

## 5.0 Water Treatment

### 5.1 General

Lincoln Water Systems (LWS) owns and operates two water treatment facilities co-located near Ashland. The West Plant was originally constructed in 1935, with major expansions between Years 1948 and 1976 to increase the plant design capacity to 60 million gallons per day (mgd). The East Plant was constructed in 1994 with an initial capacity of 50 mgd and was later increased to a plant capacity of 60 mgd by re-rating of the dual media filters. The agreement to re-rate the East Plant specifies that the filters may be operated at a maximum filter loading rate of 6.0 gpm/sf, under the condition that filter effluent turbidity is less than or equal to 0.1 Nephelometric Turbidity Units (NTU). Therefore, the total treatment capacity of the LWS water treatment facilities is 120 mgd. The East Plant facility was originally designed to be expandable to 150 mgd based upon a filter loading rate of 5.0 gpm/sf. It is anticipated that the East Plant will be expanded in increments of 30 mgd (based upon filter loading rate of 6.0 gpm/sf) to provide an ultimate capacity of 180 mgd in the future.

### 5.2 East Plant

#### 5.2.1 Water Treatment

The East Plant process flow diagram is shown in Figure 5-1. The East Plant consists of the following treatment processes:

- Ozonation for primary disinfection and oxidation of iron, manganese and atrazine.
- Free chlorine for primary disinfection.
- Filter-aid polymer addition.
- Dual media gravity filtration.
- Fluoride addition.
- Chloramines for secondary disinfection.

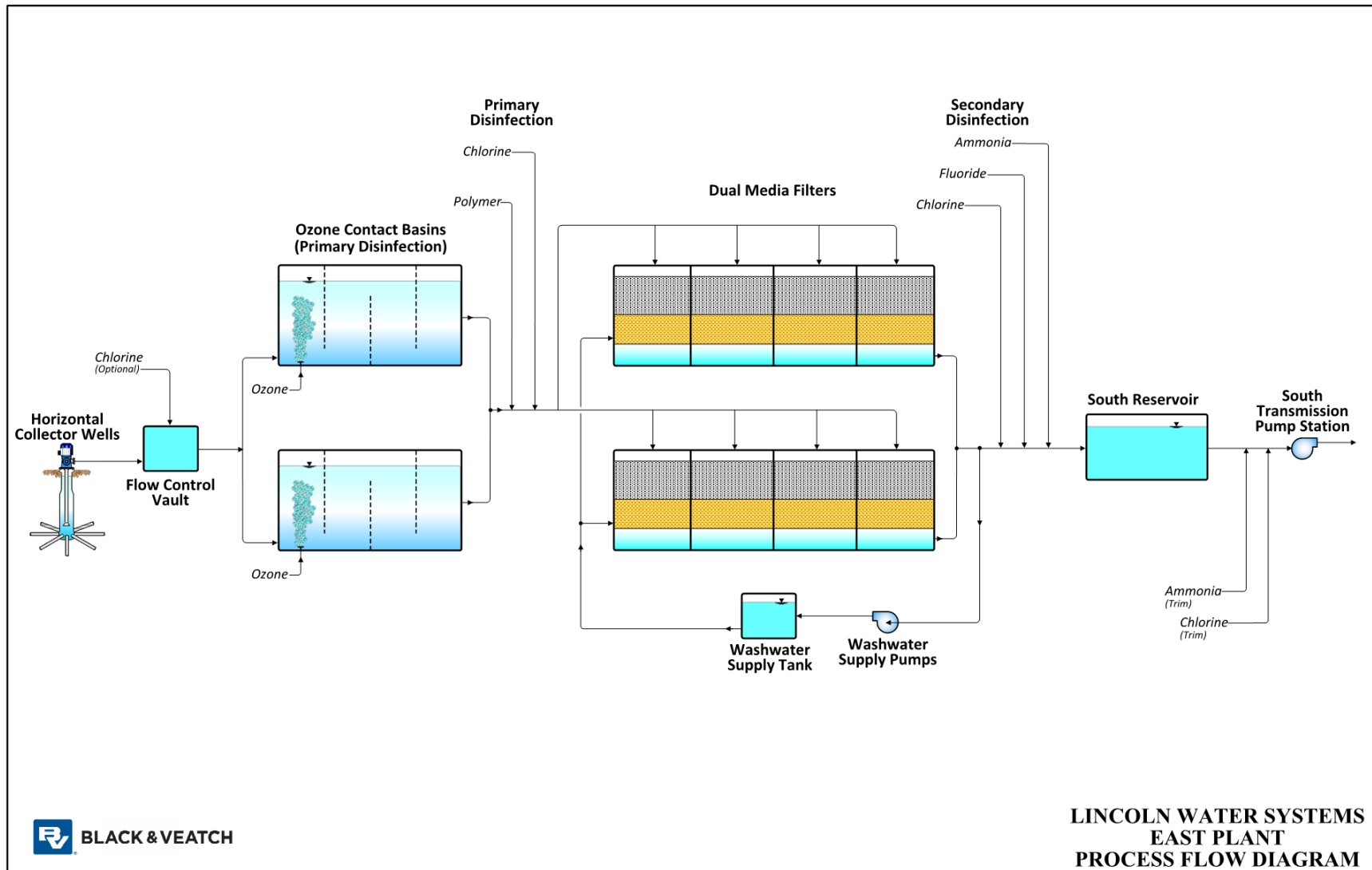


Figure 5-1 East Plant Process Flow Diagram

### 5.2.2 Water Supply

The East Plant receives raw water from the Platte River aquifer by four horizontal collector wells (HCWs). The HCW capacities are summarized in Table 5-1. The total capacity is defined as the design capacity of the well with all pumps running. The firm capacity is defined as the capacity of the well with the largest pump out of service. The hydrogeologic capacity is defined as the maximum capacity of the well as determined through performance testing. The East Plant also has the ability to receive groundwater from the vertical wells and blend supplies for control of atrazine and arsenic.

**Table 5-1 East Plant Horizontal Collector Well Rated Capacities**

Well Designation	Hydrogeologic Capacity (MGD)	Total Capacity (MGD)	Firm Capacity (MGD)
Horizontal collector well, 90-1	17.5	17.5	17.5
Horizontal collector well, 90-2	17.5	17.5	17.5
Horizontal collector well, 14-1 <sup>(1)</sup>	19.4	19.4	19.4
Horizontal collector well, 14-2 <sup>(2)</sup>	20	17.5 <sup>(1)</sup>	13.5
<sup>(1)</sup> HCW 14-2 was designed to include smaller pumps for operational considerations. The hydrogeologic capacity of the well is approximately 20 mgd.			
<sup>(2)</sup> HCW 14-2 was rerated by Layne after performance testing was conducted at the conclusion of the wellhouse construction.			

### 5.2.3 Source Water

The source water is classified as ground water under the direct influence (GWUDI) of surface water. Based on this source water classification, the East Plant is required to achieve the 3.0 log removal/inactivation of *Giardia* and 4.0 log removal/inactivation of viruses in accordance with the Surface Water Treatment Rule (SWTR). Table 5-2 provides a summary of the log removal credits received based on water treatment processes. The East Plant receives 2.0 log removal credit of *Giardia* and 1.0 log removal credit of viruses for direct filtration. The ozone and chlorine disinfection processes are designed to provide the remaining 1.0 log inactivation of *Giardia* and 3.0 log inactivation of viruses.

**Table 5-2 Log Removal/Inactivation for Filtration and Disinfection Required by SWTR**

Process	<i>GIARDIA</i> Log Removal	Viruses Log removal
Conventional sedimentation/filtration credit	2.5	2.0
Disinfection inactivation required	0.5	2.0
Direct filtration credit	2.0	1.0
Disinfection inactivation required	1.0	3.0
Slow sand filtration credit	2.0	2.0
Disinfection inactivation required	1.0	2.0
No filtration	0.0	0.0
Disinfection inactivation required	3.0	4.0

## 5.2.4 Ozone Facilities

### 5.2.4.1 Ozone Contact Basins

The ozone facility at the East Plant includes two ozone contact basins. Each ozone contact basin is sized for 30 mgd treatment capacity. The basins have a shared inlet chamber with slide gates to direct flow to either or both of the ozone contact basins. Each basin was originally designed to include four internal cells with ozone added through fine bubble diffusers in the first two cells. In Year 2013, baffle walls were installed to split the first cell of the basin to accommodate sidestream injection, which in turn improved ozone transfer efficiency and mixing. Following the retrofit, ozone is now delivered via sidestream injection in the first cell. The ozone system utilizes three sidestream injection pumps (2 duty, 1 standby). Flow is directed in a counter-current manner to maximize transfer efficiency. The ozone system improvements also included addition of new sampling locations. Ozone residual is measured in cells 2 and 4 for quantifying disinfection CT (concentration x time) credits. The design parameters for the ozone contact basin are provided in Table 5-3.

**Table 5-3 East Plant Ozone Contact Basin Design Parameters**

Design Parameter	Units	Value
Number of ozone contact basins	Nos.	2
Unit capacity	mgd	30
Unit volume	gal	281,700
Theoretical detention time at maximum capacity	min	13.5
Baffling factor, $T_{10}/T$	-	0.58
Effective contact time at maximum capacity	min	7.3

### 5.2.4.2 Ozone Generation

The East Plant's ozone generation system was upgraded in Year 2013 with two new 1300 pound per day (ppd) generators. The ozone generation system is designed to produce ozone at a concentration of 2 to 12 percent by weight. Table 5-4 summarizes the design parameters for the ozone generation system.

**Table 5-4 East Plant Ozone Generation Design Parameters**

Design Parameter	Units	Value
Number of units	Nos.	2 (1 duty, 1 standby)
Design unit capacity	ppd	1300
Design ozone concentration	% by weight	2-12
Maximum capacity at low % weight	ppd	1600
Maximum applied dose	mg/L	3.2
Assumed transfer efficiency	%	95%
Maximum transferred dose	mg/L	3.0

### 5.2.4.3 Liquid Oxygen Storage

The ozone system improvements also included the replacement of the East Plant's air preparation system (refrigerant dryers and desiccant dryers) system with a liquid oxygen (LOX) storage system and supplemental air system. Table 5-5 summarizes the design parameters for the LOX system.

**Table 5-5 East Plant LOX Storage Design Parameters**

Design Parameter	Units	Value
Number of storage tanks	Nos.	1
Tank volume	gal	13,000
Number of vaporizers	Nos.	3 (1 duty, 1 standby, 1 defrost)

### 5.2.4.4 Destruct Equipment

Three catalytic destruct systems receive off-gas from the ozone contactor through off-gas demisters, located in each contact basin. Off-gas from the contactors may contain up to 0.25 percent ozone at 95 percent transfer (and 0.6 percent ozone at 12 percent), which exceeds the 0.1 mg/L limit established by OSHA for continuous exposure. Each destruct unit is sized to achieve a maximum ozone concentration of 0.10 parts per million by volume (ppmv) measured in the effluent of the destruct unit. Vent blowers disperse the treated off-gas into the atmosphere. In Year 2013, control valves and pressure transmitters were installed to automate the destruct process.

### 5.2.5 Filters

The ozonated water is conveyed through a filter influent flume where chlorine and filter-aid polymer are added prior to distribution to the filters. Free chlorine is used to obtain additional CT credits for primary disinfection and it also enhances manganese removal through the filters. From these flumes, the chlorinated water is directed into each filter through a 30-inch filter influent pipe.

The East Plant includes eight dual media filters, which are rated for a maximum filter loading rate of 6.0 gpm/ft<sup>2</sup>. Each filter is divided into two 15 feet by 30 feet cells, which provide a total loading area of 900 ft<sup>2</sup> per filter. The filter media is dual media above a 12-inch gravel base layer supported by Leopold "Universal" underdrains. Each filter is equipped with air backwash facilities and fiberglass wash water troughs.

Table 5-6 provides a summary of the design parameters for the filtration system. Loading rate of 6.0 gpm/sf is contingent upon compliance with filter effluent turbidity less than 0.1 Nephelometric turbidity units (NTU).

**Table 5-6 East Plant Filter Design Parameters**

Design Parameter	Units	Value
Number of filters	Nos.	8
Filter media configuration	-	Dual media (10" sand, 20" anthracite)
Number of cells per filter	Nos.	2
Filter cell dimensions	ft x ft	15 x 30
Filter loading area	ft <sup>2</sup>	900
Maximum filter loading rate	gpm/ft <sup>2</sup>	6.0
Maximum capacity with all units online (N)	mgd	62.2
Maximum capacity with one unit offline (N-1)	mgd	54.4

Filter backwash is initiated after a filter run-time of 300 hours or when headloss exceeds 7 feet. Table 5-7 provides a summary of the filter backwash system design parameters and typical operating conditions.

**Table 5-7 East Plant Filter Backwash Operations**

Design Parameter	Units	Value
High rate filter backwash flow rate	mgd	22
High rate filter backwash loading rate	gpm/ft <sup>2</sup>	17
Low rate filter backwash flow rate	mgd	6
Low rate filter backwash loading rate	gpm/ft <sup>2</sup>	4.6
Filter backwash sequence	-	low rate – 3 min high rate – 8 min low rate – 3 min
Individual backwash volume	gal	147,500
Backwash volume required for 2 backwashes	gal	295,000

Backwash water is fed by gravity from the wash water supply tank, which is filled from two wash water supply pumps. The wash water supply tank is sized for a minimum of two filter backwashes; however, there are some operational challenges associated with conducting two successive backwashes due to insufficient driving pressure from low water levels in the tank. The wash water tank is a steel ground storage reservoir located southeast of the filter building.

Table 5-8 provides a summary of the design parameters for the wash water supply tank and wash water supply pumps.

**Table 5-8 East Plant Wash Water Supply Tank Design Parameters**

Design Parameter	Units	Value
<b>Wash Water Supply Tank</b>		
Number of backwash volumes	Nos.	2
Tank volume	gal	370,000
Tank diameter	ft	46
Side water depth	ft	30
<b>Wash Water Supply Pumps</b>		
Number of wash water supply pumps	Nos.	2
Pump unit capacity	gpm	940
Pump type	-	Horizontal centrifugal

Backwash return is collected in a pipeline, dechlorinated using Captor® calcium thiosulfate solution and delivered to a mixing chamber, which receives backwash return from both the East and West Plants. From the mixing chamber, the backwash return is discharged to the outfall. The plant's National Pollutant Discharge Elimination System (NPDES) permit requires total chlorine to be at non-detectable levels in the plant effluent discharge.

### 5.2.6 Clearwells & Reservoirs

Filter effluent is collected in the clearwells located underneath each row of filters. The clearwells have a baffling factor of 0.5. Table 5-9 summarizes the design parameters of the clearwells.

**Table 5-9 East Plant Clearwell Design Parameters**

Design Parameter	Units	Value
Number of clearwells	Nos.	2
Unit volume	gal	157,000
Clearwell dimensions	ft x ft	144.8 x 25
Clearwell depth	ft	5.8

From the clearwells, filtered water is conveyed by gravity to the South Reservoir. In the pipeline between the clearwells and South Reservoir, fluoride is added to achieve a target finished water concentration ranging from 0.8 to 1.2 mg/L. Additionally, chlorine and ammonia can be added at this location for disinfectant residual trimming.

The South Reservoir has 6 MG of finished water storage and is divided into two cells with baffled compartments. The South Reservoir dimensions are provided in Table 5-10.

**Table 5-10 South Reservoir Design Parameters**

Design Parameter	Units	Value
Total Volume	MG	6.0
Number of cells	Nos.	2
Reservoir dimensions	ft x ft	289.5 x 160
Reservoir depth	ft	16.5

### 5.2.7 Primary Disinfection

The East Plant is required to achieve 1.0-log inactivation of *Giardia* and 3.0-log inactivation of viruses for primary disinfection. CT credits for primary disinfection are achieved in the ozone contact basins and through chlorine residual carried through the filter influent flume and clearwell. Additional CT credits are also obtained through monochloramine residual in the reservoir.

### 5.2.8 Secondary Disinfection

Chloramines are formed in the channel between the Clearwell and South Reservoir to provide a secondary disinfectant residual. The plant has historically maintained a total chlorine residual of 2.5 mg/L at the point of entry. However, since Year 2018, the plant has operated with an elevated total chlorine residual ranging from 3.1 to 3.5 mg/L to inhibit bacterial regrowth and nitrification in the distribution system.

## 5.3 West Plant

### 5.3.1 Water Treatment

The West Plant process flow diagram is shown in Figure 5-2. The West Plant consists of the following treatment processes:

- Aeration for oxidation of iron and manganese.
- Free chlorine addition for primary disinfection.
- Filter-aid polymer addition (optional).
- Monomedia sand filtration.
- Fluoride addition.
- Chloramines for secondary disinfection.



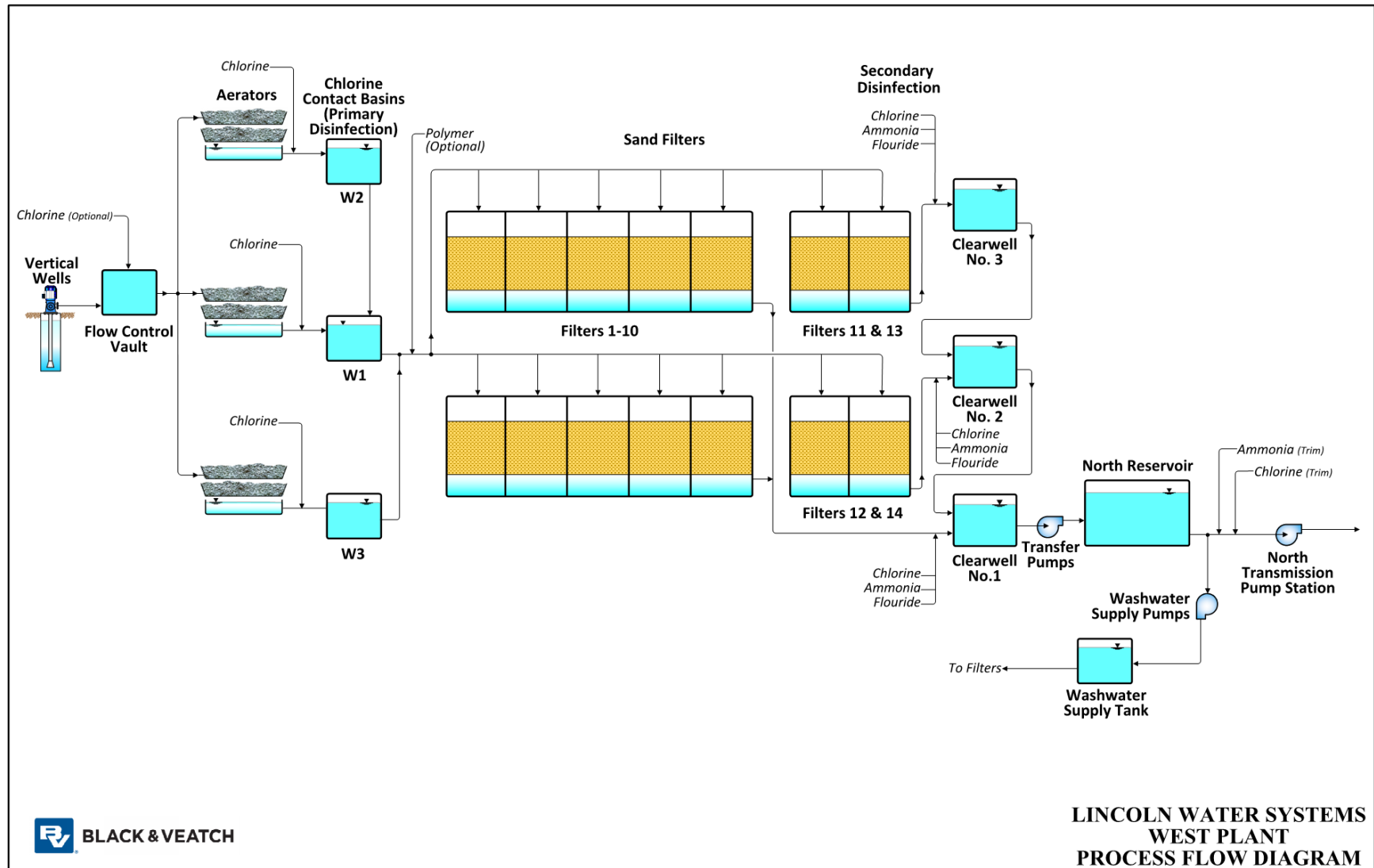


Figure 5-2 West Plant Process Flow Diagram

### 5.3.2 Water Supply

The West Plant receives ground water supplied by vertical wells and is designated as a ground water source with treatment governed by the Ground Water Rule (GWR). Based on this source water classification, the West Plant is required to achieve 4.0-log removal/inactivation of viruses in accordance with the GWR, which is accomplished by chlorine disinfection.

