Division of Water Treatment
City of Toledo

Collins Park Water Treatment Plant
20-Year Master Plan and Needs Assessment

DRAFT REPORT

October 2011

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1. Introduction

For over 70 years, the Collins Park Water Treatment Plant (WTP) has been providing safe and reliable water to its customers located throughout the City of Toledo. The treatment plant and the distribution system have grown, and continue to expand and evolve to meet the increasing needs of the Toledo area while maintaining the necessary high quality standards for drinking water. Recent and upcoming regulations, however, in addition to capacity limitations are continuing to impact treatment and operations at the Collins Park WTP. In addition, much of the equipment at the facility is original and has reached the end of its useful life. In light of these considerations, the City has elected to complete a comprehensive condition and treatment process assessment of the WTP. The condition and treatment process assessments are not only central to meeting regulatory requirements, but also essential to identifying the City's short- and long-term capital planning and revenue needs. The comprehensive needs assessment will be used to develop a 20-Year Capital Improvements Plan (CIP) program that provides a road map for delivering safe and reliable drinking water to all its customers.

1.1 Project Scope

The City of Toledo has retained ARCADIS, Inc. to prepare a comprehensive needs assessment and 20-capital capital improvements program for the Collins Park WTP. ARCADIS inspected and assessed the suitability and condition of the Collins Park WTP facilities to identify system deficiencies, mechanical or structural deterioration, operational constraints, and/or reliability concerns related to water supply needs and compliance with long-term water quality objectives. These assessments were based upon:

- Review of available data, plans, records and reports,
- Numerous site visits and inspections of the readily-accessible facilities, and
- Primary and secondary interviews with City management, engineering, operations, and maintenance personnel.

The results of the inspections and assessments are presented in this report, along with discussions of rehabilitation and replacement alternatives, opinions of probable construction costs, and recommended improvements. In consultation with City staff, ARCADIS has developed a staged program of recommended CIP projects, which address the 20-year planning needs at the Collins Park WTP.

1.2 Background

The Collins Park WTP has a rated capacity of 150 million gallons per day (MGD). The current average water production rate is approximately 80 MGD, but ranges seasonally between 60 to 140 MGD. A schematic of the existing Collins Park WTP processes is presented in Figure 1-1.

Figure 1-1: Treatment Processes

TREATMENT PROCESS SCHEMATIC

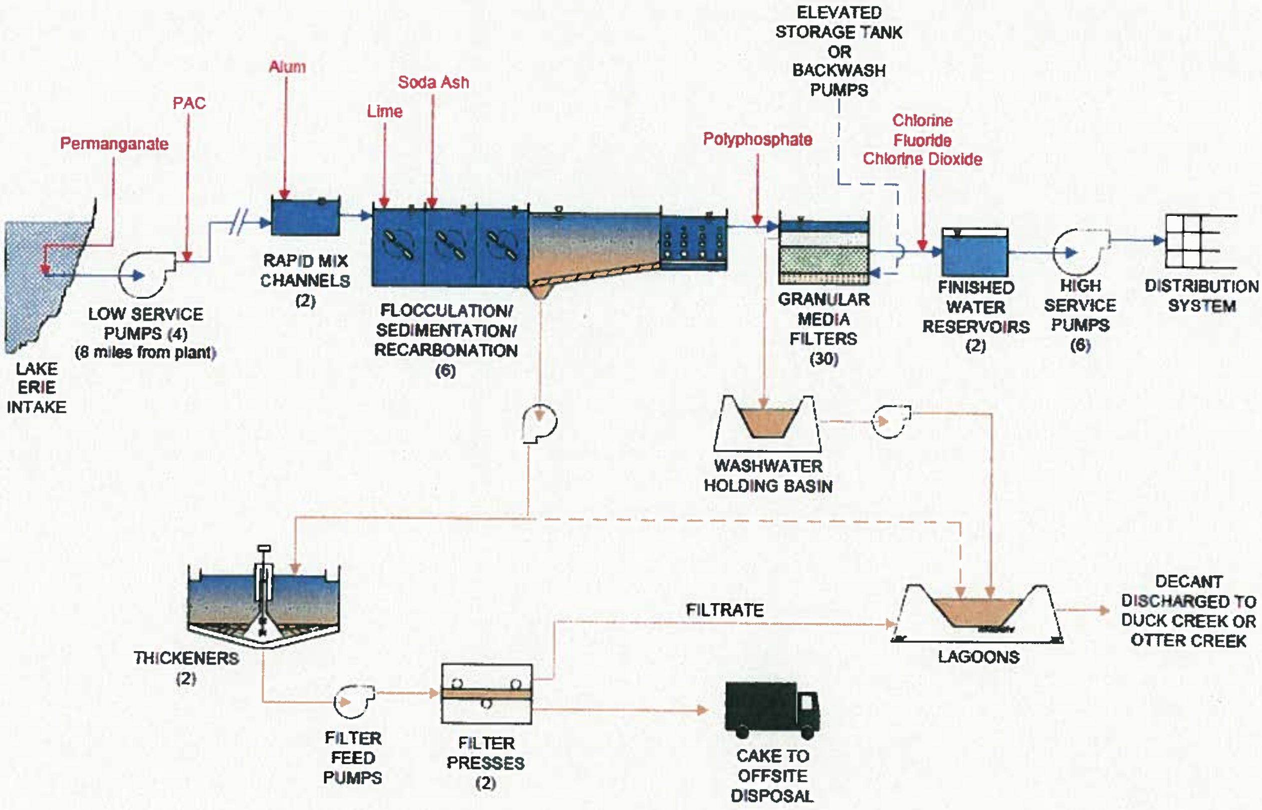


FIGURE 1-1: COLLINS PARK WATER TREATMENT PLANT PROCESS SCHEMATIC

The plant treats raw water that is withdrawn from Lake Erie through an intake crib located approximately 3 miles offshore northeast of Reno Beach. Water is conveyed to the Low Service Pumping Station by gravity through a 108-inch diameter intake conduit. The intake crib and conduit were designed to handle a raw water demand of up to 200 MGD. Potassium permanganate is added year round at this intake for zebra mussel control. It also provides some removal of taste and odor (T&O) causing compounds. At the Low Service Pumping Station, raw water first passes through traveling screens to remove debris, and is then pumped through two raw water mains, 78- and 60-inches in diameter, approximately 8 miles to the Collins Park WTP. PAC is periodically added to the raw water just before the Low Service Pumping Station discharge for T&O removal.

The plant is divided into two separate treatment plants capable of independent operation. The plants have identical processes; however, one plant is designed to treat 80 MGD (but can handle flows up to 100 MGD), while the other is able to treat 40 MGD (but can handle flows up to 50 MGD). Treatment consists of coagulation, lime softening, flocculation, sedimentation, recarbonation, and granular-media filtration. Alum is added in the rapid mix for coagulation, and lime and soda ash are added during flocculation to remove both carbonate and non-carbonate hardness. Water is then filtered through conventional-rate, dual-media units consisting of anthracite and sand. Polyphosphate is added continuously on top of the filters to prevent deposition associated with the high pH of the water applied to the filters. After filtration, water is combined into filtered water conduits that carry the water to two underground reservoirs. Chlorine is added in the conduits, and is used for both primary and secondary disinfection. Fluoride and chlorine dioxide are also added into the filtered water conduits, and are used to prevent tooth decay and oxidize T&O compounds, respectively. The reservoirs are used to collect and store filtered water, to provide disinfection contact time, and to convey finished water to the High Service Pumping Station for pumping to the distribution system.

Residuals streams are generated from the softening, coagulation, filter backwash processes, and various maintenance activities. Residuals are pumped from the WTP into the dewatering facility thickeners and then pumped into one of two plate and frame presses. The presses force water out of the solids resulting in a cake containing about 65 percent solids material. Cake is dumped into semi trucks and hauled from the plant for disposal. Water removed from the solids is captured, pumped to a filtrate lagoon, and discharged to Otter Creek under a current NPDES permit. Alternately, spent lime can be pumped to Lagoons A, B, C or E. Water decanted from these lagoons flows either to Duck Creek or to Otter Creek under a current NPDES permit.

1.3 Report Organization

This report is organized as follows:

- *Section 2: Regulatory and Water Quality Assessment* – This section discusses existing conditions and evaluates the current treatment performance at the Collins Park WTP with respect to meeting current and future regulatory requirements and the City's selected water quality goals.
- *Section 3: Capacity Assessment* – This section discusses the methodology used for the hydraulic capacity assessments and presents results from the assessment.
- *Section 4: Condition and Operational Assessments* – This section discusses the methodology used for the condition and operational assessments and presents results from both assessments.
- *Section 5: Development of Alternatives and Projects* – This section presents the development of alternatives and recommendations to address needs identified in the regulatory and water quality review assessment, capacity evaluation, and condition and operational assessments in addition to opinions of probable construction costs for each recommended improvement.
- *Section 6: CIP Development* – This section discusses the approach used to group and prioritize projects and develop the 20-Year Capital Improvements Plan (CIP) for the Collins Park WTP, and presents the recommended list of prioritized projects and CIP implementation schedule.

2. Regulatory and Water Quality Assessment

2.1 Introduction

This section discusses existing conditions and evaluates the current treatment performance at the Collins Park WTP with respect to meeting current and future regulatory requirements and the City's selected water quality goals. An evaluation was completed to identify any water quality constraints, treatment performance issues, or regulatory compliance concerns. The evaluation consisted of:

- An examination of the City's existing water quality goals,
- An assessment of historical water quality and operational data, and
- A review of current and future regulations as they apply to the Collins Park WTP.

Section 2.2 describes the current water quality goals, recent treatment performance, chemical usage, and residuals production at the Collins Park WTP. Section 0 summarizes the existing and proposed regulations and presents key findings from the water quality review with respect to each of the regulations discussed. In addition, a discussion on emerging water quality issues is presented. Section 2.4 summarizes major conclusions of the regulatory and water quality and treatment assessment and presents recommendations for further evaluating regulatory compliance and operations within the WTPand distribution system.

2.2 Water Quality Conditions and Goals

The Collins Park WTP has successfully provided clean, reliable and safe water to its customers since it has been in operation. Part of that achievement can be attributed to the City's aggressive water quality goals and dedication to public health and customer satisfaction. The City's current water quality goals as well as a review of key operational data in relation to these goals are discussed in the following sections. In addition, chemical usage and residuals production data are presented.

2.2.1 Existing Water Quality Goals

Table 2-1 summarizes the City of Toledo's existing water quality goals. Most have been adopted from federal and state regulations. The City has also established internal water quality goals for hardness to meet customer hardness requirements stipulated as part of the approval for the 40 MGD plant expansion. Water with a hardness level above 150 mg/L is generally considered "hard" and often leads to customer cost impacts and aesthetic problems in the home; therefore, the City has opted to treat the hardness to levels between 70 and 95 mg/L as calcium carbonate ($CaCO_3$).

Table 2-1: City of Toledo's Existing Water Quality Goals

Parameter	Water Quality Goals
SOFTENING	
Total hardness	70 – 95 mg/L as $CaCO_3$
Total alkalinity	40 - 75 mg/L as $CaCO_3$
Stability	>0.0 Langlier/Marble Test
CORROSION CONTROL	
Chloride to sulfate mass ratio	<0.6
Finished water alkalinity	>40 mg/L as $CaCO_3$
pH	9.0 – 9.75
90th percentile distribution system copper	<1.3 mg/L (LCR)
90th percentile distribution system lead	<15 µg/L (LCR)
PRIMARY DISINFECTION	
Giardia removal/inactivation	3.0-log (SWTR, IESWTR)
Virus removal/inactivation	4.0-log (SWTR, IESWTR)
Cryptosporidium removal/inactivation	4.0 log (LT2ESWTR, Bin 1)
SECONDARY DISINFECTION	
Chlorine residual	Residual detectable in greater than 95% of monthly samples (SWTR)
Point of entry Cl_2	▪ Min. 0.2 and <4.0 mg/L (IESWTR) ▪ Not <0.2 mg/L for 4 hrs and 5% samples/month (OAC3745-81-72)
PARTICULATES	
Combined filter effluent samples	<0.3 NTU in 95% of monthly samples collected at 4-hr intervals (IESWTR)
Individual filter effluent samples	<0.5 NTU after 4-hr of continuous operation , based on 2 consecutive samples taken 15 min apart (IESWTR)
Maximum combined filtered effluent	<0.3 NTU (IESWTR)
Maximum individual filtered effluent	< 0.3 NTU at any time, based on 2 consecutive samples taken 15 min. apart (IESWTR)
Particle counts	Maintain particle counts at baseline level to ensure steady state operation
MICROBIAL PROTECTION	
Coliforms	< 1% monthly samples coliform positive (TCR)

Parameter	Water Quality Goals
Giardia, viruses and *Cryptosporidium*	Zero in raw water (SWTR, IESWTR, LT2ESWTR)
DISINFECTION BY-PRODUCTS	
Enhanced softening	Practice enhanced softening characterized by raw water TOC removal based on influent levels (Stage 1 D/DBPR)

TOC removal	▪ If alkalinity > 120 mg/L as CaCO3,
	  ▪ If TOC < 4.0 mg/L, 15% removal required
	  ▪ If TOC 4-8 mg/L, 25% removal required
	▪ If alkalinity 60-120 mg/L as CaCO3,
	  ▪ If TOC < 4.0 mg/L, 25% removal required
	  ▪ If TOC 4-8 mg/L, 35% removal required

Distribution system TTHM (LRAA)	<80 µg/L (Stage 2 D/DBPR) with goal of < 60 □g/L
Distribution system HAA5 (LRAA)	<60 µg/L (Stage 2 D/DBPR) with goal of < 40 □g/L
Distribution system bromate (LRAA)	<10 µg/L (Stage 2 D/DBPR)
INORGANIC/ORGANIC CHEMICALS	
Arsenic	<10 µg/L (Arsenic rule)
Fluoride	<4 mg/L (Fluoride rule)
Nitrate	<10 mg/L (Phase II SOC/IOC Rule)
TASTE AND ODOR	
Threshold Odor Number	<3 TON (NSDWR)

2.2.2 Water Quality Performance

Table 2-2 summarizes the raw, finished, and distribution system water quality data for the Collins Park WTP. The data suggest that the finished water is of very high quality even though there is some significant variability in raw water levels. Parameters of highest concern and important key findings are discussed in detail below.

Table 2-2: Historical Raw, Finished and Distribution System Water Quality for the Collins Park WTP

Parameter	Raw		Finished		Distribution System	
	Average	Range	Average	Range	Average	Range
Alkalinity, mg/L as $CaCO_3$	97	76 - 186	44	30 - 85	42	23 – 72
Calcium, mg/L	41	24 - 134	28	21 – 84	28	17 - 37
Conductivity, µS	308	35 - 800	243	22 - 625	249	165 - 395
Total Hardness, mg/L as $CaCO_3$	133	94 - 231	82	53 - 184	--	--

Parameter	Raw		Finished		Distribution System	
	Average	Range	Average	Range	Average	Range
Non-Carbonate Hardness, mg/L as $CaCO_3$	37	16 - 93	38	0 - 131	--	--
Magnesium, mg/L	7.3	0 – 25.8	3.0	0 – 11.4	--	--
pH	8.2	5.2 – 9.9	9.5	8.1 – 10.2	9.4	7.1 – 10.1
TOC, mg/L	4.0	2.2 – 13.7	1.8	0.9 – 4.0	--	--
Turbidity, NTU	37	1 - 603	0.07	0 – 1.05	--	--
Average Free Chlorine Residual, mg/L	--	--	1.1	1.0 – 1.5	0.8	0.6 – 1.0
Temperature, °C	--	--	--	--	21	12 - 25
TTHM RAA, µg/L	--	--	--	--	37.8	26 – 48
HAA5 RAA, µg/L	--	--	--	--	12.6	8 - 17

[1] Data obtained from the following sources:
- (a) Operations spreadsheet for January 2000 – December 2009.
- (b) Monthly operating reports (MORs) for January 2005 – December 2010.
- (c) Water quality parameter monitoring from 2005 – 2010.
- (d) Stage 1 TTHM and HAA5 data from 2005 – 2010.
- (e) TOC data from January 2001 – January 2011.

2.2.2.1 Flow

Figure 2-1 shows the treated water flows, which generally range from 60 to 140 MGD with an average of 79 MGD. While the average flow is well below the maximum rated capacity of 150 MGD, the plant does experience peak daily flows of up to 142 MGD, nearly double the average daily flow. In addition, the demand is generally higher in the summer resulting in an average summer flow (96 MGD) that is approximately 35% higher than the average winter flow (71 MGD). This results in a reduced detention time (i.e., less time for softening/settling reactions) and the need to maintain all sedimentation basins in service during the summer months.

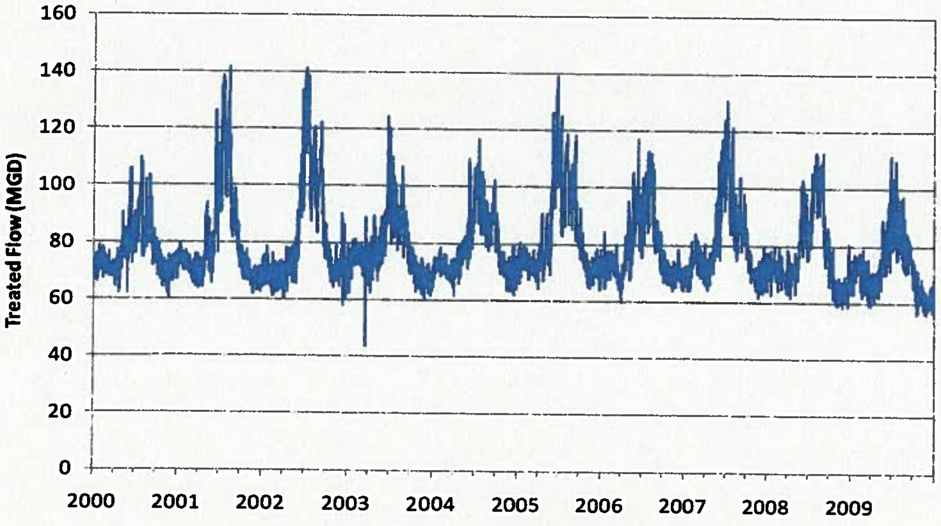


Figure 2-1: Treated Water Flow

2.2.2.2 pH

Raw and finished water pH levels are shown in Figure 2-2. Raw water pH has increased in variability in recent years; however, the finished water pH has been more consistent and is typically within the target water quality range of 9.0 to 9.75. The average pH values for each of the distribution system sampling sites range from 9.33 to 9.45, which are near the finished water average of 9.5, as shown in Figure 2-3. In addition, there is good consistency among distribution system sites with a variation of generally less than 0.5 units at each site. Maintaining consistent pH levels within the distribution system is essential for effective corrosion control since changes in distribution system pH by greater than 0.5 units, even for brief periods of time, may disrupt the passivation of metal surfaces.

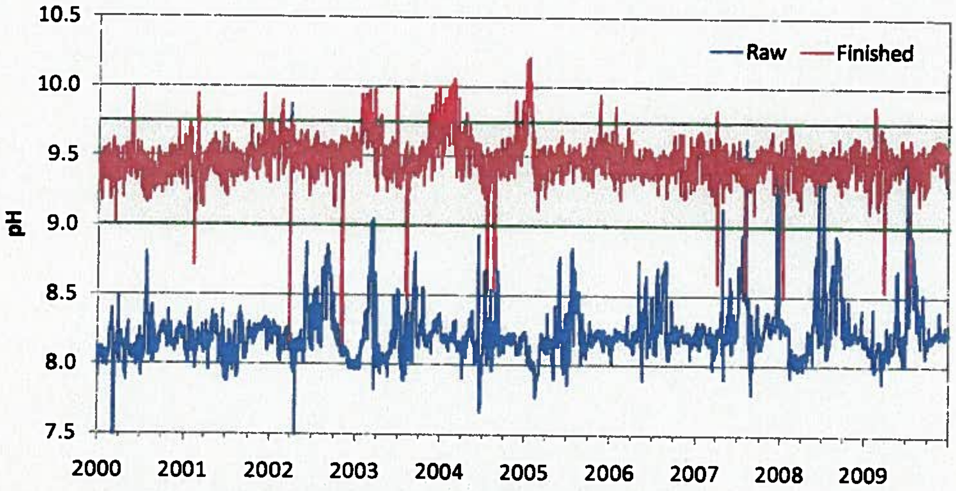


Figure 2-2: Raw and Finished Water pH

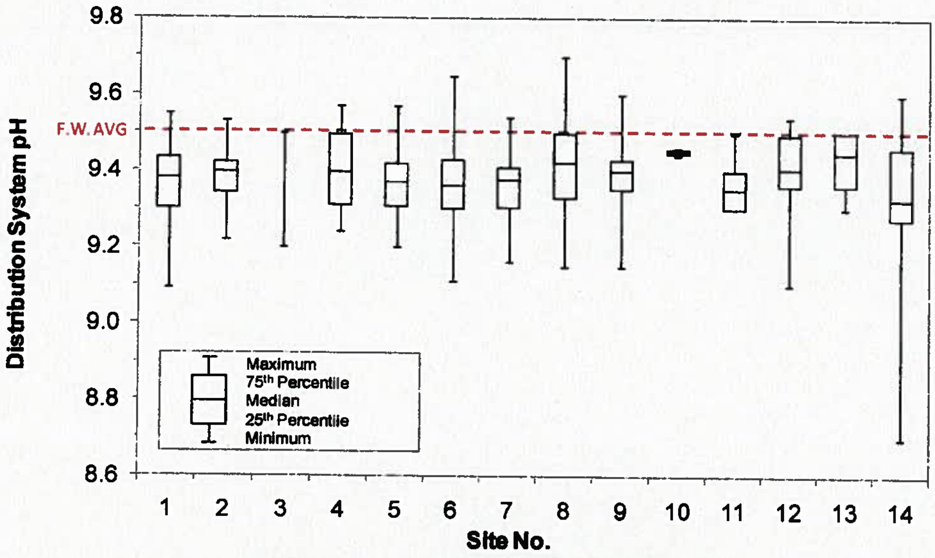


Figure 2-3: Distribution System pH

2.2.2.3 *Alkalinity*

Figure 2-4 shows historical raw and finished water alkalinities and the current water quality target range. Collins Park WTP typically has high raw water alkalinity levels, which range between 76 and 186 mg/L as $CaCO_3$. The finished water alkalinity varies seasonally and is typically below the target water quality range of 40 – 75 mg/L as $CaCO_3$ during the summer months. This is a result of the softening reactions, which are faster in warmer water, and therefore, consume more alkalinity. The observed summer decrease in alkalinity levels is typical of lime softening plants and within acceptable ranges for effective softening performance. The average alkalinity for each distribution system sampling location ranges from 38 to 47 mg/L as $CaCO_3$ and is near the finished water average of 44 mg/L as $CaCO_3$, as shown in Figure 2-5, which indicates that distribution system scales are relatively stable (i.e., little deposition or dissolving of carbonate is occurring). In addition, as shown in Figure 2-6, there is little difference between the settled and filtered water alkalinity, which indicates that there is little to no deposition occurring on the filters.

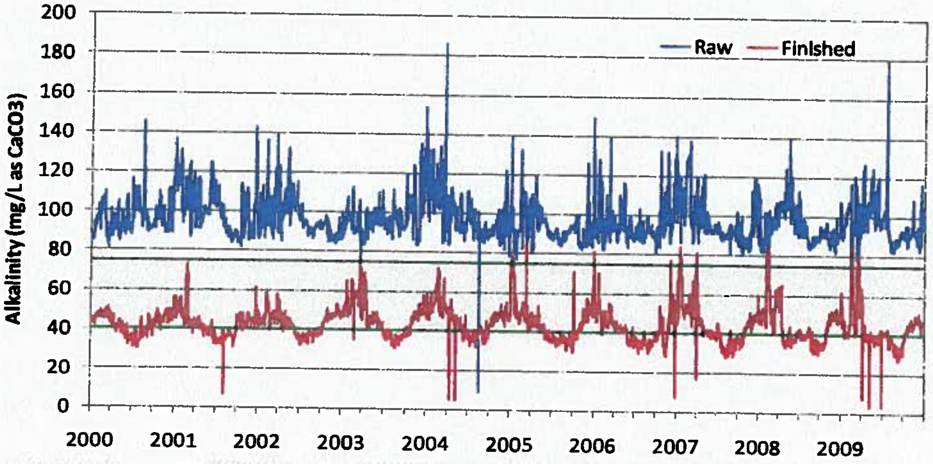


Figure 2-4: Raw and Finished Water Alkalinity

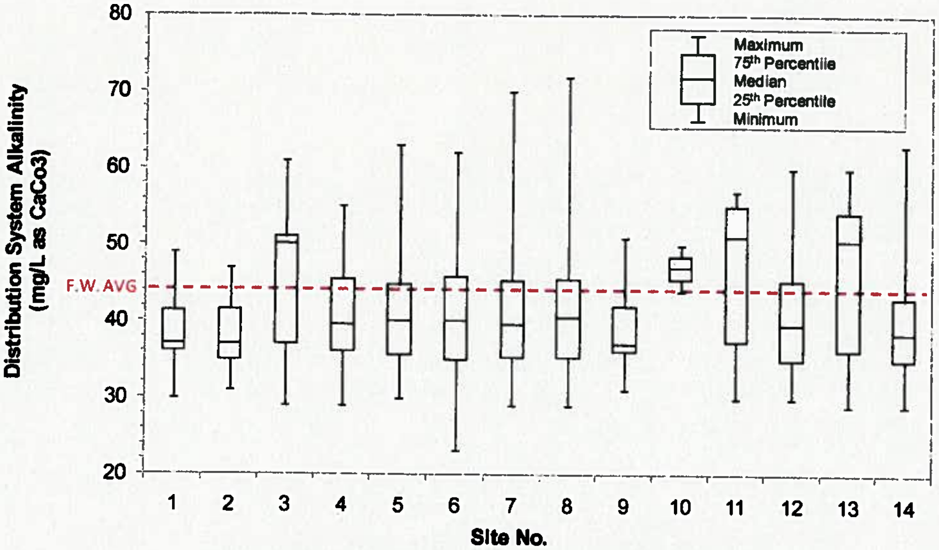


Figure 2-5: Distribution System Alkalinity

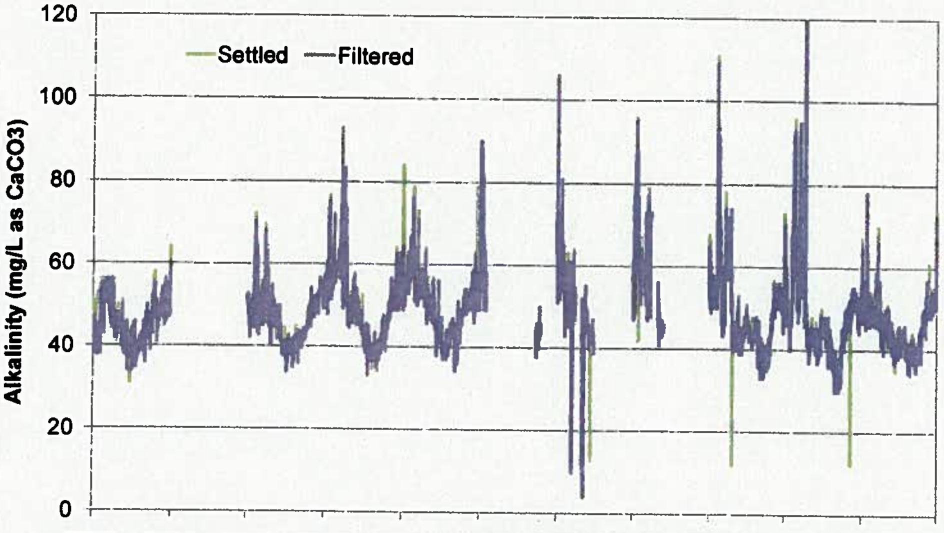


Figure 2-6: Settled and Filtered Water Alkalinity

2.2.2.4 Hardness

Raw and finished water hardness levels are shown in Figure 2-7. Raw water hardness generally ranges between 94 and 231 mg/L as $CaCO_3$ with higher values observed during the winter and spring. Finished water hardness also varies seasonally and is typically lower in summer months as a result of lower raw water hardness and faster reaction rates for softening. In general, the finished water hardness is within the target water quality range of 70 – 95 mg/L as $CaCO_3$.

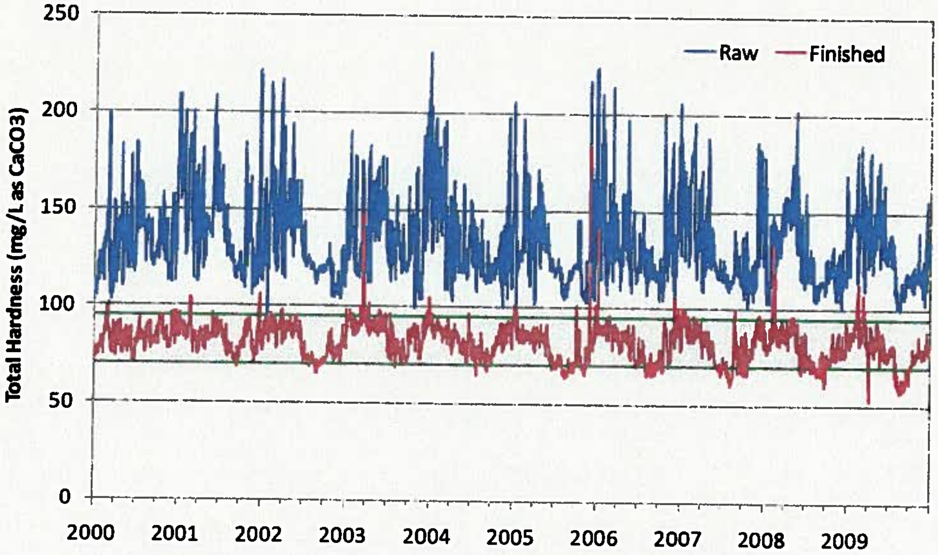


Figure 2-7: Raw and Finished Water Hardness

2.2.3 Chemical Usage

Table 2-3 summarizes the typical chemical dosages applied at the Collins Park WTP. Figures for select chemicals are included in Appendix A. General conclusions regarding the dosages applied are summarized below.

- Collins Park WTP has the ability to feed potassium permanganate at the intake for zebra mussel control. The plant previously used potassium permanganate on a seasonal basis, but began year-round addition in 2010 to provide additional oxidation and help reduce DBP levels. Plant staff has observed reduced coagulant requirements since implementing year round permanganate addition. Insufficient data is available at the time of this assessment to establish impacts on DBP formation.

- Powdered activated carbon (PAC) is added for taste and odor (T&O) control, and is generally fed year round. Dosages range from 0 - 10.5 mg/L and have increased on average in the past five years.

- Higher chemical dosages for coagulation (i.e., alum) and softening (i.e., lime, soda ash, and carbon dioxide) are added in the winter and spring as a result of higher raw water turbidity and hardness levels, respectively.

- Polyphosphate is added ahead of the filters to prevent deposition on the media that would otherwise occur due to the high pH of settled water applied to the filters. Minimizing deposition on the filters helps maintain a longer filter media life. As discussed above, there is minimal difference between the settled and filtered alkalinities, indicating little to no deposition on the filters. This indicates that current recarbonation and phosphate practices are effective at minimizing deposition on the media.

- Chlorine dosages are typically between 1 – 4 mg/L and have been fairly constant over the past decade. The applied chlorine dosage has generally been effective at meeting primary disinfection requirements and maintaining the necessary disinfectant residual in the distribution system. It should be noted, however, that the maximum dosage that can be applied with the existing system may be insufficient to meet required disinfection requirements under peak conditions (see Chapter 3 for a more detailed discussion on the chlorine system capacity).

- The average fluoride dosage is.0.8 mg/L and generally ranges from 0.5 – 1.0 mg/L. It should be noted that although the current MCL is 4.0 mg/L, it may be reduced in the near future. The U.S. Department of Health and Human Services recently recommended a fluoride level of 0.7 mg/L, which replaces the previous recommendation of 0.7 to 1.2 mg/L. Based on this recommendation, the Collins Park WTP may need to adjust their fluoride dosage to maintain a level of 0.7 mg/L or less in their finished water.

Table 2-3: Chemical Dosages at Collins Park WTP

Chemical	Average	Range
Powdered Activated Carbon, mg/L	2.1	0.0 – 10.5
Alum, gpg	1.0	0.2 – 9.2
Lime, gpg	5.4	3.2 – 10.0
Soda Ash, gpg	0.5	0.0 – 6.1
Carbon Dioxide, gpg	1.7	0.6 – 3.5
Polyphosphate , mg/L	0.8	0.2 – 1.9
Chlorine, mg/L	2.2	1.1 – 5.0
Sodium Chlorite, mg/L	0.2	0.1 – 0.5
Fluoride, mg/L	0.8	0.5 – 1.0

[1] Analyzed daily values from January 2001 through December 2010.
[2] Potassium permanganate data was not available.
[3] Outliers were considered to be erroneous readings, and are not included in the ranges listed above.

2.2.4 Residuals Handling and Disposal

Residuals streams are generated from the softening, coagulation, and filter backwash processes and maintenance activities of the various treatment tanks. Residuals consist of naturally occurring colloidal matter, suspended solids, other particulates from the raw water, and chemical residues formed during softening and coagulation. Residuals production was estimated based on hardness and turbidity removal data and average chemical dosages. Figure 2-8 shows the average monthly sludge production from January 2007 through November 2009. As indicated in the figure, the overall average and 90th percentile sludge production is approximately 180,000 and 265,000 lb/day, respectively. The sludge is composed of lime, turbidity, alum and PAC sludge with the largest contribution from the lime solids as shown in Figure 2-9.

