate Alkalinity (as CACO3)	0	0	0	0
Phenolphthalein Alkalinity (as CACO3)	0	0	0	0
pH	7.29	7.83	7.83	7.90
Total Dissolved Solids	422	428	484	482
Temperature	13.8	13.1	14.0	14.7

Dan

From: Mike Curry [mailto:mcurry@curryassociates.com]
Sent: Saturday, March 05, 2016 12:09 PM
To: Dan Held <dheld@woodardcurran.com>; Marc Thomas <mthomas@woodardcurran.com>
Cc: Andy Curry <acurry@curryassociates.com>
Subject: RE: Initial Water Stability Information

Dan ... Yes, Andy informed me of the additional samples.

From: Dan Held [mailto:dheld@woodardcurran.com]
Sent: Saturday, March 05, 2016 12:08 PM
To: Mike Curry; Marc Thomas
Cc: Andy Curry
Subject: RE: Initial Water Stability Information

Mike:

Per Andy's instruction, I pulled a new sample for the Finished water leaving the plant. I also pulled a complete set (Raw, Finished, Chatham Reservoir and New Berlin on Friday), those test results hopefully will be available next week.

Dan

From: Mike Curry [mailto:mcurry@curryassociates.com]
Sent: Saturday, March 05, 2016 12:00 PM

South Sangamon County Water Commission

Tetra Tech (RTW) Model Results*

Curry & Associates Engineers, Inc. 2016.20

Prepared by MDC on 3 March 2016

Sample Location	Finish Water	Chatham Reservoir	New Berlin
Sample Date	2/22/2016	2/22/2016	2/22/2016
Model Inputs			
Total Dissolved Solids, mg/L	440	448	384
Temperature, °C	13.8	13.5	10.6
pH	7.93	7.92	7.84
Alkalinity (as mg/L CaCO3)	290	286	286
Calcium (as mg/L CaCO3)	69.4	67.9	66.8
Chloride, mg/L	no test**	no test**	no test**
Sulfate, mg/L	69.4	68.9	70.3
Model Outputs			
Precipitation Potential mg/L	(+10.18)	(+8.96)	(+5.32)
(Desired + 4 to 10 mg/L with variations)			
Negative indicates corrosive tendency			
Positive indicates scale forming tendency			
Langelier Index	(+0.29)	(+0.26)	(+0.14)
(Desired >0)			
Negative indicates corrosive tendency			
Positive indicates scale forming tendency			
Aggressiveness Index	(+12.23)	(+12.21)	(+12.12)
<12.0 indicates corrosive tendency			
>12.0 indicates scale forming tendency			
Ryznar Index	7.34	7.4	7.55
>6.8 indicates corrosive tendency			
6.2 to 6.8 indicates "stable"			
<6.2 indicates scale forming tendency			
alkalinity / (Cl + SO4)	no report	no report	no report
<5.0 indicates corrosive tendency			
>5.0 indicates scale forming tendency			

* Tetra-Tech (RTW) Model for Water Chemistry, Process, and Corrosion Control; Michael R. Rothberg, Hong-Chang "H.C." Liang, Sarvin Tabatabaie, and Joseph R. Tamburini; available from American Water Works Association (AWWA); originally "Rothberg Tamburini Winsor" model.

** no test ... due to mis-communication; additional sample being collected.

The RTW Model Ver. 3.0 ID: **Finish Water Sample 2/22/2016**

STEP 1: Enter initial water characteristics.

Measured TDS	**440**	mg/L
Measured temperature	**13.8**	deg C
Measured pH	**7.93**	
Measured alk, as CaCO3	**290**	mg/L
Measured Ca, as CaCO3	**69.4**	mg/L
Measured Cl		mg/L
Measured SO4	**69.4**	mg/L

For CT and TTHM functions enter current:

Treated water pH	
Chlorine residual	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.

Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L
Ctrl+C to add to list	**0**	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	290	mg/L	> 40 mg/L	Interim pH	7.93		6.8-9.3
Interim Ca, as CaCO3	69	mg/L	> 40 mg/L	Precipitation potential	10.18	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.2		> 5.0	Langelier index	0.29		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	304	mg/L
Initial Ca sat, as CaCO3	36	mg/L
Initial DIC, as CaCO3	594	mg/L

Theoretical interim water characteristics

Interim acidity	304	mg/L
Interim Ca sat, as CaCO3	36	mg/L
Ryznar index	7.34	
Interim DIC, as CaCO3	594	mg/L
Aggressiveness Index	12.23	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	280	mg/L
Final Ca	59	mg/L
Final acidity	304	mg/L
Final pH	7.72	
Final DIC, as CaCO3	584	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

The RTW Model Ver. 3.0 ID: Chatham Reservoir 2/22/2016

STEP 1: Enter initial water characteristics.