### 5.3.3 Aeration

The raw water supplied by the vertical wells contains iron and manganese at concentrations of up to 0.05 mg/L and 0.3 mg/L, respectively. The raw water is delivered to three coke tray aerators to oxidize the iron and manganese. The coke tray aerators cascade the water over a series of trays containing coke coarse media. The media provides increased surface area for air-to-water contact to increase the efficiency of iron and manganese oxidation. The aerated water is collected in a contact basin located below each of the coke tray aerators. Table 5-11 provides a summary of the design parameters for the coke tray aerators.

**Table 5-11 West Plant Aerator Design Parameters**

Parameter	Aerator #1 (W1)	Aerator #2 (W2)	Aerator #3 (W3)
Flow through each unit, mgd	18.8	17.8	23.4
Tray surface area, ft <sup>2</sup>	2,175	1,720	2,210
Tray flow rate, gpm/ft <sup>2</sup>	6.0	7.2	7.4

### 5.3.4 Chlorine Contact Basins

Chlorine is added to the contact basins which are located downstream of the coke tray aerators. The contact basins are operated in parallel for the most part with an exception being the interconnect between contact basins W1 and W2. The interconnect allows effluent from Contact Basin W2 to be delivered to the midpoint of Contact Basin W1 and blended with water in that basin.

The contact basins provide sufficient contact time for primary disinfection with free chlorine and allow for manganese oxidation reactions to take place. Table 5-12 provides a summary of the design parameters for the coke tray aerators.

**Table 5-12 West Plant Chlorine Contact Basin Design Parameters**

Parameter	Contact Basin W1		Contact Basin W2	Contact Basin W3
	1 <sup>st</sup> Half	2 <sup>nd</sup> Half		
Unit volume, MG	0.32	0.32	1.20	2.21
Maximum flow rate through basin, MGD	20	37	17	23
Theoretical detention time at maximum flow rate, min	23	12.5	102	138
Baffling factor, T <sub>10</sub> /T	0.5	0.5	0.5	0.5
Effective contact time, min	11.5	6.2	50.8	69.2

### 5.3.5 Filters

The chlorinated water is conveyed through a filter influent flume where flow is distributed into two filter influent channels. Filter-aid polymer may be optionally added in the filter influent channel. The West Plant includes fourteen monomedia sand filters, which are rated for a maximum filter loading rate of 4.5 gpm/ft<sup>2</sup>. Each filter is divided into two cells, but the individual dimensions vary since the filters were constructed in three phases. Filters 1 through 6 were constructed in Year 1935, Filters 7 through 10 were constructed in Year 1948, and Filters 11 through 14 were constructed in Year 1956. The filter media consists of 36 inches of sand, which is supported by lateral underdrains on Filters 1 through 6 and clay tile underdrains on Filters 7 through 14. Table 5-13 provides a summary of the design parameters for the filtration system.

**Table 5-13 West Plant Filter Design Parameters**

Parameter	Phase 1 (1935)	Phase 2 (1948)	Phase 3 (1956)
Number of filters	6 each (Filters 1-6)	4 each (Filters 7-10)	4 each (Filters 11-14)
Number of cells per filter	2	2	2
Filter cell dimensions, ft x ft	20 x 13	20 x 13	20 x 25.5
Filter loading area, ft <sup>2</sup>	520	520	1,020
Maximum capacity with all units online, mgd	20	13	27

Filter backwash is initiated after a filter run-time of 300 hours or when headloss exceeds 7 feet. Table 5-14 provides a summary of the filter backwash system design parameters and typical operating conditions. Following the backwash, the filter is typically operated in filter-to-waste mode for approximately 10 to 15 minutes prior to being returned to service.

**Table 5-14 West Plant Filter Backwash Operations**

Design Parameter	Units	Value (Filters 1-10)	Value (Filters 11-14)
High rate filter backwash flow rate	mgd	11.5	22
High rate filter backwash loading rate	gpm/ft <sup>2</sup>	15.4	15
Low rate filter backwash flow rate	mgd	3	6
Low rate filter backwash loading rate	gpm/ft <sup>2</sup>	4	4
Filter backwash sequence	-	low rate – 3 min high rate – 6 min low rate – 3 min	
Individual backwash volume	gal	60,500	116,700

Backwash water is fed by gravity from the elevated wash water supply tank, which is filled from wash water supply pumps. The wash water tank was constructed in 1976. The wash water supply tank is sized for a minimum of two filter backwashes. Table 5-15 provides a summary of the design parameters for the wash water supply tank.

**Table 5-15 West Plant Wash Water Supply Tank Design Parameters**

Design Parameter	Units	Value
<b>Wash Water Supply Tank</b>		
Number of backwash volumes	Nos.	2
Tank volume	gal	300,000
Tank diameter	ft	43
Side water depth	ft	29.6

Backwash return is collected in a pipeline, dechlorinated using Captor® calcium thiosulfate solution and delivered to a mixing chamber, which receives backwash return from both the East and West Plants. From the mixing chamber, the backwash return is discharged to the outfall. The plant's National Pollutant Discharge Elimination System (NPDES) permit requires total chlorine to be at non-detectable levels in the plant effluent discharge.

### 5.3.6 Filter Clearwells

Filter effluent is collected in three separate clearwells located underneath the filters. Each clearwell includes an influent flume with chemical feed points for fluoride, chlorine and ammonia. Chlorine feed is available for trimming; however, usually only ammonia is fed to form chloramines for secondary disinfection. The clearwells are interconnected, such that filtered water typically flows from Clearwell 3 to Clearwell 2, and then the combined flow from Clearwell 2 feeds into Clearwell 1. Table 5-16 indicates how individual filters feed into the three clearwells and provides a summary of clearwell dimensions and storage volumes.

**Table 5-16 Filter Clearwell Design Parameters**

Parameter	Clearwell #1	Clearwell #2	Clearwell #3
Filter designation	Filters 1-10	Filters 12 & 14	Filters 11 & 13
Unit volume, gal	413,000	293,000	293,000
Basin dimensions, ft x ft	162 x 20	90.5 x 20	90.5 x 20
Basin depth, ft	17	17	17

### 5.3.7 Transfer Pumps

There are three 18 mgd transfer pumps that convey water from the clearwells to the North Reservoir. The pumps are fed by 36-inch suction lines that draw from Clearwell 1. The transfer pumps include one adjustable frequency drive (Pump No. 1) to provide variable flow capability, while Pump Nos. 2 and 3 are constant speed. The capacity of these pumps is a limiting factor to operations such that they can only convey 52-54 mgd into the North Reservoir during periods of peak demand.

### 5.3.8 North Reservoir

From the transfer pumps, water is delivered to the North Reservoir. The North Reservoir is a rectangular cast in place below grade tank with baffle walls and provides 3 MG of finished water storage.

### 5.3.9 North High Service Pump Station

There are six high service pumps in the North High Service Pump Station. Under normal operations, the plant utilizes three high service pumps (Pumps No. 1-3) to deliver finished water from the West Plant to the distribution system. The City avoids using three of the high service pumps (Pumps No. 4-6) as much as possible due to the electrical demand and associated charges. Additionally, the suction line for Pumps No. 4-6 is connected to the filter clearwells. Therefore, when these pumps are put in service to meet demands greater than 50 mgd, the plant finished water bypasses the North Reservoir.

### 5.3.10 West Transmission Pump Station

There are two diesel pumps and one electrical pump located in the West Transmission Pump Station. The west transmission pumps are typically only used for peak shaving or when the West Plant is required to operate at flow rates above 50 mgd. These pumps draw water from Clearwells 2 and 3. Therefore, when these pumps are in operation, the plant finished water bypasses the North Reservoir.

## 5.4 Chemical Systems

The East and West Plants are serviced by a common chemical storage and feed facility, which was constructed in 1992. Based on findings from a facility condition assessment, specific systems within the Chemical Building were identified as needing replacement. The following chemical equipment systems are being replaced in Year 2020:

- Chlorine feed system
- Ammonia feed system
- Polymer storage and feed system
- Fluoride feed system

### 5.4.1 Chlorine

The chlorine system is located within the first floor of the Chemical Storage Building and is currently being rehabilitated as part of an ongoing chemical system upgrade project. Chlorine is delivered and stored in one-ton containers. The chlorine system is comprised of two banks of four connected one-ton containers, two evaporators, mechanically actuated switchover valves, expansion tanks, vacuum regulators, pressure gauges, rupture disks, fifteen chlorine feeders, eductors, water supply, and chlorine solution feed assemblies. Only one chlorine gas cylinder can be open at a time.

Table 5-17 describes the chemical properties, feed rate, and feed equipment for the chlorine system currently in design and scheduled to be replaced in Year 2020. Chemical usage rates provided in the table represent minimum, average, and maximum daily chlorine usage rates from Years 2014 to 2019. Additionally, the chemical dosages have been calculated based on daily chlorine usage rates and daily plant flow rates.

**Table 5-17 Chlorine Storage & Feed System Design Parameters**

Parameter	Value
<b>Chemical Information</b>	
Delivered/Fed Chemical	100% Chlorine Gas
<b>Historical Chemical Usage Rates</b>	
Minimum (ppd)	654
Average (ppd)	2,045
Maximum (ppd)	3,283
<b>Historical Chemical Dosages</b>	
Minimum (mg/L)	3.07
Average (mg/L)	7.06
Maximum (mg/L)	9.89
<b>Feed Equipment</b>	
Type	Chlorine Gas Feeder
Quantity	15
Feeder Control	Automatic and manual start/stop. Automatic and manual rate control with local override.
<b>Ancillary Equipment</b>	
Chlorine Evaporator	
Quantity	2
Unit capacity, ppd	10,000
Vacuum Regulator	
Quantity	3 (2 duty, 1 in line spare)
<b>Piping Materials</b>	
Pressurized chlorine gas	Carbon Steel
Vacuum chlorine gas / chlorine solution	PVC

Table 5-18 provides a summary of the chlorine feed points as well as the designated feeders for the future chlorine feed system.

**Table 5-18 Chlorine Feed Points**

Feeder No.	Application Points
CHFD-201	Contact Basin W1
CHFD-202	Contact Basin W2
CHFD-203	Contact Basin W3
CHFD-204	East Filter Flume
CHFD-205	Standby
CHFD-206	84" Effluent
CHFD-207	North Pump Station Suction
CHFD-208	South Transmission Pump Station
CHFD-209	West Pump Station
CHFD-210	East Plant Clearwell E1
CHFD-211	East Plant Clearwell E2
CHFD-212	Standby
CHFD-213	Clearwell Channel W1
CHFD-214	Clearwell Channel W2
CHFD-215	Clearwell Channel W3

### 5.4.2 Ammonia

Ammonia is used to provide a chloramine residual. The bulk anhydrous ammonia storage tank, including the tank and two heater-driven vaporizers, is located outdoors adjacent to the Chemical Building parking lot. The Chemical Building is fed by ten ammonia feeders, which are located in an isolated room on the first floor of the building. The ammonia system is currently being rehabilitated as part of the chemical feed upgrade project and is scheduled to be replaced in Year 2020.

Table 5-19 describes the chemical properties, feed rate, and feed equipment for the ammonia system from the proposed design. Ammonia gas will continue to be delivered to the site in bulk and stored in the existing 2,000-gallon carbon steel storage tank. Chemical usage rates provided in the table represent minimum, average, and maximum daily ammonia usage rates from Years 2014 to 2019. Additionally, the ammonia dosages have been calculated based on daily chemical usage rates and daily plant flow rates.

**Table 5-19 Ammonia Storage & Feed System Design Parameters**

Parameter	Value
<b>Chemical Information</b>	
Delivered/Fed Chemical	100% Ammonia Gas
<b>Historical Chemical Usage Rates</b>	
Minimum (ppd)	139
Average (ppd)	251
Maximum (ppd)	386
<b>Historical Chemical Dosages</b>	
Minimum (mg/L)	0.69
Average (mg/L)	0.85
Maximum (mg/L)	0.97
<b>Feed Equipment</b>	
Type	Ammonia Gas Feeder
Quantity	10
Feeder Control	Automatic and manual start/stop. Automatic and manual rate control with local override.
<b>Piping &amp; Valves</b>	
Pipe material	Carbon Steel

All existing ammonia gas feeders will be replaced along with the existing carbon steel piping around the ammonia feeders connecting to the headers. Table 5-20 presents a summary of the ammonia feed points and designated feeders.

**Table 5-20 Ammonia Feed Points**

Feeder No.	Application Points
CHFD-101	North Pump Station Suction
CHFD-102	West Plant Clearwell W1
CHFD-103	West Plant Clearwell W2
CHFD-104	West Plant Clearwell W3
CHFD-105	Standby
CHFD-106	Standby
CHFD-107	West Transmission Pump Station Wetwell
CHFD-108	South Transmission Pump Station Influent
CHFD-109	Standby
CHFD-110	South Reservoir Influent Flume



### 5.4.3 Polymer

LWS utilizes a polyDADMAC cationic polymer (Aqua Hawk 6527) as a filter aid. The polymer storage and feed system is located within the Chemical Storage Building and is comprised of one bulk storage tank, two neat polymer transfer pumps, two polymer mixing/aging tanks with mixers, two one-percent polymer solution transfer pumps, two one-percent polymer solution day tanks, and four one-percent polymer solution metering pumps. Secondary dilution water and static mixers are used to carry the polymer solution from the metering pumps to the points of application. Polymer is fed at the East Plant filter influent and has the ability to be fed to the West Plant filter influent. The polymer system is currently being rehabilitated as part of an ongoing chemical feed upgrade project and is scheduled to be replaced in Year 2020.

Table 5-21 describes the chemical properties, feed rate, and feed equipment for the polymer system for the proposed design. The existing neat polymer storage tank, mixing/aging tanks, and day tanks will be retained. The neat polymer transfer pumps will be replaced with new diaphragm transfer pumps. The 1% polymer solution gear type transfer pumps will be replaced with progressive cavity pumps. The four metering pumps will all be replaced in kind with motorized diaphragm metering pumps. The mixing/aging tanks will be provided new mixers with longer shafts. The PVC piping and valves will only be replaced as necessary around the new pumps.

**Table 5-21 Polymer Storage and Feed System Design Parameters**

Parameter	Value
<b>Chemical Information</b>	
Delivered Chemical	Neat emulsion polymer
Specific gravity	1.05
Fed chemical	1% polymer solution
Specific gravity	1.05
<b>Historical Chemical Usage Rates (as neat polymer)</b>	
Minimum (ppd)	247
Average (ppd)	1,277
Maximum (ppd)	2,286
<b>Historical Chemical Dosages</b>	
Minimum (mg/L)	0.02
Average (mg/L)	0.20
Maximum (mg/L)	0.24
<b>Drum Pump</b>	
Service	Neat polymer
Type	Diaphragm pump
Quantity	1
Capacity, gpm	10

Parameter	Value
<b>Neat Polymer Transfer Pump</b>	
Service	Neat Polymer
Type	Diaphragm Pump
Quantity	2 (1 duty, 1 standby)
Unit capacity, gph	13
Tag numbers	CHMP-501 CHMP-502
<b>Mixing / Aging Tank Mixers</b>	
Service	1% polymer solution
Quantity	2
<b>Polymer Solution Transfer Pumps</b>	
Service	1% polymer solution
Type	Progressive Cavity Pump
Quantity	2 (1 duty, 1 standby)
Capacity, gpm	20
Tag numbers	CHTP-501 CHTP-502
<b>Polymer Solution Feed Equipment</b>	
Type	Mechanical Diaphragm Metering Pumps
Quantity	4 (3 duty, 1 standby)
Unit capacity, gph	1.16 to 47.6
Pump control	Automatic and manual start/stop. Automatic and manual stroke length and stroke speed control with local override.
<b>Piping &amp; Valves</b>	
Pipe material	PVC

Table 5-22 presents a summary of the designated feed points for each polymer metering pump included in the future polymer feed system.

**Table 5-22 Polymer Feed Points**

Metering Pump No.	Application Points
CHMP-503	East Plant filter influent
CHMP-504	East Plant filter influent
CHMP-505	East Plant filter influent
CHMP-506	East Plant filter influent

#### 5.4.4 Fluoride

The fluoride system is located within the Chemical Building with equipment split between the first floor and the basement. The system consists of two bulk storage tanks, two transfer pumps, two days tanks, and five metering pumps. Fluoride is fed into the West Plant filter clearwells and into the East Plant 84-inch finished water supply. The fluoride system is currently being rehabilitated as part of an ongoing chemical feed upgrade project and is scheduled to be replaced in Year 2020.

Table 5-23 describes the chemical properties, feed rate, and feed equipment for the fluoride system as currently designed. Chemical usage rates provided in the table represent minimum, average, and maximum daily fluoride usage rates from Years 2014 to 2019. Additionally, the chemical dosages have been calculated based on daily fluoride usage rates and daily plant flow rates.

**Table 5-23 Fluoride Storage & Feed System Design Parameters**

Parameter	Value
<b>Chemical Information</b>	
Delivered Chemical	23-25% Hydrofluorosilicic acid (18-21% Fluoride)
Specific gravity	1.21
<b>Historical Chemical Usage Rates</b>	
Minimum (ppd)	422
Average (ppd)	972
Maximum (ppd)	1,646
<b>Historical Chemical Dosages</b>	
Minimum (mg/L as F)	0.41
Average (mg/L as F)	0.57
Maximum (mg/L as F)	0.88

Parameter	Value
<b>Feed Equipment</b>	
Type	Mechanical Diaphragm Metering Pumps
Quantity	5 (4 duty, 1 standby)
Pump Control	Automatic and manual start/stop. Automatic and manual stroke length and stroke speed control with local override.
<b>Piping &amp; Valves</b>	
Pipe material	PVC

Table 5-24 presents a summary of the new fluoride metering pumps and designated feed points.

**Table 5-24 Fluoride Feed Points**

Metering Pump No.	Application Points
CHMP-301	West Plant Clearwell 2
CHMP-302	West Plant Clearwell 1
CHMP-303	West Plant Clearwell 3
CHMP-304	Standby
CHMP-305	East Plant 84" pipeline

## 5.5 Raw Water Quality

The raw water quality assessment is based on data provided for the following constituents and timeframes:

- Herbicide concentrations for individual samples collected between Years 2014 and 2019.
- Microbiological contaminant measures for individual samples collected between Years 2014 and 2018.
- General water quality parameters for individual samples collected between Years 2014 and 2018.
- Nitrogen species concentrations for individual samples collected between Years 2014 and 2018.
- Inorganics and metals concentrations for individual samples collected between Years 2017 and 2019.

### 5.5.1 East Plant Raw Water Quality Data

The East Plant primarily receives raw water from horizontal collector wells that are classified as ground water under the direct influence of surface water. A summary of the East Plant raw water quality is provided in Table 5-25.

**Table 5-25 East Plant Raw Water Quality Summary**

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX
<b>General Parameters</b>				
Alkalinity, Total	mg/L as CaCO <sub>3</sub>	165	198	223
Ammonia, Free (NH <sub>3</sub> -N)	mg/L	0	0.04	0.21
Ammonia, Total (NH <sub>3</sub> -N)	mg/L	0	0.05	0.41
Dissolved Oxygen (DO)	mg/L	0.56	2.74	5.28
Hardness, Total	mg/L as CaCO <sub>3</sub>	174	250	306
Oxidation Reduction Potential (ORP)	mV	30	304	408
pH	s.u.	7.42	7.82	8.10
Temperature	°C	8.0	18.5	29.2
Total Organic Carbon	mg/L	1.74	2.94	5.12
<b>Inorganic Chemicals</b>				
Calcium	mg/L as CaCO <sub>3</sub>	131	173	211
Chloride	mg/L	11.9	14.2	17.2
Fluoride	µg/L	186	329	417
Magnesium	mg/L as CaCO <sub>3</sub>	51	69	90
Nitrate (as N)	mg/L	0.035	2.315	4.195
Nitrite (as N)	mg/L	0.00	0.03	0.45
Phosphate (PO <sub>4</sub> )	mg/L	0.65	0.82	1.02
Potassium	mg/L	5.88	8.64	11.7
Sodium	mg/L	21.5	27.3	35.1
Sulfate	µg/L	60.8	76.0	90.6
<b>Metals</b>				
Aluminum	µg/L	ND	4.16	73.3
Antimony	µg/L	0.16	0.37	0.58
Arsenic, Total	µg/L	5.33	7.50	9.69
Barium	µg/L	99	141	173
Beryllium	µg/L	ND	ND	0.011
Cadmium	µg/L	ND	0.05	0.26
Chromium, total	µg/L	ND	0.10	0.32

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX
Cobalt	µg/L	0.03	0.11	0.21
Copper	µg/L	0.09	3.33	14.7
Germanium	µg/L	88	94	113
Germanium-1	µg/L	88	95	109
Iron, total	µg/L	ND	2.8	73.5
Lead	µg/L	ND	0.04	1.09
Manganese, Total	µg/L	1.60	43.4	199
Molybdenum	µg/L	2.20	3.52	4.90
Nickel	µg/L	0.73	1.72	27.7
Scandium-1	µg/L	91	98.5	118
Selenium	µg/L	2.93	7.93	19.3
Silver	µg/L	ND	0.002	0.276
Terbium	µg/L	87	98	121
Thallium	µg/L	ND	0.016	0.039
Zinc	µg/L	ND	2.59	102
<b>Radionuclides</b>				
Thorium	µg/L	ND	ND	0.50
Uranium	µg/L	6.99	10.3	13.0
Vanadium	µg/L	4.45	7.16	12.2
<b>Herbicides</b>				
Acetochlor	µg/L	0.15	0.30	0.49
Atrazine	µg/L	0.13	0.51	1.95
Desethylatrazine	µg/L	0.10	0.18	0.32
Metolachlor	µg/L	0.12	0.38	1.69
Simazine	µg/L	0.01	0.18	0.64
<b>Microbiological Contaminants</b>				
Coliform, total (P/A) <sup>(2)</sup>	A=0, P=1	0	0	1
E coli	A=0, P=1	0	0	0
Heterotrophic Plate Count	cfu/100 mL	0	131	999
Notes: <sup>(1)</sup> “ND” indicates that the concentration was non-detect or below the method detection limit. <sup>(2)</sup> For total coliform measurements, “P” indicates the presence of coliforms and “A” indicates an absence of coliforms in the sample collected.				