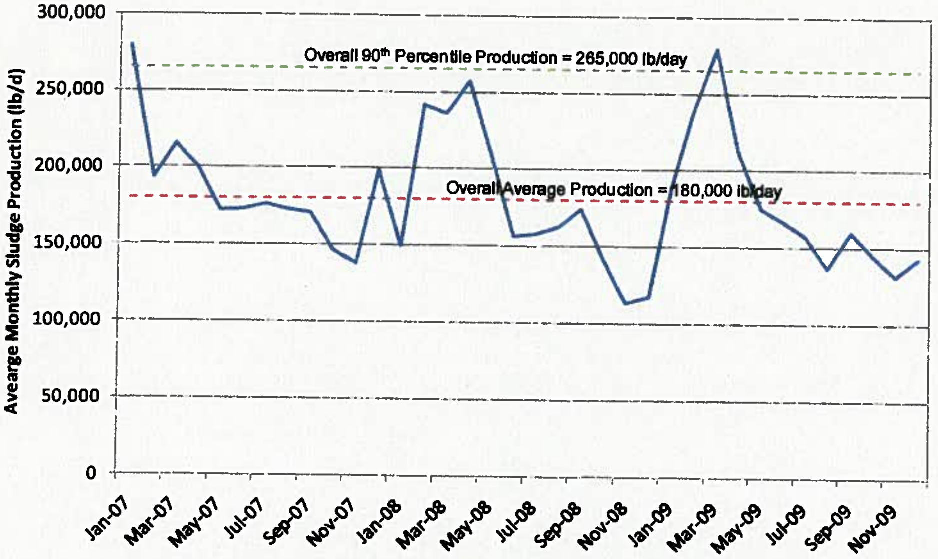


Figure 2-8: Average Monthly Sludge Production

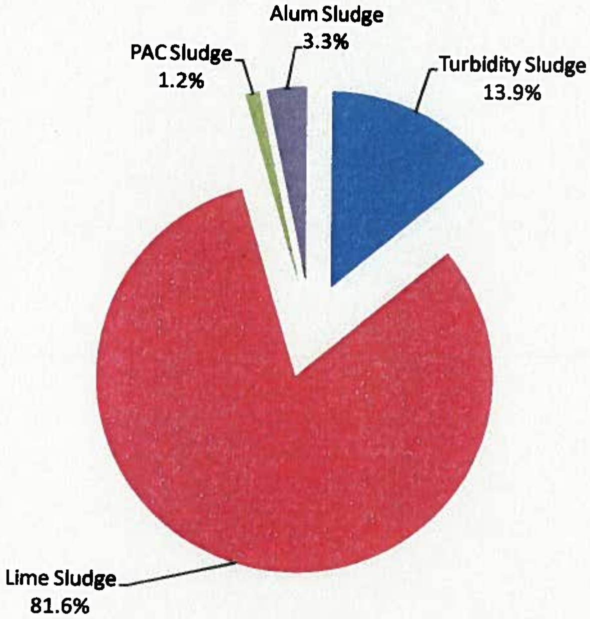


Figure 2-9: Breakdown of Residual Solids Components

2.3 Regulatory Assessment

The following sections discuss the current treatment performance at the Collins Park WTP with respect to meeting current and future regulatory requirements. Water quality data was analyzed and compared against existing and proposed regulations, and is presented in both tabular and graphical formats. In addition, emerging water quality issues are presented and discussed in relation to the current conditions and treatment performance at the Collins Park WTP.

2.3.1 Summary of Regulatory Requirements

Table 2-4 summarizes the key requirements of current, future, and proposed rules and regulations applicable to the Collins Park WTP. The sections below provide additional descriptions of each rule and discuss key findings regarding compliance with key requirements for each rule.

Table 2-4: Summary of Current, Future and Proposed Regulations

Rule		Key Requirements	Compliance Date
Existing Rules	Surface Water Treatment Rule	• 3-log inactivation/removal of *Giardia* • 4-log inactivation/removal of viruses • Maintain disinfectant residual in distribution system	June 1993
	Interim Enhanced Surface Water Treatment Rule	• 2-log removal of *Cryptosporidium* • SWTR requirements still applicable	January 2002
	Long-Term 2 Enhanced Surface Water Treatment Rule	• 3-log removal of *Cryptosporidium* • Additional *Cryptosporidium* removal/inactivation based on raw water quality bin classification	April 2012
	Stage 1 Disinfectants/Disinfection Byproducts Rule	• 80 µg/L TTHM as running annual average (RAA) • 60 µg/L HAA5 as RAA	January 2002
	Stage 2 Disinfectants/Disinfection Byproducts Rule	• Maintains same maximum contaminant levels (MCLs) for TTHM and HAA; however, compliance now based on locational running annual average (LRAA) at each sampling site • Initial Distribution System Evaluation (IDSE) to identify representative compliance monitoring sites	April 2012
	Filter Backwash Recycling Rule	• Addresses potential for concentrating pathogenic microorganisms in water treatment plants as a result of recycle practices	June 2004

Rule		Key Requirements	Compliance Date
	Total Coliform Rule	• Bacteriological monitoring of the distribution system	December 1990
	Lead and Copper Rule	• 15 µg/L action level for Lead • 1.3 mg/L action level for Copper	April 2000
	Drinking Water Regulations for Organic and Inorganic Chemicals	• Regulates MCLs for different inorganic and volatile and synthetic organic chemicals • Annual monitoring for most of the compounds	Various Dates
	Atrazine Rule	• Atrazine MCL of 3 ppb	1991
	Arsenic Rule	• MCL of 0.01 mg/L	June 2006
	Radionuclides Rule	• Gross alpha particle MCL of 15 picoCuries per liter (pCI/L) • Beta/photon emitters MCL of 4 millirems per year (mrem/yr) • Combined radium-226/228 MCL of 5 pCi/L • Uranium MCL of 30 µg/L	December 2003
	Consumer Confidence Report	• Requires annual water quality report be sent to all customers by July 1st of each year	September 1998
	Public Notification Rule	• Requires utilities to notify public of any potential risk or regulatory violation	May 2002
	Unregulated Contaminant Monitoring Rule 2	• Sets the stage for new round of monitoring requirements (2007-2011)	February 2007
Future and Proposed Rules	Revised Total Coliform Rule	• May require public water systems that are vulnerable to microbial contamination to identify and fix problem, and establish criteria for systems to qualify for and stay on reduced monitoring	2012 (final rule) 2015 (implementation)
	Lead and Copper Rule Revisions	• May include changes related to partial lead service line replacement programs; sample site collection criteria for lead and copper sites; tap sampling issues including pre-stagnation flushing, aerator removal, and maximum stagnation times; consecutive water systems; and particulate lead	2014 (anticipated)
	Unregulated Contaminant Monitoring Rule 3	• Sets the stage for new round of monitoring requirements (2013 – 2015)	2012 (anticipated)

2.3.2 Turbidity and Microbial Requirements

2.3.2.1 *Surface Water Treatment Rule*

The Surface Water Treatment Rule (SWTR) was finalized in 1989 and became effective on June 29, 1993. Major requirements of the SWTR as they apply to the Collins Park WTP include:

- 3-log removal/inactivation of *Giardia* and 4-log removal/inactivation of viruses.
- Minimum 0.2 mg/L of free chlorine residual required at entrance to distribution system, and residual must be at detectable limit throughout the distribution system.
- Combined filter effluent (CFE) turbidity should not exceed 0.5 NTU based on 95th percentile measurements taken at four-hour intervals, and should never exceed 5 NTU.

Conventional surface water treatment plants meeting the CFE turbidity requirements are granted 2.5-log *Giardia* and 2-log virus removal credits. The balance of the disinfection requirements are to be made up by chemical inactivation, i.e., chlorine, ozone, chlorine dioxide, or chloramines.

Ohio EPA has adopted the minimum disinfectant level requirements for the distribution system (Ohio Administrative Code (OAC) 3745-81-72) and included the following additional conditions:

- The disinfectant concentration entering the distribution system shall not be less than 0.2 mg/L free chlorine or 1.0 mg/L combined chlorine for more than four consecutive hours.
- The disinfectant concentration in the distribution system shall not be less than 0.2 mg/L free chlorine or 1.0 mg/L combined chlorine in more than 5 percent of samples each month for any two consecutive months.

2.3.2.2 *Interim Enhanced Surface Water Treatment Rule*

The Interim Enhanced Surface Water Treatment Rule (IESWTR) promulgated in 1998 applies to PWSs using surface water and serving 10,000 or more persons. The rule became effective on January 2002.

The IESWTR requires 2-log removal of *Cryptosporidium* in addition to the disinfection requirements previously established by the SWTR. The IESWTR also includes more stringent filtered water requirements with respect to turbidity that include, but not limited to:

- Combined filter effluent turbidity must not exceed 1 NTU at any given time.
- Combined filter effluent turbidity shall be less than 0.3 NTU in at least 95 percent of measurements taken each month.

- Systems must continuously monitor (every 15 minutes) turbidities for individual filters.

- If turbidity meters fail, systems must take grab samples and measure turbidities for each individual filter every four hours.

Conventional surface water treatment plants meeting the more stringent CFE turbidity requirements are granted a 2-log *Cryptosporidium* removal credit. PWSs are required to file an "exceptions report" if at any time the individual filter effluent (IFE) turbidity exceeds 1 NTU in two consecutive readings or if the IFE exceeds 0.5 NTU in two consecutive readings after four hours of filter operation. If no reason for the exceedance can be identified, a filter profile must be performed. If the IFE turbidity exceeds 1 NTU in two consecutive measurements in three consecutive months, the PWS must perform a self-assessment of the filter. If the IFE turbidity exceeds 2 NTU in two consecutive measurements in two consecutive months, the PWS must perform a comprehensive performance evaluation (CPE) to attempt to identify the factors limiting filter performance.

2.3.2.3 Long Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) was finalized in January 2006 and became effective March 6, 2006. The requirements of the LT2ESWTR apply to all public water systems that use surface water or groundwater under the direct influence of surface water (GWUDI). The LT2ESWTR, an extension of the IESWTR, requires additional *Cryptosporidium* removal/inactivation above that required under the IESWTR if the WTP does not fall into a Bin 1 classification.

The LT2ESWTR increases the minimum *Cryptosporidium* removal requirement from 2-log to 3-log; however, a 3-log removal credit is granted if PWSs continue to meet the CFE turbidity standards of the IESWTR. The rule requires filtered water systems to conduct source water monitoring for *Cryptosporidium*, turbidity, and *E. coli* for 24 months. The LT2ESWTR incorporates system-specific treatment requirements based on a 'Microbial Framework' approach. This approach generally involves assignment of systems into different categories (or bins) based on the results of source water *Cryptosporidium* monitoring. A PWS's bin classification will determine what, if any, additional (beyond the required 3-log) *Cryptosporidium* removal/inactivation is required. Table 2-5 summarizes the bin classifications and additional treatment requirements.

The total *Cryptosporidium* removal requirements for bins 2, 3 and 4 correspond to 4.0-, 5.0-, and 5.5-log, respectively. Bin classification is based on the highest 12-month running annual average if monthly samples are taken, or based on a two-year mean if a facility conducts monitoring twice per month (or more frequent) for 24 months. Filtered water systems providing 2.5-log of treatment in addition to conventional treatment for *Cryptosporidium* (equivalent to Bin 4) are not required to conduct source water sampling.

Table 2-5: LT2ESWTR Bin Requirements

Bin Number	Average *Cryptosporidium* Concentration	Additional Treatment Requirements for Systems with Conventional Treatment and in Full Compliance with IESWTR
1	< 0.075 oocysts/L	No action
2	≥ 0.075 to < 1.0 oocysts/L	1-log treatment (systems may use any technology or combination of technologies from microbial toolbox provided total credit is at least 1-log)
3	≥ 1.0 to < 3.0 oocysts/L	2-log treatment (systems must achieve at least 1-log of the required 2-log treatment using ozone, chlorine dioxide, UV, membranes, bag/cartridge filters, or in-bank filtration)
4	≥ 3.0 oocysts/L	2.5-log treatment (systems must achieve at least 1-log of the required 2.5-log treatment using ozone, chlorine dioxide, UV, membranes, bag/cartridge filters, or in-bank filtration)

Six years after completion of the initial characterization, systems will conduct a second round of monitoring to reassess source water characterization. If an improved *Cryptosporidium* method is available and used, reassessment will be in conjunction with re-evaluation of source water characterization structure. If a new method is not used, site-specific reassessment will occur within the LT2ESWTR source water characterization framework. Systems that provide a total of 2.5-log of additional treatment are exempt from future *Cryptosporidium* monitoring and reassessment.

Table 2-6 summarizes the critical deadlines and requirements that the Collins Park WTP has to comply with under the LT2ESWTR.

Table 2-6: LT2ESWTR Critical Deadlines and Requirements for Collins Park WTP

Requirements	Compliance Schedule
Submit Sampling Plan to EPA[1]	July 1, 2006
Begin source water monitoring	October 2006
Submit grandfathered data to EPA[2]	December 1, 2006
Complete initial round of source water monitoring	September 30, 2008
Report bin classification	March 31, 2009
Disinfection profiles/benchmarks	Prior to making changes in disinfection practices
Comply with additional requirements	March 31, 2012
Submit Sample Plan to the state for second round	January 1, 2015
Begin second round monitoring	April 1, 2015
Comply with additional requirements	On a schedule approved by the State

[1] Or submit notice of intent to grandfather data or to provide maximum required treatment in lieu of monitoring.
[2] If applicable.

The LT2ESWTR includes "microbial toolbox" options available to PWSs to meet the additional *Cryptosporidium* removal/inactivation requirements. The microbial toolbox provides guidance on the selection, design, and operation of treatment and management strategies for each of the 15 treatment options in the LT2ESWTR. Systems that provide 2.5-log treatment for *Cryptosporidium* (equivalent to Bin 4, including inactivation) in addition to conventional treatment are exempt from monitoring for purposes of selecting bin placement. Systems currently using ozone, chlorine dioxide, UV, or membranes in addition to conventional treatment can receive credit for those technologies towards bin requirements. Additional removal requirements can be achieved through application of the tools listed in Table 2-7.

Table 2-7: LT2ESWTR Microbial Toolbox Components

Toolbox Option	***Cryptosporidium* Treatment Credit (log)**			
	0.5	**1**	**2**	**>2.5**
SOURCE PROTECTION AND MANAGEMENT TOOLBOX OPTIONS				
Watershed Control Program	X			
Alternative source/ intake management	No prescribed credit			
PREFILTRATION TOOLBOX OPTIONS				
Pre-Settling Basin w/Coagulant	X			
Two-Stage Lime Softening	X			
Bank Filtration	X	X		
TREATMENT PERFORMANCE TOOLBOX OPTIONS				
Combined filter performance (0.15 NTU 95th percentile CFE)	X			
Individual filter performance	X			
Demonstration of performance (approved by the State)	X			
ADDITIONAL FILTRATION TOOLBOX OPTIONS				
Slow sand filters	X	X	X	X
Second stage filtration	X			
Membranes (MF, UF, NF, RO)	Equivalent to removal efficiency			
Bag and Cartridge Filters	X	X	X	
IMPROVED DISINFECTION				
Chlorine Dioxide	As measured			
Ozone	As measured			
UV	As measured			

[1] "X" indicates potential log credit based on proper design and implementation in accordance with EPA guidance.
[2] Criteria to be specified in guidance to determine allowed credit.
[3] Inactivation dependent on dose and source water characteristics.
[4] Additional monitoring for Cryptosporidium after this action would determine new bin classification and whether additional treatment is required (Table IV-D-1 from Federal Register page 685).

2.3.2.4 *Filter Backwash Recycling Rule*

The Filter Backwash Recycling Rule (FBRR) was finalized in 2001 and became effective on June 8, 2004. This rule provides regulatory requirements for the recycle of filter backwash water, thickener supernatant and dewatering liquids within a WTP's treatment process. The FBRR addresses the potential for concentrating pathogenic microorganisms in the treatment process and applies to all systems that practice conventional or direct filtration, and recycle spent filter backwash water (excluding membrane plants), thickener supernatant or liquids from dewatering processes.

The FBRR requires PWSs to report recycling of filter backwash, sludge thicker supernatant, and liquid from dewatering processes and maintain detail data on recycled flow and frequency of return to treatment, treatment on recycled flow, and source of water to be recycled. The deadline to complete any capital improvements, if required, associated with relocating recycle return was June 8, 2006.

The Collins Park WTP does not recycle filter backwash or any other residual stream. All waste streams are discharged to lagoons and into receiving streams through the existing National Pollutant Discharge Elimination System (NPDES) permit. Therefore, these requirements do not currently apply to the Collins Park WTP.

2.3.2.5 *Collins Park WTP Performance*

Figure 2-10 shows the average finished water and distribution system free chlorine residuals from 2005 - 2010. As seen from the figure, the finished water free chlorine residual has been maintained between 0.2 and 4.0 mg/L. In addition, the minimum distribution system disinfectant residual has never fallen below 0.2 mg/L, and therefore, has been detectable in 95% of monthly samples as required by federal and state regulations. Since mid 2010, the plant has increased chlorine residuals in the finished water to ensure minimum distribution system residuals are above the minimum residual of 0.2 mg/L

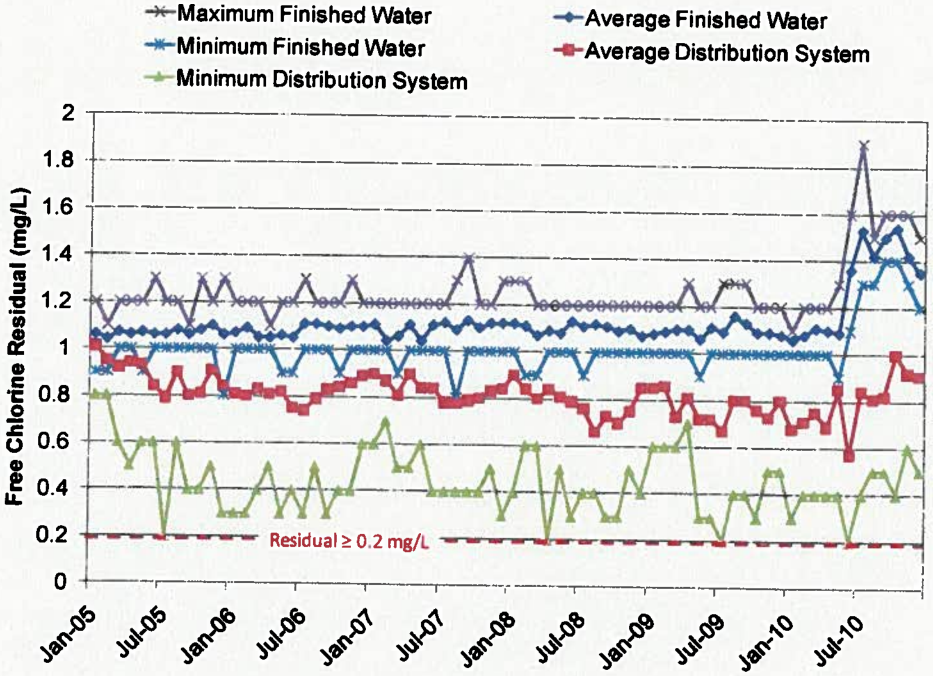


Figure 2-10: Free Chlorine Residuals

Figure 2-11 and Figure 2-12 illustrate the historical raw and finished water turbidity data, respectively. Based on the data and discussions with plant staff, the Collins Park WTP has successfully complied with all CFE requirements (i.e., must not exceed 1 NTU at any given time and must be less than 0.3 NTU in at least 95 percent of measurements taken each month) despite significant increases in raw water turbidity levels during the winter and spring. Since the Collins Park WTP is a conventional treatment plant, and it has successfully met all of the CFE turbidity requirements, it is granted 2.5-log *Giardia*, 2-log virus, and 2-log *Cryptosporidium* removal credits. In addition, Collins Park WTP has complied with all IFE monitoring requirements since 2005 based on a review of the MORs.

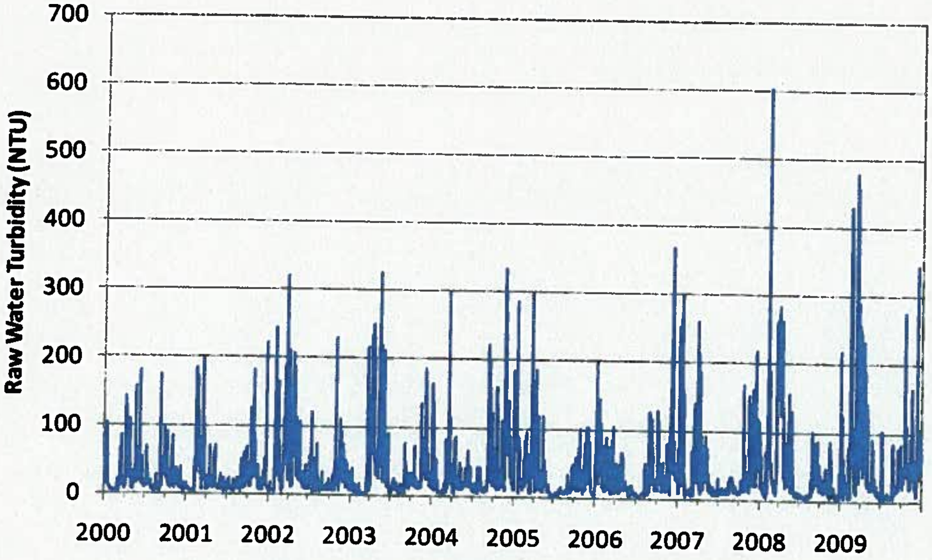


Figure 2-11: Raw Water Turbidity

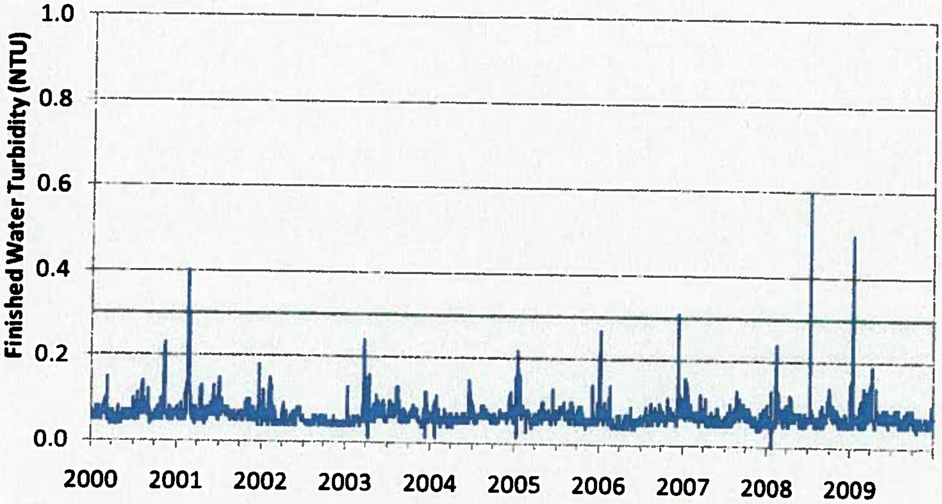


Figure 2-12: Finished Water Turbidity

The LT2ESWTR increased the minimum *Cryptosporidium* removal requirement to 3-log; however, systems that continue to meet the CFE turbidity standards of the IESWTR are granted a 3-log removal credit. As discussed above, Collins Park WTP has successfully complied with all CFE turbidity requirements as established under the IESWTR, and therefore, is not anticipated to have any issues achieving the required 3-log *Cryptosporidium* removal. In addition, all LT2ESWTR results throughout the monitoring period returned zero oocysts/L, resulting in a Bin 1 Classification. Therefore, no additional *Cryptosporidium* treatment (beyond the 3-log removal) is required for the Collins Park WTP.

As previously discussed, the Collins Park WTP complies with the IESWTR CFE turbidity standards, and therefore, is granted 2.5-log *Giardia* and 2-log virus removal credits. However, as required under the SWTR, surface water treatment plants must achieve 3-log *Giardia* and 4-log virus removal/inactivation. Therefore, Collins Park WTP must achieve the balance of the disinfection requirements (i.e., 0.5-log *Giardia* and 2-log virus inactivation) by chemical inactivation via free chlorine. CT (concentration*time) calculations were completed to estimate the log removal achieved under worst case conditions, which assumed the following:

- Peak flow rate of 150 MGD based on the maximum rated capacity of the plant.
- pH of 9.5 based on the maximum finished water pH goal.
- Temperature of 1°C based on the minimum temperature reported in the 2005 – 2010 MORs.
- Disinfectant residual concentration of 1.0 mg/L based on the minimum average disinfectant concentration reported in the 2005 – 2010 MORs.

Based on these values, Collins Park WTP can achieve 0.7-log inactivation of *Giardia* and 9.4-log inactivation of viruses, which represents an inactivation ratio of 1.4 based on the more stringent *Giardia* inactivation values (an inactivation ratio of 1.0 represents compliance). These values are conservative given that peak flows and minimum temperatures do not typically occur concurrently (i.e., peak flow of 150 MGD typically occurs during the summer months when water temperatures are higher resulting in lower CT requirements). A review of the historical MORs confirmed that the Collins Park WTP achieves much higher CT values than the values estimated here, and therefore, has no problems meeting the disinfection requirements for *Giardia* and viruses.

2.3.3 Distribution System Regulations

2.3.3.1 Total Coliform Rule

The Total Coliform Rule (TCR) was promulgated in 1989 and became effective in December 31, 1990. The TCR set the total coliform standard based on the presence or absence of the total coliform bacteria rather than the bacterial density. The key components of TCR applicable to the Collins Park WTP include:

- The maximum contaminant level goal (MCLG) for total coliform, fecal coliform, and *E. coli* was set as zero.
- Systems are required to sample monthly at representative sites throughout the distribution system and perform routine monitoring for the presence of total coliform. The Collins Park WTP, which serves between 320,001 to 450,000 people, must sample a minimum of 180 sites per month.
- For water systems analyzing at least 40 samples per month, no more than 5.0 percent of the monthly samples may be positive for total coliform.

- Every positive total coliform sample must be analyzed for fecal coliforms.

Either of the following two situations triggers immediate public notification:

- A routine sample tests positive for total coliform and for fecal coliform or *E. coli* and any repeat sample tests positive for total coliform.

- A routine sample tests positive for total coliform and negative for fecal coliform or *E. coli* and any repeat sample is positive for fecal coliform or *E. coli*.

The requirements as part of the revisions to the TCR proposed in 2010 are discussed i in the following section.

Based on a review of the MORs, the City of Toledo has not had a single coliform-positive at any of the distribution system sampling locations from 2005 through 2010. Therefore, there are no current compliance concerns with the existing TCR requirements.

2.3.3.2 Revised Total Coliform Rule

The SDWA requires EPA to review each national primary drinking water regulation (NPDWR) at least once every six years and revise them, as appropriate. As a result, EPA elected to revise the TCR to provide greater public health protection against waterborne pathogens in the public drinking water distribution systems. A federal advisory committee was established by EPA in 2007 to recommend revisions. In 2010, revisions to the 1989 TCR were proposed, and include the following changes:

- Links monitoring frequency to water quality and system performance – The revisions established criteria for well-operated small systems that must be met in order to qualify for and stay on reduced monitoring. In addition, the proposed revisions require increased monitoring for high-risk small systems with unacceptable compliance history as well as new monitoring requirements for seasonal systems, such as state and national parks.

- Establishes a MCLG and MCL of zero for *E. coli* and eliminates the MCLG and MCL of zero for total colfiorm – EPA is proposing to use *E. coli* as an indicator of fecal contamination and potential harmful pathogens as opposed to total coliform since many of the organisms detected by total coliform methods are not of fecal origin and do not have any direct public health implication.

- Assessment and corrective action required for systems vulnerable to fecal contamination – EPA is proposing a treatment technique for coliform that requires PWSs that exceeds a specified frequency of total coliform occurrence or that violate the *E. coli* MCL to conduct an assessment to identify and correct any sanitary defects, if found.

- Changes to the public notification requirements – The revisions eliminate monthly public notification requirements based only on the presence of total coliforms, and instead, require public notification when a PWS violates the *E. coli* MCL or fails to conduct the required assessment and corrective action.

The revisions are expected to be finalized in 2012.

2.3.4 Disinfection Byproducts Regulations

2.3.4.1 *Stage 1 Disinfectants and Disinfection Byproducts Rule*

The Stage 1 Disinfectants and Disinfection Byproducts Rule (DBPR) establishes maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), maximum residual disinfectant levels (MRDLs), and maximum residual disinfectant level goals (MRDLGs) for chemical disinfectants and the concentrations of disinfection byproducts (DBPs) in finished water and in drinking water distribution systems. Collins Park WTP was required to comply with requirements of the Stage 1 DBPR beginning in January 2002. The MRDLs for disinfectants and MCLs for DBPs regulated as a part of the Stage 1 DBPR is shown in Table 2-8.

Table 2-8: Stage 1 DBPR Summary

Parameter	MRDL	MRDLG	MCL	MCLG
DISINFECTANTS				
Chlorine (mg/L as Cl_2)	4.0	4.0		
Chloramines (mg/L as Cl_2)	4.0	4.0		
Chlorine Dioxide	0.8	0.8		
DISINFECTION BYPRODUCTS				
TTHM[1] (µg/L)			80	
HAA5[2] (µg/L)			60	
Bromate (µg/L)			10	0
Chlorite (µg/L)			1.0	0.8

[1] Total trihalomethanes is the sum of the concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

[2] Haloacetic acids (five) is the sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids.

Although the Stage 1 DBPR includes an MCL for bromate, this contaminant is only a concern for systems that utilize ozone in any part of their treatment process. However, since chlorine dioxide is used in the treatment process, the Collins Park WTP must conduct routine compliance monitoring and comply with the MRDL for chlorine dioxide and MCL for chlorite. Compliance with the chlorite MCL is based on the average of each 3-sample set taken in the distribution system (for both routine monthly and additional sampling). The Collins Park WTP must also comply with the MRDL for chlorine since it is used for both primary and secondary disinfection. In addition, the Collins Park WTP must comply with the requirements for total trihalomethanes (TTHMs) and the sum of five haloacetic acid species (HAA5). Compliance with the TTHM and HAA5 MCLs is based on the running annual average (RAA) of quarterly averages of all samples taken in the distribution system.

DBP data was reviewed to assess compliance with Stage 1 MCLs. Based on a visual inspection of the 2005 – 20010 MORs, Collins Park has not violated the MCL for chlorite in the distribution system. For TTHMs and HAA5, Stage 1 data was compiled to calculate RAAs, which are illustrated in Figure 2-13 and Figure 2-14 for TTHMs and HAA5, respectively. Both TTHM and HAA5 RAAs are well below their respective MCLs and have been fairly consistent since 2005. For both TTHMs and HAA5, one site, the Toledo Express Airport, maintains a higher LRAA than the other sites; however, it is unlikely that this location has a significant impact on compliance with the Stage 1 RAA MCLs given the lower LRAAs for the remaining sites.

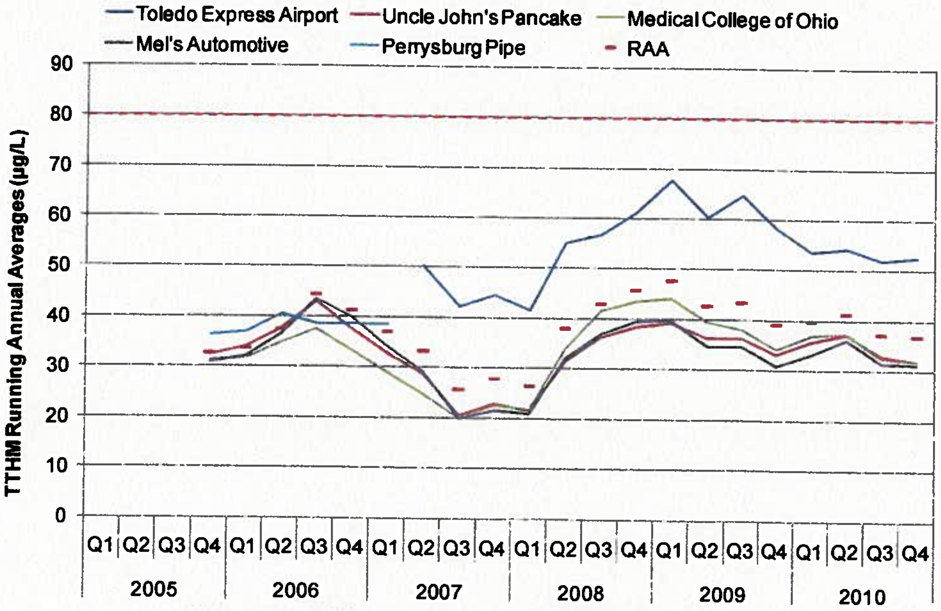


Figure 2-13: Stage 1 TTHM RAAs

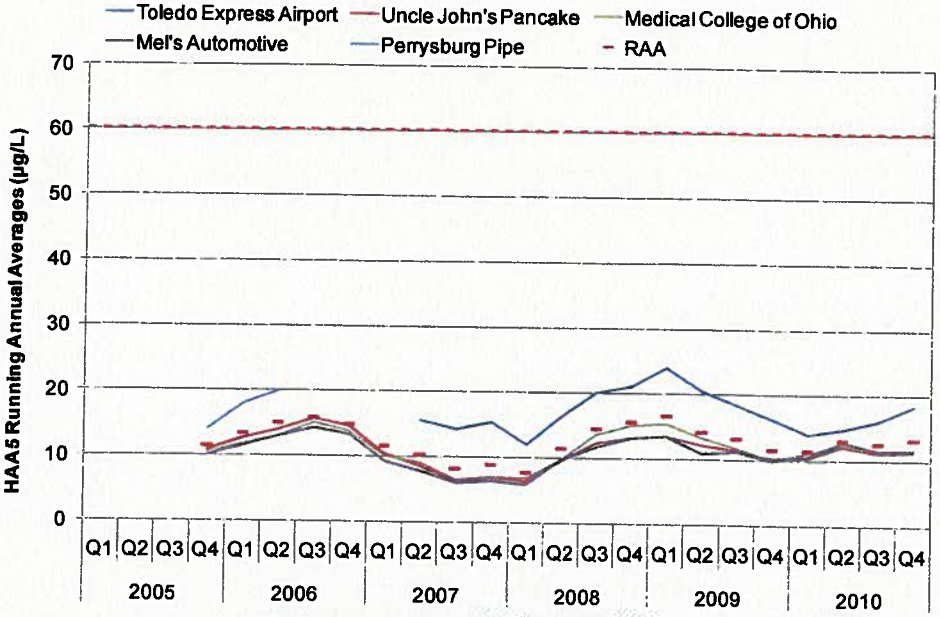


Figure 2-14: Stage 1 HAA5 RAAs

In addition, the Stage 1 DBPR requires surface water systems, using conventional treatment, to implement a treatment technique to remove total organic carbon (TOC), a surrogate measure for DBP precursors such as natural organic material (NOM). Table 2-9 summarizes the TOC removal requirements. Compliance with the TOC removal requirements is based on a running annual average of quarterly values.

Raw and finished water TOC levels are shown in Figure 2-15, and average around 3.9 and 1.8 mg/L, respectively. Based on historical source water TOC and alkalinity concentrations, Collins Park WTP is typically required to remove either 25% or 35% of TOC present in the source water (as shown in Figure 2-16). Data shows that Collins Park WTP has successfully met this requirement and on average achieves 55% TOC removal from the low service intake to the plant tap.