Measured TDS	**448**	mg/L
Measured temperature	**13.5**	deg C
Measured pH	**7.92**	
Measured alk, as CaCO3	**286**	mg/L
Measured Ca, as CaCO3	**67.9**	mg/L
Measured Cl		mg/L
Measured SO4	**68.9**	mg/L

For CT and TTHM functions enter current:

Treated water pH	
Chlorine residual	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical).
Press Alt+C to select chemicals for this list.

Alum 50% solution	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Soda ash	0	mg/L
Sodium bicarbonate	0	mg/L
Ctrl+C to add to list	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired
Interim alkalinity	286	mg/L	> 40 mg/L
Interim Ca, as CaCO3	68	mg/L	> 40 mg/L
Alk/(Cl+SO4)	4.2		> 5.0

Theoretical interim water characteristics			Desired
Interim pH	7.92		6.8-9.3
Precipitation potential	8.96	mg/L	4-10 mg/L
Langelier index	0.26		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	300	mg/L
Initial Ca sat, as CaCO3	37	mg/L
Initial DIC, as CaCO3	586	mg/L

Theoretical interim water characteristics

Interim acidity	300	mg/L
Interim Ca sat, as CaCO3	37	mg/L
Ryznar index	7.40	
Interim DIC, as CaCO3	586	mg/L
Aggressiveness Index	12.21	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	277	mg/L
Final Ca	59	mg/L
Final acidity	300	mg/L
Final pH	7.74	
Final DIC, as CaCO3	577	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

The RTW Model Ver. 3.0 ID: **New Berlin 2/22/2016**

STEP 1: Enter initial water characteristics.

Measured TDS	**384**	mg/L
Measured temperature	**10.6**	deg C
Measured pH	**7.84**	
Measured alk, as CaCO3	**286**	mg/L
Measured Ca, as CaCO3	**66.8**	mg/L
Measured Cl		mg/L
Measured SO4	**70.3**	mg/L

For CT and TTHM functions enter current:

Treated water pH		
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.

Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L
Ctrl+C to add to list	**0**	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	286	mg/L	> 40 mg/L	Interim pH	7.84		6.8-9.3
Interim Ca, as CaCO3	67	mg/L	> 40 mg/L	Precipitation potential	5.32	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.1		> 5.0	Langelier index	0.14		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	306	mg/L
Initial Ca sat, as CaCO3	48	mg/L
Initial DIC, as CaCO3	592	mg/L

Theoretical interim water characteristics

Interim acidity	306	mg/L
Interim Ca sat, as CaCO3	48	mg/L
Ryznar index	7.55	
Interim DIC, as CaCO3	592	mg/L
Aggressiveness Index	12.12	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	281	mg/L
Final Ca	61	mg/L
Final acidity	306	mg/L
Final pH	7.74	
Final DIC, as CaCO3	586	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

Mike Curry

From: Andy Curry
Sent: Thursday, March 03, 2016 7:32 AM
To: 'Dan Held'
Cc: Mike Curry; mthomas@woodardcurran.com
Subject: RE: First set completed

Good Morning Dan:

Thank you very much. I spoke with Marc late yesterday afternoon.

We will punch through the data this AM.

Thanks,

Andy Curry, P.E., President
Curry & Associates Engineers, Inc.
ph. 618.327.8841

From: Dan Held [mailto:dheld@woodardcurran.com]
Sent: Wednesday, March 02, 2016 8:16 AM
To: Andy Curry
Subject: First set completed

Gentleman:

Last week I pulled samples from the four locations: raw water prior to aeration, finished water leaving the plant, water just prior to entering the Chatham Reservoir and a sample in the village of New Berlin. Below are the results of the tests I received:

Samples from 2/22/2016	Raw Water	Finish Water	Chatham Reservoir	New Berlin
TDS	432	440	448	384
Temperature	14.2	13.8	13.5	10.6
pH	7.28	7.93	7.92	7.84
Total Residual Chlorine	0.16	1.14	.83	1.01
Calcium Hardness (as CaCO3)	221	69.4	67.9	66.8
Calcium	88.7	27.8	27.2	26.8
Sulfate	68.3	69.4	68.9	70.3
Total Alkalinity (as CaCO3)	291	290	286	286
Bicarbonate Alkalinity (as CaCO3)	291	290	286	286
Carbonate Alkalinity (as CaCO3)	0	0	0	0
Phenolphthalein Alkalinity (as CaCO3)	0	0	0	0

I pulled a sample for ammonia on the raw water but the results of that test are not back yet.

I will forward the results for the next set of samples when they become available. How long will it be before your analysis is done?

Dan