### 5.5.2 West Plant Raw Water Quality Data

The West Plant primarily receives raw water from vertical ground water wells. A summary of the West Plant raw water quality is provided in Table 5-26.

**Table 5-26 West Plant Raw Water Quality Summary**

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG	MAX
<b>General Parameters</b>				
Alkalinity, Total	mg/L as CaCO <sub>3</sub>	18.8	165	224
Ammonia, Free (NH <sub>3</sub> -N)	mg/L	0	0.04	0.25
Ammonia, Total (NH <sub>3</sub> -N)	mg/L	0	0.04	0.46
Dissolved Oxygen (DO)	mg/L	1.42	2.89	6.71
Hardness, Total	mg/L as CaCO <sub>3</sub>	144	204	269
Oxidation Reduction Potential (ORP)	mV	2.29	337	485
pH	s.u.	7.11	7.50	7.93
Temperature	°C	3.1	16.6	23.6
Total Organic Carbon	mg/L	1.51	2.17	4.00
<b>Inorganic Chemicals</b>				
Calcium	mg/L as CaCO <sub>3</sub>	109	139	194
Chloride	mg/L	15.5	17.5	18.8
Fluoride	µg/L	200	366	459
Magnesium	mg/L as CaCO <sub>3</sub>	45.2	54.8	79.1
Nitrate (as N)	mg/L	0.037	0.55	1.67
Nitrite (as N)	mg/L	0.00	0.02	0.14
Phosphate (PO <sub>4</sub> )	mg/L	0.52	0.71	0.86
Potassium	mg/L	6.53	8.81	13.1
Sodium	mg/L	24.2	34.1	50.4
Sulfate	µg/L	72.4	86.3	101
<b>Metals</b>				
Aluminum	µg/L	ND	0.77	36.8
Antimony	µg/L	0.11	0.27	0.66
Arsenic, Total	µg/L	4.62	6.72	8.76
Barium	µg/L	88	106	163
Beryllium	µg/L	ND	0.00	0.10
Cadmium	µg/L	ND	0.05	0.46
Chromium, total	µg/L	ND	0.06	2.53
Cobalt	µg/L	0.02	0.11	0.51

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG	MAX
Copper	µg/L	0.27	6.37	14.1
Germanium	µg/L	77.1	88.1	95.1
Germanium-1	µg/L	77.0	90.4	104
Iron, total	µg/L	0.03	5.63	42
Lead	µg/L	ND	0.09	1.32
Manganese, Total	µg/L	0.57	51.2	258
Molybdenum	µg/L	2.31	3.37	4.61
Nickel	µg/L	0.63	1.49	4.95
Scandium-1	µg/L	77.5	92.1	98.9
Selenium	µg/L	0.38	1.87	9.16
Silver	µg/L	ND	0.01	0.12
Terbium	µg/L	84.4	97.9	119
Thallium	µg/L	ND	0.02	0.05
Zinc	µg/L	ND	4.73	35.5
<b>Radionuclides</b>				
Thorium	µg/L	ND	0.04	0.78
Uranium	µg/L	5.32	7.72	12.1
Vanadium	µg/L	3.89	5.51	7.27
<b>Herbicides</b>				
Atrazine	µg/L	0.09	0.27	0.46
Desethylatrazine	µg/L	0.10	0.14	0.28
Metolachlor	µg/L	0.11	0.22	0.43
Simazine	µg/L	0.02	0.03	0.03
<b>Microbiological Contaminants</b>				
Coliform, total (P/A) <sup>(2)</sup>	A=0, P=1	0	0.02	1
E coli	A=0, P=1	0	0	0
Heterotrophic Plate Count	cfu/100 mL	0	45	999
Notes: (1)“ND” indicates that the concentration was non-detect or below the method detection limit. (2)For total coliform measurements, “P” indicates the presence of coliforms and “A” indicates an absence of coliforms in the sample collected.				



## 5.6 Finished Water Quality

The finished water quality analysis is based on data provided for the following constituents and timeframes:

- General water quality parameters for individual samples collected between Years 2014 and 2018.
- Nitrogen species concentrations for individual samples collected between Years 2014 and 2018.
- Inorganics and metals concentrations for individual samples collected between Years 2017 and 2019.
- Herbicide concentrations at the East and West Plant compliance monitoring sites between Years 2014 and 2019.
- Assimilable organic carbon (AOC) concentrations collected between Years 2001 and 2009.
- Microbiological contaminant measures for individual samples collected between Years 2014 and 2018.
- Disinfectant residual monitoring data between Years 2013 and 2018.

### 5.6.1 East Plant Finished Water Quality Data

A summary of the East Plant finished water quality is provided in Table 5-27.

**Table 5-27 East Plant Finished Water Quality Summary**

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
<b>General Parameters</b>						
Alkalinity, Total	mg/L as CaCO <sub>3</sub>	159	193	219	-	-
Dissolved Oxygen (DO)	mg/L	8.13	11.6	14.5	-	-
Hardness, Total	mg/L as CaCO <sub>3</sub>	180	254	317	-	-
ORP - Oxidation Reduction Potential	mV	471	505	533	-	-
pH	s.u.	7.20	7.65	7.96	-	6.5-8.5
Temperature	°C	6.70	17.5	23.5	-	-
Total Organic Carbon	mg/L	0.63	2.72	4.68	-	-
Assimilable Organic Carbon	µg acetate C/L	80	154	350	-	-
<b>Inorganic Chemicals</b>						
Calcium	mg/L as CaCO <sub>3</sub>	130	173	212	-	-
Chloride	mg/L	14.7	19.6	34.8	-	250
Fluoride	mg/L	0.60	0.81	1.05	4.0	2.0
Magnesium	mg/L as CaCO <sub>3</sub>	51	65	83	-	-
Nitrate (as N)	mg/L	1.19	2.04	3.41	10	-
Nitrite (as N)	mg/L	0.001	0.003	0.02	1	-

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
Phosphate (P04)	mg/L	0.59	0.80	1.07	-	-
Potassium	mg/L	7.0	8.8	11.7	-	-
Sodium	mg/L	21.9	27.3	34.6	-	-
Sulfate	mg/L	0.00	66.1	93.4	-	250
Metals						
Aluminum	µg/L	ND	0.34	1.75	-	50-200
Antimony	µg/L	0.16	0.37	0.58	6	-
Arsenic, Total	µg/L	6.17	7.79	9.35	10	-
Barium	µg/L	74.3	135	164	2,000	-
Beryllium	µg/L	ND	0.00	0.007	4	-
Cadmium	µg/L	ND	0.017	0.148	5	-
Chromium, Total	µg/L	ND	0.06	0.32	100	-
Cobalt	µg/L	0.009	0.064	0.091	-	-
Copper	µg/L	ND	2.87	4.83	TT (AL=1,300) <sup>(2)</sup>	1,000
Iron, total	µg/L	ND	0.72	3.86	-	300
Lead	µg/L	ND	0.07	1.27	TT (AL=15) <sup>(2)</sup>	-
Manganese, Total	µg/L	1.22	3.97	11.5	-	50
Molybdenum	µg/L	2.46	3.69	4.66	-	-
Nickel	µg/L	0.29	0.83	2.65	-	-
Selenium	µg/L	2.72	7.14	17.4	0.05	-
Silver	µg/L	ND	0.0	0.03	-	100
Thallium	µg/L	ND	0.0	0.04	0.002	-
Zinc	µg/L	ND	1.89	23.3	-	5
Radionuclides						
Thorium	µg/L	ND	0	0.62	-	-
Uranium	µg/L	6.94	9.99	12.4	30	-
Vanadium	µg/L	3.42	7.08	10.3	-	-
Herbicides						
Alachlor	µg/L	ND	ND	ND	2	-
Aldrin	µg/L	ND	ND	ND	-	-
Atrazine	µg/L	ND	0.10	0.43	3	-
Benzo [a]pyrene	µg/L	ND	ND	ND	0.2	-
Butachlor	µg/L	ND	ND	ND	-	-
Butylate	µg/L	ND	ND	ND	-	-

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
Chlordane	µg/L	ND	ND	ND	2	-
Chlorpyrifos	µg/L	ND	ND	ND	-	-
Cyanazine	µg/L	ND	ND	ND	-	-
Di (2-ethylhexyl) adipate	µg/L	ND	ND	ND	400	-
Di (2-ethylhexyl) phthalate	µg/L	ND	ND	ND	6	-
Dieldrin	µg/L	ND	ND	ND	-	-
Endrin	µg/L	ND	ND	ND	2	-
Fonofos	µg/L	ND	ND	ND	-	-
Heptachlor	µg/L	ND	ND	ND	0.4	-
Heptachlor epoxide	µg/L	ND	ND	ND	0.2	-
Hexachlorobenzene	µg/L	ND	ND	ND	1	-
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	50	-
Lindane	µg/L	ND	ND	ND	0.2	-
Methoxychlor	µg/L	ND	ND	ND	40	-
Metolachlor	µg/L	ND	0.05	0.29	-	-
Metribuzin	µg/L	ND	ND	ND	-	-
Propachlor	µg/L	ND	ND	ND	-	-
Simazine	µg/L	ND	ND	ND	4	-
Trifluralin	µg/L	ND	ND	ND	-	-
Disinfectant Residual						
Ammonia, Free (NH <sub>3</sub> -N)	mg/L	0	0.08	0.23	-	-
Ammonia, Total (NH <sub>3</sub> -N)	mg/L	0.41	0.67	1.09	-	-
Chlorine Free	mg/L	0	0.01	0.16	4.0	-
Chlorine Total	mg/L	1.42	2.61	3.91	4.0	-
Dichloramine	mg/L	0	0.18	0.76	-	-
Monochloramine	mg/L	0.25	2.30	3.43	-	-
Microbiological Contaminants						
Coliform, total <sup>(3)</sup>	A=0, P=1	0	0	0	< 5% P	-
E coli	A=0, P=1	0	0	0	< 5% P	-
Heterotrophic Plate Count	cfu/100 mL	0	0.58	6.00	-	-
Notes:						
<sup>(1)</sup> “ND” indicates that the concentration was non-detect or below the method detection limit.						
<sup>(2)</sup> AL = Action Level. ALs for lead and copper are monitored in the distribution system. Finished water quality data presented in this table is not for Lead and Copper Rule compliance monitoring.						
<sup>(3)</sup> For total coliform measurements, “P” indicates the presence of coliforms and “A” indicates an absence of coliforms in the sample collected.						

### 5.6.2 West Plant Finished Water Quality Data

A summary of the West Plant finished water quality is provided in Table 5-28.

**Table 5-28 West Plant Finished Water Quality Summary**

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
<b>General Parameters</b>						
Alkalinity, Total	mg/L as CaCO <sub>3</sub>	143	162	216	-	-
Dissolved Oxygen (DO)	mg/L	8.77	9.78	11.96	-	-
Hardness, Total	mg/L as CaCO <sub>3</sub>	180	207	283	-	-
ORP - Oxidation Reduction Potential	mV	431	501	548	-	-
pH	s.u.	7.32	7.63	7.96	-	6.5-8.5
Temperature	°C	12.50	17.9	22.7	-	-
Total Organic Carbon (TOC)	mg/L	1.70	2.16	3.70	-	-
Assimilable Organic Carbon (AOC)	µg acetate C/L	0	80	180	-	-
<b>Inorganic Chemicals</b>						
Calcium	mg/L	43.3	55.2	78.0	-	-
Chloride	mg/L	18.2	23.7	47.8	-	250
Fluoride	mg/L	0.62	0.87	1.11	4.0	2.0
Magnesium	mg/L	11.5	13.0	15.6	-	-
Nitrate (as N)	mg/L	0.42	0.90	1.71	10	-
Nitrite (as N)	mg/L	0.00	0.002	0.007	1	-
Phosphate (as PO <sub>4</sub> )	mg/L	0.50	0.71	0.90	-	-
Potassium	mg/L	7.06	8.66	11.32	-	-
Sodium	mg/L	29.2	32.6	37.3	-	-
Sulfate	mg/L	69	87	114	-	250
<b>Metals</b>						
Aluminum	µg/L	ND	0.52	3.50	-	50-200
Antimony	µg/L	0.17	0.27	0.39	6	-
Arsenic, Total	µg/L	5.45	7.00	8.72	10	-
Barium	µg/L	90.8	106	124	2,000	-
Beryllium	µg/L	ND	0.0002	0.075	4	-
Cadmium	µg/L	ND	0.024	0.082	5	-
Chromium, Total	µg/L	ND	0.04	0.63	100	-
Cobalt	µg/L	0.03	0.08	0.12	-	-

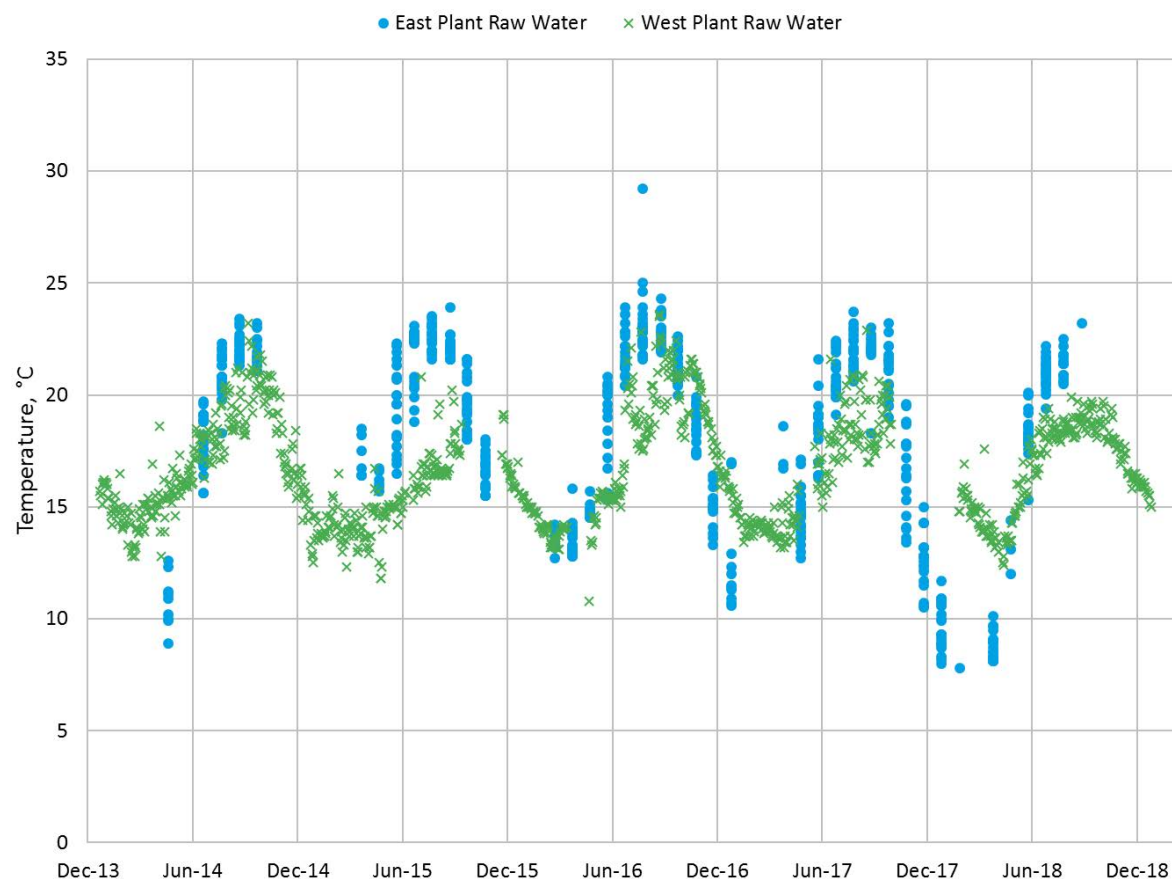
PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
Copper	µg/L	ND	1.68	3.42	TT (AL=1,300) <sup>(2)</sup>	1,000
Iron, total	µg/L	0.17	1.38	5.67	-	300
Lead	µg/L	ND	0.07	1.28	TT (AL=15) <sup>(2)</sup>	-
Manganese, Total	µg/L	0.51	2.72	30.4	-	50
Molybdenum	µg/L	2.79	3.43	4.06	-	-
Nickel	µg/L	0.57	1.16	3.56	-	-
Selenium	µg/L	0.52	2.26	27.5	0.05	-
Silver	µg/L	ND	0.06	0.32	-	100
Thallium	µg/L	ND	0.0	0.05	0.002	-
Zinc	µg/L	ND	0.45	11.6	-	5
<b>Radionuclides</b>						
Thorium	µg/L	ND	0.31	0.97	-	-
Uranium	µg/L	6.02	7.80	10.3	30	-
Vanadium	µg/L	4.22	5.27	6.78	-	-
<b>Herbicides</b>						
Alachlor	µg/L	ND	ND	ND	2	-
Aldrin	µg/L	ND	ND	ND	-	-
Atrazine	µg/L	ND	0.103	0.168	3	-
Benzo [a]pyrene	µg/L	ND	ND	ND	0.2	-
Butachlor	µg/L	ND	ND	ND	-	-
Butylate	µg/L	ND	ND	ND	-	-
Chlordane	µg/L	ND	ND	ND	2	-
Chlorpyrifos	µg/L	ND	ND	ND	-	-
Cyanazine	µg/L	ND	ND	ND	-	-
Di (2-ethylhexyl) adipate	µg/L	ND	ND	ND	400	-
Di (2-ethylhexyl) phthalate	µg/L	ND	ND	ND	6	-
Dieldrin	µg/L	ND	ND	ND	-	-
Endrin	µg/L	ND	ND	ND	2	-
Fonofos	µg/L	ND	ND	ND	-	-
Heptachlor	µg/L	ND	ND	ND	0.4	-
Heptachlor epoxide	µg/L	ND	ND	ND	0.2	-
Hexachlorobenzene	µg/L	ND	ND	ND	1	-
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	50	-

PARAMETER	UNITS	MIN <sup>(1)</sup>	AVG <sup>(1)</sup>	MAX <sup>(1)</sup>	Primary MCL	Secondary MCL
Lindane	µg/L	ND	ND	ND	0.2	-
Methoxychlor	µg/L	ND	ND	ND	40	-
Metolachlor	µg/L	ND	ND	ND	-	-
Metribuzin	µg/L	ND	ND	ND	-	-
Propachlor	µg/L	ND	ND	ND	-	-
Simazine	µg/L	ND	ND	ND	4	-
Trifluralin	µg/L	ND	ND	ND	-	-
<b>Disinfectant Residual</b>						
Ammonia, Free (NH <sub>3</sub> -N)	mg/L	0.00	0.04	0.28	-	-
Ammonia, Total (NH <sub>3</sub> -N)	mg/L	0.05	0.56	0.95	-	-
Chlorine, Free	mg/L	0.00	0.01	2.46	4.0	-
Chlorine, Total	mg/L	0.92	2.48	3.96	4.0	-
Dichloramine	mg/L	0.00	0.15	2.54	-	-
Monochloramine	mg/L	0.09	2.21	3.65	-	-
<b>Microbiological Contaminants</b>						
Coliform, total <sup>(3)</sup>	A=0, P=1	0	0	1	< 5% P	-
E coli	A=0, P=1	0	0	0	< 5% P	-
Heterotrophic Plate Count	cfu/100 mL	0.00	0.65	7.00	-	-
<b>Notes:</b> <sup>(1)</sup> "ND" indicates that the concentration was non-detect or below the method detection limit. <sup>(2)</sup> AL = Action Level. ALs for lead and copper are monitored in the distribution system. Finished water quality data presented in this table is not for Lead and Copper Rule compliance monitoring. <sup>(3)</sup> For total coliform measurements, "P" indicates the presence of coliforms and "A" indicates an absence of coliforms in the sample collected.						