Table 2-9: Stage 1 DBPR TOC Removal Requirements

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as $CaCO_3$)		
	0 - 60	> 60 - 120	> 120
> 2.0 to 4.0	35%	25%	15%
> 4.0 to 8.0	40%	30%	25%
> 8.0	50%	40%	30%

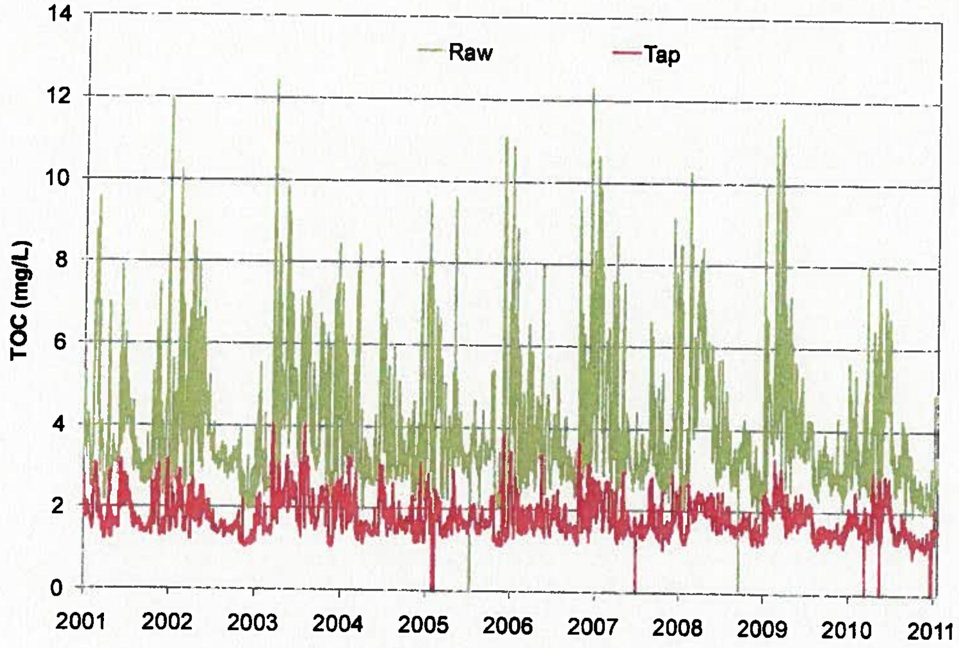


Figure 2-15: Raw and Finished Water TOC

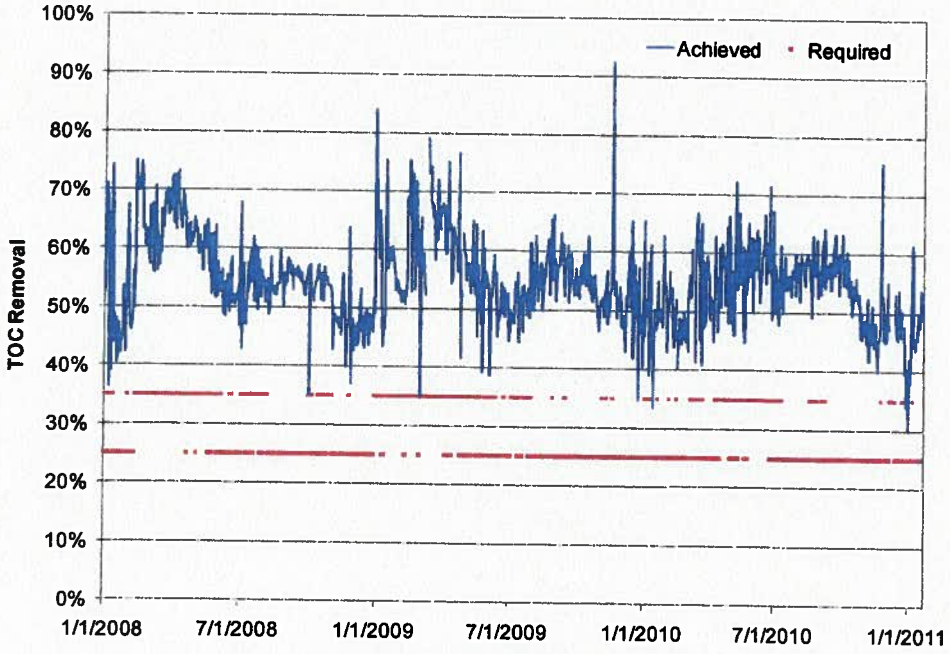


Figure 2-16: TOC Removal

2.3.4.2 *Stage 2 Disinfectants/Disinfection Byproducts Rule*

The Stage 2 DBPR increases the compliance challenge facing most drinking water utilities. Although the Stage 2 DBPR does not change any of the previous MCLs, it does change the manner in which compliance with the TTHM and HAA5 standards is determined. Under the Stage 1 DBPR, compliance with the TTHM and HAA5 MCLs was determined based on a system-wide RAA of all DBP monitoring results. Under the Stage 2 DBPR, compliance is based on a locational running annual average (LRAA) in which the average concentration at each compliance monitoring location must be less than the MCL. This approach is intended to provide more equitable water quality relative to DBPs to a utility's customers regardless of where they live in the distribution system. Again, the MCLs for TTHM and HAA5 will remain 80 µg/L and 60 µg/L, respectively, under the Stage 2 DBPR.

Under the Stage 1 DBPR, the City of Toledo was required to monitor at four locations in the distribution system for TTHMs and HAA5 on a quarterly basis. Under the Stage 2 DBPR, surface water systems serving between 250,000 and 999,999 people are required to monitor at 12 distribution system locations (total): four representatives of high TTHM, four representatives of high HAA5, and four of the current Stage 1 monitoring locations. To determine the Stage 2 DBPR monitoring locations, systems were required (unless given a waiver by the primacy agency) to conduct an Initial Distribution System Evaluation (IDSE). The City submitted their IDSE Plan to USEPA before the October 1, 2006 deadline. The critical Stage 2 DBPR compliance dates for the City of Toledo are listed in Table 2-10.

Table 2-10: Stage 2 DBPR Compliance Schedule

Requirement	Compliance Date
Submit IDSE plan or 40/30 Certification	October 1, 2006
Complete Standard Monitoring or System Specific Study	September 30, 2008
Submit IDSE Report	January 1, 2009
Begin Compliance Monitoring	April 1, 2012

The Stage 2 Rule also includes operational evaluation requirements. Operational evaluation levels (OELs) must be calculated each sampling period using the Stage 2 compliance monitoring results. If the TTHM or HAA5 OEL exceeds the Stage 2 MCL of 80 µg/l or 60 µg/l, respectively, an operational evaluation must be conducted to identify how the excursion(s) can be reduced. This evaluation must include the raw water supply, the water treatment facilities, and the distribution system. OELs for each Stage 2 monitoring site shall be calculated as follows:

- OEL = (Q1 + Q2 + 2Q3)/4

Where:

- Q1 = Quarter Before Previous Quarter Measurement
- Q2 = Previous Quarter Measurement
- Q3 = Current Quarter Measurement

Stage 2 IDSE results for TTHMs and HAA5 are illustrated in Figure 2-17 and Figure 2-18, respectively. The sites boxed in red have been selected as Stage 2 monitoring locations. Sites beginning with "SG1" are the current Stage 1 monitoring locations. For TTHMs, sites T2 and T3 may be a potential concern with respect to the TTHM LRAA MCL. In addition, sites T1, T2, T3, T9, and T10 may be a potential concern with respect to the TTHM OEL. HAA5, however, are not anticipated to be a concern under Stage 2 since all of the sites are well below the LRAA MCL. It should be noted that IDSE sample results shown are before the plant began adding potassium permanganate on a year round basis. It is anticipated that DBP levels will decrease due to the year round addition of permanganate. It is recommended that the plant continue to closely monitor DBPs going forward to verify the impact of continuous permanganate addition.

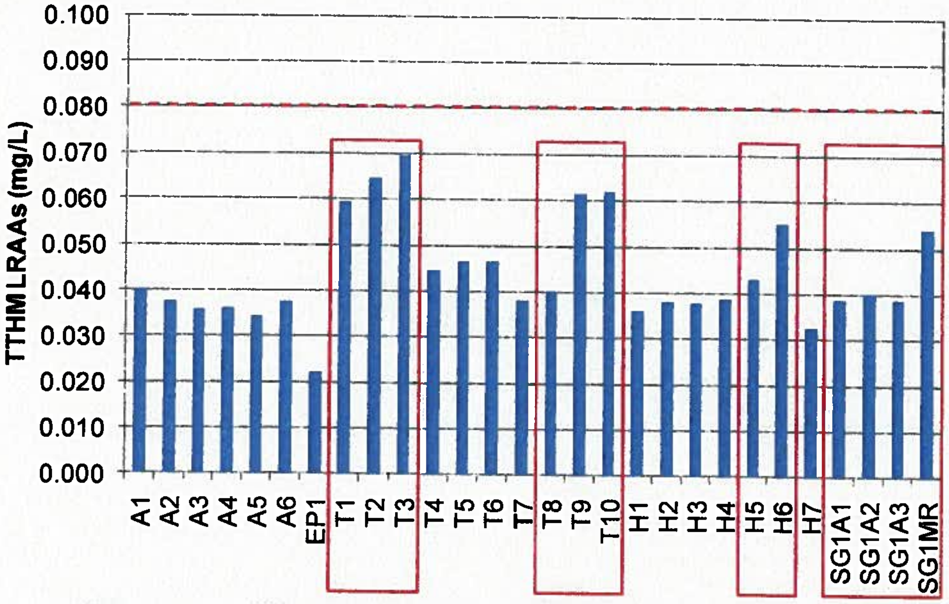


Figure 2-17: IDSE TTHM Results

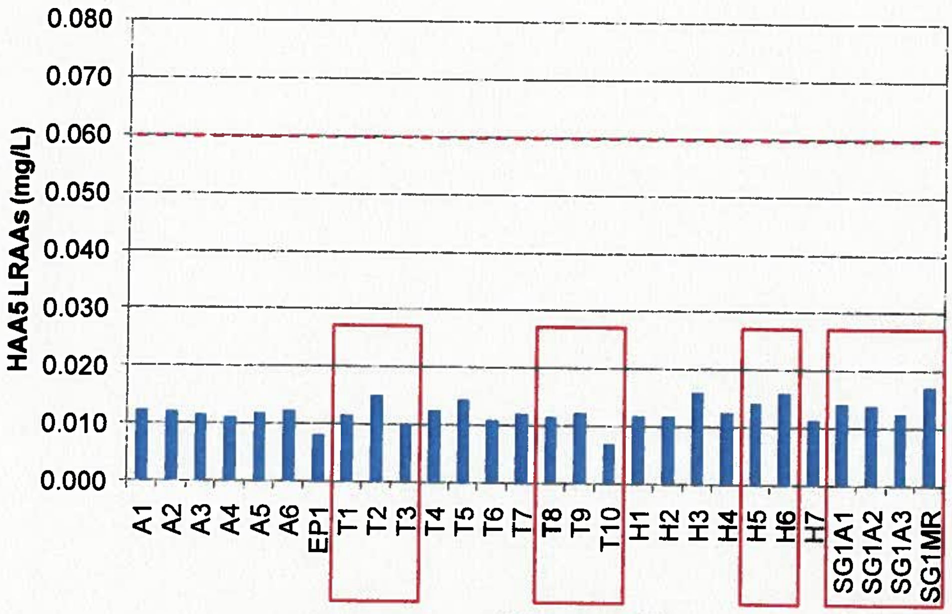


Figure 2-18: IDSE HAA5 Results

2.3.5 Organic Contaminants

NPDWRs are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. The list of regulated contaminants can be categorized into micro organisms, disinfectants and disinfectant by-products, inorganic and organic chemicals, and radio nuclides. This section discusses the chemical contaminants that are regulated by the State of Ohio, which includes federal requirements as well as more stringent requirements contained in Ohio's Primary Drinking Water Rules (PDW Rules).

2.3.5.1 Atrazine Rule

Atrazine is the most commonly applied herbicide in the U.S. with an average of 70 million pounds of active ingredient applied per year and is commonly found in drinking water sources throughout the Midwest. Atrazine potentially causes congestion of heart, lungs and kidneys, low blood pressure, muscle spasms, weight loss, and damage to adrenal glands when people are exposed to it at levels above the drinking water MCL for relatively short periods of time. Adverse health effects from lifetime exposure to levels above the atrazine MCL include weight loss, cardiovascular damage, and retinal and some muscle degeneration. Atrazine must also undergo a formal re-registration process for pesticides every six years as part of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The goal of this program is to conduct a comprehensive review of pesticides and herbicides and to evaluate their health and environmental effects and make decisions about their future use.

The current USEPA drinking water MCL for atrazine is 3 μg/L (ppb) and became effective in 1991. The atrazine rule is applicable to both surface water and groundwater PWSs. For drinking water compliance purposes, atrazine must be monitored quarterly and compliance is based on the annual average of these quarterly samples. It must be recognized that this method of sampling can overlook spikes in atrazine concentrations that typically occur during the spring and summer, post application, and can result in short-term exposures to concentrations significantly above the current drinking water MCL. In 2003, the USEPA completed its Interim Re-registration Eligibility Decision (IRED) for atrazine, outlining the label changes and risk reduction steps necessary for atrazine to meet health and environmental safety standards. In addition, the USEPA recommended a trigger level approach for monitoring of total chlorotriazines (TCT) (atrazine plus metabolites – simazine, propazine, deethylatrazine, deisopropylatrazine, and didealklatrazine) in drinking water. If a drinking water utility's finished water annual average exceeds 2.6 µg/L as TCT or 12.5 µg/L TCT as a 90-day rolling average, the utility would be binned into increased monitoring for both raw and finished water (weekly during peak season and biweekly during the remainder of the year). Any TCT sample greater than 37.5 µg/L as a rolling 90-day average may trigger a ban of atrazine in the watershed. However, it should be noted that this must occur once for at least two years out of five.

TCT can be calculated using the following USEPA's regressions:

Quarter 1: TCT (µg/L) = 1.535*Atrazine Concentration (µg/L)+0.223
Quarter 2: TCT (µg/L) = 1.394*Atrazine Concentration (µg/L)+0.107
Quarter 3: TCT (µg/L) = 1.704*Atrazine Concentration (µg/L)+0.123
Quarter 4: TCT (µg/L) = 1.630*Atrazine Concentration (µg/L)+0.122

Annual average atrazine results for the Collins Park WTP are listed in Table 2-11 along with any individual detected sample results throughout each year. Annual averages from 2003 through 2008 have been well below the MCL, and therefore, atrazine is not a current concern. It should be noted that since 2005 at least one sample per year (based on quarterly sampling) has measured a detectable level of atrazine; however, these detections have remained below the annual average MCL value and in general do not indicate any significant spikes in the spring/summer.

Table 2-11: Atrazine Sample Results

Year	Detected Sample Results[1] (mg/L)	Annual Average[2] (mg/L)
2003	Not available	0.000845
2004	Not available	0.000845
2005	0.00174 0.00099 0.00039	0.00066
2006	0.0022[3]	0.00066
2007	0.00064	0.00005
2008	0.0015	0.00050
2009	0.0013 0.00035	Not available
2010	0.00098 0.00006	Not available

[1] Results obtained from SOC data sheets for 2005-2010. Additional samples were collected each year, and were all non-detect.
[2] Results obtained from annual chemical data sheets for 2003-2008.
[3] Sample initially measured at 0.0022 mg/L, but later retested at 0.0017 mg/L.

2.3.5.2 *Volatile Organic Chemicals*

The presence of volatile organic chemicals (VOCs) is generally a sign of industrial contamination, as VOCs are not typically detected in surface waters at elevated concentrations due to their tendency to volatilize. VOC monitoring is due every year for surface waters and every three years for groundwater sources. When VOCs are detected, more frequent monitoring is required. The VOCs regulated by OAC 3745-81-12 with their respective MCLs are listed in Table 2-12.

Table 2-12: Volatile Organic Chemical MCLs

VOCs	MCL (mg/L)	MDL (mg/L)
Benzene	0.005	0.0005
Carbon Tetrachloride	0.005	0.0005
0-Dichlorobenzene	0.6	0.0005
p-Dichlorobenzene	0.075	0.0005
1,2-Dichloroethane	0.005	0.0005
1,1- Dichloroethylene	0.007	0.0005
cis-1,2-Dichloroethylene	0.07	0.0005
trans-1,2-Dichloroethylene	0.1	0.0005
Dichloromethane	0.005	0.0005
1,2-Dichloropropane	0.005	0.0005
Ethylbenzene	0.7	0.0005
Monochlorobenzene	0.1	0.0005
Styrene	0.1	0.0005
Tetrachloroethylene	0.005	0.0005
Toluene	1.0	0.0005
1,2,4-Trichlorobenzene	0.07	0.0005
1,1,1-Trichloroethane	0.02	0.0005
Trichloroethylene	0.005	0.0005
Vinyl Chloride	0.002	0.0005
Xylenes (total)	10.0	0.0005

[1] Source: OAC 3745-81-12
[2] MDL = Method Detection Limit

Sample results for the Collins Park WTP for select VOCs from 2003 through 2008 are included in Appendix B. With respect to the analyzed VOCs, all parameters were non-detect with the exception of total and individual THMs (i.e., bromodichoromethane, bromoform, dibromochloromethane, and chloroform) and total and individual HAAs (i.e., dichloroacetic acid, trichloroacetic acid, monochloroacetic acid, bromoacetic acid, and dibromoacetic acid). However, THMs and HAA5 are regulated as part of the Stage 1 and Stage 2 D/DBPRs and are discussed in Section 2.3.4. Therefore, regulated VOCs are not a current concern for the City of Toledo based on the parameters tested.

2.3.5.3 Synthetic Organic Chemicals

Synthetic organic chemicals (SOCs) are man-made compounds used for a variety of industrial and agricultural purposes. Adverse health effects from exposure to synthetic organic chemicals include damage to the nervous system and kidneys, and cancer risks. The MCLs for SOCs are listed in Table 2-13. After an initial four quarters of monitoring, if SOCs are not detected, then future monitoring is required to include two consecutive quarterly samples every three years. If an SOC is detected, then monitoring goes to quarterly, with the possibility of reduced monitoring. If an SOC is detected above the MCL, then the utility must monitor monthly.

Table 2-13: Synthetic Organic Chemical MCLs

Synthetic Organic	MCL (mg/L)	MDL (mg/L)
Alachlor	0.002	0.0002
Atrazine	0.003	0.0001
Benzo[a]pyrene	0.0002	0.00002
Carbofuran	0.04	0.0009
Chlordane	0.002	0.0002
2,4-D	0.07	0.0001
Dalapon	0.2	0.001
Dibromochloropropane	0.0002	0.00002
Di (2-ethylhexyl) adipate	0.4	0.0006
Di (2-ethylhexyl) phthalate	0.006	0.0006
Dinoseb	0.007	0.0002
Diquat	0.02	0.0004
Endothall	0.1	0.009
Endrin	0.002	0.00001
Ethylene dibromide (EDB)	0.00005	0.00001
Glyphosate	0.7	0.006
Heptachlor	0.0004	0.00004
Heptachlor epoxide	0.0002	0.00002

Synthetic Organic	MCL (mg/L)	MDL (mg/L)
Hexachlorobenzene	0.001	0.0001
Hexachlorocyclopentadiene	0.05	0.0001
Lindane	0.0002	0.00002
Methoxychlor	0.04	0.0001
Oxamyl (Vydate)	0.2	0.002
Picloram	0.5	0.0001
Pentachlorophenol	0.001	0.00004
Polychlorinated biphenyls	0.0005	0.0001
Simazine	0.004	0.00007
Toxaphene	0.003	0.001
2,3,7,8-TCDD (Dioxin)	3×10^{-8}	0.000000005
2,4,5-TP (Silvex)	0.05	0.0002

[1] Source: OAC 3745-81-12

Sample results for the Collins Park WTP for select SOCs from 2003 through 2008 are included in Appendix B. Based on the SOC analyses conducted, all parameters were non-detect with the exception of simazine; however, this compound was detected at very low levels in 2003, 2004 and 2008 and was well below the MCL of 0.004 mg/L. Therefore, regulated SOCs are not a current concern for the City of Toledo based on the parameters tested.

2.3.6 Inorganic Contaminants

2.3.6.1 Lead and Copper Rule

The Lead and Copper Rule (LCR) was promulgated on June 7, 1991. Minor revisions to the rule were proposed in April 1996. Notices of Data Availability (NODAs) for additional revisions were published in the "Federal Register" in 1998 and 1999. EPA published the final revisions on January 12, 2000 and the revised rule became effective from April 11, 2000. Another set of minor revisions were finalized on October 10, 2007 and became effective on December 10, 2007.

The LCR requires that samples be collected at cold water taps in homes/buildings that are at high risk of Lead/Copper (Pb/Cu) contamination. The rule requires large systems to conduct water quality parameters (WQP) monitoring in addition to tap water samples for lead and copper every six months unless the system qualifies for reduced monitoring. The water quality parameters include pH, alkalinity, calcium, conductivity, temperature, and orthophosphate. Samples are collected within distribution system and at each entry point to distribution system. LCR tap monitoring requirements applicable to the City of Toledo are summarized in Table 2-14.

Table 2-14: LCR Monitoring Requirements

Number of Pb/Cu Tap Sample Sites		Number of WQP Tap Sampling Sites	
Standard	Reduced	Standard	Reduced
100	50	25	10

The first set of Lead and Copper Rule Minor Revisions (LCRMR) streamlined requirements, promoted consistent national implementation, and in many cases, reduced burden for water systems. The second set of LCRMR clarified language surrounding several topics (including sample collection and reduced monitoring), and included new requirements (i.e., advanced notification for changes in treatment or source water), and several minor changes to existing requirements regarding lead service line replacement and public education. Neither set of revisions changed the action levels (ALs) of 0.015 mg/L for lead and 1.3 mg/L for copper based on 90th percentile of tap water samples. The MCLGs established by the 1991 LCR of 0 mg/L for lead and 1.3 mg/L for copper also remained unchanged.

Also of note, the Reduction of Lead in Drinking Water Act, which reduces the allowable lead in plumbing faucets and fixtures from 8% to 0.25%, was passed into law in January of 2011. While this requirement is not a NPDWR, it will help to reduce lead concentrations in the distribution system as buildings and homes begin to implement this requirement.

The historical 50th, 75th and 90th percentiles for lead and copper for the City of Toledo are illustrated in Figure 2-19 and Figure 2-20, respectively. Although the 50th and 75th percentiles are not used for compliance, they are useful for evaluating trends in lead and copper levels in the distribution system. For example, the 90th percentile may be below the action level and remain constant over multiple monitoring periods; however, the 50th and 75th percentiles may be increasing, which could indicate a rise in lead or copper concentrations (even though the system is in compliance). Based on the compiled sample results, the 90th percentile for lead exceeded the 0.015 mg/L lead action level in 1992. However, since then, the 90th percentile lead levels have been well below the action level. The 50th and 75th percentiles have also been constant and well below the action level, suggesting that lead levels are not a current concern. The 50th, 75th, and 90th percentile copper levels have also been constant and well below the copper action level of 1.3 mg/L since the earliest sampling event in 1992. Therefore, copper levels are also not a current concern. Since the 90th percentile lead and copper levels have continued to be below their respective action levels, the plant has qualified for reduced monitoring, and now monitors lead and copper levels at the tap only once every three years at a reduced number of sites.

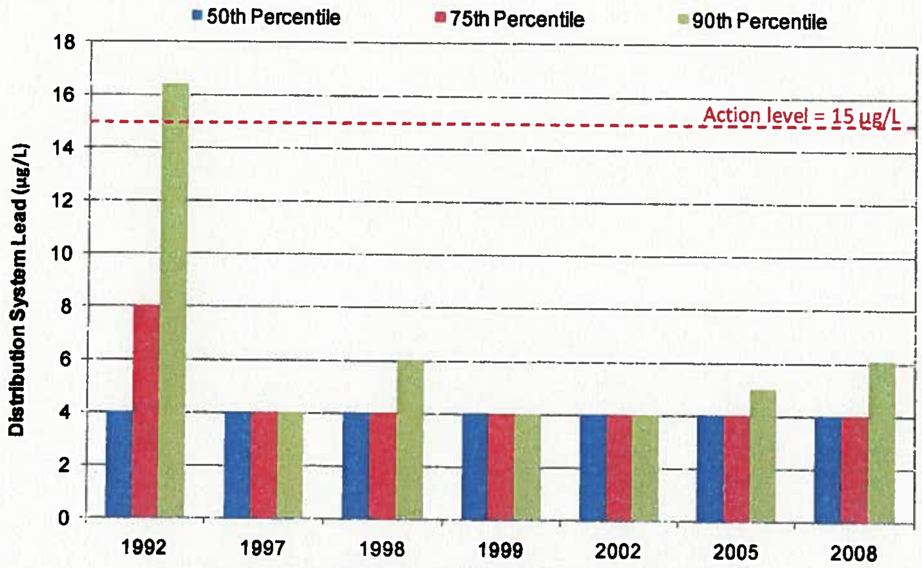


Figure 2-19: Distribution System Lead Levels

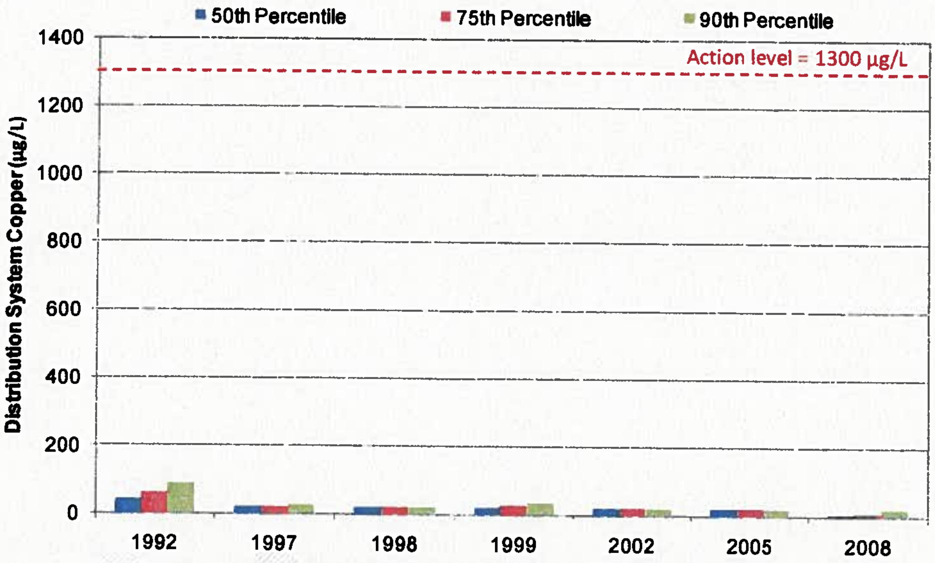


Figure 2-20: Distribution System Copper Levels

Being a large system, the Collins Park WTP is also required to monitor pH, alkalinity, temperature, calcium and phosphate in the distribution system as part of the LCR requirements. Distribution system pH and alkalinity levels are shown in Figure 2-3 and Figure 2-5, respectively. As discussed in Section 2.2.2 , they are near their respective finished water averages and are generally consistent throughout the distribution system. This indicates good stability in distribution system scale and effective corrosion control treatment performance. In addition, while finished water alkalinity values are typically lower in summer, there is no indication that this is increasing the aggressiveness of the water, re-emphasizing the stability within the distribution system with respect to lead and copper levels.

The average temperature at each distribution system sampling location is shown in Figure 2-21, and ranges from 17.9 – 21.3 °C. The temperature at Site #3 does vary more significantly than the other sites; however, the temperatures experienced at Site #3 are generally lower than other sites, and since lower temperatures result in lower solubility levels for lead and copper, this variability is not of concern.

The average calcium level at each distribution system sampling location is shown in Figure 2-22 and ranges from 26 – 30 mg/L. These values are near the finished water average of 28 mg/L and are also very consistent, indicating that little to no calcium carbonate deposition is occurring on the pipes.

As discussed in Section 2.2.3, polyphosphate is added to control deposition on the filters, not for corrosion control treatment. Therefore, the distribution system phosphate levels are not discussed with respect to lead and copper corrosion.

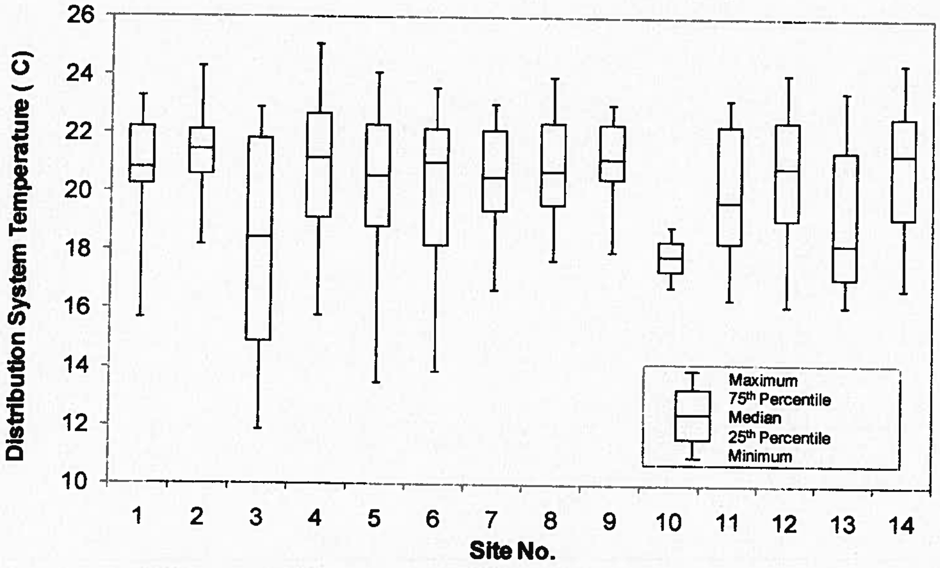


Figure 2-21: Distribution System Temperature Levels

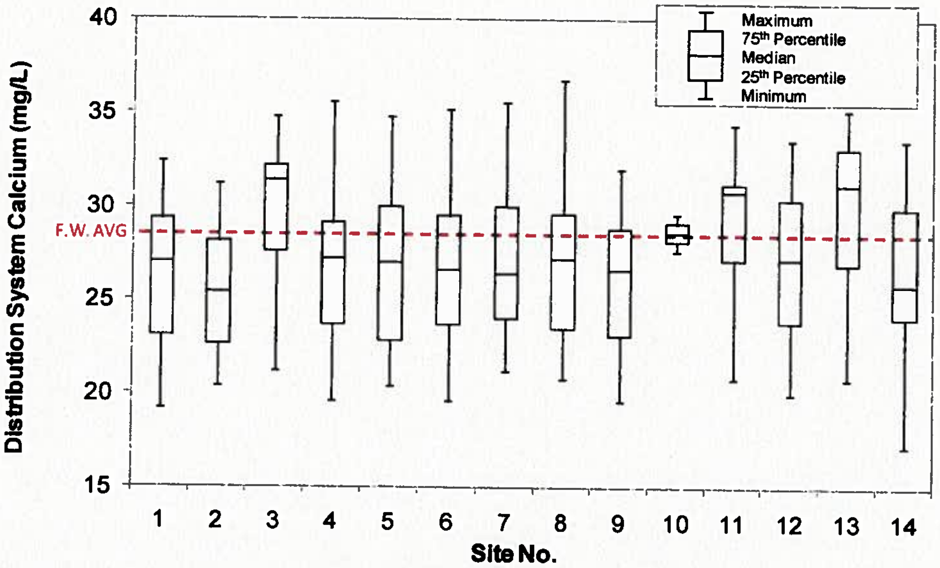


Figure 2-22: Distribution System Calcium Levels

2.3.6.2 *Lead and Copper Rule Revisions*

EPA is planning to make additional revisions to the LCR in 2012. These revisions may include changes related to partial lead service line replacement programs; sample site collection criteria for lead and copper sites; tap sampling issues including pre-stagnation flushing, aerator removal, and maximum stagnation times; consecutive water systems; and particulate lead. While some of these changes are not likely to affect the City since they have maintained compliance with the lead and copper action levels, those related to sample site selection and sample collection will likely impact the City's sampling and monitoring procedures.

2.3.6.3 *Arsenic Rule*

The revised Arsenic Rule was finalized in January 2001 and became effective in January 2006. The rule establishes an MCLG of zero and an enforceable MCL of 10 µg/L for arsenic. Arsenic must be monitored annually at the entry to the distribution system (unless otherwise directed by the State) for surface water systems, and compliance is based on a running annual average at each sampling point. A system is subject to increased monitoring if the sampling point result is above the MCL and has to collect quarterly samples until the system is reliably and consistently below the MCL.

Annual sampling results for arsenic from 2003 to 2008 are shown in Figure 2-23. As noted on the figure, all the sampling results for arsenic during this time period have been non-detect. In addition, the detection level is well below the MCL of 10 µg/L. Therefore, arsenic is not a current concern for the Collins Park WTP.

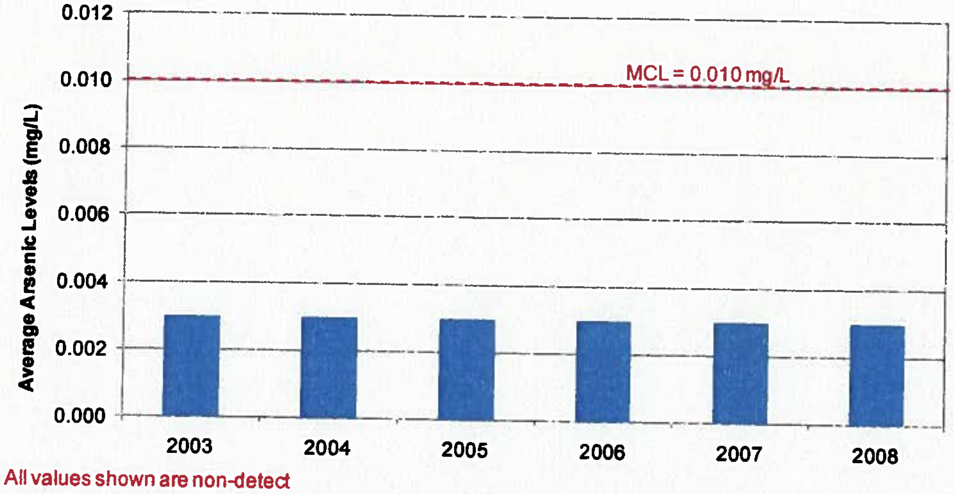


Figure 2-23: Arsenic Sample Results

2.3.6.4 *Radionuclides Rule*

The revised radionuclides rule was promulgated in December 7, 2000 and is applicable to community water systems (CWSs) of all size categories. The rule became effective in December 8, 2003. The revised rule retained the existing MCLs for combined radium-226, and radium-228, gross alpha particle radioactivity, and beta particle and photon activity. The rule regulates uranium for the first time.

The rule requires four consecutive quarters of initial monitoring for gross alpha, beta particle and photon radioactivity emitters, combined radium-226/228, and uranium. The samples must be collected at each entry point to the distribution system for initial monitoring between December 8, 2003 and December 30, 2007. Data collected between June, 2000 and December 8, 2003 could also be used to satisfy the initial monitoring requirements with permission from the State. The result from the initial monitoring determines the frequency of future (reduced or increased) monitoring. The MCLs and monitoring frequency for radionuclides are presented in Table 2-23 and Table 2-24 summarizes the monitoring requirements to comply with the rule.