## 5.7 Water Quality Trends

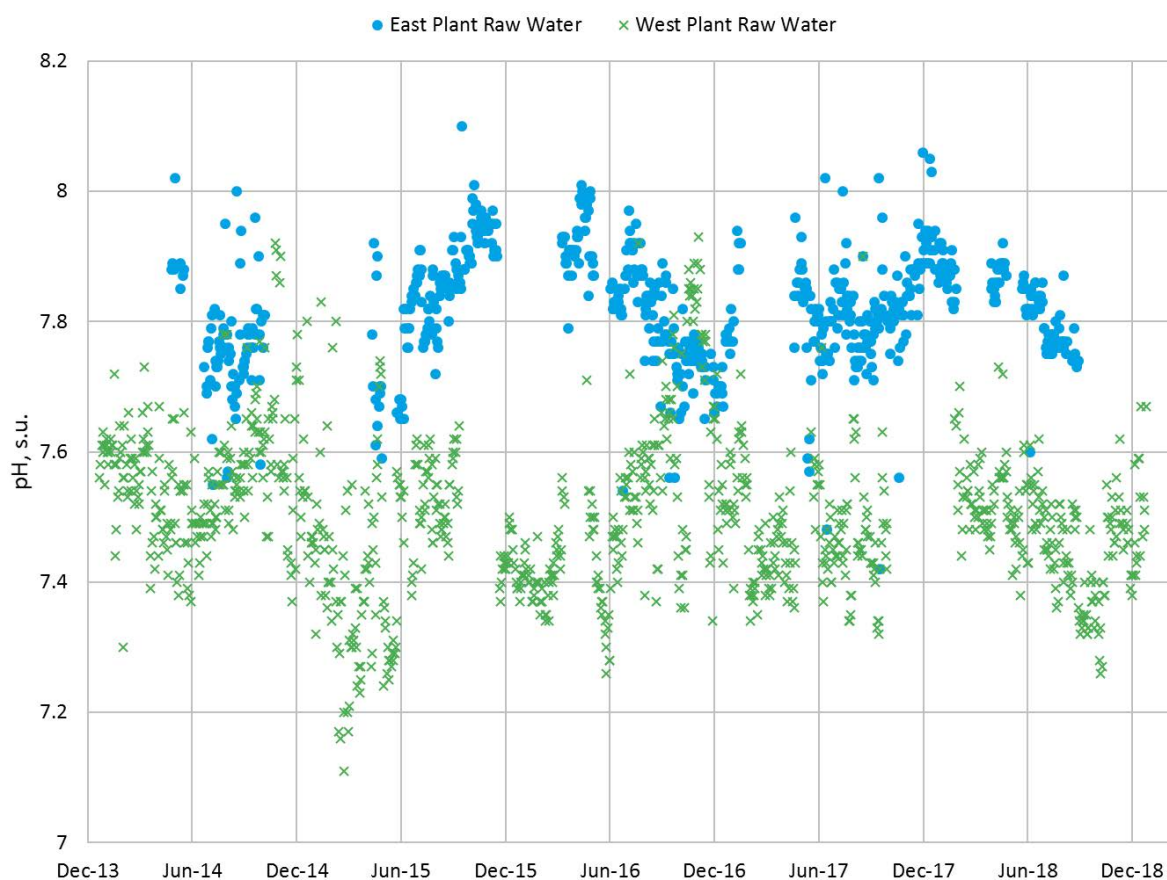
### 5.7.1 Temperature and pH

The temperature of raw water supplied to the East Plant varies seasonally, typically ranging from 8 degrees Celsius (°C) to 14°C in winter months and 20°C to 25°C in late summer to early fall. The temperature of raw water supplied to the West Plant typically ranges from 12°C to 16°C in the winter and 18°C to 23°C in late summer to early fall and is generally less impacted by seasonal variations. Between July and October, elevated water temperatures can contribute to conditions that promote biological regrowth in the distribution system. The temperature of raw water supplied by the vertical wells is typically 2-3°C lower than the temperature of water supplied by the HCWs. In recent years, Lincoln Water Systems has augmented the amount of water supplied from the vertical wells and treated through the West Plant to reduce the water temperature in the distribution system. Figure 5-3 demonstrates seasonal variations in raw water temperature supplied to the East and West Plant.



**Figure 5-3** Raw Water Temperature for Samples Collected from the East and West Plant from January 2014 to December 2018

The pH of raw water supplied to the East Plant typically ranges from 7.6 to 8.0, while the West Plant raw water pH typically ranges from 7.4 to 7.6. Figure 5-4 provides a summary of the East and West Plant raw water pH.

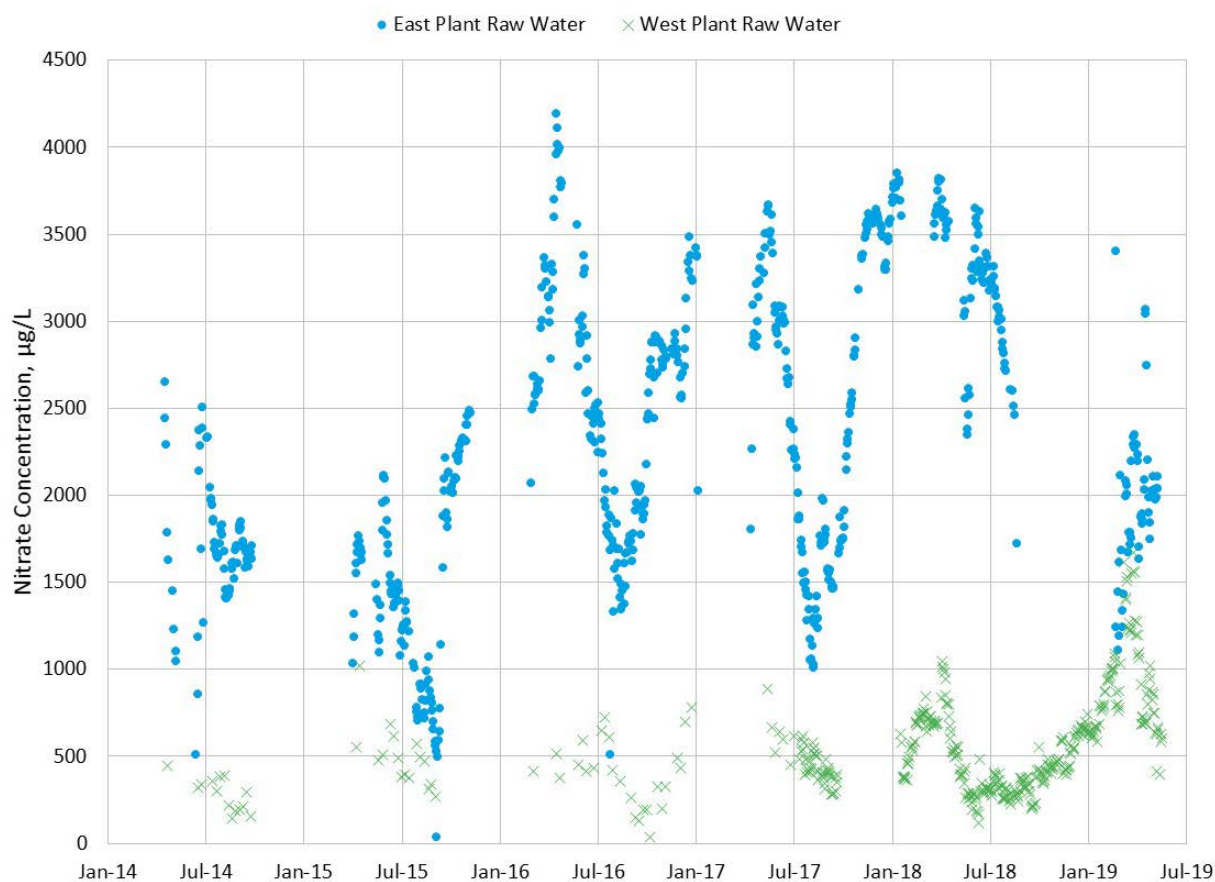


**Figure 5-4**      **Raw Water pH for Samples Collected from the East and West Plant from January 2014 to December 2018**



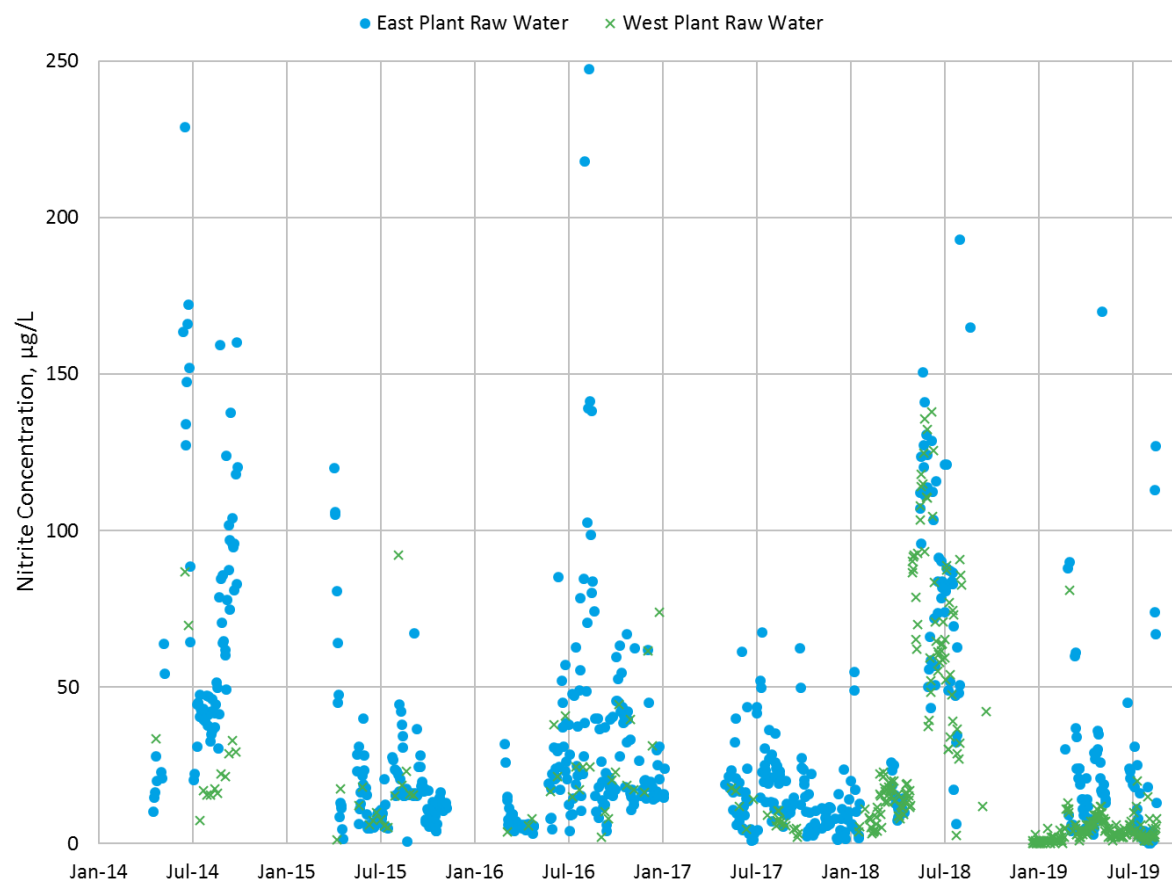
### 5.7.2 Nitrate and Nitrite

Nitrate and nitrite are naturally occurring in ground water supplies. Under the National Primary Drinking Water Regulations (NPDWR), nitrate and nitrite have a maximum contaminant limit (MCL) of 10 mg/L as N and 1 mg/L as N, respectively. Compliance with the MCL is monitored at the point of entry to the distribution system. The raw water supplied to the East Plant has significantly higher nitrate concentrations than the raw water supplied to the West Plant. The concentration of nitrate in the East Plant raw water typically ranges from 1 to 4 mg/L. Based on data collected from Years 2014 to 2019, the maximum concentration recorded at the East Plant was below 50 percent of the MCL. Figure 5-5 demonstrates the concentration of nitrate measured in the East and West Plant raw water.



**Figure 5-5** Raw water nitrate concentration for samples collected from the East and West Plant from January 2014 through July 2019.

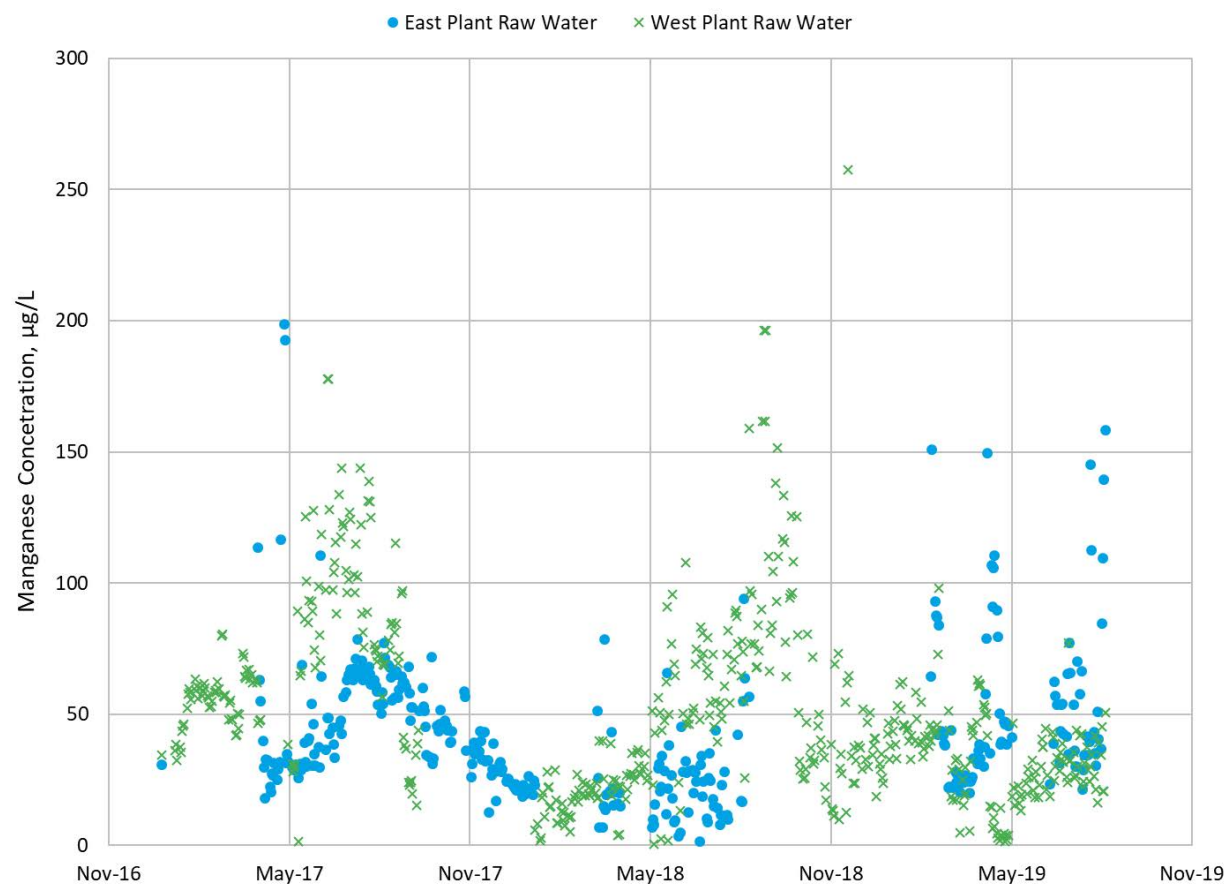
Figure 5-6 demonstrates the concentration of nitrite in the raw water supplied to the East and West Plants. Both water supplies experience significant variations in nitrite concentration with spikes typically occurring between July and August. Based on data collected from Years 2014 to 2019, the maximum concentration recorded at the East Plant was approximately 25 percent of the MCL. In some parts of the distribution system, the concentration of nitrite tends to increase between the months of August and October due to nitrification. Discussion of nitrification impacts on distribution system water quality is provided in Chapter 7.



**Figure 5-6** Raw water nitrite concentration from samples collected from the East and West Plant from January 2014 through August 2019

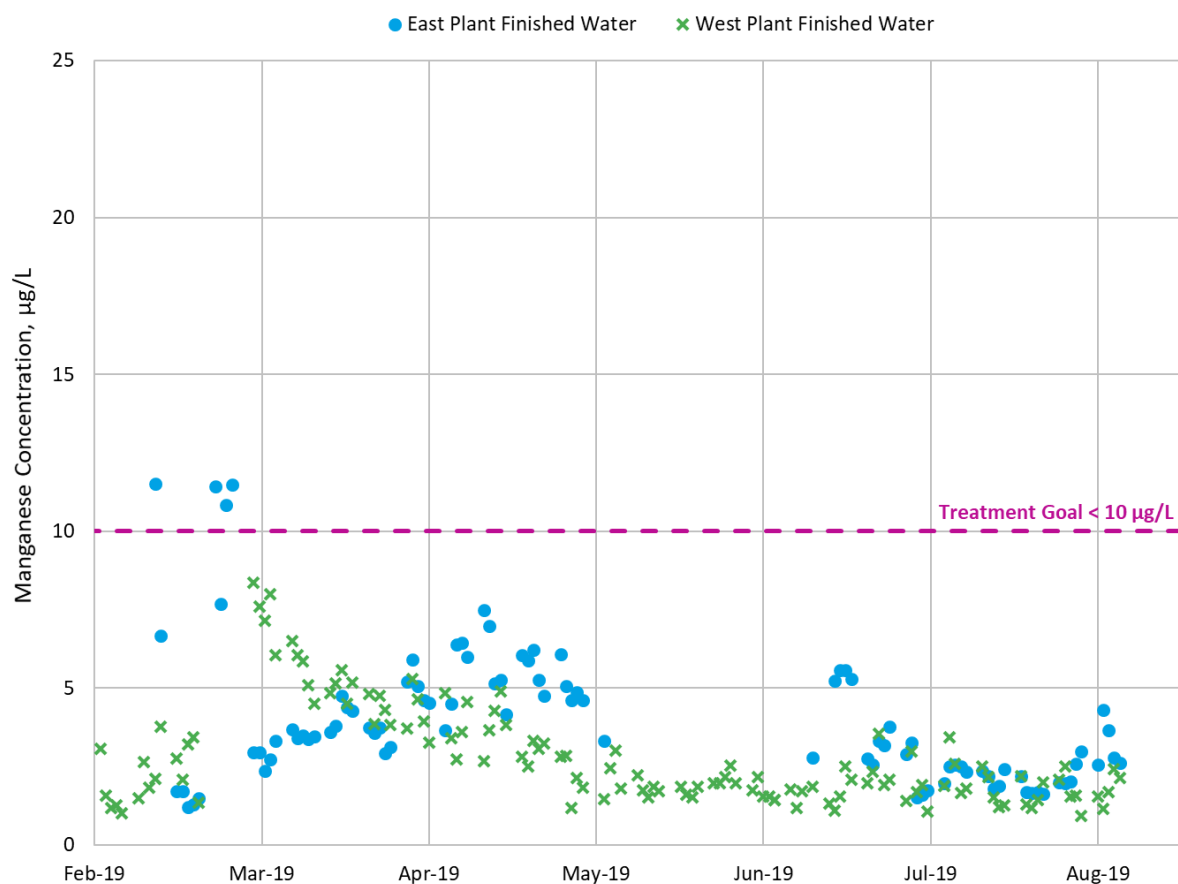
### 5.7.3 Manganese

Figure 5-7 demonstrates the concentration of manganese in the raw water supplied to the East and West Plants based on samples collected between January 2017 and August 2019. The concentration of manganese in the raw water has typically remained below 150 µg/L. Higher concentrations of manganese have been observed in the vertical wells that supply water to the West Plant than in the HCWs that supply water to the East Plant. Manganese concentrations observed in 2019 demonstrated an average raw water concentration of 43 µg/L and 51 µg/L in the East and West Plant, respectively. These concentrations are consistent with historical water quality data observed from 2005 to 2011.



**Figure 5-7** Raw Water Manganese Concentration from the East and West Plant from January 2017 through August 2019

Manganese is removed through oxidation and filtration, where the East Plant utilizes ozone for oxidation and the West Plant utilizes chlorine. The USEPA has a non-enforceable secondary MCL of 50 µg/L for manganese. LWS has a treatment goal of less than 10 µg/L of manganese in the finished water. Figure 5-8 provides a summary of the concentration of manganese in the East and West Plant finished water from January to August 2019. The West Plant was able to meet this goal 100 percent of the time, and the East Plant was able to meet this goal 96 percent of the time.



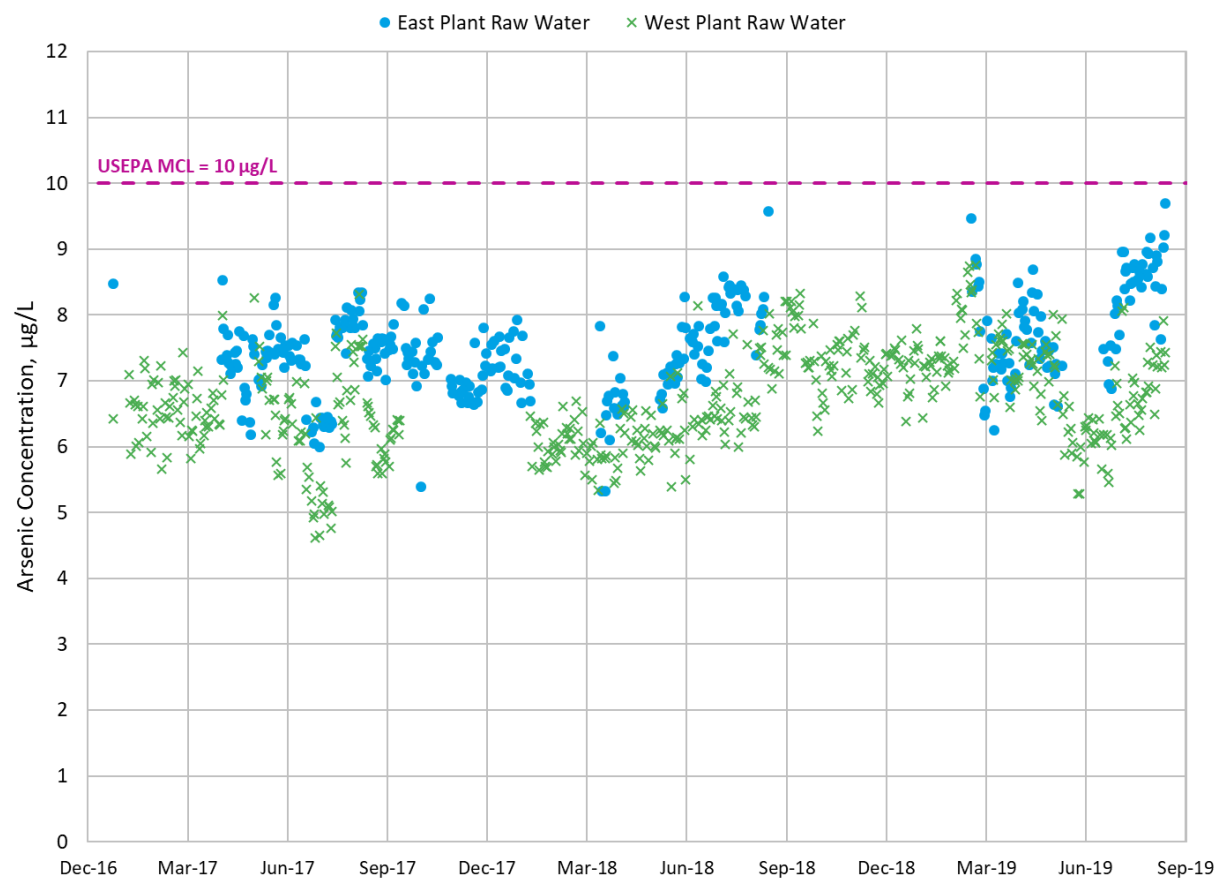
**Figure 5-8**      **Finished Water Manganese Concentration from the East and West Plant from January to August 2019**

### 5.7.4 Arsenic

Arsenic is a naturally occurring inorganic chemical, which is regulated under the NPDWR with an MCL of 10 µg/L. The Arsenic Rule requires monitoring at the point of entry based on the running annual average (RAA) of quarterly samples with provisions for reduced monitoring on an annual basis.

Figure 5-9 provides the concentration of arsenic in raw water samples collected from the East and West Plants from January 2017 through August 2019. The water quality data presented in this figure was collected from the plant's laboratory sampling program, which goes beyond the annual sampling requirements for regulatory compliance.

The concentration of arsenic has historically been higher in the HCWs servicing the East Plant, which have an average and maximum concentration of 7.5 and 9.7 µg/L, respectively. In the West Plant raw water, the average and maximum arsenic concentrations are 6.72 µg/L and 8.76 µg/L, respectively. As with atrazine, LWS has had to implement wellfield management practices to maintain compliance with the MCL, which limits the use of HCWs and the East Plant. While LWS has maintained regulatory compliance for arsenic, the concentration of arsenic in the raw water supplied from the HCWs appears to be increasing over time, trending upward towards the MCL of 10 µg/L.



**Figure 5-9** Raw Water Arsenic Concentration from the East and West Plant from January 2017 through December 2018

In 2016, LWS conducted a study to evaluate treatment alternatives for arsenic removal to meet proposed finished water quality goals of 8 µg/L, 4 µg/L and non-detect levels. The evaluation focused on arsenic removal through enhanced coagulation and provided a high-level comparison of alternative arsenic treatment technologies, including adsorption through activated alumina and iron oxide coated sand, ion exchange, and reverse osmosis from a high-level perspective.

From this evaluation, enhanced coagulation with ferric chloride was identified as the preferred alternative. The ferric chloride dose required ranged from 5 mg/L to 15 mg/L, depending on the influent arsenic concentration and finished water quality goal. Pilot testing was conducted to evaluate the impacts on filter performance from incorporating a coagulant feed with direct filtration. During the pilot, the filters experienced significant reductions in filter run time, indicating the need for a coagulation, flocculation and sedimentation process upstream of filtration in order to accommodate the ferric chloride addition for arsenic removal. The enhanced coagulation process could potentially produce residuals with high concentrations of arsenic that may require additional treatment or need to be hauled away for disposal in a hazardous waste landfill. Further evaluation should be conducted to determine the preferred approach to residuals management.

Alternatively, granular ferric hydroxide (GFH) media adsorption, which was ruled out in the previous study, may prove to be a viable alternative. This system would consist of vertical pressure vessels filled with GFH media, designed for a portion of the total plant flow depending on the arsenic finished water quality goal. Media replacement frequency would depend on the finished water quality goal for arsenic. When GFH media is exhausted, it is typically hauled away and replaced with new media. In most cases, the exhausted media is disposed of in a landfill as a non-hazardous waste, provided that the toxicity characteristic leaching procedure (TCLP) test indicates that arsenic leaching potential is less than 5 mg/L.

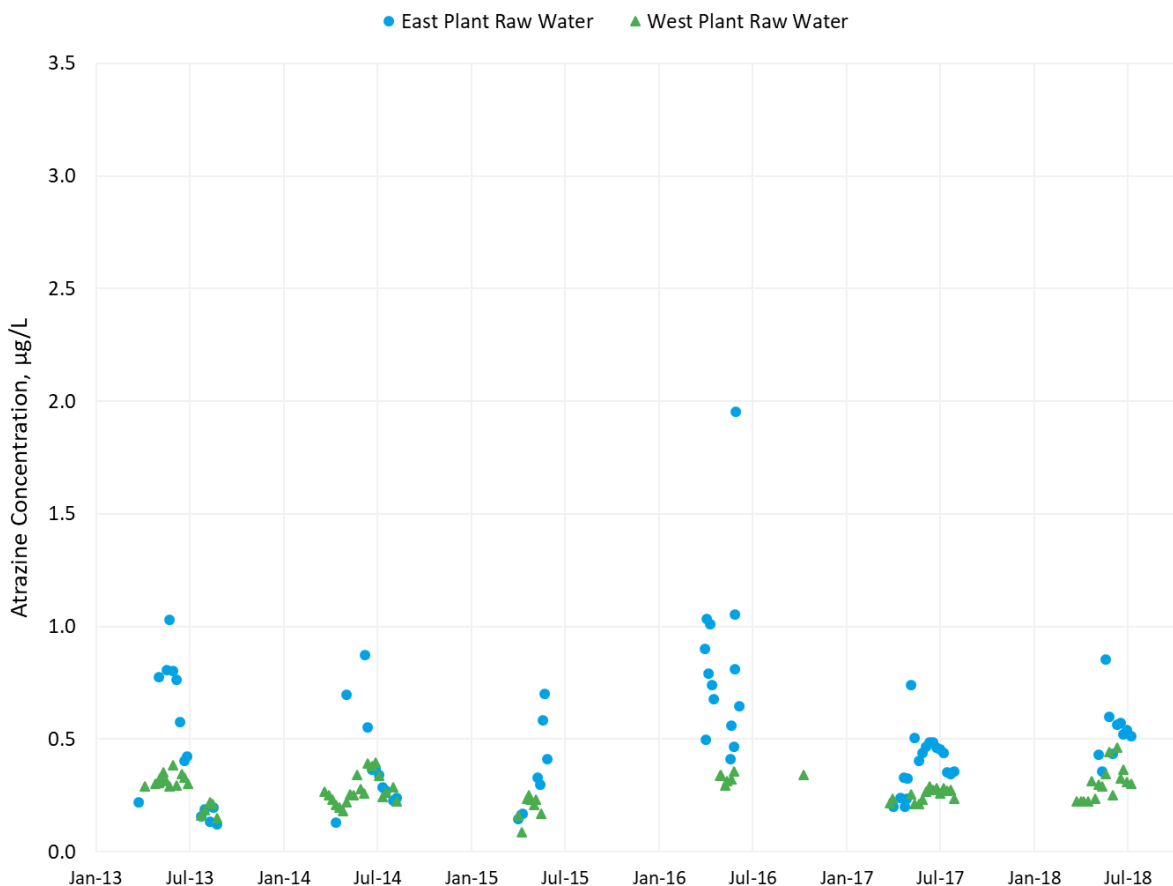
Given the relatively high concentrations of arsenic in the HCWs and continued expansion of water supplied from HCWs, it is recommended that LWS conduct further evaluations of viable arsenic removal technologies to determine the most cost-effective treatment approach.

### 5.7.5 Atrazine

Atrazine is a widely used herbicide regulated under the NPDWR by USEPA and has a maximum contaminant limit (MCL) of 3 µg/L. The Platte River experiences elevated levels of atrazine in the late spring/early summer due to runoff from agricultural fields. Between May and July, the average concentration of atrazine in the Platte River is typically 6 µg/L, with spikes as high as 10 to 15 µg/L.

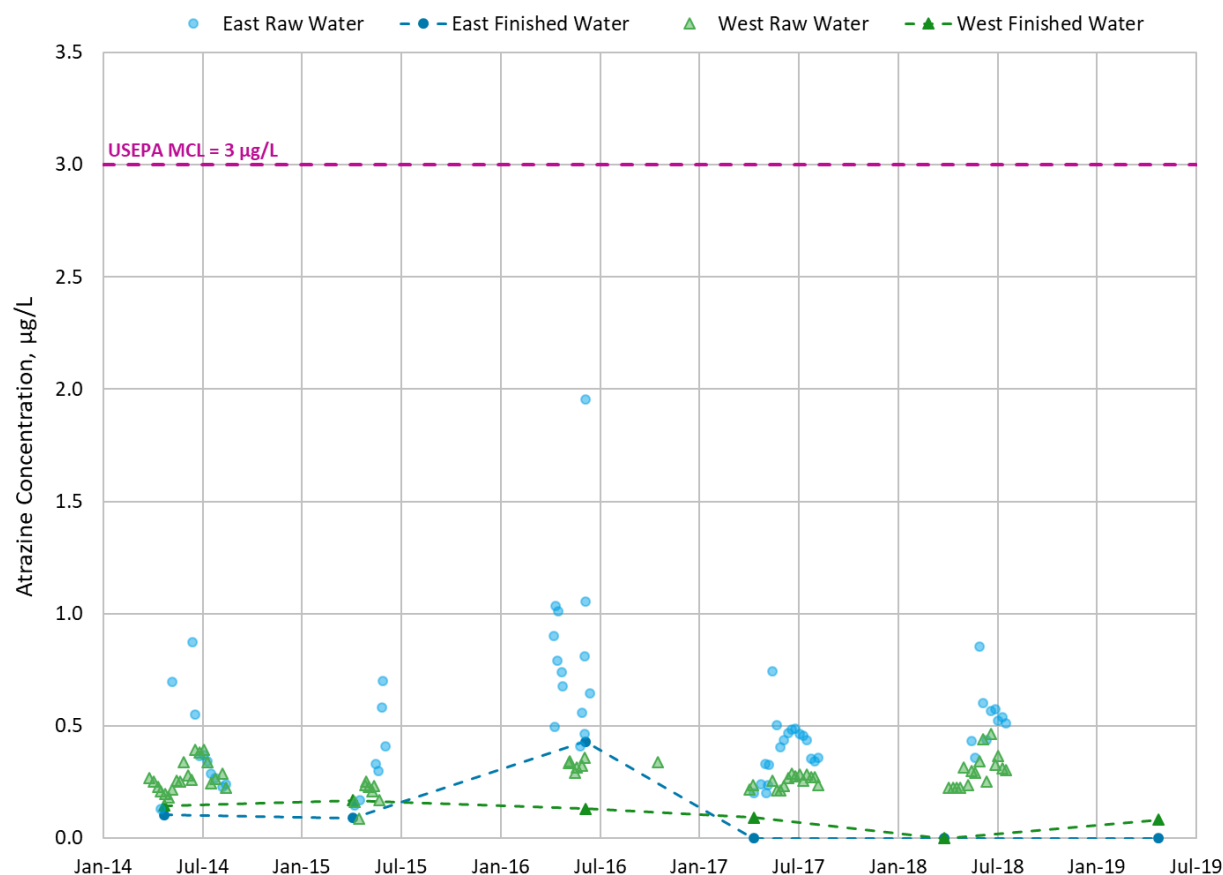
Figure 5-10 demonstrates the concentration of atrazine in the raw water supplied to the East and West Plants from February 2013 to August 2018. The figure shows that the concentration of atrazine in both raw water supplies has remained relatively consistent over the past five years. Since the West Plant is supplied from ground water wells, the raw water delivered to the West Plant is less subject to these spikes in atrazine. The average and maximum atrazine concentrations in the West Plant raw water are 0.27 µg/L and 0.46 µg/L, respectively.

Since the East Plant relies on horizontal collector wells (HCWs), the raw water delivered to the East Plant does experience seasonal spikes in atrazine, as demonstrated in the figure. The concentration of atrazine in the East Plant raw water is considerably lower than the concentration observed in the river due to river bank filtration. The average and maximum atrazine concentrations in the East Plant raw water are 0.51 µg/L and 1.95 µg/L, respectively.



**Figure 5-10 Raw Water Atrazine Concentration from the East and West Plant from February 2013 through August 2018**

Given the relatively high concentrations of atrazine in the Platte River, LWS has undertaken atrazine management practices during the spring and summer when agricultural runoff contributes to elevated atrazine levels. Since the HCWs are influenced by water quality in the river, the concentration of atrazine is higher in the HCWs than in the groundwater supplied from the vertical wells. The East Plant treatment process includes ozonation, which reduces the concentration of atrazine in the finished water by approximately 50 percent. However, in order to ensure compliance with the MCL, LWS has had to implement wellfield management practices, by which they limit the use of the HCWs during periods of elevated atrazine in the river and utilize only the West Plant for drinking water supply. Based on compliance monitoring data presented in Figure 5-11, the concentration of atrazine in the East and West Plant finished water has been maintained below 0.5 µg/L since Year 2014.



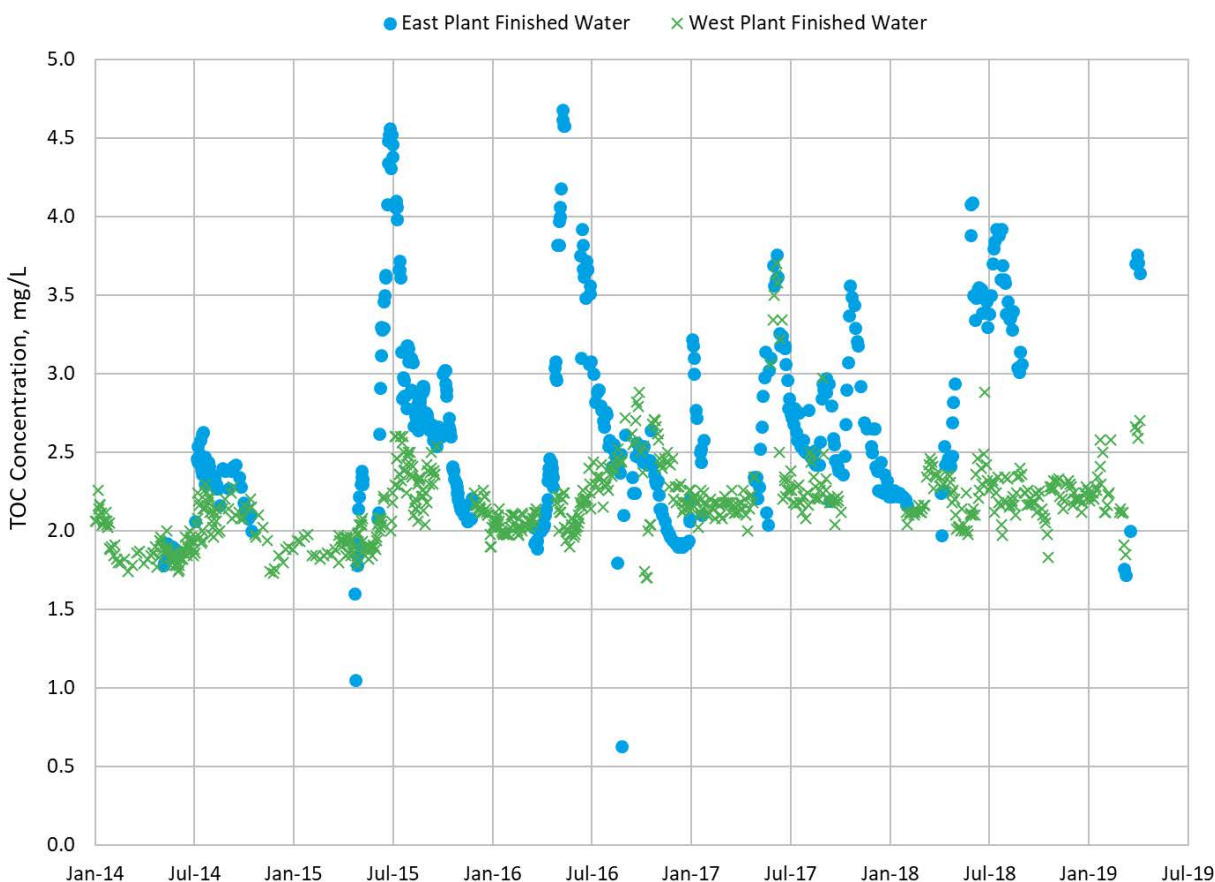
**Figure 5-11 East and West Plant Finished Water Atrazine Concentration from January 2014 to July 2019**

### 5.7.6 Total Organic Carbon

Total organic carbon (TOC) is used as a surrogate measure for the amount of natural organic matter (NOM) present in water. NOM reacts with chlorine to form regulated disinfection byproducts (DBPs), including total trihalomethanes (TTHM) and the five regulated haloacetic acids (HAA5). TOC management practices are typically used to reduce the concentration of TOC in the finished water and control the DBP formation in the distribution system based on the TOC removal requirements established in the Stage 1 Disinfectants and Disinfection Byproduct Rule. LWS is not required to meet the TOC removal requirements due to their source water characteristics and ability to maintain TTHM and HAA5 concentrations of less than 40 µg/L and 30 µg/L, respectively.

Figure 5-12 provides a summary of the East and West Plant finished water TOC concentrations from January 2014 to April 2019. The West Plant finished water TOC ranges from 1.70 to 3.70 mg/L with an average concentration of 2.16 mg/L; whereas the East Plant finished water TOC ranges from 0.63 mg/L to 4.68 mg/L with an average concentration of 2.71 mg/L. Historical data indicates that water supplied from the HCWs typically has higher concentrations of TOC than water supplied from the vertical wells and is subject to greater variability due to seasonal changes on the Platte River. As the City continues to expand the use of HCWs for raw water supply, impacts on TOC and DBP management should be evaluated.