Table 2-15: Radionuclides MCLs and Monitoring Frequency

Constituent	MCLG	MCL	MDL	Monitoring Frequency
Gross Alpha (excluding Radon & Uranium)	0 pCi/L	15 pCi/L	3 pCi/L	Quarterly every 4 years
Beta Particle and Photon Radioactivity	0 mrem/yr	4 mrem/yr	4 pCi/L	Quarterly every 4 years Tritium & Strontium annually
Combined Radium-226 228	0 pCi/L	5 pCi/L	1 pCi/L	Quarterly every 4 years
Uranium	0 µg/L	30 µg/L	1 µg/L	Quarterly every 4 years

Table 2-16: Radionuclides Rule Monitoring Requirements

Initial Monitoring
Four consecutive quarters for gross alpha, combined radium-226/228, and uranium.
Reduced Monitoring
One sample every 9 years, if the average of the initial monitoring results for each contaminant is below the detection limit.
One sample every 6 years, if the average of the initial monitoring results for each contaminant is greater than or equal to the detection limit, but less than or equal to one-half the MCL.
One sample every 3 years, if the average of the initial monitoring results for each contaminant is greater than one-half the MCL but less than or equal to the MCL.
One sample every 3 years, if running annual average of gross beta particle activity minus the potassium-40 activity is less than or equal to 50 pCi/L.
Increased Monitoring
Quarterly sampling until 4 consecutive quarterly samples is below the MCL.
Speciate as required by State and sample at initial monitoring frequency, if gross beta particle activity minus potassium-40 activity exceeds 50 pCi/L.

Available sample results for radionuclides from 2003 through 2008 are listed in Table 2-17. All gross alpha and radium-228 samples have been non-detect. In addition, many of the beta particle samples have been non-detect and those that were detected were measured at very low levels. Therefore, radionuclides are not a current concern for the Collins Park WTP. However, it should be noted that radium-226 and uranium sample results were not available for this review to be able to confirm compliance with their respective MCLs.

Table 2-17: Radionuclide Sample Results

Parameter	Sample Results (pCi/L)[1]					
	2003	2004	2005	2006	2007	2008
Gross Alpha	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Beta Particle[2]	<4.0	<4.0	<4.0	5	<4	4
Radium-228[3]	--	--	<1.0	<1.0	--	--

[1] Values preceeded by a "<" mean that the sample result was below the current method detection limit.
[2] The MCL and MCLG for Beta Particle and Photon Radioactivity of 4 (four) and 0 (zero), respectively, are listed in millirems per year.
[3] Radium-228 is regulated under the combined MCL for Radium-226 and Radium-228 of 5 pCi/L.

2.3.6.5 *Inorganic Chemicals*

Inorganic chemicals are required to be monitored annually at the entry point for surface water sources and once every three years for ground water sources. Some constituents, such as nitrate, nitrite and asbestos, have difference monitoring schedules. Asbestos need only be measured once every nine years unless the system is vulnerable to asbestos contamination. Surface water systems must monitor for nitrate quarterly. The regulated inorganic chemical compounds and their respective MCLs are listed in Table 2-18. Ohio EPA has established more stringent MCLs for some contaminants compared with federal regulations and therefore, the MCLs listed in the table are based on OAC 3745-81-11.

Table 2-18: Primary Inorganic MCL Standards

Inorganic Chemicals	MCL (mg/L)	MDL (mg/L)
Antimony	0.006	0.003
Arsenic	0.010	0.001
Asbestos	7 MFL	0.01 MFL
Barium	2	0.002
Beryllium	0.004	0.0002
Cadmium	0.005	0.0001
Chromium	0.1	0.001
Cyanide (as free cyanide)	0.2	0.02
Fluoride	4.0	
Mercury	0.002	0.0002
Total nitrate and nitrate (as Nitrogen)	45	NA

Inorganic Chemicals	MCL (mg/L)	MDL (mg/L)
Nitrate (as Nitrogen)	10	0.01
Nitrite (as Nitrogen)	1	0.01
Selenium	0.05	0.002
Thallium	0.002	0.001

[1] MFL = million fibers per liter greater than 10 microns
[2] There are multiple methods available. MDLs are based on Atomic Absorption: Furnace method.
[3] Source: OAC 3745-81-11

It should be noted that although the current MCL for fluoride is 4.0 mg/L, the recommended fluoride level has been lowered to 0.7 mg/L as a result of spotting on children's teeth and research that suggests lower IQs in children. As a result, EPA may reduce the allowable MCL for fluoride in the near future.

Sample results for select inorganic compounds for 2003 through 2008 are also included in Appendix B. Based on the analyses conducted, all parameters were non-detect with the exception of fluoride and nitrate; however, both compounds were detected at levels well below their respective MCLs. Therefore, regulated inorganic compounds are not a current concern for the City of Toledo based on the parameters tested.

2.3.7 Emerging Issues

As analytical methods and detection technology continue to advance more and more chemicals are being detected in drinking water. The contaminants that are new to water and wastewater includes pharmaceutical and personal care products (PPCPs), perfluorooctanoic acid (PFOA or C8), caffeine, toxins, endocrine disrupting compounds (EDCs), methyl tertiary butyl ether (MTBE), nano-materials, etc. The contaminants that made the contaminant candidate list are being analyzed for detection method so that they can be regulated for public health safety.

2.3.7.1 Unregulated Contaminant Monitoring Rule

The Unregulated Contaminants Monitoring Rule (UCMR) was designed to evaluate and prioritize contaminants for inclusion in federal drinking water regulations for the purpose of protecting public health. The rule intends to document the occurrence of the contaminants on the Candidate Contaminant List (CCL) to determine whether or not future regulation is warranted.

Based on the data from the first UCMR monitoring cycle (2001 - 2005), USEPA announced the second CCL (CCL2). The UCMR 2 rule describes the design for second UCMR cycle of 2007 to 2011. The list carried forward 51 of the original 60 contaminants identified in March 1998. The rule became effective in February 5, 2007. The effective monitoring period for UCMR 2 was January 2008 to December 2010. Collins Park WTP completed their sampling for the UCMR 2 in 2008. All parameters analyzed were non-detect for all samples collected.

The final third CCL (CCL3) was published in September 2009, and included 104 chemicals or chemical groups and 12 microbiological contaminants. The list includes, among others, pesticides, DBPs, chemicals used in commerce, waterborne pathogens, pharmaceuticals, and biological toxins. Twenty-four contaminants from the CCL3 are being considered for the UCMR 3, which is likely to be proposed in early 2011 and finalized in 2012, with monitoring to being in 2013. The UCMR 3 will follow the same basic format as the UCMR 1 and UCMR 2; however, consecutive systems will now also have to conduct the monitoring.

2.3.7.2 Methyl Tertiary Butyl Ether (MTBE)

MTBE has undergone UCMR monitoring to determine the viability of regulating the compound or removing it from the contaminant candidate list. All large PWSs systems have to monitor and report the presence of MTBE in their water supplies.

In December 1997, EPA issued an advisory as a guidance to keep the concentrations of MTBE in the range of 20 to 40 ppb of water or below to probably avoid unpleasant taste and odor and negative health effects. In UCMR monitoring, MTBE was detected 24 times in 17 out of 3,469 potable water systems. Of the 24 detections, the maximum concentration of MTBE was 49 µg/L, and the mean concentration was 14.7 µg/L. It is still unclear whether the MTBE concern is in localized regions or widespread throughout the country. It is very likely that if MTBE detections are localized, the monitoring would spark state regulation rather than federal. While the USEPA is still in the process of revising its MTBE risk assessment, the State of California has set an enforceable standard of14 µg/L for MTBE.

MTBE was sampled in 2003 and 2004, and both results were below the detection limit. Therefore, MTBE is not a current concern for Collins Park WTP.

2.3.7.3 Perchlorate

Another contaminant of concern for PWSs is the presence of perchlorate. Similar to MTBE, perchlorate was included in the UCMR and all large PWSs must monitor for perchlorate in their supplies. Perchlorate is used as the primary ingredients of solid rocket propellant and has an adverse effect on the thyroid gland and body metabolism when ingested. In UCMR monitoring, perchlorate was detected 583 times in 145 out of 3,405 systems. The maximum concentrations were observed in Puerto Rico (420 µg/L) and Atlantic Beach, Florida (200 µg/L). The mean concentration for the 583 detected samples was 9.8 µg/L. These perchlorate samples tended to be at the high end of the range and thus might warrant federal regulation sometime in the future.

Currently available information indicates that the EPA is planning to regulate perchlorate and that the standard could be in the range of 2 ug/L (which is the current standard in Massachusetts) to 15 ug/L, which is the non-enforceable interim health advisory from EPA. It is anticipated that the regulation may take approximately 2 years to develop.

Perchlorate data is not currently available for Collins Park WTP.

2.3.7.4 *Endocrine Disrupting Compounds and Pharmaceuticals and Personal Care Products*

Man-made chemicals, or their breakdown products, that are known to be capable of interfering with human endocrine system are categorized as EDCs. Potential health effects of exposure to EDCs include adverse reproductive outcomes, birth defects, breast cancer, developmental disabilities, endometriosis, thyroid problems and testicular cancer. EDCs include industrial chemicals such as polychlorinated biphenyl (PCBs), as well as a wide variety of pesticides, including herbicides, fungicides, nematocides, and insecticides (e.g., endosulfan, methoxychlor).

PPCPs we use daily, and some household compounds are starting to appear in drinking water systems around the country and in Europe. Some of these compounds are known to be hormonally active (i.e., EDCs), but their significance in drinking water is still not clear. Future monitoring and testing would need to be carried out to determine which of these compounds, if any, would pose a threat to human health and at what dose. While EDCs and PPCPs are not monitored nationwide, the State of California has proposed that any groundwater recharge reuse project "monitor the recycled water for EDCs and pharmaceuticals specified by the Department".

Sample results for select EDCs and PPCPs for 2003 through 2008 are included in Appendix B. Each parameter analyzed has been non-detect. Therefore, based on the parameters sampled, EDCs and PPCPs are not a current concern for Collins Park WTP.

2.3.7.5 *Algal Toxins*

Algal toxins was added to the 1998 CCL for consideration for possible future regulation. From a public health standpoint human illness associated with toxic algal blooms and consumption of toxin-contaminated shellfish in the US are paralytic, neurotoxic, amnesic, and diarrhetic shellfish poisoning. EPA has listed microcystin-LR, LA, RR, YR, cylindrospermopsin, and anatoxin-a as the most important algal toxins in the US. EPA anticipates developing analytical methods to quantify algal toxin occurrence in drinking water after which regulations can be set for utilities.

In addition, given recent significant recurring algal blooms in Ohio, the Ohio EPA is considering implementing MCLs and monitoring requirements for algal toxins before federal requirements are established. Algal toxin data is not currently available for Collins Park WTP. However, algal toxins may be a key concern given that the Collins Park source of supply and intake location is susceptible to algal blooms.

2.3.7.6 *N-nitrosodimethylamine*

N-nitrosodimethylamine (NDMA) is primarily known as an industrial contaminant commonly found with perchlorate and also forms as DBPs during chlorine or chloramine disinfection of water or wastewater systems. EPA has listed NDMA as a probable human carcinogen based in animal studies. Research is underway to determine the extent of NDMA occurrence in drinking water systems. EPA has proposed monitoring for NDMA under UCMR 2. California established the notification of 10 ng/L due to analytical method limitations. NDMA is also discussed in the Stage 2 D/DBPR as emerging DBPs, which have an estimated one in a million life time cancer risk of 7 ng/L based upon the induction of tumors. Current information indicates that it is possible that EPA could propose a standard as low as 10 or 20 ng/L if NDMA is regulated in the future.

NDMA was not detected during the UCMR 2 sampling, and therefore, is not a current concern for Collins Park WTP.

2.3.7.7 Chromium (VI)

Total chromium is a required nutrient for adults with a recommended daily intake of 50 to 200 µg. Total chromium [sum of Chromium (III) and Chromium (VI)] is regulated by EPA with an MCL of 0.1 mg/L, but no specific limit has been set for Chromium (VI). Chromium (VI) may cause cancer in laboratory animals, but the evidence of carcinogenicity via ingestion is not compelling. The National Toxicology Program (NTP) has been conducting toxicity studies on Chromium (VI), which may lead to future regulation. In addition, the EPA announced a recommendation to water utilities to provide additional monitoring for this contaminant.

Chromium (VI) sampling data is not currently available; however, annual values for total chromium for 2003 – 2008 were all non-detect, suggesting that chromium (VI) is presently not a concern for Collins Park WTP.

2.3.7.8 Groups of Contaminants

EPA is currently considering a new strategy to regulate some contaminants in groups and not individually. The EPA has identified three groups that may be ready for regulation, which include:

- Carcinogenic VOCs - This group is most likely the first to be regulated, and includes eight VOCs that are currently regulated (e.g., TCE, PCE) and eight additional contaminants that are included in the CCL3 list. As discussed in Section 2.3.5.2, all VOCs with the exception of the individual THMs and HAA5 were non-detect, and are not expected to be a concern for Collins Park WTP depending upon the specific compounds and limits included in the regulation.

- Nitrosamines – There are six nitrosamines that may be monitored under the rule, one of which is NDMA, which has been the most commonly occurring contaminant among the UCMR contaminants (and at relatively high concentrations compared to other nitrosamines). See Section 2.3.7.6 for additional information on NDMA. As discussed in Section 2.3.7.1, all UCMR 2 results were non-detect, which included all six nitrosamines. Therefore, nitrosamines are not anticipated to be problematic for the Collins Park WTP given the promulgation of a regulation.

- Chlorinated DBPs – There are some concerns about health effects of chlorinated DBPs at lower levels than are currently regulated. As discussed in Section 2.3.4, TTHMs and HAA5 are not a current concern; however, TTHMs may be of concern once Stage 2 D/DBPR takes effect. In addition, TTHMs and HAA5 may be problematic if there is a significant reduction in the MCLs.

EPA has also identified the three groups (perfluorocarbons (PFCs), organophosphates, and carbamates) for future consideration and three additional groups (triazines, cyanotoxins, and chloroacetanilides) for long-term consideration. The groups considered for future regulation have defined data gaps that first need to be addressed while the groups under long-term consideration have significant data gaps in addition to other concerns that must first be addressed.

2.3.7.9 *SWDA Six-Year Review*

As mentioned above, EPA is required to review each NPDWR at least once every six years and revise them, as appropriate. In March 2010, EPA released the results of the Second Six-Year Review, and has decided to revise four standards, which include:

- Tetrachloroethylene (PCE) and Trichloroethylene (TCE) (VOCs) – PCE and TCE are known carcinogens and are currently regulated at 5 µg/L, with MCLGs of zero. A health assessment is currently in process for these compounds, but new analytical feasibility and treatment technique information may justify lowering the standard for these compounds. Sampling data from 2003 through 2008 shows that all results for both PCE and TCE were non-detect. Therefore, PCE nor TCE is anticipated to be a concern even if the MCLs were reduced.

- Acrylamide and Epichlorohydrin (polymers) – These compounds are commonly-used polymers, and they have a MCLG of zero. Recent improvements in manufacturing techniques have resulted in lower levels of these compounds than those achieved using current treatment techniques. Additional work is needed to understand the impacts of these new techniques on treatment and to ensure that treatment is not compromised by the establishment of a stricter standard. Collins Park WTP does not add polymers in their treatment processes; therefore, these compounds are not a current concern.

2.3.8 Other Regulatory Requirements

2.3.8.1 *Consumer Confidence Reports Rule*

The Consumer Confidence Reports (CCR) Rule requires water systems to prepare and provide to their consumers annual consumer confidence reports on the quality of the water delivered by the systems every July. The annual CCR informs consumers what's in their water, where it comes from, and where they can obtain addition information. The CCR encourages consumer awareness and confidence in water supply. The CCR rule became effective September 18, 1998. The City of Toledo has been sending out yearly reports to its customers in accordance with the rule.

2.3.8.2 *Public Notification Rule*

The Public Notification Rule (PNR) was promulgated in May 18, 2000 and became effective from May 6, 2002. The PNR requires public water systems to notify the people who drink their water if the level of a contaminant in the water exceeds EPA and State drinking water regulations, if there is a waterborne disease outbreak or any other situation that may pose a risk to public health, if the water system fails to test its water as required, or if the system has a variance or exemption from the regulations. Depending on the severity of the situation, water suppliers have from 24 hours to one year to notify their customers. EPA sets strict requirements on the form, manner, content, and frequency of public notices. Public notification has to be provided in addition to the annual water quality report (CCR). Collins Park WTP has not exceeded any state or federal drinking water regulations, and therefore, has not had to notify the public.

2.4 Summary of Water Quality Performance at the Collins Park WTP

The water quality review for Collins Park WTP showed consistent compliance with rules and regulations, thus providing high quality water with complete consumer satisfaction. The data illustrated compliance with existing MCLs, treatment techniques, and monitoring requirements, and demonstrated that the plant on average achieves removals for turbidity, TOC and hardness beyond current standards. In addition, Collins Park WTP has consistently met all requirements regarding the removal/inactivation for *Giardia*, *Cryptosporidium*, and viruses.

Collins Park WTP has also simultaneously complied with all existing distribution related regulations including the Stage 1 DBPR, LCR and TCR. In addition, Collins Park WTP is well-positioned for compliance with the LT2ESWTR since the plant has historically complied with all CFE and IFE turbidity requirements and was classified as a Bin 1 facility. However, while DBP levels are not a current concern, compliance with the MCL and OEL for TTHMs may be problematic at some locations under the Stage 2 DBPR.

Emerging contaminants can be an area of major concern since Collins Park WTP is supplied by a surface water source, which tend to be highly susceptible to algal blooms and contamination from industrial, agricultural and recreational activities. Some of the contaminants on the CCL may require monitoring or undergo regulatory determination in the future. How USEPA will proceed with this is uncertain, but a contaminant-by-contaminant approach is costly and cumbersome. Regulatory attention to groups of compounds may be more feasible. Based on the available sampling data, many of the contaminants under consideration are not a current concern for Collins Park WTP. However, given that the Ohio EPA may pursue a regulation that controls the presence of algal toxins, it is recommended that Collins Park consider implementing a sampling and monitoring program to identify the occurrence of algal toxins and develop a response plan that identifies methods to control and remove the toxins, if detected.

3. Hydraulic Capacity Assessment

3.1 Introduction

As part of the 20-Year Master Plan and Needs Assessment, ARCADIS/Malcolm Pirnie was tasked with determining the hydraulic capacity of the plant using available data. From this determination, the overall affect upon unit processes and the need for expansion of the treatment capacity of the plant was determined. The findings of this assessment are summarized in this section.

The approach for this hydraulic determination encompassed a number of different factors. The process included an examination of each unit process during maximum day flows, maximum hourly flows and firm capacity with the largest unit out of service. Once the varying flows were analyzed, the unit processes were further reviewed for their ability to meet current and future regulatory standards including the new Ohio Capacity Rule, rated capacities, future demands, operational parameters, maintenance issues and overall water quality goals. All of this was considered when determining if a plant addition was necessary from a capacity viewpoint.

It would be prudent to repeat the hydraulic testing at the Collins Park WTP to verify the results. The procedure to do this is described in the next section.

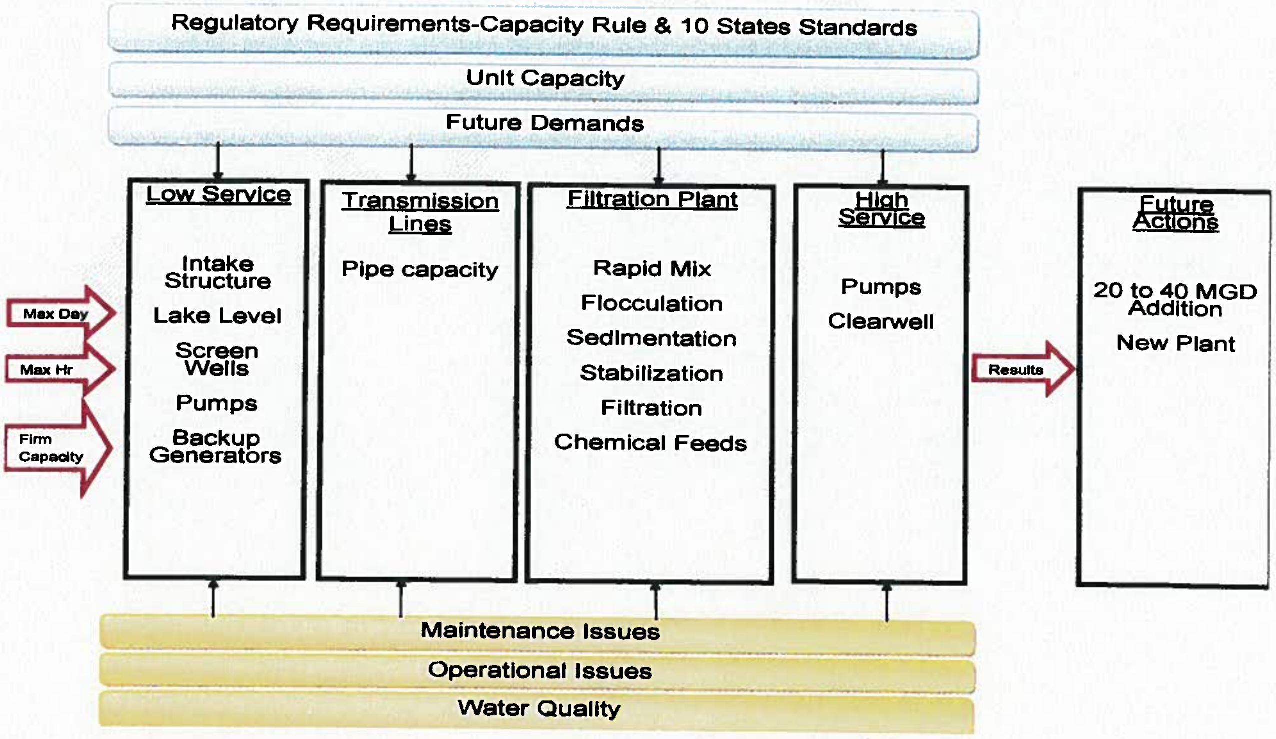


Figure 3-1: Hydraulic Capacity Overview

3.2 History

Hydraulic testing has been performed at the Collins Park WTP in 1967, 1968 and 1982. The basic configuration of the treatment process has not changed since 1982 with the exception of certain improvements, which will be discussed in this section.

The results of the 1982 hydraulic capacity testing will be reviewed in the following subsections. The system was tested by increasing the flows from Low Service to the WTP from 93 MGD to 184 MGD. This is the range of flows that are normally available during high flow times. Measurements were taken at 45 places within the system to determine base elevations of the water levels and help determine a hydraulic grade line and therefore hydraulic capacity of the system. In addition to the flow measurements, analytical data was taken to ensure that water quality parameters were being achieved. Hazen-Williams "C" Factor analysis was taken on the transmission pipe from the intake to Low Service.

3.2.1 Intake Results

Hydraulic testing of the intake conduit consisted of determining the Hazen-Williams "C" Factor by setting the Low Service Pumpage at a given rate and measuring the water surface elevations in the surge well and in a representative location of the lake surface level.

From these measurements, the total head loss was determined for the intake conduit. Based on the pumping rate, losses in the conduit were calculated and deducted from the head loss to determine the friction head loss in the conduit. From the recorded length of the conduit and calculated friction loss, the Hazen-Williams coefficient "C" was determined to be 92 to 95 in 1982. A more detailed discussion of this will be presented later in this section.

3.2.2 Low Service Pump Station Results

The Low Service results were as follows:

- The maximum capacity of Pump No. 1 operating alone at a speed of 430 RPM is 74 MGD with a lake level of 573.7 USGS.
- The maximum capacity of Pump Nos. 1 and 3 operating together is approximately 133 MGD without cavitation. Pump No. 1 was operating at approximately 465 RPM and Pump No. 3 at speed 11.
- The maximum capacity of Pump Nos. 1, 3 and 4 operating together is approximately 168.5 MGD. Pump No. 1 was operating at controller setting 98 (508 RPM) and Pump Nos. 3 and 4 at speed 11.
- The maximum capacity of Pump Nos. 1, 2, 3 and 4 operating together is estimated to be 184 MGD. Pump No. 1 was operating at controller setting 98 (508 RPM) and pump No. 2, 3 and 4 at speed 11.
- "C" Factor influences the ability of the low service station to deliver water to the filtration plant.
- Lake water levels influence the ability of the low service pumps to deliver water to Collins Park.

3.2.3 Results from Treatment Plant Results

The results from the filtration plant are as follows:

- At flows of 184 MGD, the distribution within the plant was as follows:
  - Basins 1 and 2-62 MGD
  - Basins 3 and 4-60 MGD
  - Basins 5 and 6-62 MGD
- Overflow of the sidewall weirs in flocculation basins 1-4 occurred.
- Weir overflow was also noticed in 1988. The problem is that overflow and backwash water surcharged the wash water handling facility.
- New effluent valves and rate of flow controller installed in the early 1990's has helped with this problem although not eliminated it.
- Up to flows of 160 MGD, the inlet gates on all basins do not need to be changed. Above this, changes need to be made to force water to certain basins.
- At high flow rates, the filtered water should be split between the two reservoirs for parallel operation rather that series flow.
- Parallel operation of reservoirs will allow for greater head loss across the filters for proper rate of flow control, prevent accidental surcharging of the weir chamber in the new reservoir and will increase the capacity of the chlorine injectors by reducing the back pressure in the piping.
- Raw water turbidities increase above flow rates of 150 MGD due to the scouring of the raw water lines.
- The quality of flocculated, settled and filtered water decreased with higher flows. The 40 MGD plant performed worse than the 80 MGD plant in this respect.

3.2.4 Overall Summary

The hydraulic capacity of the Low Service Pump Station is 184 MGD with all pumps in service and a lake level of about 573.61 feet. The rated capacity of all four pumps is about 203 MGD. The firm capacity of the station is about 143 MGD, assuming the largest pump is out of service (i.e. Pump No. 1, which has a capacity of 60 MGD). The pumping capacity of the Low Service Pump Station is, however, governed by the lake levels, the "C" factor resistance of the intake conduit, the hydraulic grade line from the lake to the water levels in the pumping wells and the drawdown caused by the pumps in the pumping wells during operation.

Since 1982, the "C" factors have improved from the historical average of 92-94 to a current "C" factor of 108, primarily due to potassium permanganate addition for zebra mussel control. Permanganate is added at the intake to prevent zebra mussels from attaching to the interior surface of the transmission pipe. The addition of permanganate also helps remove algae and moss from building-up on the pipe interior wall, resulting in a cleaner interior surface of the pipe.

The low service pumps have routinely been rebuilt (see Section 4 for details); however, this has not significantly affected their pumping capacity. The rebuilds have increased the mechanical efficiency of the pumps, but has not altered their overall capacity to transmit water.

The filtration plant can process the 184 MGD flow with some adjustments and modification to the treatment process.

3.3 Ohio Capacity Rule

The purpose of the Ohio Approved Capacity Rule is to provide, in a manner efficient and free of unnecessary delays, a framework for establishing an approved capacity for: 1) water-supply sources, 2) drinking water treatment plants, and 3) source/WTP systems.

Approved capacity means the allowable rate at which water may be processed by a component of a water-supply source or a WTP and is based on the limiting component. Approved capacity of a source/WTP system is the lesser between the approved capacity of the source or the WTP itself.

The approved capacity of a water-supply source must be large enough that source water can be delivered to the WTP at a flow rate equivalent to the: 1) design-year average-day demand on a continuous basis, and 2) design-year maximum-day demand on at least a one-day basis.

The approved capacity of a water-supply source must be:

- Average-day production on a continuous basis, and
- Maximum-day production on at least a one-day basis

The approved capacity of the WTP must be large enough that finished water can be: 1) processed at a flow rate equivalent to the design-year maximum-day demand, 2) disinfected at a flow rate equivalent to the design-year peak-hour of treatment rate, and 3) delivered to the distribution system at a flow rate equivalent to the design-year peak-hour demand.

The approved capacity of the source/WTP system must be large enough that finished water can be delivered to the distribution system at a flow rate equivalent to the design year peak-hour demand.

The approved capacity of the WTP finished water must be:

- Flow rate equivalent to the maximum-day production
- Disinfected equivalent to the peak-hour rate, and
- Delivered to the distribution system at the peak-hour production.

Component capacity of surface water sources is based on the limiting component for the combination of stream flow, source-water storage capacity, and/or source-water pumping based on generally established hydrologic analysis methods.

For components in which the design criteria for determining component capacity is based on supplying the average-day water demand, the component capacity is the allowable rate not to be exceeded over a 12-month period, or the period during the year the water-supply source or WTP component is in operation if the water-supply source and/or WTP component is not operated 365 days each year.

For components in which the design criteria for determining component capacity is based on supplying the maximum-day water demand, the component capacity is the allowable rate not to be exceeded over a one-day period, or the period during the day the water supply source or WTP component is in operation if the water-supply source and/or WTP component is not operated 24 hours each day.

Specific performance and capacity criteria established in the Ohio EPA rule to rate the various WTP processes which are applicable to the Collins Park WTP are outlined below:

3.3.1 Source-Water Pumping

- The component capacity for most components is based on all units in service except the largest source-water pump needs to be considered out-of-service.
- Source-water pumping stations pumping directly to the WTP must be able to supply
- at least the maximum-day production.

3.3.2 Water Treatment Plant

- The component with the smallest maximum-day capacity (i.e., the limiting component) determines the approved capacity of the WTP.
- The component capacity for most components is based on all units in-service.
- For WTPs processing surface water-supply source(s) the approved capacity is determined with the largest filter and/or finished-water pump(s) out-of-service.

3.3.3 Water Treatment Plant Unit Processes

1. Rapid mix/coagulation units

Required criteria:	
Number of units	≥ 2 (TSS Section 4.1.a)
G value	Based on an engineering submission that justifies the design basis for the G value
Recommended criteria:	
Detention time	≤ 30 sec with mixing equipment capable of imparting a minimum velocity gradient (G) of at least 750 fps/ft. The design engineer should determine the appropriate G value and detention time through jar testing (TSS Section 4.1.2.a)*

2. Mechanical flocculation basins

Required criteria:	
Number of units	≥ 2 (TSS Section 4.1.a)
Recommended criteria:	
Flow-through velocity	≥ 0.5 fpm and < 1.5 fpm

Detention time	≥ 30 min (TSS Section 4.1.3.b)*

3. Settling basins

Required criteria:	
Number of units	≥ 2 (TSS Section 4.1.a)
Launder loading (weir overflow) rate	≤ 20,000 gpd/ft (TSS Section 4.1.4.c.1)
Detention time	≥ 4 hrs for clarification (TSS Section 4.1.4.a)
Outlet Velocity	< 0.5 fps entrance velocity at submerged orifices
Recommended criteria:	
Surface loading rate	≤ 0.5 gpm/sf for clarification ≤ 0.75 gpm/sf for softening
Flow-through velocity	≤ 0.5 ft/min (TSS Section 4.1.4.d)
Length: width Ratio	≥ 3:1

4. Recarbonation units

Recarbonation basins	
Required criteria:	As justified by an engineering submission for plants that use precipitative softening
Recommended criteria:	
Detention time	
Total	≥ 20 min (TSS Section 4.8.1.a.1)
Mixing compartment	≥ 3 min (TSS Section 4.8.1.a.2.a)
Diffuser submergence	≥ 7.5 ft (TSS Section 4.8.1.a.2)

5. Filters

The accepted filtration rate for a single media sand or anthracite filter is 2.0 gallons per minute per square foot (gpm/sf) of filter area with the largest filter out-of-service.
Filtration rates greater than 2.0 gpm/sf for single media sand or anthracite filter may be approved if justified by an engineering submission.

6. Backwash

Required criteria:	
Number of sources	A minimum of a primary and backup system (e.g. Two pumps, tank and a pump
Flow capacity	> 15 gpm/sf for 15 minutes; (TSS Section 4.2.1.11.a for 15 gpm/sf; TSS Section 4.2.1.11.d for 15 min.) > 20 gpm/sf recommended, based on water temperature) (TSS Section 4.2.1.11.a)

7. Clearwells

Required criteria:	
Number of units	> 2 (TSS Section 7.1.2.d)
Detention time	ability to demonstrate 0.5-log inactivation of *Giardia lamblia and 2.0-log inactivation of viruses* at peak-hour of treatment, minimum clearwell level, minimum water temperature, and maximum pH value using an approved effective volume factor; seasonal ratings must be justified by an engineering submission documenting the CT requirements contained in OAC rule 3745-81-72 can be met during all seasons

3.4 Current and Projected Water Demands

The City of Toledo, like many other cities, is experiencing a shift in the concentration of population from the City to the outer limits of the metropolitan area. This is evidenced by data obtained from the Toledo Metropolitan Area Council of Governments (TMACOG), which was utilized for the future demand projections presented herein. The projections consider a 25 year planning period with demands projected through 2035.

3.4.1 Population Projections

An estimate of the future population and the proper distribution of the population are necessary in the design of future water facilities. Improvements to the system are dependent on population and demands of customers, both residential and commercial within the water service area. Data available from the TMACOG was utilized as the basis for estimating population for the design period.

The Collins Park WTP supplies water directly to City customers in addition to multiple contract service areas that are located outside of the City. Water is delivered to these areas through either master meters (Maumee; Perrysburg; Sylvania; Fulton County; Wood County/Northwestern Water and Sewer District and Monroe County, MI/South County Water) or through booster pumping stations (Northwest Lucas County and Southwest Lucas County contract service areas).

Table 3-1 shows past populations of the City of Toledo and surrounding areas as well as the projected population of these areas for 2035. This data is provided by the U.S. Census, as well as from TMACOG. This supports the general trend of the population shifting from within City limits to the adjacent communities and suburbs.

Table 3-1: Population Projections

Service Area	2000 Census Population	2005 Service Population	2035 Service Population
Toledo	313,619	304,326	242,650
Wood Co./NWW&SD	16,012	16,498	19,812
Sylvania	18,670	21,200	21,200
Maumee	15,237	15,080	12,908
Monroe Co./South County Water	39,940	34,112	60,399
Perrysburg	29,197	24,621	37,744
Southwest Lucas County	45,367	39,498	61,730
Northwest Lucas County	36,452	26,453	35,943
Fulton Co.	42,084	0	15,789
Southeast Lenawee Co.	6,344	0	13,252
TOTALS	**562,922**	**481,787**	**521,428**

3.4.2 Current and Future Water Demands

Present and future water demands are directly related to the residential, commercial and industrial development located in the service area. In 2010, the annual pumpage expressed as daily water use was 73.1 MGD for the average day and 116.6 MGD for the maximum day. The peak hour pumping rate from the WTP in 2010 was 147 MGD. Table 3-2 shows the record in past years of average day, maximum day, and peak hour water demands. This table also is representative of water sold to contract service areas outside the City limits.

Table 3-2: Record of Past Water Use

Year	Avg. Day MGD	Max. Day MGD	Peak Hour* MGD
1980	73	113	153
1981	71	117	136
1982	69	105	123
1983	68	114	140
1984	70	112	131
1985	72	119	146
1986	70	102	125
1987	71	117	142
1988	79	147	177
1989	73	115	133
1990	72	115	146
1991	75	129	148
1992	69	101	119
1993	72	118	158
1994	76	132	144
1995	75	120	157
1996	77	124	n/a

Year	Avg. Day MGD	Max. Day MGD	Peak Hour* MGD
1997	76	116	155
1998	81	132	160
1999	83	137	156
2000	77	109	138
2001	81	141	166
2002	82	139	170
2003	78	125	144
2004	79	117	137
2005	84	137	154
2006	78	118	144
2007	81	131	158
2008	77	111	153
2009	72	104	132
2010	73	117	147

*Data for Peak Hour does not include Heatherdowns Pumpage.

Table 3-3 shows the existing average day and maximum day demands for each of the suburban service areas. This data was obtained from the governmental units that control the various contract service areas.

Table 3-3: Existing Suburban Water Demands

Service Area	Avg. Day MGD	Max. Day MGD
Wood Co./NWW&SD	3.35	6.04
Sylvania	2.14	4.85
Maumee	2.35	4.68
Monroe Co./South County Water	3.36	7.35
Perrysburg	2.57	4.84
Southwest Lucas County*	8.06	14.50
Northwest Lucas County	2.81	5.90
Fulton County	1.50	1.75

*Includes Fulton County

A critical element of the suburban customers is that they should not draw water from Toledo at a rate above their peak hour demand rate. Peak hour demand should be supplied by the customers own pumps from ground storage reservoirs or from elevated tanks. In all cases, Toledo delivers water through pressure sustaining valves to a ground storage reservoir from which each suburban customer pumps into its own distribution system.

The estimated population presently served within Toledo and surrounding communities was shown in Table 3-1. The water usage, in terms of gallons per capita per day, is presented in Table 3-4. These usage rates are calculated by combining the data in Table 3-1 with the demands shown in Tables 3-2 and 3-3. These figures include residential and industrial use, public use and loss.

Table 3-4: Per Capita Water Use

Service Area	Existing	Design
Toledo	184.5	185
Wood Co./NWW&SD	203.3	205
Sylvania	101.1	100
Maumee	156.1	155
Monroe Co./South County Water	98.5	100
Perrysburg	104.2	105
Southwest Lucas County	166.1	165
Northwest Lucas County	106.2	105
Fulton Co.	1100	315
Southeast Lenawee Co.		90

The second column of Table 3-4 shows the gallons per capita usages that will be used to project the future design demands. The design per capita usages were multiplied by the TMACOG 2035 population projections shown in Table 3-1 for each service area to obtain the 2035 average day demands. These demands are displayed in Table 3-5.

Table 3-5: Estimated 2035 Average Day Demands

Service Area	MGD
Toledo	44.9
Wood Co./NWW&SD	4.1
Sylvania	2.1
Maumee	2.0
Monroe Co./South County Water	6.0
Perrysburg	4.0
Southwest Lucas County	10.2
Northwest Lucas County	3.8
Fulton Co.	5.0
Southeast Lenawee Co.	1.2
TOTAL	**83.3**

In addition to average day demands, a water system must be designed to deliver future maximum day and peak hour demands. Water demands are expressed as average daily demand, maximum daily demand, and peak hourly demand to properly design a water distribution system.

After analyzing this information and taking into account variation in water loss and the past 1996 Study ratios, the following ratios were used for projecting future water demand on the Toledo Water System.

Table 3-6: Estimated Future Ratios of Demand

Maximum Day to Average Day	1.60
Peak Hour to Maximum Day	1.31
Peak Hour to Average Day	2.10

These ratios are only slightly different than the ratios of demands used in the 1996 study. When applying the ratios of demand listed in Table 3-6 to the year 2035 average day demand, yields the following 2035 maximum day and peak hour water demands. The diurnal demands experienced are included in Appendix B.

Table 3-7: Estimated 2035 Total System Demands

Average Day	83.3 MGD
Maximum Day	133.3 MGD
Peak Hour	174.9 MGD

The water demands listed in Table 3-7 are totals for the entire system, including all existing and future suburban water contract service areas.

To confirm the future demand projections, historical pumpage was graphed and a best fit curve was applied to the data and extrapolated through 2035. The following graphs show the information:

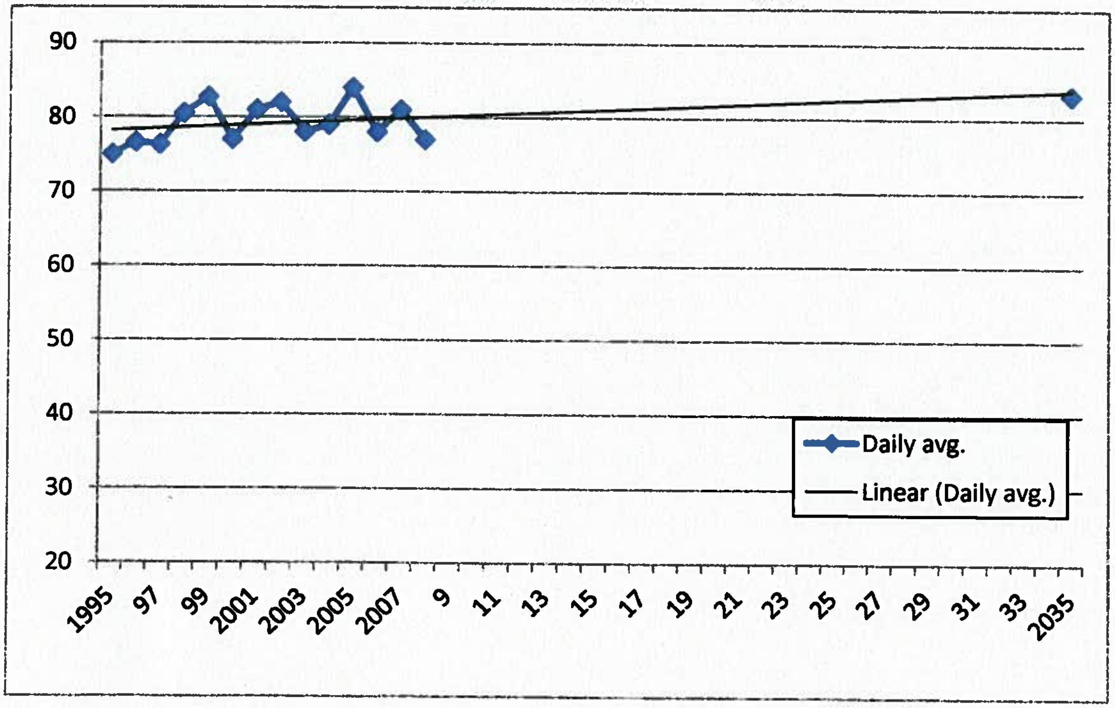


Figure 3-2: Toledo Water Daily Projection to 2035

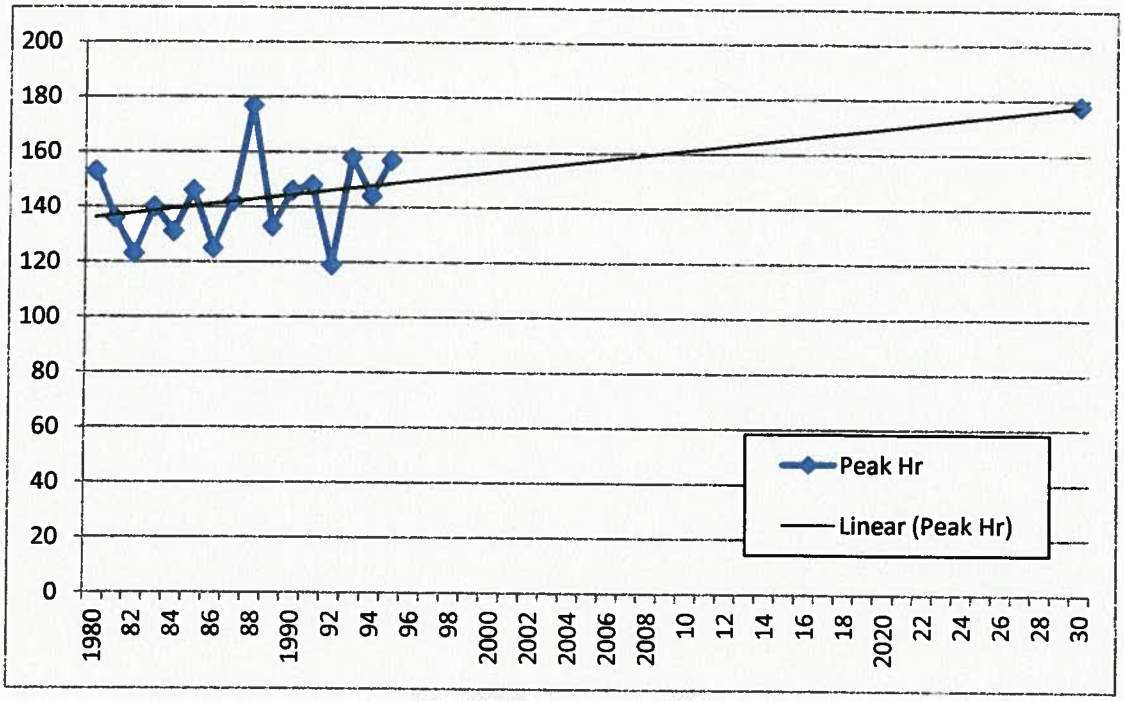


Figure 3-3: Toledo Water Peak Hour Projection to 2030

The projected 2035 daily average flow of 83.3 MGD presented in Table 3-7 agrees closely with the extrapolated flow of 83 MGD from Figure 3-2. Also, the data from Figure 3-3 projects peak hour of 178 MGD in 2030 while the data from Table 3-7 (from the water distribution study information) projects a peak hour of 174.9 MGD. Again, the agreement is close.

The projected 2035 average demand of 83.3 MGD is approximately 13.8% higher than the 2010 average of 73.1 MGD. However, when compared to the daily average from 2000 to 2010, the daily average is about 78.3 MGD, which represents only a 6.3 % difference to the 2035 projected average flow.

The data shows that the expected growth demands over the Master Planning period is relatively flat and the overall system demands will remain fairly constant. Much of this trend is explained by the demographics of the population base of the metropolitan area.

The shift in population from the City of Toledo to the suburban communities is shown in Tables 3-3 and 3-5. Some communities such as Maumee and Sylvania will remain constant or slightly decrease while most of the outlying communities increase significantly. This relative distribution of the increasing numbers in the outlying communities is directly related to the smaller numbers within the City itself. The amount of water needed for the City of Toledo will decrease and the anticipated demands for the outlying communities will increase. However, the overall amount will remain relatively constant as both areas are within the water service area. The overall volume of water needed does not significantly change over the study period.

This finding is consistent with the results of the Water Distribution Study.

3.5 Low Service Pumps

To evaluate Low Service Pumping capacity, consideration must be given not only to the capacity of the pumps, but also to the associated upstream and downstream components. Components associated with Low Service Pumping are illustrated in the following diagram:

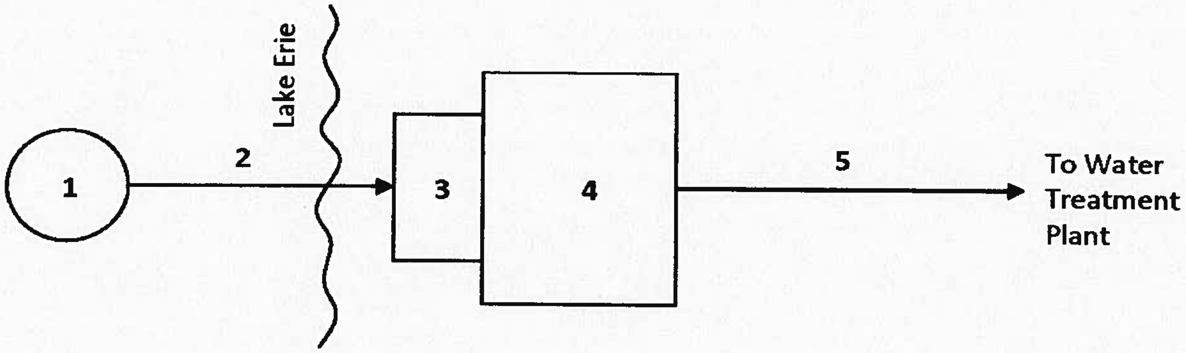


Figure 3-4: Intake and Low Service Diagram

Where:

1. Intake
2. 108-inch diameter intake conduit
3. Traveling Water Screens
4. Low Service Pumps
5. 78-inch and 60-inch diameter raw water mains

With the exception of the pumps, the capacity of each component is determined assuming all units are in service. In accordance with Ten States Standards, the firm pumping capacity is determined assuming the largest pump is out of service. A summary of component capacities is presented in Figure 3.4

The Low Service Pumps have a combined rating of 203.4 MGD. In using Ten States Standards the firm capacity of the pumps is 143 MGD.

Table 3-8: Low Service Pumps

Pump Number:	**1**	**2**	**3**	**4**
Manufacturer:	Worthington	Worthington	Worthington	Worthington
Capacity:	41,700 gpm	33,200 gpm	33,200 gpm	33,200 gpm
Capacity (mgd):	**60**	**47.8**	**47.8**	**47.8**

Table 3-9: Low Service Basis of Design

Component	Number of Units	Design Criteria	Required/ Recommended	Component Capacity (MGD)	Flow Basis of Component Capacity/ Ratio	Equivalent Maximum-day Capacity (MGD)
Intake	One	Inlet port velocity <0.3 fps to reduce potential for frazzle ice formation	recommended	300		
Intake Conduit	One	Intake conduit headloss	required	165[1]	Maximum-day 1.0	165[1]
Traveling Water Screens	Two	2.5 fps max. clear opening flow through velocity with clean screen	recommended	160		
Low Service Pumps	Four	Maximum-day Without largest	required	143	Maximum-day 1.0	143
Raw Water Mains	Two	5 fps or less velocity	recommended	167		

[1] Based on record (1918-2008) low monthly mean lake water elevation of 569.1, conduit "C" factor of 105, and suction bell submergence for prevention of vortices per Hydraulic Institute recommendations.

Periodic testing has been conducted on the 108-inch diameter intake conduit to determine the headloss from the Intake to the Low Service Pumping Station at various flow rates. The observed headloss values are used to calculate a Hazen Williams "C" factor. The "C" factor is a measure of the pipe wall roughness. Since water flows by gravity from the Intake Structure to the Low Service Pumps, the higher the headloss through intake conduit, the lower the water level becomes at the Low Service Pumps. If the conduit headloss is too great, the submergence of the pump suction bells becomes inadequate, thus limiting pumping capacity. As noted in Table 3.9, the Intake conduit capacity is based on a historical, low monthly mean lake elevation of 569.1 and a conduit "C" factor of 105. This represents a worst case scenario for lake levels.

In the 1980's, zebra mussels infested the Intake Conduit. This resulted in higher headlosses through the conduit due to the mussels attached to the conduit wall. The higher headlosses are illustrated in Figure 3-5 (the lower the "C" factor, the higher the headloss). To combat this condition, sodium hypochlorite started being fed at the intake. This practice was very effective, but discontinued due to concerns over disinfection by products. Soon thereafter, potassium permanganate began being utilized to control zebra mussel infestation on the pipe walls. A summary of historical "C" Factor test results are illustrated in the following Figure 3-5.

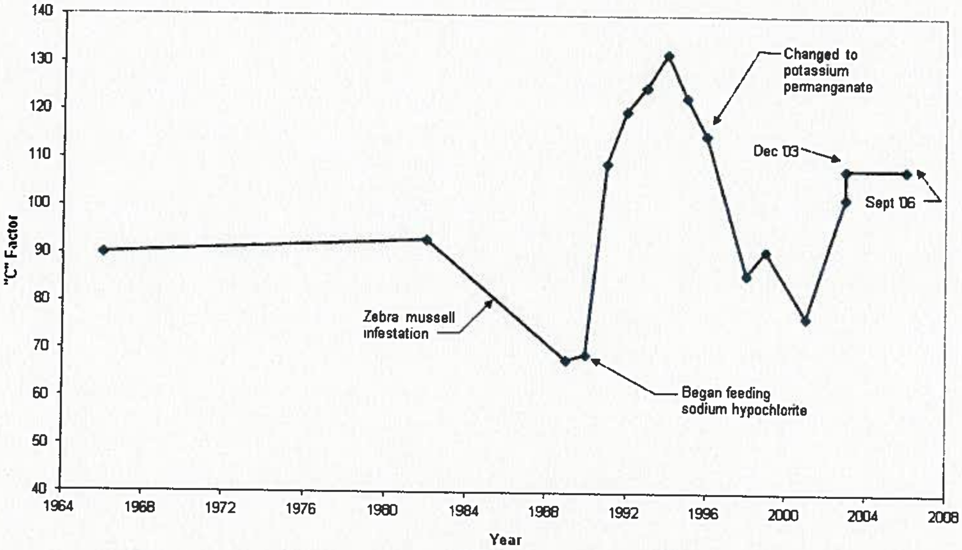


Figure 3-5: Historical C Factor Results

The firm capacity of the Low Service Pumps is 143 MGD as taken from the pump ratings. From operational experience at normal lake levels, the actual capacity of three pumps typically exceeds the rated capacity and can go up to 168.5 MGD. The average day and maximum day demands can be met with the largest pump out of service. Based on historical performance, it is assumed that the hydraulic capacity of the Low Service Pump Station is sufficient to meet projected future demands during the planning period.

3.6 Water Treatment Plant Hydraulics of Unit Processes

Each of the unit processes at the water treatment plant was examined to determine if the capacity of the process would meet the hydraulic demands.

Table 3-10: Basis of Design for the Collins Park WTP

Component	Number of Units	Design Criteria	Required/ Recommended	Component Capacity (MGD)	Flow Basis of component Capacity/ Ratio	Equivalent Max-day Capacity (MGD)
Rapid Mixing	Two (2)	Min 2 units	Required	Meets		
		Min G-Value of 750	Recommended	Not met		
		Max detention time of 30 sec	Recommended	Meets		
Flocculation	Six (6)	Min 2 units	Required	Meets		
		Flow thru vel. 0.5-1.5 fps	Recommended	30	1.0	30
		Min detention time of 30 min	Recommended	159	1.0	159
Sedimentation	Six (6)	Min 2 units	Required	Meets		
		Max weir overflow rate of 20,000 gpd/ft	Required	10	1.0	10
		Max detention time of 4 hrs	Required	95	1.0	95
		Max outlet Vel of 0.5 fps	Required		1.0	
		Max surface Load rate of 0.75 gpm	Recommended	149	1.0	149
		Max flow-thru Vel. Of 0.5 fpm	Recommended	37	1.0	37
		Max length/ width ratio of 3:1	Recommended	Meets		
Recarbonation	Six (6)	Max detention time of 20 min	Recommended	60	1.0	60
		Min mixing time of 3 min	Recommended	106	1.0	106
		Min diffuser submerge of 7.5 ft	Recommended			
Filtration	Thirty (30)	Max filter rate of 3 gpm/sf	Required	168	1.0	168
		Primary & Second Backwash Sources	Required	Meets		
		Max wash Q capacity of 15 gpm/sf for 15	Required	Meets		
Clearwells	Two (2)	Min 2 units	Required	Meets		
		0.5 log inactivation of Giardia	Required	210	1.0	210
		2.0 log inactivation of Viruses	Required	2555	1.0	2555
HS Pumps	Six (6)	Peak hour demand flow capacity	Required	180	1.2	150

Each area was evaluated to determine its equivalent maximum-day capacity. At the conclusion of the evaluation, the overall treatment capacity was determined to be the capacity of the lowest area's ability in the treatment process. The evaluation results are documented in Table 3-10. The Collins Park WTP has the following seven main areas that were evaluated as they relate to the treatment process.

- Rapid Mix
- Flocculation
- Sedimentation
- Recarbonation
- Filtration
- Clearwells

- High Service Pumping

3.6.1 Rapid Mix

The capacity associated with this area of the treatment process requires that a minimum of two units be provided. The Collins Park Water Treatment Plant does satisfy this minimum requirement as it has two (2) units. The Ohio Capacity Rule recommends that a mixing intensity G-Value of 750 be attained and that the detention time not exceed 30 seconds. Given the current arrangement of mixing in the raw water channels, mixing intensity G-Values have been projected at levels lower than 750. The detention time between the existing baffles in each of the raw water channels is approximately 10 seconds.

The plant generally achieves good mixing and floc formation with the current channels. However, it is recognized that additional mixing intensity and improved chemical application may be beneficial to this process. Section 5 discusses several options to improve mixing intensity and chemical application in the rapid mix channels.

3.6.2 Flocculation

The Ohio Capacity Rule associated with this area of the treatment process requires that a minimum of two units be provided. The Collins Park Water Treatment Plant does satisfy this minimum requirement as it has six (6) flocculation basins. The rule recommends that the flow-through-velocity be between the range of 0.5 and 1.5 feet per minute (ft/min) and that the basin detention time be a minimum of 30 minutes. The flocculation basins at the Collins Park WTP do not meet the recommended flow-through-velocity and minimum detention time criteria.

The results of the hydraulic flows through the flocculation basins indicates that they technically do not meet all of the standards, however, the lime-soda ash softening system and the treatment process develops floc with excellent settleability characteristics. As discussed in Section 2, the overall treatment process produces excellent quality water and as such the need to expand the size of the basins is not considered necessary at this time. In addition, as discussed in section 5, an addition to the treatment plant of 40 MGD will provide extra capacity and reduce the flow through velocities in all basins.

3.6.3 Sedimentation

The Ohio Capacity Rule associated with this area of the treatment process requires that a minimum of two units be provided, the weir overflow rate not exceed 20,000 gallons per day per foot (gpd/ft) and the basin detention time be a minimum of 4 hours. The Collins Park WTP satisfies the minimum unit number requirement as it has six (6) sedimentation basins. However, it does not provide adequate detention time or weir overflow rate. The rule also recommends that the maximum surface load rate be 0.75 gallons per minute per square foot (gpm/sf), the flow-through-velocity not exceed 0.5 feet per minute (ft/min), and the basins have a minimum length-to-width ratio of three to one. The treatment plant meets the surface load rate criteria and the minimum length-to-width criteria, but does not meet the maximum flow-through-velocity criteria.

Again, the results of the hydraulic flows through the sedimentation basins on the 80 MGD side of the plant indicates that they technically do not meet all of the standards, however, this is a lime-soda ash softening system and the treatment process develops excellent floc. Most of the flocc settles in the first one-third of the basin. Based on historical performance, the overall treatment process produces excellent quality water and does not overload the filters with carry-over solids. As such the need to expand the size of these basins is not considered necessary at this time. In addition, as discussed in Section 5, an addition to the treatment plant of 40 MGD will provide extra capacity and reduce the flow through velocities in all basins.

3.6.4 Recarbonation

The Ohio Capacity Rule associated with this area of the treatment process recommends that the basin detention time be a minimum of 20 minutes, the minimum detention time for mixing be 3 minutes, and a minimum diffuser submergence of 7.5 feet.

These standards are recommended standards. The Collins Park WTP has a detention time in the recarbonation basins of 10 minutes, mixing detention time of 1.9 minutes on the 80 MGD side and 3.5 minutes on the 40 MGD side. However, it should be noted that additional detention time and mixing is provided in the effluent conduit from the recarbonation basin to the filters, which provides adequate time for effective stabilization as evidenced by the historical performance of the process (see Section 2 for details).

This study is recommending an addition to the treatment plant of 40 MGD which will provide extra capacity and reduce the flow through this area and increase efficiencies.

3.6.5 Filtration

The Ohio Capacity Rule associated with this area of the treatment process requires that the filtration rate be determined with the largest filter out of service, that primary and secondary means of filter backwash are provided and that the minimum backwash flow capacity be 15 gpm/sf for 15 minutes.

The Collins Park WTP essentially meets these requirements. If a plant addition is constructed, additional filters will be built and reduce the flow to existing filters. We have also recommended improvements to the backwash system pumps.

3.6.6 Clearwells

The Ohio Capacity Rule associated with this area of the treatment process requires that a minimum of two units be provided, that sufficient CT time be provided to achieve 0.5-log inactivation of giardia lamblia, and that sufficient CT time be provided to achieve 2.0-log inactivation of viruses.

The two-35 MGD clearwells meets the current requirements (see discussion in Section 2.3.2.5).

3.6.7 High Service Pumping

The Ohio Capacity Rule associated with this area of the process requires that the pumping capacity meet the distribution system peak hour demand with the largest high service pump out of service.

The High Service Pump Station has a combined capacity of 179.6 MGD firm capacity with Pump No. 6 out of service. This is not readily apparent by simply looking at the pump ratings. Many factors go into determining pump combinations and usage, which can be found in the operations manual.

Table 3-11: High Service Pump Capacities

Pump No.	Pump Capacity (MGD)	Head (feet)	Cell (1)
1	64.8	210	A
2	64.8	210	A
3	50.0	210	B
4	64.8	210	C
5	40.0	210	C
6	67.7	210	B

(1) Only one pump operates per cell at one time

(2) High Service Pump Component Capacity 179.6 MGD

3.7 Chemical Feeds at the Water Plant

There are a number of chemical feed systems at the Collins Park WTP. In determining if the plant can meet future hydraulic demands, the capacity of the chemical feed systems also needs to be verified with respect to meeting future demands. The plant uses the following major chemicals:

- Alum
- Lime
- Soda Ash
- Carbon Dioxide
- Polyphosphate
- Chlorine Dioxide
- Fluoride
- Chlorine

3.7.1 Alum

The chemical system for alum consists of 2,000 gallon storage tanks, transfer pumps, day tanks and alum Rotodip feeders.

The total bulk storage tank volume of 24,000 gallons provides approximately 10 days of storage under average flow and dosage conditions. This is insufficient to meet the recommended Ten States Standard of 30-day storage under average usage conditions. Under peak usage conditions, the total bulk storage volume can be utilized in a single day.

The Rotodip feeders are capable of feeding 43,200 gallons per day. The actual projected feed requirements under peak hour conditions is about one quarter of this rate. As such, the alum Rotodip feeders have sufficient capacity to meet future demands.

3.7.2 Lime

The lime feed system is composed of storage bins and lime slakers. The slaker capacity is sufficient but, at high pumpage times, the demand requires that three slakers be used. At other times, the flow split between the 80 MGD and 40 MGD plants may need to be adjusted. Each slaker is capable of feeding 96,000 lb/day and the maximum day usage is roughly 215,000 lb/day. Three units will need to be used with two to the 80 MGD side.

Overall, the slakers have the necessary capacity to meet the present and future demands.

3.7.3 Soda Ash

The soda ash feed system is composed of storage bins and dry, gravimetric feeders.

The highest soda ash feed over the ten year data period was approximately 6.2 grains per gallon (GPG) or 106 parts per million (PPM). At the peak hour flow rates, the current soda ash feeders would be able to meet this demand. This feed rate, along with the other highest feed rates, occurred in the spring of the year during the lake turnover. This does not correspond to the highest pumpage times of the summer.

The soda ash feed equipment capacity is sufficient to meet projected future demands.

3.7.4 Carbon Dioxide

The carbon dioxide feed system was recently renovated in 2009. At that time, the capacity of the feed system was investigated and designed accordingly. As discussed in Section 5, some improvements to the section of the system that was not upgraded under the last improvement are necessary to meet feed requirements.

3.7.5 Polyphosphate

The polyphosphate system is fed at a relatively constant feed rate and is flow paced to meet the demand of the system. The existing metering pumps are sized to be able to meet this demand.

3.7.6 Fluoride

The fluoride feed, at peak demand, is approximately 1,500 pounds per day. The feeders are capable of producing 3,744 pounds per day. Therefore, the existing feed equipment is adequate to meet the demand. In addition, a recent reduction in the recommended fluoride concentration guideline to 0.7 mg/L will lower the amount of fluoride that needs to be fed.

3.7.7 Chlorine and Chlorine Dioxide

The chlorine building at the Collins Park WTP has capacity for ten 1-ton cylinders on line and storage for 20 more tanks. The usual withdrawal rate per tank is approximately 360 lb/day. When higher feed rates are necessary, tank withdrawal rates can be pushed to 500-600 lb/day. At these higher withdrawal rates, the total pounds per day with all tanks on line is about 6,000 lb/day.

After the tanks, chlorine gas is collected and delivered to chlorinators. Each chlorinator is rated at 2,000 lb/day and with 4 units, the total rated capacity is about 8,000 lb/day. The actual feed is 1,500 lb/day, for a total of 6,000 lb/day as indicated above. The limiting factor is the number of tanks on line and the vacuum that is able to be created.

Under the Ohio Capacity Rule, chlorine analysis is required and considered to be a vital part of the treatment process to produce safe finished water. It is the one treatment process that must be able to meet the capacity to produce water.

The capacity is based upon the peak hour flows and feed rates. In 2003, a maximum dosage of 7.7 ppm was needed. High dosages occur when the lake is in the process of turnover or colloidal particles are suspended within the water column, which creates a high chlorine demand. It should be noted that when the highest plant flows occur in the summer season, the maximum chlorine dosages are generally lower at approximately 4.7 ppm

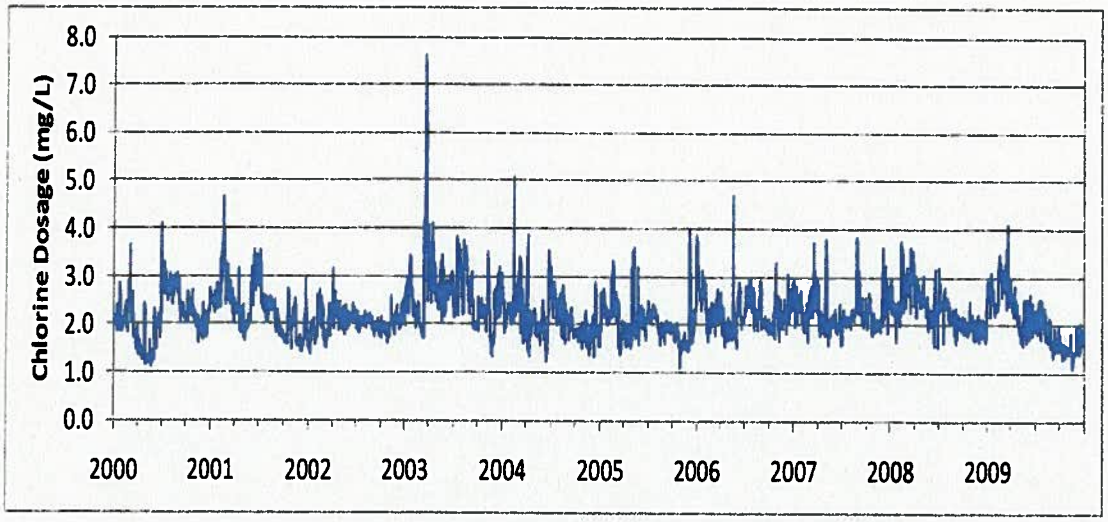


Figure 3-6: Chlorine Dosages from 2000 - 2010

The current chlorination system was originally designed for an average dosage of 2.7 ppm. The average feed rates as listed below:

- Avg. from 2000-2009 was 2.2 ppm
- Avg. from 1997-2000 was 2.3 ppm
- Avg. from 1972-1975 was 2.1 ppm

Over the time the system has been in service, the maximum day feed rates have risen dramatically. The average maximum feeds for the same time periods are as follows:

- Max day avg. 2000-2009 was 4.5 ppm with spike of 7.7 ppm
- Max day avg. 1997-2000 was 5.1 ppm with spike of 6.8 ppm
- Max day avg. from 1972-1975 was 2.9 ppm

To determine the capacity to meet the current demands, a review of the pumpages is as follows:

- Avg. day from 1980-2008 is 80.8 MGD
- Avg. from 2000-2009 was 79 MGD
- Max day avg. 1980-2008 was 121.1 MGD
- Daily Avg. flow in summer from 2000-2009 was 96 MGD
- Daily Avg. flow in winter from 2000-2009 was 71 MGD
- Peak Hour flow Avg. from 2000-2009 was 142 MGD
- Peak Hour flow Avg. from 1980-1996 was142.3 MGD
- Peak Hourly Max. flow was 177 MGD

The capacity is controlled by feed rate and pumpage calculation as follows:

Usage=ppm (feed rate) X 8.34 X MGD (pumpage)

At 4.7 ppm and a peak hourly feed rate of 176 MGD, the estimated usage per day is about 6,900 lb/day. This exceeds the maximum withdrawal rate from the tanks of 6,000 lb/day.

In the spring, the required dosage can be as high as 7.7 ppm and the pumpage can reach 90 MGD. Under these conditions, the usage is about 5,800 lb/day which is below the capacity of the tanks. This assumes that all chlorinators are in service and working at peak efficiency.

The ability to meet chlorine demands is questionable and can only be met by assuming high withdrawal rates from the tanks and all equipment in service. With algae becoming a larger issue in summer months, the organic load will be increasing. Chlorine feed rates could increase due to the need to oxidize the organic load. An increase in $KMNO_4$ would be needed to offset the organic load from the algae, but could still leave cellular components that still need to be oxidized.

Events of colloidal material coming in from the lake have created situations where the current system is running at maximum capacity and sufficient chlorine feed is questionable.

3.8 Operational Capacity Issues

There are a number of operational issues that can affect the ability to meet the needed capacity of the system. These were analyzed to ensure that these issues would be addressed to prevent capacity restrictions. Also, these issues will be examined to determine if capital improvements are necessary. They are as follows:

- Zebra mussel infestation of the source water line significantly affects the capacity of the system. Zebra mussel infestation will reduce the C factor and inhibit the ability to get the amount of water to the Low Service Pump Station that is needed. To combat zebra mussels, the City of Toledo has installed a potassium permanganate system.
- Algal blooms in summer are becoming more severe adding to the organic load and ultimately affecting the ability of the chlorine system to meet required demands. A new chlorine facility is recommended to meet the current and future demands.
- High flow rates scour the source water line from the intake and the raw water lines between the Low Service Pump Station and the WTP. This increases turbidity at the plant and increases the debris that may come up on the screens at Low Service Pump Station. Proper addition of potassium permanganate should help with this issue.
- Proper treatment during high flow events is critical in maintaining capacity. This will allow for better settling and reduce the amount of solids on the filters. When excessive backwashing is necessary, it has a tendency to restrict flow and reduce capacity.
- Flocculator basin side depth in the 80 MGD plant are problematic during high flow events. The side wall extensions that are clamped on boards should be made permanent.
- High loss of head due to filter clogging at high flows can influence capacity. Intervals between filter washing and head loss readings that trigger backwashing should be adjusted.
- Reservoir operation during high flow events should be monitored and modified if CT values can be maintained.

- Operation of the system storage becomes critical during times of high flows. The 70 MGD storage at the plant and 8 MGD at Heatherdowns influences the capacity during the diurnal flows of the day. Filling of satellite system storage is also critical.
- Adjustment of the raw water inlet gates on the basins, rate of flow controllers and filter effluent during high flows needs to be part of the operational plan.
- Chlorine feeds during high flow events can be marginal. A new facility should be built.