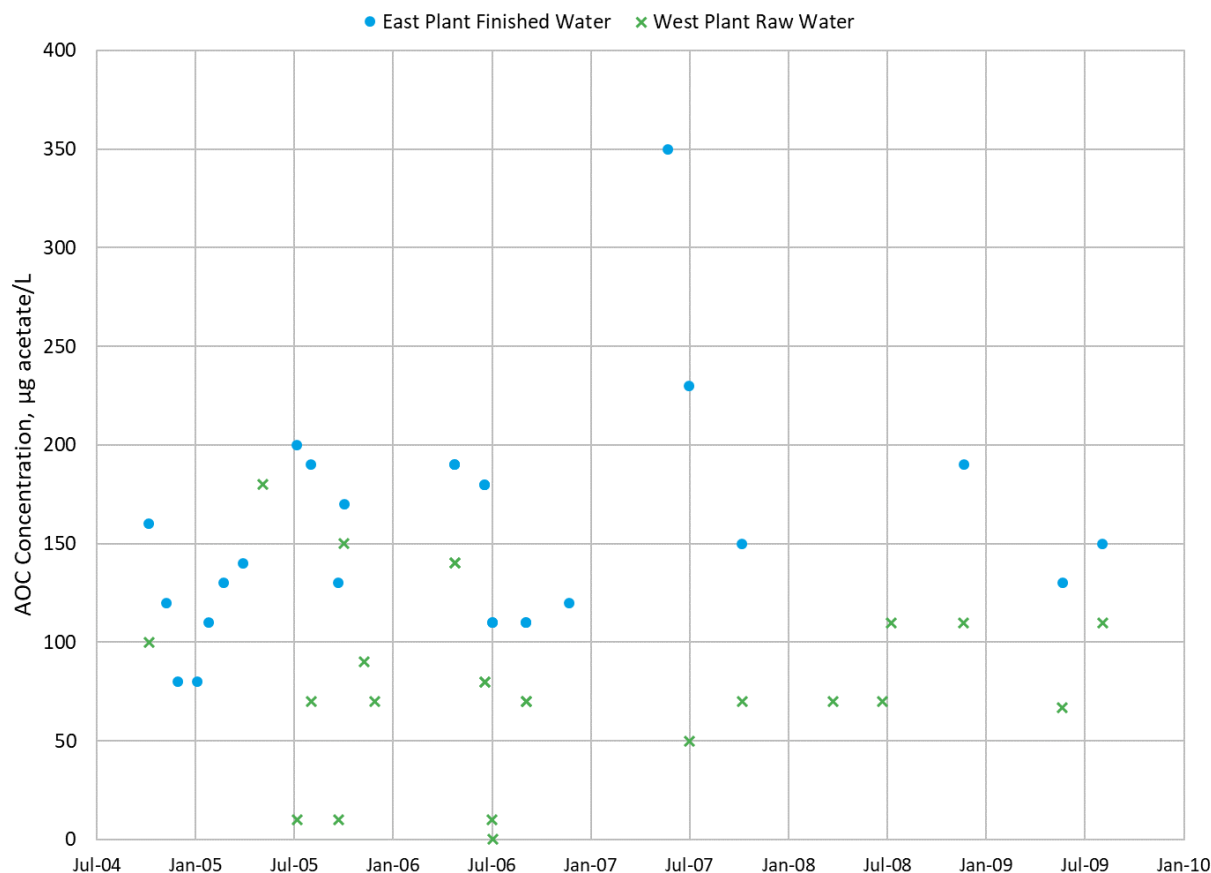


**Figure 5-12 East and West Plant Finished Water TOC Concentration from January 2014 to April 2019**

### 5.7.7 Biological Stability

Assimilable organic carbon (AOC) is a parameter used to measure the biological stability of water and can be used as an indicator for potential bacterial regrowth in the distribution system. AOC represents the amount of carbon that is readily taken up by microorganisms for bacterial growth and is measured in  $\mu\text{g}$  acetate carbon per liter. Biodegradable dissolved organic carbon (BDOC) can also be used to assess biological stability. BDOC is measured as the net change in DOC consumed by biologically active sand or biofilm on a borosilicate glass bead column.

LWS monitored the concentration of AOC in the East and West Plant finished water from January 2004 to July 2009. Results from AOC monitoring are shown in Figure 5-13. During this period, the average and maximum concentration of AOC in the East Plant finished water was  $154 \mu\text{g/L}$  and  $350 \mu\text{g/L}$ , respectively. The average and maximum concentration of AOC in the West Plant finished water was  $80 \mu\text{g/L}$  and  $180 \mu\text{g/L}$ , respectively. The East Plant is subject to higher concentrations of AOC due to the ozonation process, which oxidizes organic compounds into smaller, more readily biodegradable dissolved organic compounds.



**Figure 5-13 East and West Plant Finished Water AOC Concentration from July 2004 to July 2009**

The AWWARF Report No. 90794 – Investigation of Biological Stability in the Distribution System defines thresholds for various water quality parameters affecting biological stability. Specifically, the article focuses on water temperature, disinfectant type and residual, AOC and BDOC. Based on a study with water quality analysis from 64 utilities across the United States, it was found that systems with the following finished water quality conditions were more likely to have coliform occurrences.

- Temperature > 15°C
- Total chlorine residual < 1.0 mg/L
- AOC > 100 µg/L
- BDOC > 0.3 µg/L

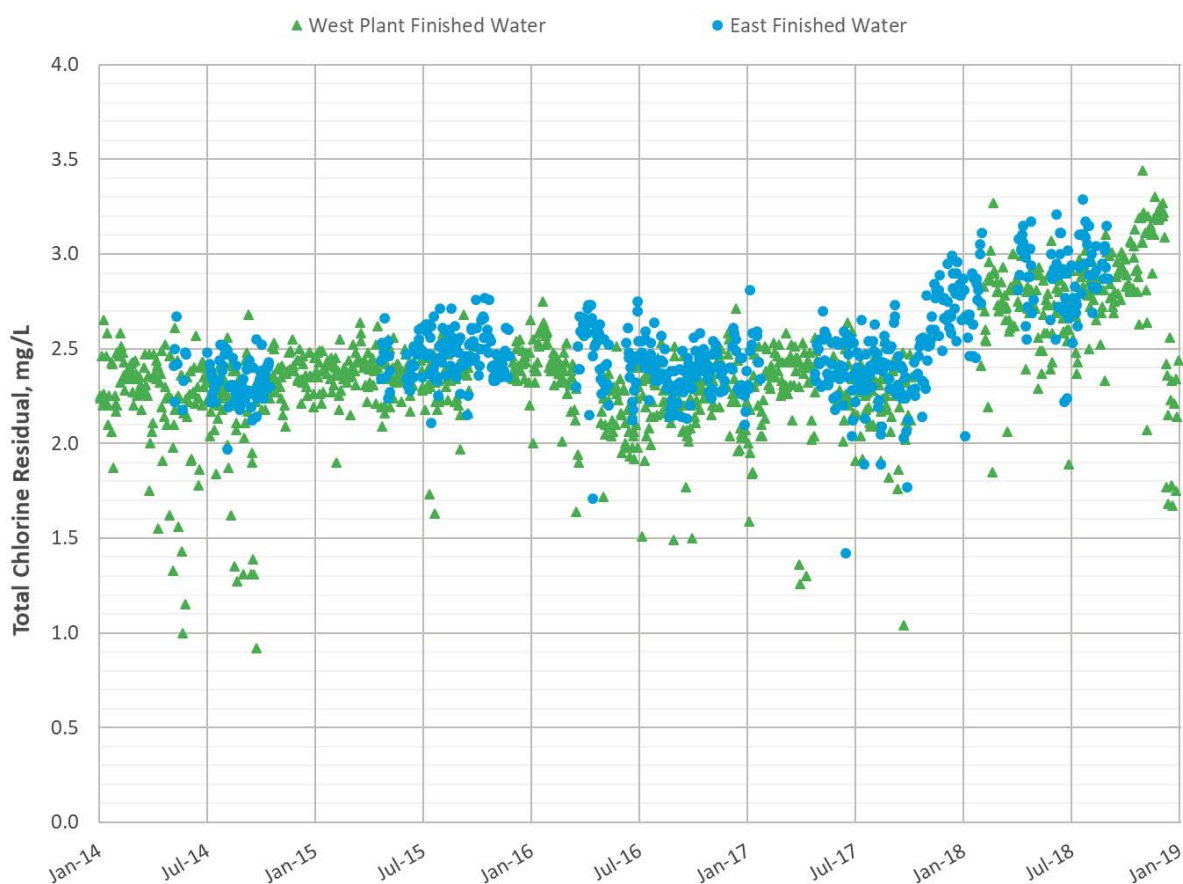
The research report further categorizes low, moderate and high concentrations of AOC and BDOC as demonstrated in Table 5-29. The impact of BDOC on finished water stability is temperature-dependent. When water temperature is less than 15°C, higher concentrations of BDOC (up to 0.3 µg/L) may sufficiently prevent bacterial regrowth. However, under warmer conditions at temperatures greater than 20°C, maintaining a concentration of BDOC less than 0.15 µg/L is recommended for preventing bacterial regrowth. Based on these definitions, the East Plant finished water has moderate to high AOC, whereas the West Plant finished water has low to moderate AOC.

**Table 5-29** Categorization of Low, Moderate and High Concentrations of AOC and BDOC

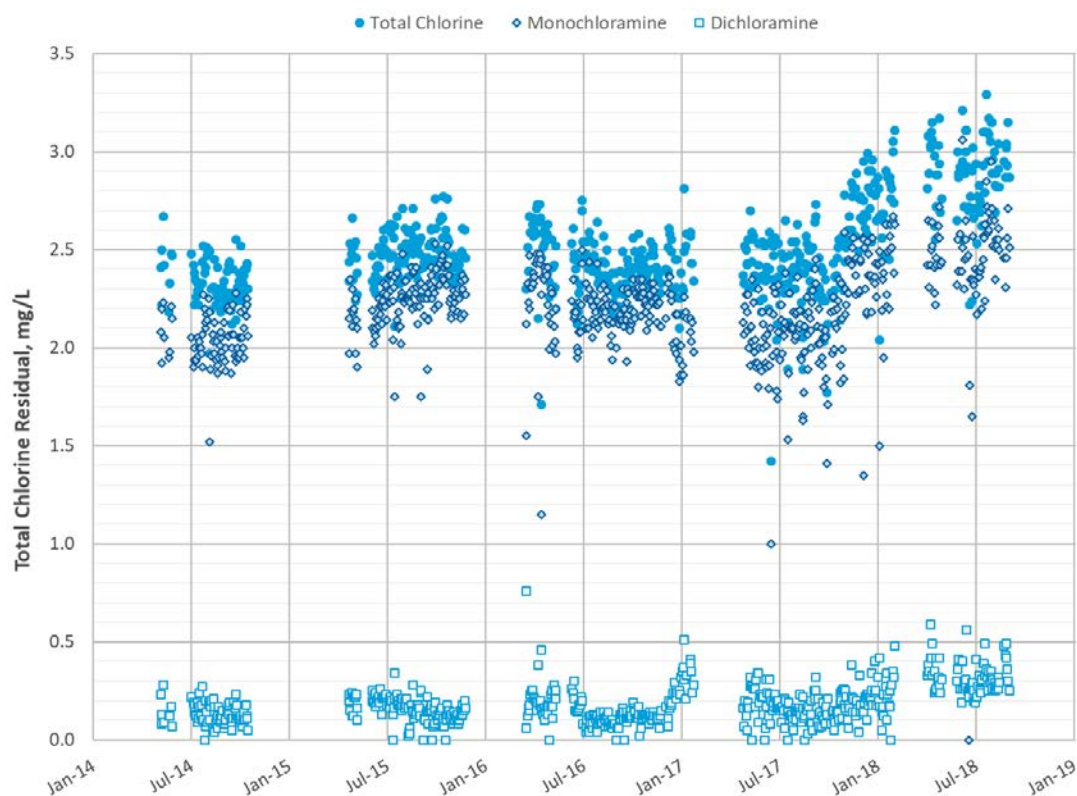
Category	AOC, $\mu\text{G/L}$	BDOC, $\mu\text{G/L}$
Low	< 50	< 0.15
Moderate	50-150	0.15-0.3
High	> 150	> 0.3

### 5.7.8 Disinfectant Residual

LWS has historically targeted a total chlorine residual of 2.5 mg/L as  $\text{Cl}_2$  in the finished water from both East and West Plants. LWS increased their target finished water total chlorine residual to 3.0 mg/L in December 2017 and eventually to 3.5 mg/L in 2019, as a means for controlling nitrification. Figure 5-14 shows the total chlorine residual in the plant finished water from January 2014 through January 2019.

**Figure 5-14** East and West Plant Finished Water Total Chlorine Residual from January 2014 to January 2019

Chloraminated systems rely on the breakpoint curve to drive formation of monochloramines. Based on the breakpoint curve, it is typically desirable to operate with a target chlorine-to-ammonia ( $\text{Cl}_2\text{-NH}_3$ ) mass ratio of 3 to 5 with most plants adopting a narrower target of 4.0 to 4.5. Operating on the left of this ratio ( $\text{Cl}_2\text{-NH}_3$  ratio  $\leq 3$ ) results in excess free ammonia in the finished water, which increases the potential for nitrification. Operating on the right of this ratio ( $\text{Cl}_2\text{-NH}_3$  ratio  $> 5$ ) results in the formation of undesirable chloraminated species such as dichloramine and trichloramine, which leads to objectionable taste/odor and less stable residual (faster degradation of total chlorine residual). Figure 5-15 and Figure 5-16 show the relationship between total chlorine, monochloramine and dichloramine for the East and West Plant finished water, respectively. As demonstrated in the figures, LWS is primarily forming monochloramine, which on average makes up approximately 90 percent of the total chlorine residual.



**Figure 5-15 East Plant Finished Water Chloramine Speciation from January 2014 to August 2018**



**Figure 5-16 West Plant Finished Water Chloramine Speciation from January 2014 to January 2019**

It is generally recommended to maintain finished water free ammonia concentrations of less than 0.1 mg/L. Based on the finished water quality data provided by LWS, the average concentration of free ammonia from the East and West Plant finished water is 0.08 mg/L and 0.04 mg/L, respectively. This demonstrates a healthy relationship between chlorine residual and ammonia dosing. The high percentage of total chlorine present as monochloramine and low concentrations of free ammonia helps reduce the potential for nitrification.

## 5.8 Regulatory Summary

This section provides an overview of existing regulations, contaminants undergoing regulatory determination, and potential future regulatory changes. Based on an analysis of the water quality data received and understanding of the plant's treatment systems, it appears that the LWS Ashland plants are in compliance with applicable rules and regulations.

## 5.9 Existing Regulations

### 5.9.1 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR), published in Year 1989, was the first rule passed by EPA to protect the public against pathogens. Subsequent rules have been passed to supplement the SWTR primarily in response to discovery of DBPs and discovery that some pathogens, such as *Cryptosporidium*, are highly resistant to traditional disinfectants.

The SWTR established MCLGs of zero for *Giardia*, viruses, and Legionella. The following treatment techniques were required to protect against these pathogens:

- Filtration, unless specific avoidance criteria are met.
- Maintenance of a disinfectant residual in the distribution system.
- Removal or inactivation of 99.9 percent (3-log) *Giardia* and 99.99 percent (4-log) viruses.
- Maximum allowable turbidity in the combined filter effluent (CFE) of 5 nephelometric turbidity units (NTU) and 95th percentile CFE of 0.5 NTU or less for plants with conventional treatment or direct filtration.
- Watershed protection and source water quality requirements for unfiltered PWSs.
- The SWTR established two criteria for demonstrating maintenance of a disinfectant residual:
  - A minimum residual of 0.2 mg/L entering the distribution system.
  - A detectable residual throughout the distribution system.

Disinfection requirements specified in the SWTR are summarized in Table 5-30. Disinfection requirements are based on pathogen removal credits given for filtration and inactivation credits given for disinfection. Conventional treatment receives 2.5-log removal credit for *Giardia* and 2.0-log removal credit for viruses. Disinfection is required to achieve the remaining 0.5-log *Giardia* inactivation and 2-log virus inactivation.

The CT method is used to determine disinfection credits achieved during treatment. In this method, CT is defined as the product of C, the residual disinfectant concentration in mg/L, and T10, the detention time in minutes corresponding to the time for which 90 percent of the water has been in contact with at least the residual concentration. Ratios of T10 to the theoretical hydraulic detention time, T, can be determined with tracer tests. In the absence of tracer test results, EPA provides guidelines for T10/T ratios based on the extent of baffling in a basin. The T10/T ratio is often referred to as a “baffling classification.”

**Table 5-30 Log Removal/Inactivation Credits and Requirements Under the 1989 SWTR**

Process	<i>Giardia</i> Cysts	Viruses
Total log removal/inactivation required	3.0	4.0
Conventional sedimentation/filtration credit	2.5	2.0
Direct filtration credit	2.0	1.0
Slow sand filtration credit	2.0	2.0
Diatomaceous earth credit	2.0	1.0



### 5.9.2 Total Coliform Rule

The Total Coliform Rule (TCR) was published in Year 1989 to improve public health by reducing fecal pathogens in drinking water to minimal levels. The TCR requires testing representative samples across the distribution system for total coliforms at a prescribed frequency. Any positive test result triggers repeat sampling and testing for *Escherichia coli* (*E. coli*).

Compliance with the TCR is based on the presence or absence of total coliforms as determined each calendar month. Specific requirements are as follows:

- Total coliform samples must be collected at locations representative of the distribution system according to a written sampling plan.
- Samples must be collected at regular time intervals throughout the month. Monitoring frequency depends on population. The City of Lincoln population was 261,796 in 2010 and is projected to grow to 371,700 by 2040.
- Systems serving 220,001 to 320,000 people must sample at least 150 times per month.
- Systems serving 320,001 to 450,000 people must sample at least 180 times per month.
- If a sample tests positive for coliforms, a set of repeat samples must be collected within 24 hours. The repeat set must include the original sample location and one sample each within five service connections upstream and downstream of the original sample.
- If any repeat sample tests positive for total coliforms, another set of repeat samples must be collected.
- Any sample that tests positive for coliforms must also be analyzed for fecal coliforms or *E. coli*.
- A monthly MCL violation is triggered if more than 5 percent of samples test positive for total coliforms. Any monthly MCL violation must be reported to the state no later than at the end of the next business day and must be reported to the public within 30 days.
- Any positive repeat result for fecal coliform or *E. coli* signifies an acute MCL violation. An acute MCL violation must be reported to the state no later than at the end of the next business day and must be reported to the public within 24 hours. Acute MCL violation is also triggered if any routine sample tests positive for fecal coliform of *E. coli* followed by a total coliform-positive repeat sample.

### 5.9.3 Revised Total Coliform Rule

EPA published the Revised Total Coliform Rule (RTCR) in the Federal Register on February 13, 2013 and minor corrections on February 26, 2014. The intent of the RTCR is to increase public health protection through the reduction of potential pathways of entry for fecal contamination into the distribution system. The RTCR establishes a maximum contaminate level (MCL) for *E. coli* and uses *E. coli* and total coliforms to initiate a “find and fix” approach to address fecal contamination that could enter into the distribution system. *E. coli* is considered to be a more specific indicator of fecal contamination and the potential presence of harmful pathogens than total coliform bacteria, the RTCR reflects a shift in compliance requirements that focuses more on the presence/absence of *E. coli* in the distribution system. Monitoring requirements remained the same, but under the RTCR, a system was required to test any total coliform-positive sample for *E. coli*. Any *E. coli*-positive sample must be reported to the state no later than the end of the next business day. Systems with violations are required to conduct assessments to find and fix the source of contamination. All

public water systems (PWSs), except aircraft PWSs subject to the Aircraft Drinking Water Rule, must comply with the RTCR starting April 1, 2016.

#### 5.9.4 Interim Enhanced Surface Water Treatment Rule

The IESWTR was developed in conjunction with the Stage1 Disinfectants and Disinfection Byproduct Rule (Stage 1 DBPR) in Year 1998. The purpose of the rule was to increase protection against microbial pathogens, particularly *Cryptosporidium*. Key provisions of the IESWTR are as follows:

- Established an MCLG of zero for *Cryptosporidium*.
- Set 2-log *Cryptosporidium* removal requirement for systems that filter.
- Lowered combined filter effluent (CFE) turbidity requirements to 1.0 NTU maximum, and 0.3 NTU at the 95th monthly percentile.
- Required individual filter turbidity monitoring continuously (every 15 minutes).
- Established provisions for disinfection benchmarking.
- Added *Cryptosporidium* to the definition of GWUDI and in the watershed control requirements.
- Required covers on finished water reservoirs.
- Required sanitary surveys for all systems to be conducted by the state every 3 years.

Monitoring of *Cryptosporidium* has indicated non-detect levels of *Cryptosporidium* in the raw water supplied to the East and West Plants.

#### 5.9.5 Filter Backwash Recycle Rule

The Filter Backwash Recycling Rule was published in 2001 to improve protection against microbial contaminants by establishing requirements for recycling practices. This is not applicable to LWS at this time since they do not currently practice backwash recycle.

The Filter Backwash Recycling Rule has the following three requirements:

- A system must notify the state in writing about its recycle practices if it recycles one of the aforementioned regulated flows.
- Regulated recycle flows must be returned through all processes of the system's conventional treatment.
- Recordkeeping is required for recycle streams.
- The regulated recycle streams are as follows:
  - Spent filter backwash.
  - Thickener supernatant.
  - Liquids from dewatering processes.



### 5.9.6 Long-Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) was published in Year 2006 to provide further protection against *Cryptosporidium* and other microbial pathogens. It was intended to supplement previous surface water treatment regulations and to increase treatment requirements for systems with higher *Cryptosporidium* risk.

- Requires monitoring to determine an average *Cryptosporidium* level.
- An initial 2 years of monthly monitoring is required followed by a second round of monitoring 6 years later to determine if source water conditions have not changed.
- Monitoring results are used to assign the system into one of four bin classifications based on *Cryptosporidium* risk.
- Additional treatment requirements for *Cryptosporidium* are required for high risk bin classifications.
- Requires PWSs with uncovered reservoirs to cover the reservoir or provide treatment to achieve 4-log virus, 3-log *Giardia*, and 2-log *Cryptosporidium* inactivation, removal, or both.