3.9 Maintenance Issues

There are a number of maintenance issues that can affect the ability to meet the needed capacity of the system. These were analyzed to ensure that these issues would be addressed to prevent capacity restrictions. Also, these issues will be examined to determine if capital improvements are necessary. They are as follows:

- All capacity measurements during the summer months assumes all basins are in service. There is no redundancy in the capacity as all six basin are in service. The addition of 40 MGD will help alleviate this.
- Sedimentation basins can be used if chain mechanism fails, however, the flocculation basin use without mixers will affect water quality. The addition of the 40 MGD plant will allow for basins to be removed from service and repaired during summer months, unlike current restraints.
- The chemical conveyance system is a maintenance issue which would affect the water quality if a failure occurs during high flows. A new system is recommended.
- Rotating screens at Low Service are worn and could effects flow rates if a failure occurs. They essentially protect the pumping units from debris and provide a channel for the water. Significant repairs or replacement of the rotating screens is recommended.

3.10 Water Quality Issues

Water Quality issues can affect the ability to meet capacity demands in that it does no good to be physically able to pump at a certain rate if the water produced does not meet standards. These are some of the issues to be considered.

- Failure of the flocculation basins drive mechanisms or paddles, may cause a water quality issue if the basins were required to be used at high flows without mixing. We have recommended replacement of the drive mechanisms.
- The chemical conveyance system would affect the water quality if a failure occurs. Significant repairs or replacement of the feed system is recommended.
- Algal blooms in summer are becoming more severe. They add a large taste and odor issue that requires treatment. The KMON4 and carbon feed systems are the primary sources of treating this problem. The KMNO4 is a relatively new system, while the carbon system is older.

- High pumpages scour the source water line from the intake and the raw water lines between Low Service and the Plant. This will increase turbidity at the plant and increase the debris that may come up on the screens at Low Service. Both cause Water quality issues.

3.11 Plant Addition

ARCADIS/Malcolm Pirnie was directed to investigate the need for a plant addition as part of this project. The study of the plant addition was based on the needs of the future system, customer demands, the maximum day pumpages, hydraulic grade lines in the existing plant, need for redundancy of plant processes as well as regulatory requirements concerning capacity increases and overall treatment limits.

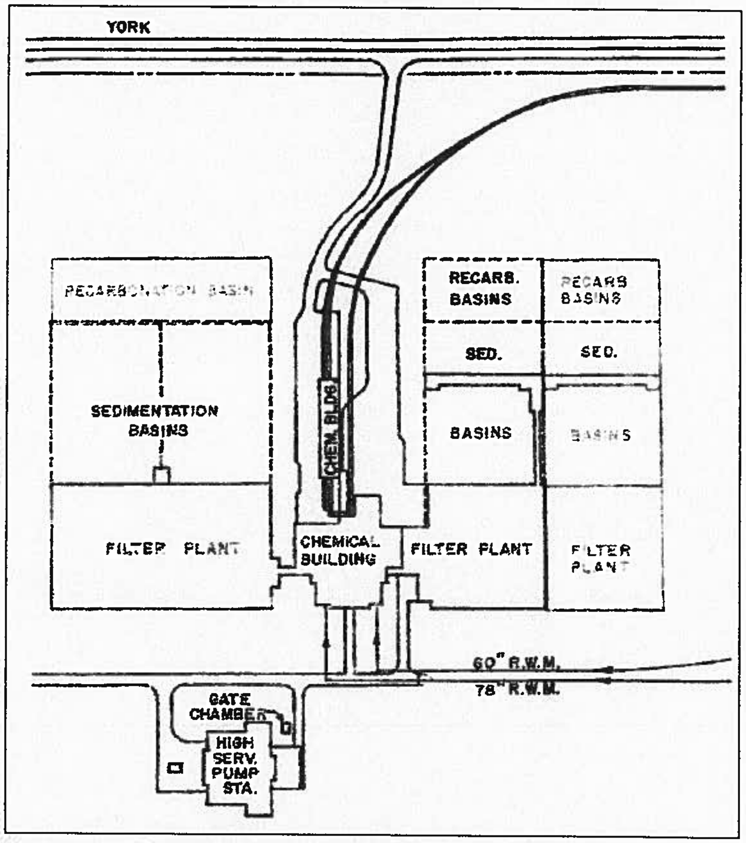


Figure 3-7: Plant 40 MGD Addition

The team began to investigate the need for a plant expansion as part of the capacity issue. We first looked at previous studies that recommended a plant addition of 40 MGD. This addition was envisioned to be a mirror image of the existing 40 MGD plant and be built adjacent to that facility. In fact, when the 40 MGD plant was constructed, it was designed to be expanded in the future. As such, many of the connections are already in place to allow for construction without interruption of the existing treatment plant. These include:

- Removable concrete block walls in the superstructure
- Removable reinforced concrete walls in the substructure
- Settled water conduit connection and bulkhead for the west half of the expansion
- Filtered water conduits for the expansion beneath the filter boxes
- Tees in the 30-inch wash water line for connection to the new facility
- Fittings in place for extending sludge piping from the 40 MGD plant
- Numerous valves and piping for normal operation of the expansion facility

The plant addition pictured above shows a traditional lime / soda ash system. This is not to say that a newer technology such as membranes or others could not be designed to meet the City's needs. It is believed that these newer technologies can afford exceptional treatment and offer substantially advantages when trying to address future needs.

The newer technologies are used successfully to combat a variety of issues. Currently, the Toledo system is meeting all of the regulatory requirements, however, there are issues worth considering in the future. For example, The State of Ohio is looking into algal toxins. Algal toxins are difficult to remove and some of the newer technologies could prove useful. The Toledo Water System is subject to algal blooms as the intake is located in the western basin of Lake Erie.

A full exploration of all options should be done when the plant expansion is considered.

3.11.1 Plant Addition-Capacity

As previously discussed, the future demands on the system do not support the need for a plant expansion based purely from a capacity aspect. The demands in the year 2035 are relatively unchanged from present needs. The daily average pumpage since 2000 has been 78.3 MGD and the projected demand in 2035 is 83 MGD or a 6.3 % increase.

The existing infrastructure would also not support the additional capacity of 40 MGD. To do so, the following changes would have to be made:

- Intake modifications with the possibility of second intake line
- Modification to the Low Service Pumps to increase capacity
- Physical addition to 40 MGD plant
- Chlorine Building modifications or second facility
- Addition of additional lime slaker as well as all chemical feeds
- EPA approval of deficient part of the 80 MGD plant that do not meet Ten States
- Standards
- Increase the capacity of the sedimentation basins
- Additional capacity in the recarbonation chambers
- Modification to the High Service Pumps to increase capacity

3.11.2 Plant Addition-Operational

We next examined the issue of adding the 40 MGD for operational purposes.

The flow through the unit processes of the treatment plant does not meet Ten States Standards. The plant has been able to meet all regulatory standards for finished water and thus has not needed to increase the size of these processes. Since the rated capacity of the plant is sufficient to meet the system demands, no additional rated capacity should be requested from the Ohio EPA. However, the use of the extra 40 MGD will benefit the overall flow calculation through the plant.

The critical measure on operational efficiency in the flocculation basin is detention time. The present detention time is able to meet the standard during average day. With the addition of 40 MGD, the detention time calculation would meet the standard at maximum day and peak hour.

Similarly, the detention time and surface loading rate in the sedimentation basins are probably the most important factor in ensuring proper treatment. Currently, the 4 hour detention time meets the average day, but with the additional 40 MGD, it is much closer to meeting the maximum day usage.

The maximum surface loading rate is currently right at the maximum day rate. With the addition of the 40 MGD, it would also meet peak hour recommendations.

By increasing the detention times in the flocculation and sedimentation basins, there will likely be a a corresponding improvement in the resultant water quality, especially as the pumpage reached maximum day and peak hour or under certain conditions.

When algae blooms in the Western Basin of Lake Erie or there is a lake turnover and colloidal material is in the raw water, extra care is needed on the treatment to ensure good quality water. An additional 40 MGD would help by dividing the load through more basins and allow for a more efficient process.

3.11.3 Plant Addition-Maintenance

Maintenance can only occur in off peak pumpage times for the flocculation and sedimentation basins. In the summer during high pumpage times, all treatment basins need to be in service to allow for enough physical capacity to adequately treat the volume of water to meet the demands. With the addition of a 40 MGD plant, basins could be taken out of service for maintenance and repair work at any season. This means that repair work can be accomplished when it is needed not when it is convenient.

In the summer, higher pumpages can scour the raw water lines and brings in zebra mussel shells. As a result, the flocculation basins see more mussel shells which often clog the flocculator paddles and cause mechanical problems. If the paddle mechanism becomes inoperable, the basin will need to stay in service with one pass of the flocculator mechanism not working. This reduces the efficiency of the treatment process. By have the availability of the 40 MGD addition, basins with zebra mussel shells could be removed from service and repaired, even during summer months.

3.11.4 Plant Addition-Constructability Issues

Improvements and rehabilitation to the various treatment processes will require unit processes to be out of service. These unit processes may require that a treatment train (flocculation and sedimentation basin) be out of service for the duration of the improvement. Without the 40 MGD plant expansion, all repairs would be confined to off peak pumping periods. Flocculator repairs to chain mechanisms and sedimentation basin sludge collector chain would require a fixed repair schedule during the winter months.

There are certain repairs that may not be possible without the 40 MGD addition. Surface wash piping and cone check valves may require the entire 80 MGD plant to be out of service. To do this even in the winter season would require the 40 MGD addition to have enough capacity to meet demands.

3.11.5 Plant Addition-Summary

The plant addition of 40 MGD is recommended from an operational, maintenance and constructability standpoint. This addition would facilitate implementation of rehabilitation improvements of existing treatment processes, help maintain the water quality of the drinking water and facilitate treatment and maintenance activities now and into the future.

3.11.6 Property Acquisition

The Collins Water Treatment Plant will be adding transformers, additional treatment units as well as other improvements and the available space for expansion or new facilities is limited on the current footprint. Although open area seems to be available, underground structures, lagoons, green energy equipment and underground piping prevents construction of any new facilities in almost all of these areas.

An immediate need will occur during the construction of the new disinfection facilities. It will be necessary to relocate the existing maintenance building on the northern part of the water treatment plant grounds to a piece of property the City owns on Collins Park Road. This site may be the only logical alternative for this building, but access in and out of the building will be limited and could be disruptive to other, adjacent property owners.

Future needs of the plant such as chemical storage, additional maintenance equipment storage, administrative office space, laboratory facilities, sludge processing equipment or additional treatment units may require additional property to build.

Property acquisition, along Collins Park Road adjacent to the plant, will need to be part of the planning and capital costs process.

3.12 Summary

The following are the major points of the hydraulic capacity investigation:

- Existing Conditions
    - Current approved maximum day capacity is 150 MGD
- 2035 Projected water demands
    - Average day demand: 83 MGD
    - Maximum day demand: 134 MGD

  - Peak hour demand: 177 MGD
- Low Service operational maximum is 184 MGD
- Peak hourly flow operationally is 177 MGD
- Peak Hourly capacity for High Service is 180 MGD
- Future demands are relatively flat
- Many treatment unit capacities do not meet Ten States Standards and the Ohio Capacity Rule, however, they meet Ohio EPA WQ standards
- Additional rating capacity of the plant is not recommended
- New Chlorine facility needs to be built
- A 40 MGD plant addition is recommended

4. Condition and Operational Assessments

4.1 Introduction

An assessment of the Collins Park Water Treatment Plant (WTP) infrastructure was conducted between December 2010 and January 2011 with the goal of evaluating the suitability of WTP facilities to comply with water quality objectives with specific regard to their current physical condition. The assessment also identified deficiencies, operational constraints, and/or reliability concerns.

In addition to the condition assessment, an operational assessment was performed to identify administrative, design, operational and maintenance aspects that may limit optimal performance. This information was used to further calibrate findings of the previously performed water quality, capacity and condition assessments. Some operational limitations may require minor changes to existing features, and when implemented, may improve process efficiency, potentially eliminating the need for certain capital improvements.

This section discusses the methodology used for the condition and operational assessments and presents results from both assessments, grouped by the following discipline areas: process mechanical, electrical, instrumentation and controls (I&C), structural/architectural, and mechanical/HVAC.

4.2 Condition Assessment Methodology and Overall Results

An inventory of 663 assets was developed for the condition assessment of the Collins Park WTP. Figure 4-1 shows the number of assets by process area.

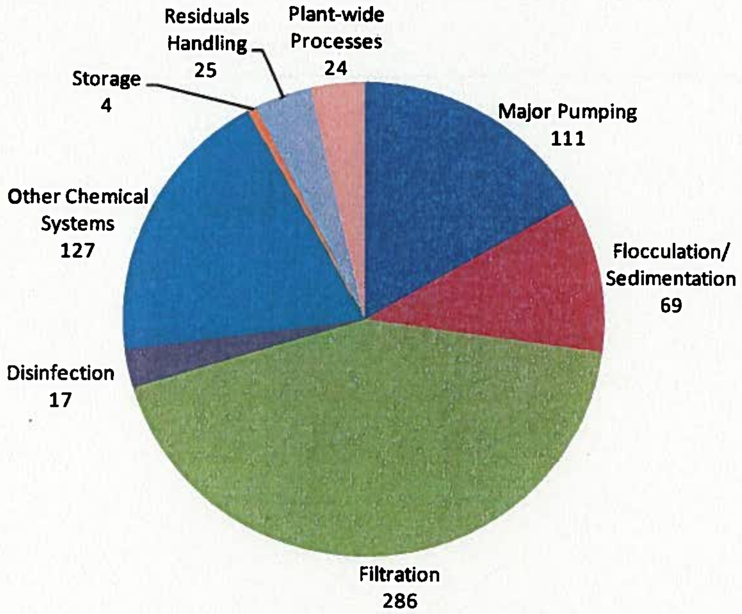


Figure 4-1: WTP Assets by Process Area

The condition assessment conducted for the Collins Park WTP included the following components:

- Physical condition assessment
- Performance condition assessment
- Criticality assessment
- Renewal and replacement evaluation

The physical, performance, and criticality assessments were used to develop a relative risk for all the WTP assets, which were subsequently used in conjunction with effective useful life (EUL) estimates to develop a prioritization score for each key asset at the plant. Each component of the condition assessment is discussed below.

4.2.1 Physical Condition Assessment

The physical condition is an assessment of the functional state of the assets given their age, operating conditions and maintenance history. Individual assessments were performed for the following disciplines: process mechanical, electrical, I&C, structural/architectural and mechanical/HVAC (heating, ventilation and air conditioning). Assets were evaluated on a scale of 1 (very good) to 5 (very poor).

Figure 4-2 summarizes the physical condition of the assets evaluated. Approximately 75% of the assets were assigned a score of 1 (very good), 2 (good), or 3 (fair). The remaining 25% of assets received a score of 4 (poor) or 5 (very poor), and are presented in Table 4-1. Figure 4-3 presents the physical condition scores of the same assets by process area. Complete listings of the physical condition assessment results are included in Appendix E.

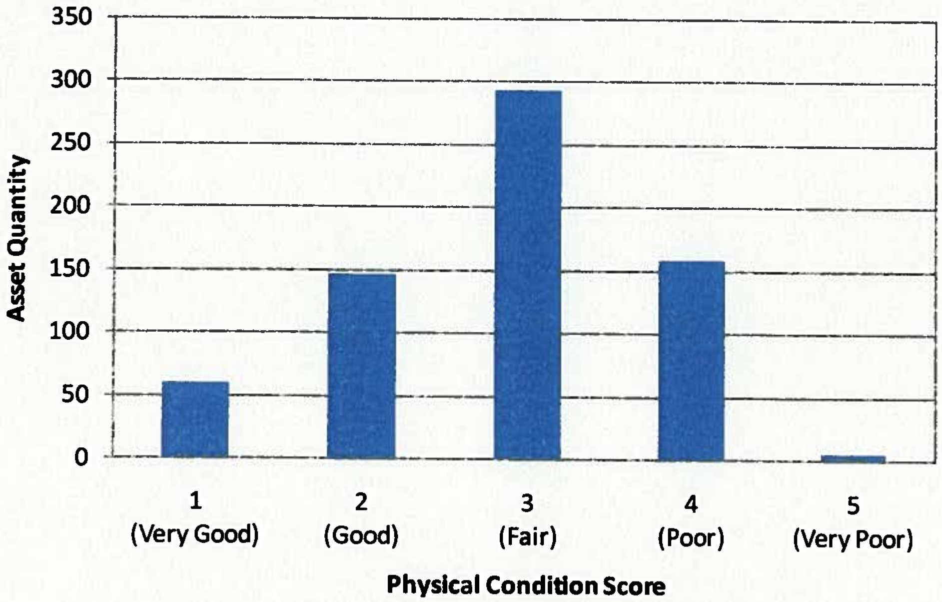


Figure 4-2: Overall Physical Condition of WTP Assets

Table 4-1: WTP Assets Rated Poor (4) or Very Poor (5) for Physical Condition

Process	Equipment Group	Asset Name	Year	Age	Physical Condition
BOILERS	PIPING AND VALVES	80 MGD PLANT BOILER PIPING	1940	71	5
FILTRATION	BUILDING STRUCTURE	STEEL FRAME W/ MASONRY WALLS	1940 - 1955	56 - 71	5
FILTRATION	PIPING AND VALVES	80 MGD PLANT SURFACE WASH WATER PIPING	1988	23	5
PLANT WATER	PIPING AND VALVES	80 MGD PLANT PIPING	1940	71	5
BOILERS	PIPING AND VALVES	40 MGD PLANT BOILER PIPING	1956	55	4
CARBON	FEEDERS	FEEDERS	1940	71	4
CARBON	TANKS	BULK TANK MIXERS	1940	71	4
CARBON	PUMPS	CARRIER WATER PUMPS	2001	10	4
CAUSTIC SODA	PUMPS	CAUSTIC SODA METERING PUMP	1940	71	4
CHEMICAL STORAGE	CHEMICAL UNLOADING AREA	DUST COLLECTORS	1940	71	4
CHEMICAL STORAGE	PIPING AND VALVES	VALVES	1940	71	4
CLEARWELL	CLEARWELL	UNDERGROUND CONCRETE	1940	71	4
FILTRATION	PIPING AND VALVES	GALLERY CONE VALVES, FILTER WASH WATER PIPING (40 MGD Plant only), & MAIN FILTER INFLUENT AND DRAIN PIPING	1940 - 1956	55 - 71	4
FILTRATION	SURFACE WASH PUMPS	SURFACE WASH PUMPS (80 MGD Plant only)	1988	23	4
FILTRATION	SUMP PUMPS	80 MGD PLANT SUMP PUMP	1995	16	4
FLOCCULATION-SEDIMENTATION	FLOCCULATION-SEDIMENTATION BASINS	FLOC DRIVES, BYPASS GATES & INLET VALVES	1940 - 1956	55 - 71	4
FLOCCULATION-SEDIMENTATION	FLOCCULATION-SEDIMENTATION BASINS	SLUDGE COLLECTORS & CROSS COLLECTORS	1987 - 1989	22 - 24	4
LOW SERVICE PUMP STATION	DISCHARGE PIPING	DISCHARGE PIPING	1940	71	4
LOW SERVICE PUMP STATION	HVAC	EXHAUST FANS, AC UNIT, UNIT HEATERS & WINDOW AC UNIT	1940 - 1996	15 - 71	4
LOW SERVICE PUMP STATION	RAW WATER SCREENS	RAW WATER SCREENS	1993	18	4
PLANT WATER	PIPING AND VALVES	40 MGD PLANT PIPING	1956	55	4
RAPID MIX CHANNEL/ CHEMICAL STORAGE	SUMP PUMPS	SUMP PUMP 2	1940	71	4
SLUDGE DEWATERING FACILITY	ACID WASH SYSTEM	ACID WASH PUMP & TANK	1940	71	4
SLUDGE DEWATERING FACILITY	CORE BLOW COMPRESSOR	COMPRESSOR	1998	13	4
SLUDGE DEWATERING FACILITY	PUMPS	THICKENED SLUDGE PUMPS	1998	13	4
SODA ASH	STORAGE BIN AREA	SODA ASH BINS	1940	71	4
SODA ASH	FEEDERS	SODA ASH FEEDERS	1988	23	4

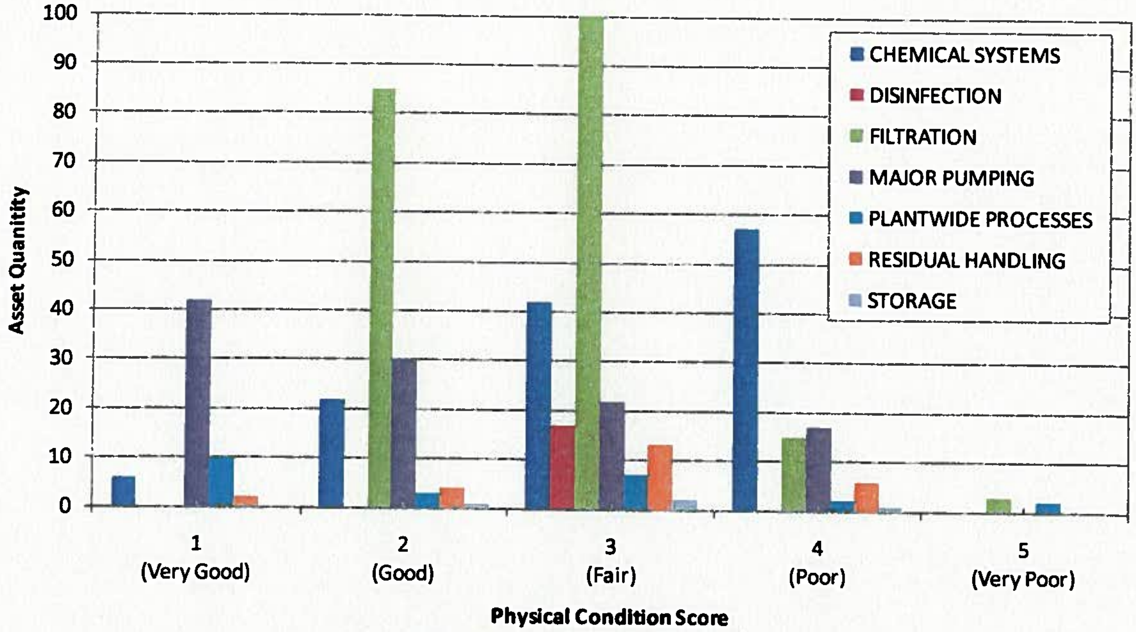


Figure 4-3: Physical Condition of WTP Assets by Process Area

4.2.2 Performance Condition Assessment

The performance condition is a measure of the ability of the asset to meet operational requirements over the planning period. The assessment ratings consider whether the asset is likely to continue to meet operating objectives or if factors such as obsolescence, capacity and reliability have resulted in unacceptable performance. The same standardized 1 (very good) to 5 (very poor) scoring was used for all performance criteria. The criteria and weighting factors were developed with assistance and input from Collins WTP staff at the Condition Assessment Guidelines Workshop conducted by ARCADIS/Malcolm Pirnie engineering and technical staff on December 7, 2010, and are summarized in Table 4-2. As part of the workshop, staff voted on the relative importance of each criterion, which determined the weighting to be used in calculating the overall performance score. Plant staff was asked to weigh in on the proposed performance criteria by affixing stickers to a poster board describing each of the criteria. Each participant was given 15 stickers with three different colors, each representing a different degree of importance as follows:

- Red stickers – Most important (5 stickers total) – each worth 5 points
- Yellow stickers – Somewhat important (5 stickers total) – each worth 3 points
- Green stickers – Least important (5 stickers total) – each worth 1 point

Each participant was asked to place stickers according to how important they felt each criterion was. Participants could place up to four stickers on a single criterion and had to vote for each criterion at least once. The weightings for each criterion were determined based on the total points received from the voting exercise.

As seen in Table 4-2, plant staff ranked capacity highest, followed by obsolescence, regulatory, reliability, and O&M issues. Although capacity and regulatory compliance typically tend to be the top two criteria, the plant staff assigned higher rankings to obsolescence and reliability since most of the equipment at the Collins Park WTP is original and in poor condition. A weighted score was then calculated for each asset to determine an overall performance condition. Appendix D provides details of the voting procedure and assessment criteria

Table 4-2: Performance Condition Weighting Factors

Performance Criteria	Description	Voting			Points			Total	Weight
		Red	Yellow	Green	Red	Yellow	Green		
Capacity	Ability to meet CURRENT and FUTURE capacity needs. Evaluation is coordinated with the Regulatory/Capacity review in the overall Master Plan.	9	12	4	45	36	4	85	**27%**
Obsolescence	Status of equipment as "best available", "industry standard", "tried and true" in terms of efficiency, overall technology, cost of ownership.	5	11	8	25	33	8	66	**21%**
Regulatory	Ability to meet CURRENT and FUTURE regulatory requirements. Evaluation is coordinated with the Regulatory/Capacity review in the overall Master Plan.	8	3	10	40	9	10	59	**19%**
Reliability	Average time equipment is available when needed (frequency of breakdowns).	10	2	4	50	6	4	60	**19%**
O&M Issues	Frequency of O&M issues (excluding breakdowns).	3	7	9	15	21	9	45	**14%**

Figure 4-4 summarizes the overall performance condition of the assets. All of the Collins Park WTP assets scored less than 4 at the time of the assessment. In addition, the majority of the assets received a performance condition score between 1 and 1.9 (very good to good) indicating that most assets meet their performance requirements. Assets receiving the lowest performance scores between 3 and 3.9 (fair to poor) are presented in Table 4-3. Figure 4-5 shows the performance condition scores by process area. From this figure, it is evident that the flocculation/ sedimentation process is the lowest performing among the processes areas. Appendix E includes a complete listing of the performance condition assessment results.

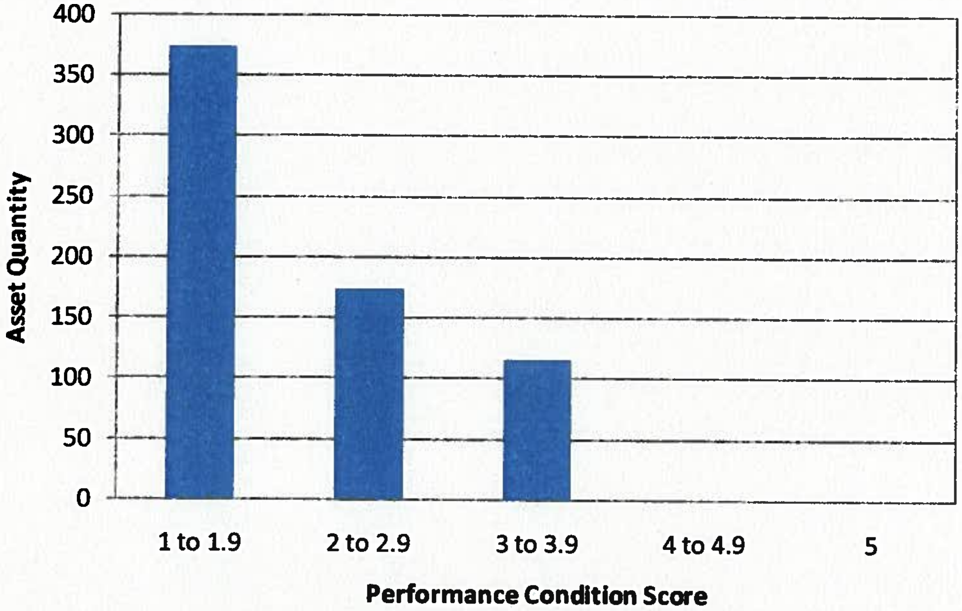


Figure 4-4: Performance Condition Summary

Table 4-3: Lower-Performing WTP Assets

Process Area	Group	Performance Score
Flocculation/Sedimentation	Flocculation/sedimentation basins 1 - 6	3.62
Chemical storage	Piping and valves	3.49
Chemical storage	Chemical unloading area	3.35
Filtration	Surface wash pumps	3.20
Chemical Storage	Lime and soda ash storage bin area	2.89
Lime and Soda Ash	Conveyor system	2.72
Low Service	Pumps	2.50
Low Service	Electrical	2.50
Low Service	HVAC	2.52
Low Service	Vacuum priming system	2.56
Plant Facilities	I&C	2.62
Sludge Dewatering	Core blow compressor	2.73
Sludge Dewatering	Pumps	2.89

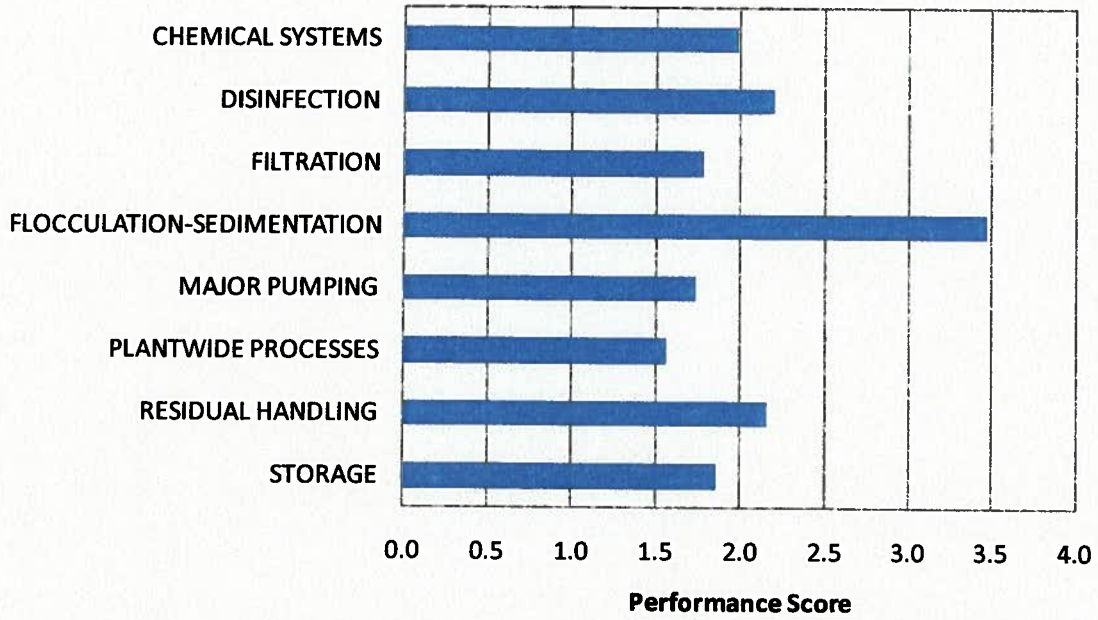


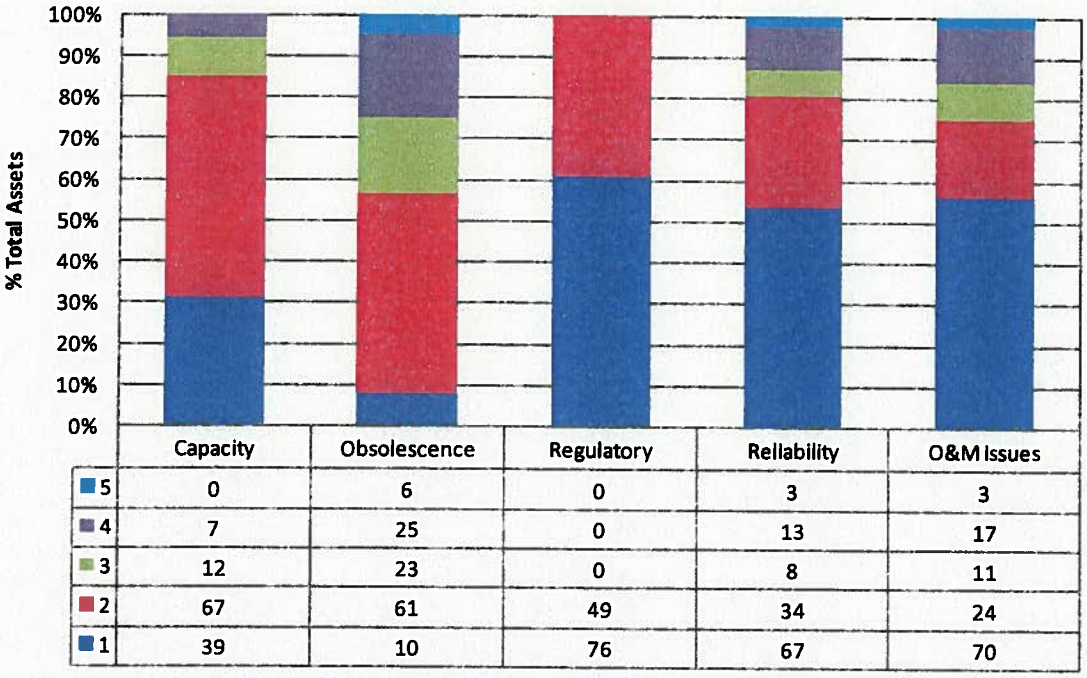
Figure 4-5: Summary of Performance Condition by Process Area

Figure 4-6 shows the assets by performance category. 39 assets received a performance score of 1 (very good) for their ability to meet current and future capacity under average and peak flows. While no assets received a score of 5 (very poor), the flocculation/ sedimentation basins were assigned a score of 4 (poor) for capacity because all the basins must be kept in service during peak flow periods, due to a lack of adequate redundancy. The chlorine system also scored poorly since the capacity is insufficient to meet peak feed requirements (see Section 3 for details).

Scores for obsolescence varied widely, but most assets were assigned a score of 2 (good). A large number of assets (40) were assigned a score of 4 (poor) or 5 (very poor) since most of the equipment is original and over 70 years old. Among the highest were the electrical system, pumps and raw water screens at the Low Service Pump Station; the lime and soda ash conveyor systems; and the electrical system at the High Service Pump Station.

Assets were similarly divided with respect to reliability and O&M issues. The majority of assets received a score of 1 (very good) or 2 (good); however, 16 assets were assigned a score of 4 (poor) or 5 (very poor) for reliability because they do not function properly or are in poor condition. Among the highest were the surface wash pumps for filtration, the compressor for the sludge dewatering facility, and the HVAC system in the Low Service Pump Station. In addition, 20 assets were assigned a score of 4 (poor) or 5 (very poor) for O&M issues including the surface wash pumps for filtration, the piping and valves for the chemical storage and feed systems, and the piping and valves in the sludge dewatering facility.

The best scores were assigned under the regulatory category, where all of the assets received a score of 1 (very good) or 2 (good), which is consistent with the plant's ability to meet current and projected water quality goals and regulatory requirements as detailed in Section 2.



	Capacity	Obsolescence	Regulatory	Reliability	O&M Issues
🟦 5	0	6	0	3	3
🟪 4	7	25	0	13	17
🟩 3	12	23	0	8	11
🟥 2	67	61	49	34	24
🟦 1	39	10	76	67	70

Figure 4-6: WTP Assets Performance by Category

4.2.3 Criticality Assessment

The final component of the overall assessment considers the "criticality" or consequence of asset failure. The criteria considered include regulatory impacts, level of service disruption to customers, safety, and economic loss. The evaluation was conducted via assigning a weighting to each criteria along with a score of 1 (no impact) to 3 (severe impact). The criteria and weightings were developed with assistance and input from Collins Park WTP staff at the December 7, 2010 Condition Assessment Guidelines Workshop. During the workshop, plant staff were asked to vote on the relative importance of each criterion, which determined the weighting used in calculating the overall criticality score. The voting procedure used to establish the criticality criteria weightings was identical to the one used for the performance condition weightings (see section 4.2.2). Results of the weighting exercise are summarized in Table 4-4. Redundancy was given the highest weighting (36%) primarily because this is a key issue with the existing flocculation/sedimentation basins. During the summer, the current system does not provide enough redundancy to allow a basin to be out of service during high flow periods. All other criteria received similar weightings between 15 and 17%. Appendix D provides details of the voting procedure and assessment criteria.

Table 4-4: Criticality Condition Weighting Factors

Performance Criteria	Description	Voting			Points			Total	Weight
		Red	Yellow	Green	Red	Yellow	Green		
Redundancy	Availability of equipment redundancy at peak and/or average conditions. Also considers redundancy of supporting systems (dual feeds, back-up generator, UPS, dual PLC, etc.)	18	8	3	90	24	3	117	**36%**
Level of Service	Impact of failure on ability of WTP to meet operational goals. Considers potential impacts to overall distribution system and to customers.	6	7	4	30	21	4	55	**17%**
Safety	Potential for severe injury resulting from failure. Considers Toledo staff and the public.	1	10	15	5	30	15	50	**16%**
O&M Impacts	Impact of failure as measured by level of effort and cost for repair. Also considers impacts from inefficient operation (labor, chemicals, power, etc.) at the WTP as a result of failure.	6	5	7	30	15	7	52	**16%**
Regulatory Compliance	Impact of failure on ability of WTP to meet WQ standards. Also considers potential impact on WQ compliance in Distribution System.	5	6	5	25	18	5	48	**15%**

Figure 4-7 summarizes the overall criticality scores by process area. Disinfection, major pumping, and flocculation/ sedimentation processes were identified as the areas with the greatest potential consequence to the plant in the event of a failure. Complete listings of the criticality assessment results are included in Appendix E.

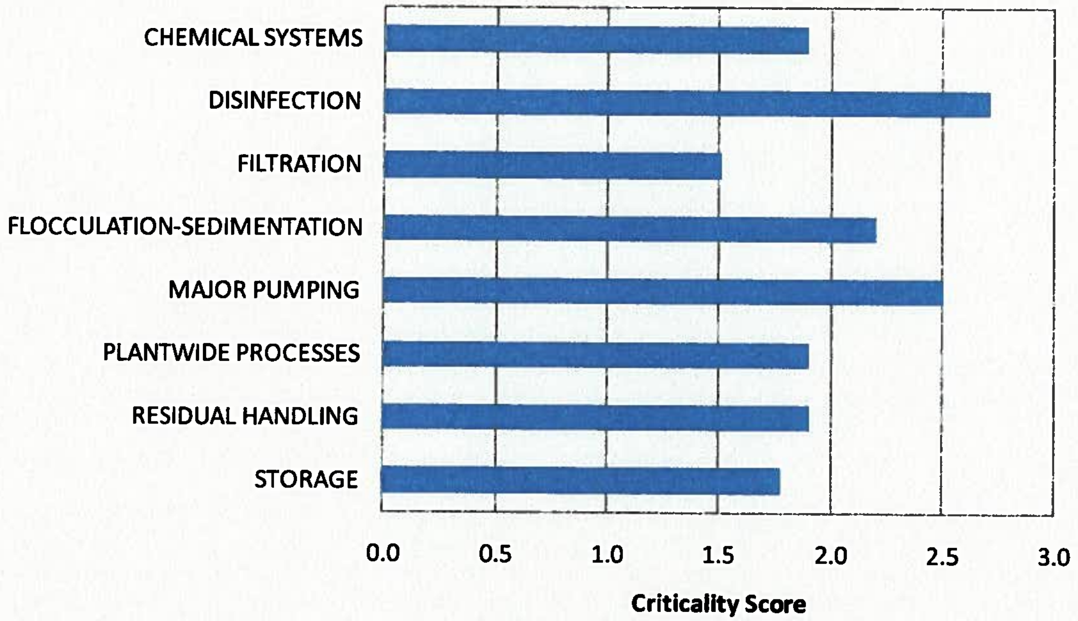


Figure 4-7: Summary of Criticality/Consequence of Failure Scores

4.2.4 Replacement and Renewal (R&R) Evaluation

The results of the physical condition, performance condition, and criticality assessments were utilized to calculate a relative risk score for all the WTP assets based on the following relationship:

Risk = (Physical Condition + Performance Condition) x Criticality

The risk scores were used to develop an initial screening for potential asset renewal and replacement (R&R) needs for consideration in the overall CIP development. The complete listings of risk priority scores for all assets are included in Appendix E.

Each asset involved in the assessment was subsequently categorized by asset class and type to assign expected useful life (EUL) values from industry accepted values and based on experience with similar assessments. The EUL values are summarized in Table 4-5. Based on the age of the asset, a remaining useful life was calculated. The remaining life of the asset was used in conjunction with the risk score to determine the overall R&R priority of an asset. The effective and remaining useful life estimates for all assets are included with the assessment results in Appendix E.

Table 4-5: WTP Equipment Effective Useful Life Baseline

Equipment Class	Equipment Type	EUL (yrs)	Comment
Pumps	All Process Pumps	30	
Process Equipment	Filters	30	
	Flocculator Paddles	20	
	Gear Motor Drives	30	Flocculator units, settling basins
	Telescoping Valves	40	Sludge draw-off
Chemical	Feed and Transfer Pumps	12	
	Storage Tanks	30	Indoors FRP
	Lime Equipment	20	
	Packaged Feed Equipment	20	
Gates	Sluice Gates	40	
HVAC	Fans	25	Chemical duty 15-20
	Unit Heaters	30	Gas or electric
	AHU/AC Units	20	Rooftop and large units
	General HVAC equipment	30	
Electrical	Generator and Motor	35	Inside building
	Transformers	40	
	Motor Control Centers	30	
	General Electrical Equipment	30	Lighting, panels, etc.
Structural	Process Tanks	70	Structural concrete
	Building Structures	70	Concrete/Masonry
	Building Roofs	30	Membrane

Figure 4-8 shows the grouping of assets according to R&R priority based on the risk and EUL assessments. Replacement periods were assigned to each priority group from Group 1 (requirement replacement in years 0 – 2) to Group 5 (requiring replacement in years 16 – 20). Most of the assets fall in R&R groups 2, 4 or 5. Five assets including the boiler piping (80 MGD plant), the filtration area building structure (both the 80 and 40 MGD plants), and the surface wash and plant water piping (80 MGD plant) were identified as the highest priority assets, requiring replacement in years 0 – 2. Complete listings of the R&R priority groups assigned to each asset are included in Appendix E.

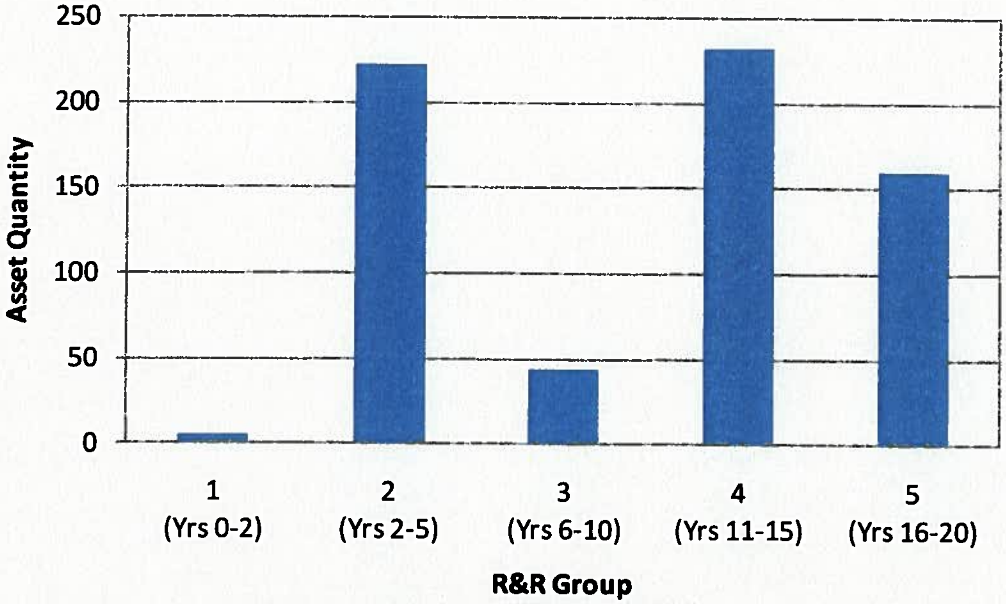


Figure 4-8: R&R Priority of WTP Assets

4.3 Operational Assessment

Operations specialists from ARCADIS/Malcolm Pirnie performed an operational assessment on January 26 & 27, 2011. The operational assessment was performed through City of Toledo staff interviews and a detailed process-by-process tour of the WTP facilities. ARCADIS/Malcolm Pirnie personnel focused on process monitoring, operational aspects, and engineering features that have the greatest impact on interprocess and finished water quality. A special emphasis was placed on aspects and features that may require minor changes and minimal capital resources to effect favorable changes. Results from the operational assessment are summarized by process area in Section 4.4.1. Recommendations from the operational assessment are included in Section 5. Detailed recommendations are documented in the *Collins Park WTP Master Plan and Needs Assessment Operational Assessment Summary Technical Memorandum*, dated February 17, 2011 (refer to Appendix F).

4.4 Detailed Assessment Results

The subsequent sections present detailed assessment results for both the condition and operational assessments by discipline including: process mechanical, electrical, I&C, structural/architectural, and mechanical/HVAC. Recommended improvements are discussed in Section 5.

4.4.1 Process Mechanical

Details of the process mechanical equipment at the Collins Park WTP were gathered during the condition and operational assessments and through staff interviews. In this section, details of each process area are described followed by a list of observations, identified deficiencies, and operational needs.

4.4.1.1 Raw Water Intake

Figure 4-9: Raw Water Intake

Raw water is withdrawn from Lake Erie through an intake crib located approximately 3 miles offshore northeast of Reno Beach (see Figure 4-9). Water is conveyed to the low service pumping station by gravity through a 108-inch diameter intake conduit. The intake crib and conduit were designed to handle a raw water demand of up to 200 MGD. However, C-factor testing has not been conducted in a number of years and is therefore recommended to confirm the current peak capacity of the intake conduit. No other process mechanical observations or deficiencies were noted for the raw water intake.

4.4.1.2 Low Service Pumping Station

Raw water first passes through traveling screens to remove debris, and is then pumped through two raw water mains, 78- and 60-inches in diameter, approximately 8 miles to the Collins Park WTP.

Figure 4-10: Low Service Pump

The pumping station contains four horizontal split case, double suction, centrifugal low service pumps (see Figure 4-10). The pumps are located in drywells that have a floor elevation approximately 10 feet below the mean lake water surface elevation. Each pump has a bottom style suction which draws water into the pump through a 60-inch diameter suction bell from a wet well located directly below the pump. The floor of the wet well is approximately 25 feet below the mean lake water surface elevation. Pumps 1 and 2 are located in the north well, and Pumps 3 and 4 the south well. The characteristics for each low service pump are summarized in Table 4-6.

Table 4-6: Low Service Pumps

Pump No.	Capacity (MGD)	Head (ft)	Horsepower (hp)	Speed (rpm)	Voltage (V)	Manufacturer
1	60	114	1,500	0 – 505	2,400	Worthington
2	47.8	100	1,100	0 – 605	2,400	Worthington
3	47.8	100	1,100	0 – 605	2,400	Worthington
4	47.8	100	1,100	0 – 605	2,400	Worthington

Pumps No.'s 2, 3, and 4 are identical and were installed in 1940 as part of the original station construction. Each of these pumps has most recently been re-built in 2003, 2001, and 2002, respectively. Variable speed pumping for these three pumps is achieved through the use of resistor banks, which date back to the original station construction in 1940. Pump No. 1 was installed in 1980 and re-built in 2000. Variable speed pumping for Pump No. 1 is achieved by an energy recovery drive, which was also installed in 1980.

Each low service pump discharges through a 30-inch cone valve manufactured by Chapman (1940) with a hydraulic oil actuator (see Figure 4-11). The station contains one hydraulic oil accumulator system, which serves all four pump check valve hydraulic actuators. The discharge pipe then enters the pipe vault where it is diverted to either an upper or lower header by a series of electrically actuated gate valves. The headers deliver raw water to the 78 and 60-inch raw water mains. Venturi meters for each raw water main are located in a metering vault just west of the pumping station to measure the flow rate through each main. The 78-inch main conveys raw water to the 80 MGD plant. The 60-inch main conveys raw water to the 40 MGD plant.

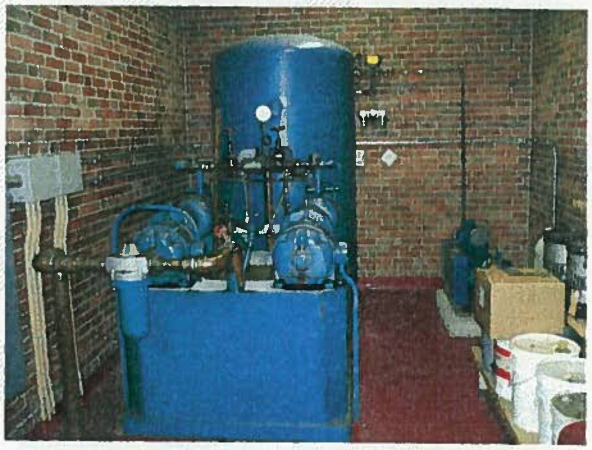


Figure 4-11: Low Service Pump Station Hydraulic Oil Actuator

Each pump is equipped with a vacuum priming system to prime the pump prior to start-up. Depending on the lake elevation along with the station pumping rate, the suction well hydraulic grade line can be below the pump casing. Under these conditions, it is necessary to fill the pump casing with water, i.e. prime the pump, prior to starting the pump. One vacuum pump and bladder tank serves a pair of low service pumps.

Raw water samples are acquired in the permanganate building using pumps that convey water from the intake crib prior to the addition of permanganate. A HACH APA 6000 analyzer is installed near the sampling station but was never commissioned. The analyzer would provide on-line continuous monitoring of the raw water hardness. The unit includes a filter apparatus that helps assure a particulate free sample is provided to the analyzer.

Based on field investigations and discussions with plant staff, the following observations and deficiencies were identified for the low service pumping station:

- **Raw Water Screens**
    - The raw water screens are in poor condition and at the end of their expected useful service life.
    - The screen washwater system is deficient and requires both washwater pumps and fully opening a hydraulic valve to adequately clean the screens.
    - Frazzle ice forms on the screens. Plant staff has noted the need for a dedicated blower system to remove frazzle ice. The plant currently uses a compressor; however, its capacity is insufficient to address frazzle ice buildup.
- **Pumps**
    - Although there are enough pumps to meet peak flows, the plant cannot operate between 70 and 90 MGD because of the limited flow range that can be achieved with the current energy recovery drives and resistor banks...
    - Replacement parts for the pumps are difficult to obtain. Pumps may be out of service for extended time periods while custom replacement parts are obtained (for example, Pump No. 1 was recently out of service for one year before replacement parts were available).
    - Pump No. 1 is over 30 years old and was last re-built in 2000. Variable speed operation is achieved through the use of an energy recovery drive, which is obsolete and inefficient.
    - Pumps No. 2, 3, and 4 are over 70 years old, but underwent re-builds in 2003, 2001, and 2002 respectively. Variable speed operation for each of these pumps is achieved using resistor banks with wound rotor motors. The resistor banks are obsolete and inefficient.
    - Pump cone check valves are over 70 years old, repair parts are difficult to obtain, and hydraulic oil is leaking from actuator cylinders.
    - One oil accumulator serves all four pump check valve hydraulic actuators. In the event of failure, none of the check valves can operate. This is a redundancy issue.
    - Pump Nos. 1 and 2 cannot be isolated. If the plant loses a vacuum pump, both low service pumps have to be taken out of service. This becomes a critical issue during high flow periods. A vacuum priming system similar to that of the High Service Pumping Station along with valving improvements would allow each pump to be isolated.
    - There is extensive surface corrosion on the piping in the Pipe Vault due to the damp, humid environment. Some pipe couplings are in poor condition, and there is some pipe support degradation in this area.
- **Discharge Piping Gallery**
    - Oil leaking is evident at cone check valves.
    - Significant surface corrosion on piping has occurred due to damp environment (see Figure 4-12).
- **Sampling & Monitoring**
    - There is no automated sampling of the raw water quality.

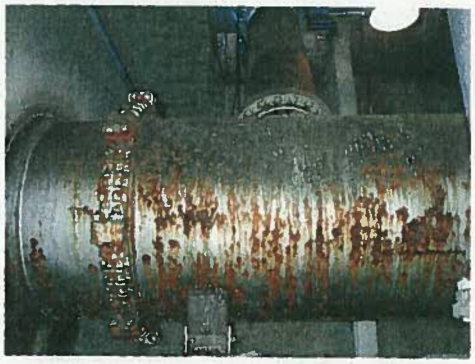


Figure 4-12: Corroded Piping in Low Service Pump Station

4.4.1.3 *Rapid Mix*

Pretreated water from the low service pumping station is conveyed to the WTP, which is essentially divided into two separate treatment plants capable of independent operation. Flow enters the plant through two interconnected raw water rapid mix channels that split flow between the 40 and 80 MGD trains (see Figure 4-13).

Figure 4-13: Rapid Mix Channel

Liquid alum is applied to each raw water channel about 20 feet downstream of the inlet. Each channel is equipped with alternating baffles to impart mixing energy to increase dispersion of alum into the water. As alum is mixed in the raw water, the coagulation process begins. Alum-treated water reaches the end of each raw water channel and enters either the upper or lower outlet conduit, where it is then directed to the appropriate flocculation basins for further treatment.

The following observations and deficiencies were identified for the rapid mix:

- Lower hydraulic mixing occurs in the 40 MGD channel. In addition, mixing intensity varies with flow.
- Additional baffling or alternate mixing is needed to improve coagulation in the rapid mix channels.

4.4.1.4 *Flocculation, Sedimentation, and Recarbonation*

Alum treated water enters the flocculation basins in each treatment train via flow control valves. Four flocculation basins are provided for the 80 MGD plant. A concrete wall divides each flocculation basin into three separate passes or stages . Each stage has a series of six horizontal paddle assemblies to produce the gentle mixing necessary for flocculation. Two flocculation basins are provided for the 40 MGD plant. A wooden baffle wall divides each flocculation basin into three separate passes or stages. Each stage has a series of five horizontal paddle assemblies to produce the gentle mixing necessary for flocculation. Normally, all six flocculation basins are operated at the same time. Raw water flow is split to each pair of basins to provide a maximum flow of about 20 MGD to each basin.

Figure 4-14: Horizontal Flocculator Paddles

Flocculation energy is currently imparted using horizontally mounted paddles (see Figure 4-14). The paddles, drives and associated equipment are from the original installation and have reached the end of their useful service lives. These systems have recently been prone to failure and require frequent corrective maintenance. In addition, many of the moving parts are located beneath the water surface, which typically requires the basin to be removed from service for maintenance to occur. This has a significant impact on operations, especially during high demand periods. It is also uncertain whether or not the existing blade configuration and speeds provide optimal flocculation conditions prior to sedimentation.

Flocculated water flows to the respective sedimentation basin to undergo settling of suspended floc particles. Each sedimentation basin in the 40 MGD plant is split into two sections: one that runs roughly the first two-thirds of the basin, and the other that runs the remaining one-third of the basin. The sedimentation basin in the 80 MGD plant has one long section. For both plants, each section is equipped with separate cross collector and basin drags to move settled solids toward the appropriate sludge valves.

Settled water (relatively low in turbidity and suspended particles) rises upward near the effluent end of each sedimentation basin and discharges over a wooden baffle wall to the appropriate recarbonation basin. Carbon dioxide gas (CO_2) is supplied through diffusers and is distributed as fine gas bubbles. These fine bubbles rise upward in the reaction zone against the water flow. The counter-current flow between water and gas bubbles promotes mixing of CO_2 into the water. As the CO_2 bubbles are absorbed into the water, chemical reactions take place to begin recarbonation.

The following observations and deficiencies were identified for flocculation, sedimentation, and recarbonation:

- **General**
    - Redundancy is a key issue for the flocculation/sedimentation basins. All basins must remain in service during the summer to meet the high demands, resulting in a limited maintenance period (maintenance on all basins must be completed during low flow periods). Meeting peak flow conditions is becoming increasingly difficult due to the lack of redundancy and age and condition of the flocculation equipment.
- **Flocculation**
    - The flocculation equipment is past its useful life and should be replaced. Flocculator paddles are prone to failure and require frequent corrective maintenance. The most common problem with the flocculator system is bending and breaking of arms primarily due to zebra mussel accumulation and concrete from the roof (see structural section for details). The shear drives for the 40 MGD flocculators do not always shear, resulting in bent arms and paddles.
    - Blade speeds are difficult to adjust with the current flocculator drives and therefore are not adjusted. There is uncertainty that the blade configuration and rotating speeds are optimal for flocculation. New flocculator drives with VFDs should be installed to more easily adjust flocculator speed based on plant flows.
    - Substantial solids accumulation is present in the flocculation effluent channels in the 80 MGD plant, which may impact the flow balance delivered to the sedimentation basins. In addition, septic conditions are present, which could potentially be detrimental to downstream water quality. It should be noted, however, that no appreciable impact to downstream treatment processes has been observed by Plant staff due to the solids accumulation in the effluent channel.
    - Temporary wood boards have been installed between the flocculation passes in the 40 MGD plant. These boards should be replaced with a permanent concrete system.

- **Sedimentation**
    - Sludge collector drives have been reliable but are past their useful life and should be replaced.
    - Sludge collectors near the end of Basin Nos. 5 and 6 have been out of service for over eight years, resulting in solids carryover during high flow periods. This has reportedly affected filter effluent turbidities and run times for the 40 MGD train.
    - The sludge removal pumps have been reliable and work well; however, they have reached the end of their useful life and should be replaced.
- **Recarbonation**
    - The recarbonation tank volume in the 40 MGD plant is insufficient to meet necessary contact times for recarbonation; however, additional contact time is available in the effluent channel that leads to the filters, which in conjunction with the recarbonation basin provide a total contact time that is adequate for effective recarbonation.
    - The CO_2 storage tank system is new and in excellent condition. The current CO_2 system has been effective for pH adjustment and stabilization; however, plant staff has noted recurring leaks in the feed piping and low transfer efficiencies.
    - Staff have indicated that controls of carbon dioxide feed on the 40 MGD side are very sensitive and often result in undesirable pH values in water applied to the filters.

4.4.1.5 Filtration

The filters at the Collins Park WTP are dual media filters and are used to remove suspended solids from the recarbonated water (see Figure 4-15). The filters are divided into six banks of five filters each, with a common filter gallery located between each bank. Thirty dual media filters, each consisting of 18” of sand and 6” inches of anthracite, are loaded at a rate of 3 gallons per minute per square foot (gpm/SF).

Figure 4-15: Filters

Water flows into the center gullet for each filter through the appropriate 30-inch influent line and valve, and then into the filter through the washwater troughs. The two cells in each filter are operated as a single filter while in service. Water flows downward through the filter media in each filter cell. As the water passes through the media, most of the suspended solids in the water become trapped in the spaces between the media grains. Filtered water continues flowing through the media and passes through the gravel to the underdrain system. The rate of flow controller for each effluent line controls the flow rate through each filter cell to maintain a constant flow rate through each filter in service. Water passes through each rate of flow control valve and enters the filtered water conduit for the appropriate even numbered or odd numbered filters. The effluent from each filter flows to the reservoirs located at the south end of the treatment plant property.

The following observations and deficiencies were noted for filtration:

- **Filter Boxes**
    - The filters in the 80 MGD plant were completely refurbished in the 1990s (including media and surface wash piping replacement), and are generally in good condition. The filter media and surface wash piping for the 40 MGD plant are from the original installation and may need to be replaced.
    - Plant staff has noted that on average, approximately 2 – 3 inches of media has been lost. Although the plant has been able to regularly meet the CFE turbidity goal, addition of media to restore the original total media depth is necessary.
    - The majority of filters for both the 40 and 80 MGD plants do not have safety railings, posing a safety hazard for staff accessing the filters.
    - The roof drain discharges directly to the filter surface. This configuration is not considered acceptable as drainage can potentially contaminate the treated water at a point after pretreatment.
- **Filter Pipe Gallery**
    - Many valves and actuators were replaced in the 1987 Filter and Control Improvements Project. The filter pipe gallery is generally in good condition, but the valves and actuators are nearing the end of their useful life and should be replaced (see Figure 4-16).
    - Washwater piping and valves; and plant water and boiler piping are in poor condition. Significant leaks and corrosion are present.
    - Extensive piping and valves throughout the pipe gallery are original, and over 70 years old, with areas of significant corrosion. Much of the piping is in need of rehabilitation and painting.
    - Piping in many areas is not color coded and/or not clearly labeled.


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Figure 4-16: Filter Pipe Gallery

- **Filter Backwash and Surface Wash**
    - The backwash procedures observed appeared to provide for favorable cleaning of the media. However, it was noted that backwash was initiated when the water level was at the top of the backwash troughs. This may not allow for the desired level of media cleaning during surface wash, and does not permit visual confirmation that the surface arms are actuating.
    - The plant can only backwash one filter at a time due to constraints with the existing lagoon and reclaim system, resulting in limited flexibility for filter backwash operations.
    - Backwash pumps were rebuilt approximately 10 to15 years ago, and the contactors and motor starters were recently rebuilt. Overall, the pumps work well and have been reliable.
    - The surface wash pumps in the 80 MGD plant are routinely out of service due to VFD board issues. During these outages, the plant must rely on the elevated tank for surface and backwashes. No issues were noted with the surface wash pumps at the 40 MGD plant.

  - The elevated storage tank fill pumps have been very reliable. The fill pump in the high service pump station was last rebuilt in 2010, while the fill pump in the backwash room will require a rebuild in the near future. .
- **Filter Operations**
  - Filter run times are generally in the range of 45 to 72 hours, which are considered adequate for this type of plant and source water. However, shorter run times have been observed for the 40 MGD plant, likely due to added solids carryover from the sedimentation basins with the inoperable solids collection equipment.
  - The plant currently maintains all filters on-line and in service during all flow conditions and continuously feeds polyphosphate on top of the filters to prevent deposition associated with the high pH of the pre-filtered water. , Pre-filtration phosphate addition is needed due to the high pH water, which is a result of softening practices. A review of alkalinity data shows no significant scale deposition on the filters, indicating effective performance of the phosphate addition.
  - There currently is no filter monitoring program at the plant to verify the condition of the filter media and filters.

4.4.1.6 Chemical Storage and Feed Systems

The following sections provide a brief description of each chemical storage and feed system and results of the condition and operational assessments with respect to each chemical.

Potassium Permanganate

Potassium permanganate is applied to the raw water via a diffuser ring at the intake for zebra mussel control. Permanganate also helps oxidize some of the taste and odor (T&O) causing compounds in the raw water. Permanganate is added via a new feed system located in a separate building at the low service pump station site (see Figure 4-17). The permanganate feed system is not flow paced. Instead, doses are manually adjusted by WTP personnel based on residual permanganate levels measured at the low service pumping station.

Figure 4-17: Permanganate Feed System

The following observations and deficiencies were identified for the permanganate storage and feed system:

- The permanganate storage and feed system is new and is in good condition; however, there are occasional problems with maintaining a consistent backpressure given the long distance between the metering pumps and the application point. Plant staff also noted several operational issues, including motor failures and mechanical seal problems since startup.
- Year round feeding of permanganate has led to positive downstream impacts, such as a decrease in required alum dosages.

- The permanganate feed is currently not flow paced; however, the system is configured to provide flow pacing if desired.
- Safety improvements are needed and include installation of level sensors and automated valves.
- Sufficient contact time is available for the permanganate to react prior to the introduction of subsequent chemicals under all flow conditions.

Powdered Activated Carbon

Powdered activated carbon (PAC) is added to the raw water just before it discharges from the low service pumping station for T&O control. The PAC feed system utilizes bulk underground slurry storage, pumps located in the basement of the pumping station and Rotadip type feeders (see Figure 4-18). PAC feed is periodically interrupted due to PAC solids buildup in the bottom of the pump slurry chamber. During summer months, it is adjusted to minimize T&O detected in the distribution system. Doses are manually adjusted by WTP personnel. Staff noted that the feed capacity of the PAC system is adequate to provide the necessary dosages (in conjunction with permanganate) to address most significant T&O events.

Figure 4-18: PAC Feeder

The following observations and deficiencies were identified for the PAC storage and feed system:

- The current PAC feed system is effective and reliable, but near the end of its useful service life.
- The PAC feed system is not currently flow paced. A system was installed several years back to allow flow pacing, but was never implemented.
- Safety improvements are needed and include installation of level sensors and automated valves.
- Improvements are needed to provide adequate water supply to the PAC feed system.
- Sufficient contact time is available for the PAC to react prior to the introduction of subsequent chemicals under all flow conditions.

Alum

Alum is introduced at the water surface in the rapid mix channels via a primary system consisting of Rotadip feeders (see Figure 4-19). A backup feed system is also available to feed alum to the 40 MGD rapid mix channel. The Rotadip alum feeders provide a minimum dosage of about 0.3 grains per gallons (GPG), which at times is higher than actual dosages required for effective coagulation. Although the backup alum feed system that can provide lower dosages, plant staff noted that the

Figure 4-19: Alum Day Tank and Rotadip Feed System

system is not flow paced and not ideally suited as the primary feed system. The backup alum feed system is typically used to supplement the Rotadip feeders during high flow and dosage periods.

The following observations and deficiencies were identified for the alum storage and feed system:

- The alum application method is not optimal for effective pretreatment. It is unlikely that this application method allows for complete mixing throughout the cross section of flow. A more effective chemical application and mixing method is necessary to increase the distribution of alum.
- The Rotadip feed system works well; however there are no backup feeders. A single Rotadip feeder is dedicated to each treatment train providing no redundancy in case of equipment failure. The backup alum system can be used to supplement the Rotadip feeders during high flow periods or serve as an emergency backup in case of alum system failure. However, the backup system can only feed the 40 MGD rapid mix channel and is not adequately sized to meet peak dosage requirements.
- The turndown ratio on the Rotadip feeders is insufficient to meet low dosages, resulting in alum overdosing during low flow conditions.
- The backup alum feed system is not flow paced.
- The total bulk storage tank volume of 24,000 gallons provides approximately 10 days of storage under average flow and dosage conditions. This is insufficient to meet the recommended Ten States Standard of 30-day storage under average usage conditions. Under peak usage conditions, the total bulk storage volume can be utilized in a single day. The lack of bulk storage capacity has not been an issue to date given that a local alum supplier can quickly replenish alum supplies. However, additional storage volume is recommended to ensure an adequate supply can be maintained and to increase operational flexibility in the event the local alum supply is not as readily available in the future.
- No spill containment is provided for the alum bulk storage tanks. This is a safety issue in particular considering that the boiler system is housed in the same room. The alum transfer pumps are located on ground level between the bulk storage tanks and would be inaccessible in the event of an alum leak. Spill containment and relocation of the transfer pumps is required to address this safety issue.

Lime and Soda Ash

On the 40 MGD train, lime is added via a slurry line to a chamber immediately upstream of the flocculation basins that provides rigorous hydraulic mixing. On the 80 MGD train, lime slurry (see Figure 4-20) is added to the surface of flow in the first pass of the flocculation basin. Soda ash is added to the surface of flow at the second pass of flocculation in both treatment trains. The pH in each flocculation basin is typically around 10 to 10.5, and is maintained by adjusting the lime slurry flow into each basin.

Figure 4-20: Lime Slurry

The following observations and deficiencies were identified for the lime and soda ash storage and feed systems:

- For the 80 MGD plant, lime addition occurs on the surface of the first pass, which is not ideal to provide complete mixing. Relocation and/or reconfiguration of the lime application should be considered to improve chemical dispersion.
- For the 40 MGD plant, lime addition occurs in the chamber prior to the flocculation basins, resulting in adequate hydraulic mixing.
- Soda ash application occurs on the surface of the second pass for both plants and does not provide complete mixing.
- Bulk storage has several inoperable valves and a number of tanks that are not used. The plant currently cannot rotate nor utilize all storage bins due to the damaged valves.
- The vacuum system works well; however, no redundancy has been provided and there is limited space to perform the required maintenance.
- Rapid wear of the rotary valves is a recurring problem for plant staff. Periodic pipe leaks are also problematic.
- Soda ash lines in the current transfer system are often clogged.
- Plant staff must routinely manually remove lime solids to an outside dumpster using a wheelbarrow, which is a labor intensive operation.

Polyphosphate

Polyphosphate is added continuously on top of the filters to prevent deposition associated with the high pH of the water applied to the filters. The typical polyphosphate dosage is about 0.5 mg/L as P. The storage and feed system consists of bag loaders, bulk storage tanks, feed pumps and a carrier water line (see Figure 4-21). The feed system is currently located in the Chemical Feed Room between the alum day tanks. A review of alkalinity data shows no significant scale deposition on the filters, indicating effective performance of the phosphate addition. No deficiencies were noted for this system.

Figure 4-21: Polyphosphate Storage and Feed System

Chlorine

After filtration, water is combined into filtered water conduits flowing to the underground reservoirs. Chlorine is added to this flowstream for disinfection. Two reservoirs are provided for the Collins Park WTP just south of the high service pumping station. The reservoirs are used to collect and store filtered water, to provide disinfection contact time, and to convey finished water to the high service pumping station suction wells.

The chlorine system contains one-ton chlorine gas containers, evaporators, chlorinators, injectors, carrier water piping, and a scrubber system in the event of a leak. Liquid chlorine is extracted from the containers and volatilized via evaporators. Once in the gaseous form, chlorinators are used to meter the amount of gas added to the carrier water (see Figure 4-22). Injectors located near the chlorinators mix the metered chlorine gas with the carrier water stream to form a chlorine solution, which is then piped to the appropriate application points.

Figure 4-22: Chlorinators

Chlorinated water flows to two on-site underground reservoirs, which provide the necessary contact time to meet disinfection requirements (see Section 2.3.2.5 for additional details). Normally, the reservoirs are operated in series to provide the most effective chlorine contact time. Summer time free chlorine residuals entering the reservoirs are maintained between 1.6 mg/L and 1.7 mg/L.. Higher residuals are needed during the summer because chlorine residual dissipates more rapidly in warm water. Winter time free chlorine residuals are maintained around 1.25 mg/L . These residuals result in the desired free chlorine residual leaving the plant between 0.9 mg/L and 1.0 mg/L.

The following observations and deficiencies were identified for the chlorine storage and feed system:

- The current feed system does not have adequate capacity to meet peak flow and dosage conditions (see Section 3 for details).
- Problems with the pressure regulators are common. In addition, pressure regulators are needed, but not provided, at each tank.
- Currently, all ventilation lines are piped to a single header. Separate ventilation lines are needed to be able to effectively identify where leaks are located when they develop.
- The current configuration requires that the entire chlorination system be shutdown if a leak is detected. An extended system shutdown can compromise the plant's ability to meet disinfection requirements.
- Sodium chlorite is stored in the same room as caustic soda, which is used for the scrubber system. No spill containment or separation between chemicals is provided.