Since *Cryptosporidium* was found to be non-detect in raw water samples collected from the East and West Plant, both facilities are categorized under Bin 1 and do not require additional treatment for *Cryptosporidium*.

### 5.9.7 Stage 1 Disinfectant/Disinfection Byproduct Rule

The Stage 1 DBPR was published in Year 1998 to reduce potential health risk from exposure to DBPs. The Stage 1 DBPR prescribed MCLs for DBPs and set maximum residual disinfectant levels (MRDLs) for disinfectants. Stage 2 DBPR also set requirements for total organic carbon (TOC) removal in enhanced coagulation and enhanced softening.

The Stage 1 DBPR set MCLs for two groups of organic DBPs: total trihalomethanes (TTHMs) and five haloacetic acids (HAA5); and for two inorganic DBPs: chlorite and bromate, as shown in Table 5-31. Compliance with TTHM and HAA5 MCLs is based on the running annual average (RAA) of samples from all monitoring locations across the distribution system.

**Table 5-31 Maximum Contaminant Levels for Disinfection Byproducts in the Stage 1 DBPR**

Disinfection byproducts	MCL (MG/L)
Total trihalomethanes (TTHM)	0.080
Haloacetic acids (HAA5)	0.060
Chlorite	1.0
Bromate	0.010

MRDLs were set for chlorine, chlorine dioxide, and chloramines as shown in Table 5-32.

**Table 5-32 Maximum Residual Disinfectant Levels in the Stage 1 DBPR**

Disinfectant	MRDL (MG/L)
Chlorine	4.0
Chlorine dioxide	0.80
Chloramines	4.0 (as Cl <sub>2</sub> )

Table 5-33 summarizes the TOC removal requirements based on source water TOC and alkalinity. LWS is not required to meet the TOC removal requirements listed in the table, as their system meets alternative compliance criteria specified under 40 CFR 141.135(a)(2). Alternative compliance criteria is met through source water TOC less than 4.0 mg/L and source water alkalinity greater than 60 mg/L as CaCO<sub>3</sub>, with TTHM and HAA5 maintained at less than 50 percent of the MCLs.

**Table 5-33 Percent TOC Removal Required by Enhanced Coagulation and Enhanced Softening in the Stage 1 DBPR**

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as CaCO <sub>3</sub> )		
	0 -60	>60 - 120	> 120
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

### 5.9.8 Stage 2 Disinfectant/Disinfection Byproduct Rule

The Stage 2 DBPR tightened compliance monitoring requirements for TTHM and HAA5 by requiring compliance at each monitoring site in the distribution system.

Each system was required to conduct an Initial Distribution System Evaluation (IDSE) to identify locations with high DBP concentrations. IDSE results were used to determine sampling sites for Stage 2 DBPR compliance. Systems were required to begin Stage 2 DBPR monitoring in April 2012.

MCLs for TTHM and HAA5 remained at the Stage 1 DBPR levels, but the calculation method was changed. Under the Stage 2 DBPR compliance for TTHM and HAA5 is calculated as the RAA at each sampling site, referred to as a locational running annual average (LRAA).

Sampling frequency remained quarterly, but the Stage 2 DBPR increased the required number of sampling sites. For systems serving 250,000 to 999,999 people, the number of sampling sites increased from 4 to 12 per quarter.

### 5.9.9 Arsenic Rule

The Arsenic Rule was published in 2001 to reduce exposure to arsenic in drinking water. The arsenic MCL was reduced from 50 µg/L to 10 µg/L. Each system must take one arsenic sample per year at each entry point to the distribution system. A system with an arsenic measurement above the MCL must collect quarterly samples.

### 5.9.10 Radionuclides Rule

Radionuclide regulations were first promulgated by EPA in Year 1976 as part of the SDWA Standards for three groups of radionuclides: beta and photon emitters, radium, and gross alpha radiation. Radon and uranium were added to the list in the 1986 SDWA amendments. The Radionuclides Rule was published in 2000 to reduce exposure to radionuclides in drinking water.

Regulated contaminants in the Radionuclides Rule are listed in Table 5-34. MCLs for Beta/photon emitters, gross alpha particle radioactivity, and combined radium-226 and radium-228 remained at existing levels. Uranium was regulated for the first time.

**Table 5-34 Radionuclide Rule MCLs**

Regulated Radionuclide	MCL
Beta/photon emitters	4 mrem/yr
Gross alpha particle	15 pCi/L
Combined radium-226/228	5 pCi/L
Uranium	30 µg/L

### 5.9.11 Lead and Copper Rule

The Lead and Copper Rule (LCR) was published in Year 1991 to minimize lead and copper levels in drinking water by reducing water corrosivity. The LCR set action levels (ALs) of 0.015 mg/L (15 µg/L) for lead and 1.3 mg/L for copper based on 90th percentile values of samples drawn from customer taps. Exceedance of an AL is not a violation, but it triggers further required action. This action could include water quality parameter monitoring, corrosion control treatment, replacement of lead service lines, and source water monitoring and treatment.

When the LCR was originally enacted, systems were required to collect first draw samples for two consecutive 6-month sampling periods from taps at homes considered at risk for lead and copper based on the service line material and premise plumbing. The number of samples required depends on population served. Systems serving more than 100,000 people are required to collect 100 samples for standard monitoring and 50 samples for reduced monitoring. Criteria for reduced monitoring are as follows:

- Any system that meets optimal water quality parameters and is less than the action level for both lead and copper for two consecutive six-month monitoring periods can monitor once a year.
- Any system that meets optimal water quality parameters and is less than the action level for both lead and copper for three consecutive years of monitoring can monitor once every three years.

The system is required to provide analysis results to all customers whose taps were sampled within 30 days regardless of the result. All systems are required to provide an educational statement about lead in drinking water in their consumer confidence report regardless of lead levels.

Since 1991, the EPA has published minor revisions to the LCR. The 2000 revisions clarify that large systems that meet the criteria of §141.81(b)(3), are as follows: *“Any water system is deemed to have optimized corrosion control if it submits results of tap water monitoring conducted in accordance with first draw tap monitoring requirements and source water monitoring conducted in accordance with the source water monitoring requirements within the Rule, that demonstrates for two consecutive 6-month monitoring periods that the difference between the 90th percentile tap water lead level and the highest source water lead concentration is less than the Practical Quantitation Level for lead specified in § 141.89(a)(1)(ii) as 0.005 mg/L (5 µg/L).”*

Any water system may be deemed by the state to have optimized CCT if the system demonstrates to the satisfaction of the state that it has conducted activities equivalent to the corrosion control steps applicable to such system under the relevant sections of the LCR. If the state makes this determination, it shall provide the system with written notice explaining the basis for its decision and shall specify the water quality control parameters representing optimal corrosion control in accordance with § 141.82(f). Water systems deemed to have optimized corrosion control under this paragraph shall operate in compliance with the state-designated optimal water quality control parameters in accordance with § 141.82(g) and continue to conduct lead and copper tap and water quality parameter sampling in accordance with § 141.86(d)(3) and § 141.87(d), respectively.

The EPA has proposed changes to the current LCR that are discussed in Section 5.11.1.

### 5.9.12 Lead-Free Materials Regulations

The SWDA prohibits the “use of any pipe, any pipe or plumbing fitting or fixture, any solder, or any flux, after June 1986, in the installation or repair of (i) any public water system; or (ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead free” <sup>2</sup>. At the time, lead-free was defined as having less than 8 percent lead content.

The U.S. Federal Reduction of Lead in Drinking Water Act (RLDWA) was enacted in 2011 and took effect in 2014, further reducing the allowable lead content of lead-free materials, as follows:

- Not containing more than 0.2 percent lead when used with respect to solder and flux.
- Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

On 17 January 2017, the EPA published a proposed rule entitled “Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water” to establish labeling requirements to differentiate plumbing products that meet the lead-free requirements from those that are exempt from the lead-free requirements and to require manufacturers to certify compliance with the lead-free requirements <sup>1</sup>. This rule would codify revisions to the SDWA prohibition on use and introduction into commerce of certain products that are not lead-free as enacted in the RLDWA of 2011 and the Community Fire Safety Act of 2013 <sup>1</sup>.

<sup>2</sup> United States Environmental Protection Agency, "Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water," United States Environmental Protection Agency, 17 January 2017. [Online]. Available: <https://www.federalregister.gov/documents/2017/01/17/2017-00743/use-of-lead-free-pipes-fittings-fixtures-solder-and-flux-for-drinking-water>. [Accessed 17 January 2017].

## 5.10 Ongoing Regulatory Determination Process

### 5.10.1 Drinking Water Candidate Contaminant List

The SDWA requires EPA to publish a Contaminant Candidate List (CCL) every five years identifying contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations (NPDWR), but that are known or anticipated to occur in public water systems. EPA is required to determine whether to regulate at least five contaminants on the CCL every five years, a process termed “regulatory determination.” The regulatory determination process considers available health effects and drinking water occurrence data, as well as availability of suitable analytical protocols. Contaminants for which sufficient data or methods are not available to support a regulatory determination may be carried forward from the current CCL to the next. CCLs are used to set regulatory, research, and occurrence-investigation priorities within EPA.

The SDWA specifies that contaminants on the CCL shall be regulated if the EPA Administrator determines that:

- The contaminant may have an adverse effect on the health of persons.
- The contaminant is known to occur, or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern.
- In the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems.

If EPA determines that regulation of a contaminant in the CCL is warranted, the Agency must develop and promulgate a NPDWR based on the timeline established by the *1996 SDWA Amendments*.

The first Contaminant Candidate List (CCL 1) was published in draft form in March 1998, and the second Contaminant Candidate List (CCL 2) was finalized in February 2005. Subsequent sections describe the regulatory determinations resulting from the third CCL and provides an overview of the contaminants recently added to the fourth CCL for regulatory determination.

#### 5.10.1.1 Candidate Contaminant List 3

EPA implemented a different process to develop CCL 3 than was used for CCL 1 and CCL 2. This new process considered evaluations from previous CCLs and included substantial expert input and recommendations from various groups, including the National Academy of Science’s National Research Council, the National Drinking Water Advisory Council (NDWAC), and the Science Advisory Board. Contaminants of emerging concern contained in CCL 3 (September 2009) include 116 microbial pathogens, inorganic compounds, synthetic organic chemicals, disinfection byproducts (DBPs), hormones, and pharmaceuticals.

Preliminary regulatory determinations for contaminants on CCL 3 were published in the Federal Register on October 20, 2014. With this action EPA made regulatory determinations for five unregulated compounds. A positive determination was made to regulate strontium and negative determinations were made for dimethoate, 1,3-dinitrobenzene, terbufos, and turbufos sulfone. Regulatory determinations for other contaminants listed on CCL 3 were not made because they did not meet one or more of several criteria including availability of nationally representative finished water occurrence data, a completed health assessment, or a widely available analytical method for analysis.

On January 4, 2016, EPA published in the Federal Register the final determinations not to regulate four of the 116 CCL 3 contaminants – dimethoate, 1,3-dinitrobenzene, terbufos, and turbufos sulfone. EPA delayed the final regulatory determination on strontium to consider additional data and decide whether there is a meaningful opportunity for health risk reduction by regulating strontium in drinking water.

#### **5.10.1.2 Contaminant Candidate List 4**

The fourth Contaminant Candidate List (CCL 4) was published in draft form on February 2, 2015 (80 FR 6076). The Draft CCL 4 lists 100 chemicals or groups of chemicals and 12 microbial contaminants. EPA solicited nominations for contaminants to include in CCL 4 in May 2012 (77 FR 27057) and two of the nominated chemicals, nonylphenol and manganese, were ultimately selected for inclusion in Draft CCL 4. EPA previously made a negative regulatory determination for manganese in 2003 as part of CCL 1 (68 FR 42898); however, included it in Draft CCL 4 due to new health effects data that showed some potential neurological effects. Other contaminants included in Draft CCL 4 include those from CCL 3 not selected for regulatory determination. The Final CCL 4 was published on November 17, 2016 and it included 97 chemicals or chemical groups and 12 microbial contaminants.

In March 2020, the EPA announced that the following contaminants from CCL 4 would not be regulated: 1,1-dichloroethane, acetochlor, methyl bromide, metolachlor, nitrobenzene, and RDX.

#### **5.10.2 Unregulated Contaminant Monitoring Rules**

The Unregulated Contaminants Monitoring Rule (UCMR) program was developed in coordination with the CCL regulations. The data collected by the UCMR process is used to support analysis and review of contaminant occurrence, to guide the CCL process, and to support determination of whether to regulate a contaminant to protect public health. The Safe Drinking Water Act Amendments of 1996 required EPA to establish criteria for a program to monitor unregulated contaminants and to identify not more than 30 contaminants to be monitored every 5 years. EPA published a list of unregulated contaminants for the first UCMR cycle (UCMR 1) in September 1999 and a second cycle (UCMR 2) in January 2007. Since Year 2013, EPA has published a third and fourth list for monitoring of unregulated contaminants under the UCMR.

##### **5.10.2.1 UCMR 3**

EPA published the UCMR 3 in May 2012. The structure of UCMR 3 is similar to previous UCMRs. UCMR 3 requires all systems serving greater than 10,000 people to monitor for 21 List 1 contaminants and systems serving greater than 100,000 people to monitor for the seven List 2 contaminants. One notable difference between UCMR 3 and previous rules is that consecutive systems are required to conduct monitoring. Participating systems will conduct UCMR 3 monitoring during one consecutive 12-month period between 2013 and 2015. UCMR 3 included six perfluorinated compounds, including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). The EPA established health advisories for PFOS and PFOA, recommending individual or combined concentrations of less than 70 nanograms per liter (ng/L) in drinking water supplies. Further discussion on the potential for regulatory determination on PFAS compounds is provided in Section 5.11.3.1.

##### **5.10.2.2 UCMR 4**

EPA published the final UCMR 4 in the Federal Register on December 20, 2016. UCMR 4 monitoring will occur from 2018-2020 and includes monitoring for a total of 30 chemical contaminants: 10 cyanotoxins (nine cyanotoxins and one cyanotoxin group) and 20 additional contaminants (two



metals, eight pesticides plus one pesticide manufacturing byproduct, three brominated haloacetic acid (HAA) disinfection byproducts groups, three alcohols, and three semivolatile organic chemicals (SVOCs)). UCMR 4 requires all community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) serving greater than 10,000 people to monitor for the 20 additional contaminants, and it requires that systems served by surface water and ground water under the direct influence of surface water (GWUDI) also monitor cyanotoxins. Of the CWSs and NTNCWSs serving 10,000 or fewer people, a nationally representative set of 800 randomly selected SW and GWUDI systems will monitor for cyanotoxins and a different set of 800 randomly selected systems will monitor for the 20 additional contaminants. Sampling for the selected cyanotoxins will occur twice a month for four consecutive months during the timeframe of March through November, while the typical quarterly monitoring cycle will be used for the additional 20 contaminants.

## 5.11 Potential Future Drinking Water Regulations

The Safe Drinking Water Act and its amendments require that the EPA reevaluate existing drinking water regulations on a periodic basis and develop and promulgate new standards and regulations as necessary to protect public health. Several regulations have been proposed by EPA and are in various stages of development, review, and approval.

### 5.11.1 Proposed Lead and Copper Rule Revisions

On October 10, 2019, the EPA released proposed LCR revisions that were published in the federal register on November 13, 2019. The proposed LCR includes several revisions with a focus on switching from reactive to proactive measures to improve finished water quality at the customers' tap. Some of major revisions in the proposed LCR include:

- Public water systems (PWSs) must develop a publicly available lead service line (LSL) inventory (including lead goosenecks and downstream galvanized iron service lines on both PWS's side and homeowner's side).
- Retain the current lead AL of 15 µg/L, and add a new lead trigger level of 10 µg/L.
- If the 90th percentile lead level exceeds the AL, then the PWS must fully replace 3 percent of LSLs annually for consecutive 6-month monitoring periods.
- PWSs must "find-and-fix" individual sites with tap lead levels greater than the AL by conducting additional sampling to locate the lead source and working with their Primacy Agency to identify if corrective actions are needed.
- PWSs must replace the water system-owner portion of an LSL when a customer chooses to replace their portion of the LSL.
- "Testing out" of LSLs based on sampling results would be prohibited, and instead LSLs should be included in an inventory for replacement.
- Partial LSL replacements would no longer be allowed except in rare circumstances.
- LCR compliance sampling modifications would include a new Tier structure with LSLs as Tier 1 and copper pipe with lead solder as Tier 3; additionally, pre-flushing and removal of aerators would be prohibited, and the use of wide-mouth bottles would be required.
- PWSs must notify customers within 24 hours of a lead AL exceedance, and notify individual customers within 24 hours if their tap sample exceeded the lead AL.
- PWSs must test for lead at 20 percent of schools and 20 percent of childcare facilities.

- Calcium hardness would no longer be an accepted corrosion control treatment (CCT), and orthophosphate would be the only accepted phosphate-based corrosion inhibitor.
- Water quality parameter (WQP) monitoring data would be reviewed during sanitary surveys, and WQPs related to calcium hardness would be eliminated.

The new lead trigger level of 10 µg/L was proposed to prompt water systems to take proactive actions to reduce lead levels prior to exceeding the lead AL. If the 90th percentile lead concentration exceeds the new trigger level of 10 µg/L, the PWS would be required to complete the following:

- Conduct a corrosion control study to either re-optimize their existing CCT or develop a CCT (i.e., small/medium systems that did not previously treat for corrosion).
- Complete annual LCR monitoring at the standard number of sites.
- Conduct public outreach on ways to minimize lead leaching.
- Work with the PWS's Primacy Agency to set an annual goal for replacing LSLs.

There are no proposed changes to the LCR revisions based on copper sampling or the copper concentrations measured. The public comment period on the proposed LCR was open until February 12, 2020. The final LCR is anticipated to be promulgated in 2020.

### 5.11.2 Radon

EPA proposed new regulations for radon in October 1999. Two alternative compliance approaches were included in the proposed radon rule:

- States can elect to develop programs to address the health risks from radon in indoor air through adoption and implementation of a multimedia mitigation program. Under this approach, individual water systems would be required to reduce radon levels in the treated water to 4,000 pCi/L or lower. EPA will encourage states to adopt this approach, as it is considered the most cost-effective way to achieve the greatest reduction in radon exposure risk.
- If the State elects not to develop a multimedia radon mitigation program, individual water systems will be required to reduce radon levels in their system's treated water to 300 pCi/L, or to develop local multimedia mitigation programs and to reduce radon levels in drinking water to 4,000 pCi/L.

Systems with radon levels at or below 300 pCi/L would not be required to treat their water to remove radon. States will likely be granted fairly wide latitude in developing and implementing the multimedia programs, and it is expected that the programs will differ significantly from state to state. The need for radon treatment will be based on results of quarterly monitoring. If the state regulatory agency commits to the multimedia mitigation and alternative MCL compliance approach within 90 days of final promulgation of the rule, it will be granted an additional 18 months to achieve compliance.

Considerable controversy currently surrounds the regulation of radon in drinking water supplies, and modification of this regulation as currently proposed could significantly alter the requirements contained in the final rule. There is no recent information on the status of this proposed regulation, and no revised timeline for its implementation has been issued by EPA.



### 5.11.3 Contaminants on the Regulatory Horizon

On January 4, 2016, EPA delayed the final regulatory determination on strontium to consider additional data and decide whether there is a meaningful opportunity for health risk reduction by strontium in drinking water. The Final CCL 4 was published on November 17, 2016 and it included 97 chemicals or chemical groups and 12 microbial contaminants. Cyanotoxins are in the CCL 4 and included in the UCMR 4 monitoring. In December 2016, EPA announced the review results for the Agency's third Six-Year Review (Six-Year Review 3) and eight NPDWRs were chosen as candidates for regulatory revision. These eight NPDWRs include chlorite, *Cryptosporidium* (under the Surface Water Treatment Rule (SWTR)), interim enhanced surface water treatment rule (IESWTR and LT1), haloacetic acids (HAA5), heterotrophic bacteria, *Giardia lamblia*, *Legionella*, total trihalomethanes (TTHM), and viruses (under the SWTR).

In addition to the 76 NPDWRs reviewed in detail for the Six-Year Review 3, 12 other NPDWRs were included in the review but were not given detailed consideration because of other recent or ongoing regulatory actions (e.g., lead, copper, total coliforms (under Aircraft Drinking Water Rule (ADWR) and RTCR), *E. coli*, and eight carcinogenic volatile organic compounds (cVOCs)). The Six-Year Review 3 also evaluated unregulated DBPs including chlorate and nitrosamines.

#### 5.11.3.1 Per- and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances are a class of thousands of man-made chemicals that are used in the manufacture of many industrial and consumer products, including firefighting foams, water- and oil-resistant coatings, cookware, food packaging, medical devices, cosmetics, lubricants, inks and paints. PFAS chemicals consist of a carbon chain (an alkyl group) that is highly substituted with fluorine atoms and contains other functional groups, such as carboxylic acids, sulfonic acids, and ethers. Their properties make them heat stable, non-biodegradable, bioaccumulative, and very persistent in the environment. They are also highly mobile in water and difficult to remove as conventional treatment processes are ineffective at reducing concentrations.

Due to their widespread application, PFAS are now found in many drinking water sources across the United States and thus impact both water and wastewater treatment facilities. As a result, concern from federal and state regulators over these chemicals has steadily increased over the past decade. In February 2019, the USEPA issued a PFAS Action Plan aimed at comprehensively addressing PFAS in the environment. The USEPA has proposed regulating PFAS under the Safe Drinking Water Act (SDWA), the Toxic Substances Control Act (TSCA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as Superfund), and the Clean Air Act.

Currently, there are no federal maximum contaminant levels (MCLs) established for PFAS chemicals under the SDWA. In 2016 the USEPA established non-enforceable drinking water health advisory levels for two prevalent PFAS chemicals, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). The health advisory level for the total concentration of both PFOA and PFOS in drinking water is 70 ng/L. However, the USEPA is in the process of making a regulatory determination for PFOA and PFOS as part of the PFAS Action Plan. The proposed regulatory determination is currently under interagency review and has not been made public. Still, the USEPA has signaled that they intend to establish an MCL for PFOA and PFOS, and potentially others.

State-level regulators, in some cases, have outpaced the USEPA in establishing their own guidance and regulations. Almost half of U.S. states have established some form of PFAS guidance values for groundwater and/or drinking water, but the approaches vary. A handful of states have established

or proposed state-wide drinking water MCLs. To date, the State of Nebraska has not established any PFAS related drinking water guidance values or regulations.

### 5.11.3.2 Cyanotoxins

A chemically diverse group of over 100 cyanobacterial metabolites have been identified as cyanotoxins, which have been variously classified as neurotoxins, hepatotoxins, and contact irritants. Assuming EPA waits until the UCMR 4 monitoring is complete in 2020, the Agency could either make a positive regulatory determination or simply move directly to a proposed rule. A cyanotoxin rule would typically involve a two-year development period (2022) and a final rule could follow in approximately another two years (2024). If the Agency elects to make a positive regulatory determination prior to developing a proposed rule, then the timing of the regulatory determination rulemaking would figure into this timeline and delay the proposed rule by two to seven years. There is also increasing focus at the state level on harmful algal blooms and recreational water use.

### 5.11.3.3 Nitrosamines

Five organic nitrogen-containing compounds (4 nitrosamines and nitrosopyrrolidine) that have been detected in treated drinking water are listed on CCL 4. Formation of these compounds is associated with disinfection with free chlorine in the presence of naturally occurring ammonia in the source water or ammonia added to treated water to form a combined-chlorine residual. Formation of these nitroso-compounds requires a nitrogenous organic precursor. Dimethylamine has been shown to be particularly reactive in formation of N-nitrosodimethylamine (NDMA) in drinking water, with formation from several other less reactive precursors possible.

Regulation of nitrosamines in drinking water remains controversial for several reasons. Recent research on human exposure to nitrosamines indicates that drinking water contributes a very small percentage (less than 0.01 percent) of total exposure compared with natural formation in the body and consumption in certain foods. Therefore, it is unclear whether or not a regulation for nitrosamines would meet the SDWA criteria for “a meaningful opportunity for health risk reduction for persons served by public water systems”. Likely strategies for reducing nitrosamine formation in drinking water, such as limiting or discontinuing use of polyDADMAC polymers or chloramine disinfectant residual, would also present simultaneous compliance issues with other currently regulated contaminants.

MCLs for individual nitrosamines or as a chemically similar group of several compounds would be established during the rulemaking process. The body of research on animal and human responses to nitrosamine exposure indicates the MCLs for nitrosamines in drinking water would be at the nanogram per liter (ng/L) level. While Health Canada has established a maximum allowable concentration of 40 ng/L in drinking water, several agencies have adopted non-enforceable guidelines and advisory levels for NDMA in drinking water as indicated below:

- World Health Organization guideline of 100 ng/L.
- Massachusetts guideline level of 10 ng/L.
- State of California notification level of 10 ng/L and public health goal of 3 ng/L.
- EPA Regions 3 and 6 nonenforceable screening level of 0.42 ng/L of NDMA.
- Arizona water quality criterion of 30 ng/L in NPDES permits.

A decision not to regulate nitrosamines as part of the preliminary regulatory determinations for contaminants on CCL 3 was published in the Federal Register on October 20, 2014. However, EPA

evaluated existing Microbial/Disinfection Byproducts (MDBP) regulations and unregulated DBPs including nitrosamines as part of Six-Year Review 3. Because nitrosamines are DBPs that may be introduced or formed in public water systems related to disinfection practices, EPA believes it is important to evaluate these DBPs in the context of the review of existing MDBP regulations. Nitrosamines are included in the CCL 4.

The AWWA Governmental Affairs Office recommends that a utility consider sampling for nitrosamines if it did not participate in UCMR 2, to develop an understanding of nitrosamine occurrence and formation patterns within its system (AWWA, 2012). If it has not already done so, LWS should consider implementing a sampling program to analyze NDMA in the distribution system in anticipation of a potential future NDMA regulation.

#### **5.11.3.4 Strontium**

Strontium occurs in drinking water supplies due to dissolution of naturally-occurring mineral deposits, and due to its commercial and industrial uses in pyrotechnics, steel production, as a catalyst, and as a lead scavenger. EPA delayed the final CCL 3 regulatory determination on strontium to consider additional data and decide whether there is a meaningful opportunity for health risk reduction by regulating strontium in drinking water. A final rule on strontium is expected in 2019 or 2020.

#### **5.11.3.5 Chlorate**

Chlorate compounds are used in agriculture as defoliants or desiccants and may occur in drinking water related to use of disinfectants such as chlorine dioxide. A decision not to regulate chlorate as part of the preliminary regulatory determinations for contaminants on CCL 3 was published in the Federal Register on October 20, 2014. However, EPA evaluated existing MDBP regulations and unregulated DBPs including chlorate as part of Six-Year Review 3. Because chlorate is a DBP that may be introduced or formed in public water systems related to disinfection practices, EPA believes it is important to evaluate this DBP in the context of the review of existing MDBP regulations. Chlorate is included in the CCL 4.

#### **5.11.3.6 Perchlorate**

On February 11, 2011, EPA published its decision to move forward with the development of a regulation for perchlorate, a contaminant evaluated under CCL 2. Under the current regulatory schedule, a proposed MCL for perchlorate would have been expected sometime in 2014, and a final MCL no later than 2016, with compliance required by 2019. However, EPA is still finalizing its peer review of the modeling research recommended by a Science Advisory Board in conjunction with the Food and Drug Administration. A panel meeting of the peer reviewers was held on January 10 and 11, 2017, and a subsequent peer review will be scheduled to evaluate methods to develop a maximum contaminant level goal (MCLG) for perchlorate in drinking water.

Finished water quality data for perchlorate was not available in the dataset provided for the project. If perchlorate monitoring has not already been conducted, it is recommended that LWS monitor perchlorate to determine if they will be in compliance with a potential new perchlorate rule.

#### **5.11.3.7 Fluoride**

In January 2011, the United States Department of Health and Human Services (HHS) announced a proposed recommendation that fluoride levels in drinking water be set at an optimal level of 0.7 mg/L. Concurrent with the HHS announcement, EPA announced plans to initiate a review of the current MCL and MCLG for fluoride. HHS's proposed recommendation would replace the Year 1962

US Public Health Standard of 0.7 to 1.2 mg/L, under which the optimal fluoride level is determined based upon the ambient air temperature of the geographic region. HHS believes that this revised optimal concentration will provide the best balance of public protection from dental caries (tooth decay) and the desire to limit the risk of dental fluorosis (spotting/pitting damage to tooth enamel), particularly in children.

Starting in Year 2015, the HHS's recommended optimal fluoridation level of drinking water is 0.7 mg/L. While the HHS guidance is advisory rather than regulatory, EPA could elect to modify current regulations governing maximum fluoride levels in response to HSS recommendations and to the agency's review of recent research results.

In December 2016, EPA announced the review results for the third Six-Year Review, and it was determined that a revision to the NPDWR for fluoride is not appropriate at this time. EPA determined that the potential revision of the fluoride NPDWR is a lower priority that would divert significant resources from the higher priority rulemakings that the Agency intends to undertake, but the Agency will continue to monitor the evolving science, and, when appropriate, will reconsider the fluoride NPDWR's relative priority for revision.

#### **5.11.3.8 Hexavalent Chromium**

The existing regulation for total chromium in drinking water was reevaluated by EPA as part of Six-Year Review 2. However, since the Agency had initiated a reassessment of health risks associated with chromium exposure, EPA decided not to revise the NPDWR while that effort was in progress. EPA began a rigorous and comprehensive review of hexavalent chromium health effects following the release of the toxicity studies by the National Toxicology Program in 2008. In September 2010, EPA released a draft scientific assessment for public comment and external peer review.

Hexavalent chromium ( $\text{Cr}^{6+}$ ) has come under increased scrutiny recently with the release of an Environmental Working Group study in December 2010 that found levels of hexavalent chromium exceeding the non-enforceable public health goal set by the California Department of Public Health (CDPH) in the tap water of 25 of 35 US cities tested. Based on additional recent research, the schedule for the hexavalent chromium human health assessment was revised by EPA in Feb 2012, with the final version now expected to be approved and posted in the near future. When this human health assessment is finalized, EPA will carefully review the conclusions and consider all relevant information to determine if a new standard needs to be set. Hexavalent chromium levels in public drinking water supplies are currently being monitored as part of UCMR 3. EPA Six-Year Review 3 determined that a revision to the existing regulation for total chromium was not appropriate for revision at this time as the health effects assessment is still ongoing.

In a separate regulatory action, the CDPH adopted a drinking water MCL for hexavalent chromium of 10  $\mu\text{g/L}$ , which became effective July 1, 2014. The regulations adopted by CDPH specify initial monitoring requirements, approved analytical methods and detection limits, and best available technologies for treatment. Compliance with the MCL is based on a running annual average (RAA) of hexavalent chromium measurements averaged quarterly.

#### **5.11.3.9 Volatile Organic Compounds**

In January 2011, the EPA Administrator announced that carcinogenic Volatile Organic Compounds (cVOCs) will be the first contaminants regulated as a group rather than as individual compounds under the Agency's new Drinking Water Strategy. Eight currently regulated cVOCs and eight currently unregulated cVOCs have been proposed for regulation as a group. In December 2016, EPA announced the review results for the Six-Year Review 3. The reviews of eight cVOCs were

included but were not given detailed consideration because of other recent or ongoing regulatory actions. The eight cVOCs mentioned in the Six-Year Review 3 include 1,2-Dichloroethane (Ethylene dichloride), 1,2-Dichloropropane, Benzene, Carbon Tetrachloride, Dichloromethane (Methylene chloride), Tetrachloroethylene (PCE), Trichloroethylene (TCE), and Vinyl chloride. The ultimate form of this regulation remains to be determined.

#### **5.11.3.10 Methyl Tertiary Butyl Ether**

Methyl tertiary butyl ether (MTBE) is an oxygenate additive used in gasoline to increase the octane number. It has been widely used in gasoline in the United States as a replacement for lead; however, its use has declined in recent years due to incorporation of ethanol in fuels. MTBE is very soluble and has been detected in numerous water supplies but is most commonly found in ground water supplies.

In 1997, EPA issued a drinking water advisory for MTBE of 20 to 40 µg/L based on taste and odor. MTBE was included in CCL 1 and CCL 2 for evaluation, with negative regulatory determinations because its regulation would not present a meaningful opportunity for health risk reduction for persons served by public water systems. Because of several prominent cases of drinking water contamination with MTBE in the past, public interest related to MTBE regulation remains active. Therefore, MTBE was carried over to CCL 3 and CCL 4 for further evaluation; however, no schedule for revision of the health risk assessment for MTBE has been set.

#### **5.11.3.11 Legionella**

*Legionella* bacteria can cause a serious type of pneumonia called Legionnaires' disease, and also a less serious infection called Pontiac fever that has symptoms similar to a mild case of the flu. The bacterium grows best in warm water conditions including large plumbing systems, cooling towers (air-conditioning units for large buildings), and hot water tanks and heaters. EPA's third six-year review notice (January 11, 2017) highlights an opportunity to further reduce the risk posed by *Legionella*. The notice suggests a linkage being drawn between maintaining a secondary disinfectant residual and reducing the risk posed by *Legionella*.

### **5.12 Water Treatment Plant Improvements, Expansion and Rehabilitation**

As indicated in Figure 5-17, the existing treatment capacity of 120 mgd for the combined East and West Plants is capable of meeting projected demands through the Year 2037. The 2014 Master Plan had identified the next plant expansion to occur at the West Treatment Plant by means of filter rehabilitation. The scope of this master plan update included additional focus on condition assessment of the existing treatment plants, along with input from operations, to take a second look at this approach and compare expansion of the two plants. This section also addresses improvements to the East Plant for arsenic removal.

#### **5.12.1 East Plant Improvements for Arsenic Removal**

LWS will need to implement a treatment system in the future to address the relatively high concentrations of arsenic in the HCWs and expected concentrations of arsenic in the future HCWs. Previous studies evaluated the use of enhanced coagulation with ferric chloride to meet proposed finished water quality goals of 8 µg/L, 4 µg/L and non-detect levels. At the required dosages of ferric chloride (5 to 15 mg/L), filter run times and filter productivity were significantly reduced. As such, arsenic treatment through enhanced coagulation is not feasible with direct filtration and would require implementation of a clarification basin upstream of filtration.

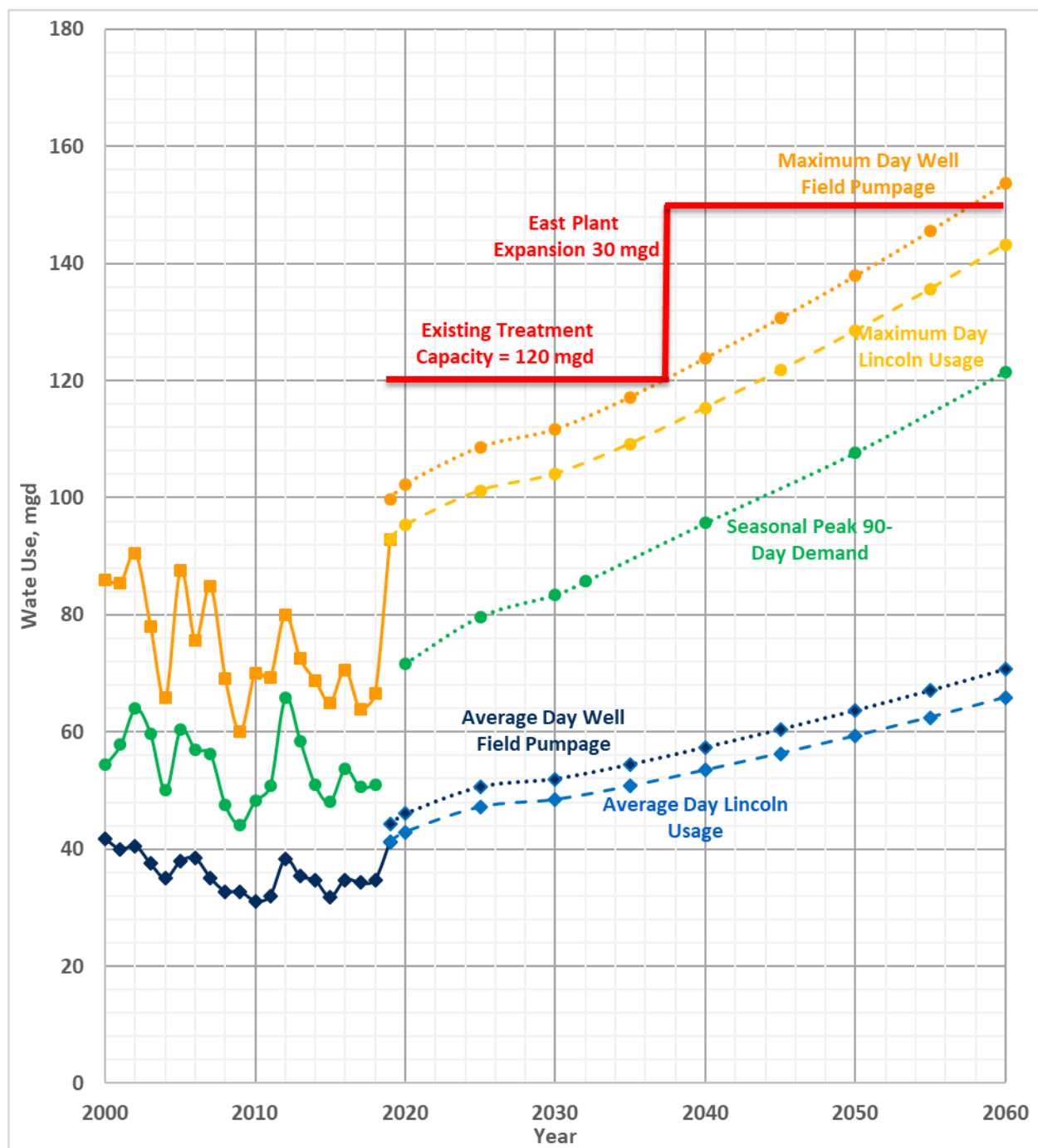


Figure 5-17 Future Treatment Expansion



Additional bench-scale testing is recommended to further investigate treatment alternatives and identify a cost-effective solution for arsenic treatment. In the absence of a formal process evaluation, a conceptual opinion of probable construction cost (OPCC) has been developed for CIP planning purposes. The conceptual OPCC is based on implementation of an arsenic adsorption system located downstream of the existing filters at the East Plant. The adsorption system would consist of vertical pressure vessels filled with a granular ferric oxide (GFO) or granular ferric hydroxide (GFH) media. Based on preliminary assumptions, the vessel design considers an empty bed contact time (EBCT) of 4 minutes and treatment capacity of 35 MGD (58 percent of maximum plant flow) to achieve a blended water arsenic concentration of 6 µg/L. The system is expected to include a transfer pump station and 18 vessels, each 12 ft in diameter. Implementation of an arsenic treatment system is scheduled to occur in Year 2025.

### 5.12.2 Water Plant Expansion

Throughout the condition assessment activities, multiple concerns were identified by staff, primarily regarding the ability to physically process over 70 mgd through the West Water Treatment Plant, based upon previous operational knowledge from the 1980's. Specifically, when the West WTP was pushed to rates around 70 mgd, a bypass was utilized which circumvented the entire treatment process including aeration, chlorine contact, and filtration. This operational practice was subsequently discontinued as the safe drinking water act (SDWA) was amended and the bypass has been disabled.

In light of these restrictions, in order to expand the West WTP some other modifications would be required in addition to the filter rehabilitation. Other recommended improvements include replacement of the existing clearwell transfer pumps (which would increase capacity and simplify CT calculation), addition of a fourth aerator and contact basin, chemical feed modifications, and an allowance for hydraulic improvements to ensure the facility could convey the flows. The total capital cost for expansion of the West WTP by 12 mgd is summarized in table D-1. The planning level opinion of probable capital cost is \$10,749,000 for a 12 mgd expansion, which equates to an expansion cost of \$0.90/gallon.

Alternatively, the East WTP currently has a capacity of 60 mgd (originally 50 mgd prior to filter re-rating). The plant was configured such that 16 additional filters can be added to provide additional capacity of 120 mgd. As part of the study B&V provided costing analysis of adding either two filters (15 mgd) or four filters (30 mgd), additional ozone capacity and associated infrastructure. The cost to add only two filters was not deemed to be in the City's best interest as it would be inefficient with respect to building walls, foundations, ozone system expansion, etc. Therefore, we would recommend that the next expansion of the East Water Treatment Plant should be 30 mgd. The planning level opinion of probable capital cost for this expansion would be \$24,804,000 which equates to \$0.83/gallon. Expansion of the East WTP would also be more beneficial from a treatment perspective as the City will add one or two more collector wells in the interim, increasing their reliance on groundwater which is under the influence of surface water.

It is therefore our recommendation that the City plan on expansion of the East Water Treatment Plant starting in Year 2032, which allows sufficient time for design and construction prior to the need in Year 2037 as shown in Figure 5-17. The opinion of probable construction cost for this improvement is \$24,804,000 in Year 2020 dollars.

### 5.12.3 Water Plant Rehabilitation

It has been almost 30 years since any major rehabilitation projects have occurred at the two water treatment plants. Based upon the condition assessment work completed as part of this study we recommend budgeting \$2,285,000 for a rehabilitation project at the West Water Treatment Plant and \$669,000 for a rehabilitation project at the East Water Treatment Plant, both within the first six years of your capital improvement project. The improvements associated with these rehabilitation projects are summarized in Appendix D and have a cost basis of Year 2020.