The City is currently requesting proposals for design of a new chlorination system in a dedicated building that would replace the existing system. The current chlorination room is planned to be converted into a storage room.

Fluoride

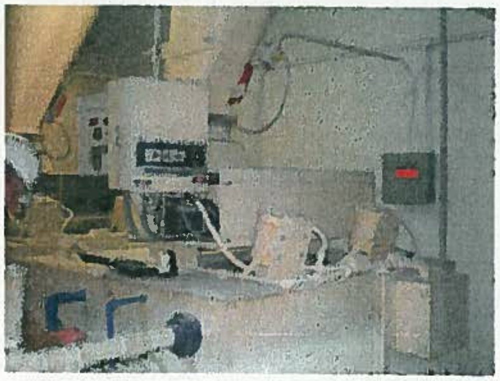


Figure 4-23: Fluoride Feeders

Fluoride is used to prevent tooth decay, and is added immediately following chlorination before the underground reservoirs. Fluoride is typically added at dosages between 0.5 – 1.0 mg/L.

The storage and feed system consists of dust collectors/bag loaders, storage bins, feeders, and solution mixing tanks. Fifty pound bags of fluoride are loaded into the bag loaders on each shift to keep the storage bins full. The dust collector is operated manually when fluoride is loaded into a bag loader. The feeders (see Figure 4-23) are used to prepare the fluoride solution from dry sodium fluorosilicate. A solution mixing tank is located below a fluoride feeder and is used to mix the dry fluoride with water to form a fluoride solution. Water is continuously supplied to each solution mixing tank while the fluoride feeder is operating. The solution concentration depends on the amount of fluoride added to the solution tank. Fluoride solution discharges from each mixing tank and flows through the basement to the appropriate feed points.

The following observations and deficiencies were identified for the fluoride storage and feed system:

- The current fluoride feed system is planned for replacement in early 2012.
- The storage is currently located in an unrestricted area. A dedicated storage room with adequate ventilation is needed to house the fluoride storage equipment.

Chlorine Dioxide

Chlorine dioxide is used as needed to oxidize T&O compounds, and is added in conjunction with chlorine before the underground reservoirs. It is generated on-site from chlorine gas and sodium chlorite via four chloride dioxide generators, each able of producing 500 pounds per day of chlorine dioxide (see Figure 4-24). The feed system is designed to feed up to 2 mg/L of chlorine dioxide to the filtered water; however, chlorine dioxide is typically added at a dose of about 0.2 mg/L. The concurrent addition of chlorine with chlorine dioxide before the underground reservoirs may not be the optimal location for T&O control and overall water quality control. Separating the chlorine dioxide and chlorine application points should be considered to more effectively use the oxidizing benefits of chlorine dioxide in an effort to improve water quality performance.

Figure 4-24: Chlorine Dioxide Generation System

4.4.1.7 High Service Pumping Station

Six horizontal split case centrifugal, double-suction pumps are located in the high service pumping station (see Figure 4-25). These pumps are used to convey treated water from the plant reservoirs to the City's distribution system. The pumps and motors are mounted in three separate dry wells with a floor elevation approximately 18 feet below grade. Two pumps are located in each well as follows: Well A - Pumps No. 1 and 2; Well B - Pumps No. 3 and 6; and Well C - Pumps No. 4 and 5. Each pump has a bottom style suction, which draws water into the pump through a

Figure 4-25: High Service Pump

60-inch diameter suction bell from a wet well located directly below the pump. The floor of the wet well is approximately 35 feet below grade. The characteristics for each pump are summarized in Table 4-7.

Table 4-7: High Service Pumps

Pump No.	Capacity (gpm)		Head (ft)		Horsepower (hp)		Speed (rpm)		Voltage (V)	Manufacturer
	High Speed[1]	Low Speed[1]	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed		
1	38,000	34,000	140	110	1,500	1,250	450[2]		7,200	Fairbanks Morse
2	45,000	39,600	200	160	3,000	2,000	514	450	6,900	Fairbanks Morse
3	45,000	–	210	–	3,000	–	514	–	6,900	Fairbanks Morse
4	45,000	39,600	210	160	3,000	2,000	514	450	6,900	Fairbanks Morse
5	27,776	–	210	–	2,000	–	506[2]		7,200	Trans America DeLaval
6	47,000	41,500	210	161	2,800	1,750	514	450	6,900	DeLaval

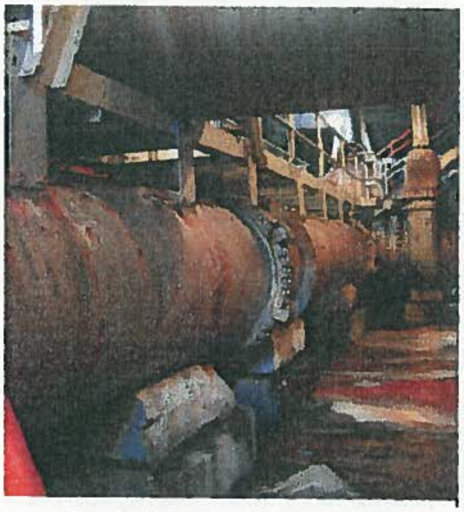
[1] For pump nos. 2, 4, and 6 two synchronous motors are used to achieve high and low speed operation.

[2] New VFD currently being installed.

Pump Nos. 1, 2, 3, and 4 were installed in 1940 as part of the original station construction. Each of these pumps has most recently been re-built in 2011, 1993, 1994, and 1992, respectively. Pump No. 6 was installed in 1949 and was most recently rebuilt in 1988. Pump No. 5 was installed in 1980. New variable speed drives are currently being installed on Pump Nos. 1 and 5.

Discharge piping from each pump is routed into the main pipe room where cone check valves and venturi meters are located. The cone check valves are operated by hydraulic oil actuators. The station contains one hydraulic oil accumulator system, which serves all six pump check valves. Discharge flow is then routed into either an upper or lower header by a series of electrically actuated gate valves to the two 72-inch and 96-inch trunk water mains.

Each pump is equipped with a vacuum priming system to prime the pump prior to start-up. The normal reservoir water level is below the pump casing creating a suction lift condition. Given this condition, it is necessary to fill the pump casing with water, i.e. prime the pump, prior to starting the pump. There is one vacuum pump and bladder tank in each pump drywell that services two high service pumps.



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ery

The following observations and deficiencies were identified for the high service pumping station:

- **Pumps**
    - Although there are enough pumps to meet peak flow conditions, the plant cannot operate in the total range of flows needed because of the limited flow range that can be achieved with the constant speed pumps. Addition of VFDs for Pump Nos. 1 and 5 should help address the current flow range gap.
    - Pump Nos. 1, 2, 3, and 4 are over 70 years old, but underwent re-builds in 2011, 1993, 1994, and 1992, respectively. As part of the current rebuild project for Pump No. 1, a new VFD is being installed.
    - Pump No. 6 is over 60 years old and was last re-built in 1988.
    - Pump No. 5 is 30 years old. A new variable speed drive is currently being installed.
    - The cone check valves for the pumps are over 70 years old, repair parts are difficult to obtain, water is leaking from the valves at the stem, and hydraulic oil is leaking from the actuator cylinders.
    - One oil accumulator serves all six pump check valve hydraulic actuators. In the event of failure, none of the check valves would be able to be operated. This is a redundancy issue.
    - Vacuum priming systems were replaced in 2008.
- **Discharge Piping Gallery**
    - The cone check valves are in poor conditions and leaking oil and water.
    - There is surface corrosion on the piping in the Main Pipe Room due to the damp, humid environment (see Figure 4-26).
    - The condition of piping and valves in the valve vaults on the west side of the station was not inspected during the condition assessment but their condition is suspect given that they are over 70 years old. Inspection of these valve vaults is recommended to verify the condition of the piping and valves.

4.4.1.8 Residuals Handling and Dewatering Facility

Figure 4-27: Dewatering Facility Thickener

The sludge dewatering facility was constructed in 1997 to provide an alternate means to the lagoons of dewatering and disposing of WTP residuals. A majority of the equipment in the facility is original. Residuals are pumped from the WTP into the dewatering facility thickeners (see Figure 4-27). Thickened sludge is pumped into a press pre-fill tank by three thickened sludge pumps. These pumps are 10 horsepower, horizontal vortex centrifugal pumps, each rated for 750 gpm at 16 feet of total dynamic head. The residuals are then pumped into the plate and frame presses by a combination of the quick fill and high pressure pumps. There are two horizontal vortex centrifugal type quick fill pumps manufactured by WEMCO, and three 75 horsepower, 350 gpm at 225 psi, piston type high pressure pumps manufactured by ABEL. There are two plate and frame presses, each capable of producing 437 cubic feet of cake per day (see Figure 4-29). Each press contains 125 plates and can operate with a maximum closing pressure of 4,500 psi. The presses are located above a tractor trailer bay so that upon completion of the pressing run, the cake is dropped into a semi-trailer for removal from the site.

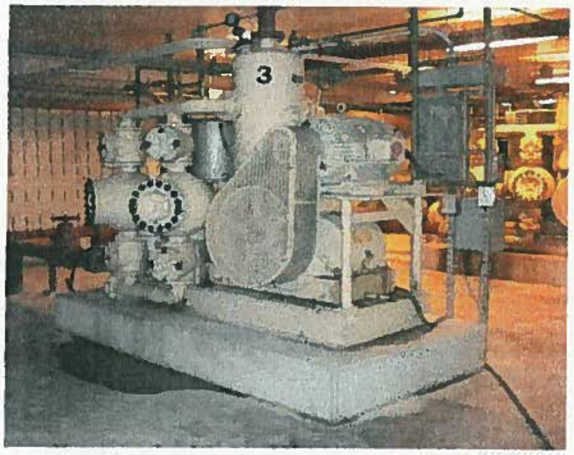

Figure 4-29: High Pressure Pump

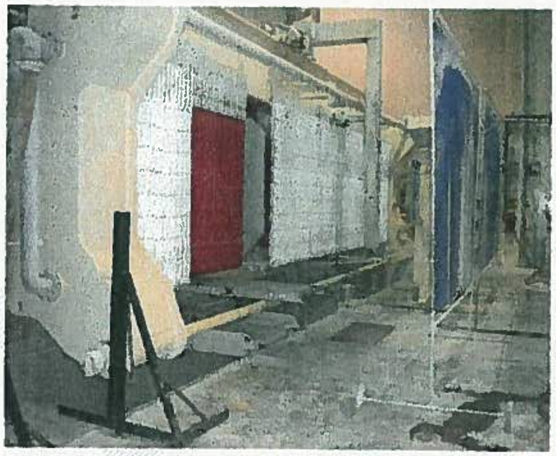

Figure 4-28: Plate and Frame Filter Press

The following observations and deficiencies were identified for the sludge dewatering facility:

- **Plate and Frame Presses**
    - A plate rehabilitation and fabric replacement project is currently underway for the two plate and frame presses.
    - The presses spray sludge during operation, which has damaged wall mounted unit heaters, and generally left a mess in the press room. Portable tarp panels have been constructed to block the spraying sludge (see Figure 4-28); however, the presses cannot be seen from the operator room due to the tarps. Splash guards are recommended to address this issue.
    - Numerous press supporting components are in need of maintenance and repairs, including valve actuators, light curtains, and wash bars.
- **Miscellaneous**
    - The thickened sludge pumps are showing signs of aging with corrosion, leakage, and support degradation present. Replacement of these pumps is recommended.
    - Compressor No.2 on the Core Blow Compressor has been out of service for an extended period.
    - Seal water pumps have to be operated on Hand due to problems with their associated controls.
    - The air cushion system on the High Pressure Pumps must be operated manually because the components for automatic operation are not functional.
    - Quick Fill Pump No. 2 has been out of service since January 2009.
    - The overflow pump check valves are leaking.

4.4.1.9 *Waste Washwater Pumping Station*

Figure 4-30: Waste Washwater Pump

Three horizontal end-suction centrifugal pumps, manufactured by ITT-AC, are located in the waste washwater pumping station (see Figure 4-30). Each pump is 75 horsepower and rated for 5,000 gpm at 42 feet of total dynamic head.

Filter washwater flows by gravity from the WTP to the washwater holding basin located near the pumping station. Water in the holding basin can be pumped to either Lagoon D or recycled to the head of the WTP. Plant drains for both the 80 MGD plant and the 40 MGD plant are also connected to the washwater holding basin. When the flocculation and sedimentation basins are drained, water and spent lime solids discharge to the holding basin and ultimately are pumped to Lagoon D.

Pump No. 1 is dedicated for washwater recycle to the Plant. Pump No. 3 is dedicated for washwater pumping to Lagoon D. Pump 2 can be used for washwater recycle or for lagoon pumping. Each pump has a 24-inch suction bell and a 24-inch butterfly valve on its suction piping, and a discharge butterfly valve, check valve, a pressure gauge, and mechanical seals. The discharge pipe from each pump is connected to a 24-inch discharge header exiting the south wall of the pumping station. A butterfly valve is provided on the header between each pump to route washwater flow from a selected pump either to Lagoon D for storage or to the plants for recycle.

The following observations and deficiencies were identified for the waste washwater pumping station:

- The pump check valves and discharge header at the wall penetration are leaking.
- Pumps have been re-built; however, the date of the last re-build is unknown.

4.4.1.10 *Heatherdowns Pumping Station*

Constructed in 1972 to boost water pressures in the southwestern portion of the water distribution system, the Heatherdowns Pumping Station contains three 600 horsepower, 4,160 volt, variable speed, vertical turbine pumps; each rated for 13.5 MGD at 172 feet of total dynamic head (see Figure 4-31). Variable speed operation is achieved through the use of an eddy current coupling. There is no mechanical connection between the pump and motor, and the motors are constant speed. The speed of the pump is varied by the magnetic force applied at the coupling.

A cone check valve is installed on the discharge of each pump. The valves are opened and closed using hydraulic oil actuators. The station has one hydraulic oil accumulator serving the three cone valve actuators.

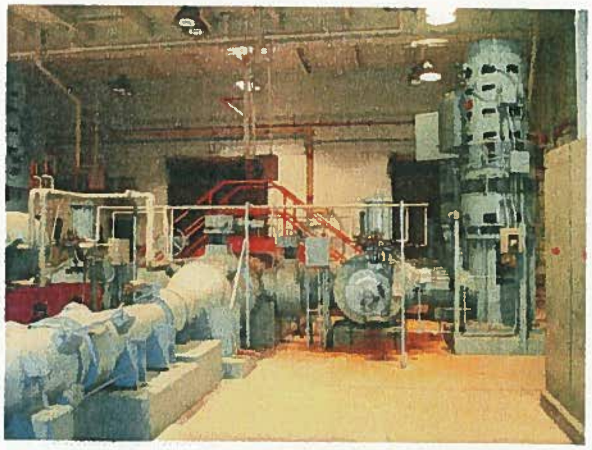

Figure 4-31: Heatherdowns Pump Station

The underground clearwell is filled from distribution system piping through two angle pattern pressure reducing valves. These valves were installed in 1997 as part of an improvements project.

The following observations and deficiencies were identified for the Heatherdowns Pumping Station:

- The pumps and motors are 40 years old. Pump No. 3 was out of service at the time the field investigations were completed. The eddy current variable drives are obsolete and parts are becoming difficult to obtain.
- Since the pumps are located directly in the clearwell, if a pump has to be removed for service, the entire clearwell needs to be bacteria tested prior to placing back into service. Consideration should be given to locating the pumps outside the clearwell in cans where they could be isolated for maintenance.
- Some water leakage is evident at the cone valves.
- Clearwell Fill Valve No. 1 is leaking, and some surface corrosion on valve was noted.

4.4.2 Electrical and I&C

During the condition assessment, ARCADIS/Malcolm Pirnie staff completed a detailed review of the electrical/I&C components of the plant facilities. Observations including significant deficiencies are presented in detail below.

4.4.2.1 Low Service Pumping Station

The main switchgear was installed when the Low Service Pumping Station was built. The existing service has two Toledo Edison 2,400 Volt feeds. At the time 2,400 Volts was common but now the voltage is no longer used by Toledo Edison. The switchgear is in good condition but is old. The circuit protection is provided by the original mechanical relays. Three of the pump drives are wound rotor motors with resistor banks for pump control. The original motors and pumps have been rebuilt over the years. One pump was replaced with a new wound rotor motor and energy recovery drive in 1982. The drive is now obsolete and replacement parts are not available. The standby generators were added in 1987 and are in good condition. The 480 volt transformers were replaced in 1987 and 1988 and are also in good condition.

The following observations and deficiencies were identified for the Low Service Pumping Station:

- The current service voltage is not standard. If a Toledo Edison service transformer fails, there would be no replacements in stock, a replacement would have to be built.
- The energy recovery drive is obsolete and replacement parts are not available. The drive also has problems with dependability.

- The wound rotor motors and resistor bank drives are inefficient and are limited in the operating range they can provide for the pumps.
- The switchgear is in good condition but is past its expected useful life. The mechanical protective relays are obsolete and not as repeatable as modern protective devices. Expandability is limited for future improvements.

4.4.2.2 *Water Treatment Plant*

The electrical equipment at the plant was installed when the plant was built and when the various expansion and improvements have been constructed. Depending on the equipment in use, the load of the plant can exceed the capacity of the unit substation.

The following observations and deficiencies associated with the WTP were identified:

- The Residuals Handling and Dewatering Facility does not have standby power.
- The motor control centers, panel boards and switchboards are past their life expectancy and will need replacement within the Master Planning period.
- The Unit Substation at the plant is overloaded and is showing signs of corrosion. In addition, the substation room is hot and needs improved ventilation.

4.4.2.3 *High Service Pumping Station*

Most of the electrical equipment was installed when the High Service Pumping Station was built. The High Service switchgear provides power for the entire plant. The switchgear has three separate buses and two Toledo Edison 7,200 Volt services. The three main and three tie circuit breakers were replaced in 2003 when the standby power facility was installed. Two of the high service pumps are variable speed and four are constant speed. High Service Pump No. 5 was installed in 1982 with a wound rotor motor and an energy recovery drive. The drive has recently been replaced with a new variable frequency drive. Pump No. 1 is currently under construction and will be rebuilt with a new motor and variable frequency drive. The four other pumps are constant speed with synchronous motors. The circuit protection is provided by the original mechanical relays. The 480 volt transformers were replaced in 1987. The Stand-By Power Facility was built in 2003 and provides backup power for the plant.

The following observations and deficiencies were identified for the High Service Pumping Station:

- Switchgear is good condition but is past its expected useful life. The mechanical protective relays are obsolete and not as repeatable as modern protective devices. The 600 Amp.bus limits load placed on each service. Expandability is limited for future improvements.
- The 480 Volt switchgear and panel boards are original and past their expected useful life.

4.4.2.4 *Residuals Handling and Dewatering Facility*

During the site visits, it was noted that the existing service for the Residuals Handling and Dewatering Facility is separate from the plant and there is no backup power. As a result, the facility cannot operate during a power outage. Existing electrical equipment for the Residuals Handling and Dewatering Facility was installed when the facility was build and is generally in good condition.

4.4.2.5 Heatherdowns Pumping Station

Most of the electrical equipment at the Heatherdowns Pumping Station was installed when the station was built in 1971 and is generally in good condition. The pump station has a 4160 volt power system for three 600 HP pumps. The three pumps have 4160 Volt constant speed motors and eddy current variable speed drives. There is no standby power on site.

The following observations and deficiencies were identified for the Heatherdowns Pumping Station:

- The facility does not have a backup power source. As a result, the facility cannot operate during a power outage.
- The eddy current drives are obsolete and past their expected useful life.

4.4.2.6 Plant Control System

The Plant Control System was supplied by Bristol Babcock and installed in 1989. The system consists of Programmable Logic Controllers (PLC's), redundant servers and operator work stations. The server has redundant computers and is located in the control room. The operators monitor and control the plant using the operator work stations. The work stations are located in the plant control room and at High Service Pumping Station. The PLC's are located around the plant close the process equipment. The inputs and outputs for the process equipment are connected to the PLC's. The PLC's contain the programs that control the process. An Ethernet data highway connects the PLC's, servers and workstations together, allowing them to share control and monitoring information. The servers and work stations have been upgraded, and are new. The plant control system is obsolete, and PLC replacement parts are not available.

The following observations and deficiencies were identified for the Plant Control System:

- The plant control system and associated PLC hardware are obsolete. Replacement parts are no longer available for this equipment. The system cannot be expanded for plant improvements.

4.4.3 Structural/Architectural

During the condition assessment, ARCADIS/Malcolm Pirnie staff completed a detailed review of the structural/architectural condition of the plant facilities. Observations including significant deficiencies are presented in detail below.

4.4.3.1 Raw Water Intake

During the site visits, it was observed that the intake structure is difficult to access due to its high elevation. In addition, plant staff noted that there are damaged walkways within the structure. An overall structural integrity assessment and general inspection of the structure is necessary. The current monitoring program for the intake conduit is adequate; however, the inspection frequency may need to be increased.

4.4.3.2 Flocculation, Sedimentation and Filtration

During the site visits, it was observed that pieces of concrete from inside some of the flocculation/sedimentation and filter enclosure areas have been breaking off and falling into the basins (see Figure 4-32). Hardhat signs have been posted to alert staff of the danger. Inside these areas, several pieces of concrete were found missing from the concrete roof deck. Concrete pieces had likely fallen into the open-top basins. In addition, wherever concrete had spalled, severely corroded reinforcing steel bars were observed.

Figure 4-32: Concrete Roof Deck In Flocculation/Sedimentation Area

The roof structure of the flocculation/sedimentation and filters areas is comprised of painted structural steel framing with precast concrete slabs overtop of the steel beams. The precast slabs span approximately 8 feet, and are commonly referred to as "channel slabs". Each slab has a nominal width of two feet. These slabs are not nearly as common today as they were 60 or 70 years ago. They were very popular at the time these structures were built, and especially well-suited to moist or humid environments. The installation is quick as they are laid in place over the structural steel and only require some simple metal clips to secure them to the steel. This roof deck system is very conducive to large roofs with minimal openings and few concentrated loads.

The precast channel slabs provide a continuous flat top surface for roofing; however, on the underside they are "toes-down" with conventional bar reinforcement in each leg of the channel. The slabs are made with minimal concrete cover over the reinforcement, and the section only has a 3 inch or so overall thickness, with the center of the channel slab being only 1.5 inches thick. The only bar reinforcement in the slab is a single rod in each "toe" of the channel. This bar gives the slab its structural ability to span 8 ft across the structural steel beams.

Moisture has attacked the bar reinforcement. As the steel corrodes, it expands and pops the thin bottom layer of concrete off. The corroded steel reduces the load bearing capacity of the structure because less steel is available to carry the load and less of the concrete and steel are bonded together acting as one, which is necessary for reinforced concrete sections to behave as intended.

When steel reinforcing bars are not effective, the slab strength decreases and the failure of concrete alone is sudden and without warning. Immediate collapse of these weakened sections is possible. As has been previously discussed, personnel should not be permitted beneath or on top of roof deck sections that are missing concrete and in need of replacement.

4.4.3.3 *Finished Water Reservoirs*

The at-grade concrete on top of the finished water reservoirs is deteriorating (see Figure 4-33). Concrete risers that frame the access hatches and frame gate operators are constructed from the reservoir top slab and extend upward to a point where they are slightly above grade. This concrete is exposed to weather and winter freeze-thaw cycling and is cracking and spalling.

Figure 4-33: Concrete On Top of Reservoirs

4.4.3.4 *High Service Pumping Station*

During site visits, it was noted that the steel pipe supports have deteriorated and are in need of repair in the High Service Pumping Station (see Figure 4-34).

Figure 4-34: High Service Pump Station Pipe Supports

4.4.3.5 *Residuals Handling and Dewatering Facility*

Anchors that hold the large steel hopper to concrete framing are corroding (see Figure 4-35). These anchors are embedded in the bottom of the large concrete beams framing the slab openings for the plate and frame presses. Replacement will be difficult as these are embedded in the concrete, so it is important that they be coated and properly protected. Proper paint protection will avoid the much more costly demolition of the concrete to replace embedments, and extend their useful life.

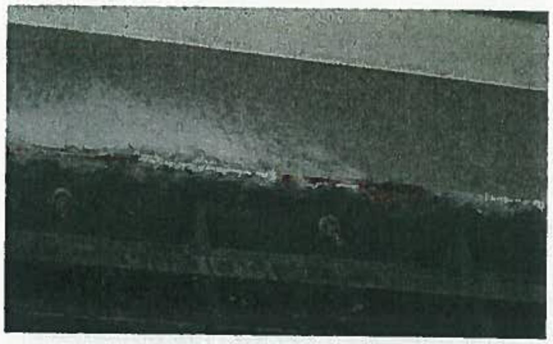

Figure 4-35: Hopper Anchors In Residuals Handling and Dewatering Facility

4.4.3.6 *Heatherdowns Pumping Station*

Aggregate panels on the exterior of the masonry walls provide architectural accent for the expanse of brick. These panels have no structural significance to the building integrity. However, some of the aggregate covered panels are losing their attachments and are falling (see Figure 4-36). It is believed that the panels are plywood backup, faced with an epoxy-aggregate matrix. These panels may be near the end of their useful service life and should be removed, especially if the failed attachments are a safety concern.

Figure 4-36: Aggregate Covered Panels

4.4.3.7 *General*

Masonry

The brick exteriors of the 80 MGD and 40 MGD buildings are suffering from considerable movement. The brick (as constructed) has very few vertical relief joints (i.e. expansion joints). As a result, the brick has undergone considerable cracking over the years by way of normal expansion and thermal changes (see Figure 4-37). It is apparent that many cracks have opened up over the years and that mortar and caulking have been used repeatedly to keep the brick relatively closed-up to insects and weather.

Figure 4-37: Cracking In Brick Structures

Exterior brick facades provide a fairly good barrier against weather; however, that brick and mortar are relatively porous when subjected to wind-driven rain. This is the reason why current masonry wall design incorporates flashings and weep holes, to collect and drain moisture that penetrates the brick exterior. At the time of this construction, the state of the practice was different, and no flashings and weeps were used.

Another ramification of water penetrating the brick exterior is corrosion of any steel materials within the masonry. In these structures steel columns, beams and lintels are all buried within the masonry walls. Since they are out of sight they cannot be painted on a regular basis and the amount of corrosion on this embedded steel is unknown. However, the exterior brickwork and movement out of the plane of the wall provides some indication that corrosion is occurring within the masonry. .

Windows and Doors

In several locations, brickwork is moving at the heads of windows and doors (see Figure 4-38). This is a fairly common occurrence where lintels corrode, expand the steel, and move masonry. Unfortunately, resolution of this problem is labor intensive. Complete removal of neighboring masonry is required in order to replace or repair loose lintels or any other embedded steel framing. Refurbishing of the steel is followed by replacement of masonry in and around the steel members. A considerable amount of shoring is required to ensure the remaining masonry above the opening does not collapse.

Figure 4-38: Deterioration around Windows

Additionally, coping materials at the tops of parapet walls are notorious for allowing water penetration into the wall structure. Because the parapets see more thermal changes than any other portion of the wall, movement is magnified, as is the chance for moisture penetration. Coping needs to be rehabilitated when the neighboring masonry is reworked.

Caulked joints in masonry need to maintain flexibility and weathertighness. Cracked, brittle caulk is not functional and needs to be removed and replaced.

Roofing

Roofing assemblies on all buildings typically have about a 20 year service life. As a result, a schedule should be developed to replace a portion of the roof every few years.

Tunnels

During the site visits, some of the concrete beams and slabs in the plant piping tunnels have deteriorating concrete and corroded bars on the underside (see Figure 4-39). In some instances, structural reinforcing bars are exposed and rusting, and in some places,

Figure 4-39: Deterioration in Tunnels

corroding steel bars are evident. Corrosion will eventually lead to significant spalling as the steel continues to rust and expand. The main longitudinal bars are not seriously corroded yet.

The repair for the tunnels will require removal of loose concrete, cleaning excessive corrosion from the steel bars, and replacing concrete around the reinforcing steel. The concrete provides corrosion protection on the bars. Overhead repairs add to the difficulty of a proper repair.

4.4.3.8 Administration Building

Plant staff noted that dedicated office, meeting and storage space in the administration building is insufficient to meet current plant needs. Many plant staff offices are located in areas not originally intended for office use and are located throughout various areas of the building. Some offices are located in process areas with operating equipment and chemicals. A new dedicated area where all office and meeting space is centrally located and is separate from the process equipment and chemicals is needed.

4.4.4 Mechanical/HVAC

During the condition assessment, ARCADIS/Malcolm Pirnie staff completed a detailed review of the mechanical/HVAC condition of the plant facilities. Observations including significant deficiencies are presented in detail below.

4.4.4.1 Low Service Pumping Station

The Low Service Pumping Station mechanical HVAC systems consist primarily of a gas fired steam boiler system for heating (Figure 4-40) installed in 2005. Heat is distributed by terminal units consisting of steam unit heaters, unit ventilators, and radiators (see Figure 4-41) placed throughout the station, which were installed when the station was built. Miscellaneous electric unit heaters, a window AC unit, and a leibert AC unit are used for office, control room, and restroom conditioning. Ventilation is supplied by roof mounted exhaust fans.

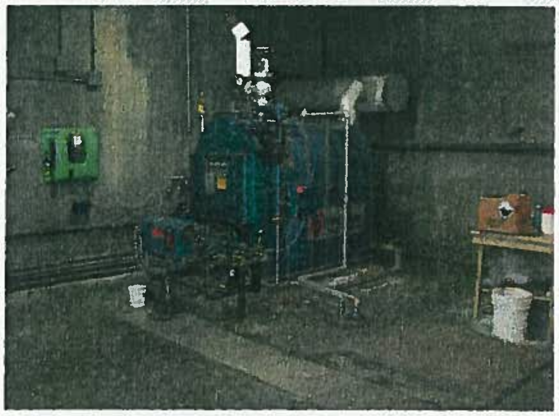

Figure 4-40: Low Service Pumping Station Boiler

Figure 4-41: Radiator in Low Service Pump Station

Based on our field investigations and discussions with plant staff, the following observations and deficiencies were identified:

- The steam boiler is fairly new but has recurring operational issues. Plant staff noted that the boiler is typically out of service about 50% of the time.
- The system does not have direct digital controls (DDC).
- The majority of HVAC equipment is generally operational; however, it is dated, not in good working order, and nearing the end of its expected useful life.

4.4.4.2 Water Treatment Plant

The water treatment plant mechanical HVAC systems consist primarily of two new gas fired steam boilers for primary heating (see Figure 4-42) installed in 2010. Heat is distributed by terminal units consisting of steam unit heaters, unit ventilators, and radiators placed throughout the 40 MGD plant and 80 MGD plant, which were mostly installed when the plants were constructed. Several gas fired unit heaters are also utilized for heating throughout the plant. Package gas heat / electric cooling units, installed around 2005, are used for office, control room, and restroom conditioning. Ventilation is supplied through these package units and through roof mounted exhaust fans and make-up air units.

Figure 4-42: Water Treatment Plant Boilers

Figure 4-43: Water Treatment Plant HVAC

Based on our field investigations and discussions with plant staff, the following observations and deficiencies were identified:

- The steam boilers are new and in good working order. All other HVAC equipment and distribution equipment and piping is operational; however they are dated, in poor condition and nearing the end of their expected lives (see Figure 4-43).
- There are no DDC controls.

4.4.4.3 *Polymer Building*

The Polymer Building mechanical HVAC systems consist primarily of electric unit heaters for heating. Ventilation is supplied through a side wall mounted exhaust. The HVAC equipment was installed in 2008 and is in good working order.

4.4.4.4 *High Service Pumping Station*

The High Service Pumping Station mechanical HVAC systems consist primarily of split air conditioning systems with electric heat or heat pumps for offices and the control room conditioning installed in 2010. Electric unit heaters, installed in 2010 are placed throughout the station for heating in restrooms and pit areas. Ventilation is supplied through roof mounted exhaust fans installed when the station was constructed. The HVAC equipment is new and in good working order.

4.4.4.5 *Residuals Handling and Dewatering Facility*

The Residual Handling and Dewatering Facility mechanical HVAC systems was installed in 1996 and consist primarily of a gas fired hot water boiler system for heating. H eat is distributed by terminal units consisting of 24 hot water unit heaters. A rooftop package gas heat / electric cooling unit is utilized in the office and control room for space conditioning. Ventilation is supplied through the rooftop package unit and side wall exhaust fans (see Figure 4-45).

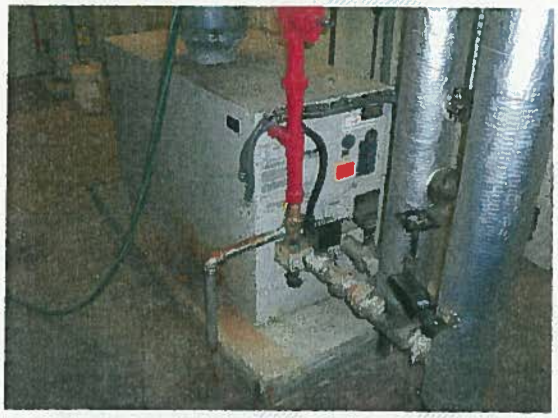

Figure 4-44: Residuals Handling and Dewatering Facility Boiler

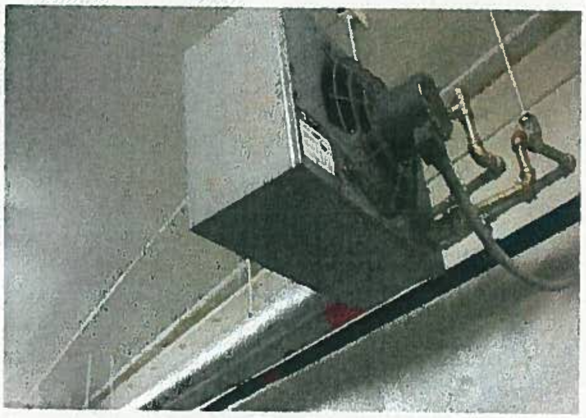

Figure 4-45: Exhaust Fan in Residuals Handling and Dewatering Facility

Based on our field investigations and discussions with plant staff, the following observations and deficiencies were identified:

- The HVAC equipment is operational; however it is dated and nearing the end of its useful service life.
- There are no DDC controls.

4.4.4.6 *Waste Washwater Pumping Station*

The Waste Washwater Pumping Station mechanical HVAC systems consist of an electric unit heater. Ventilation is supplied by and inline exhaust fan. The HVAC equipment is dated and in fair condition but is still operational.

4.4.4.7 *Heatherdowns Pumping Station*

The Heatherdowns Pumping Station mechanical HVAC systems consist primarily of several gas fired unit heaters for heating installed around 2000. No cooling systems are present, and ventilation is supplied by roof mounted exhaust fans. The HVAC equipment is dated but in decent condition and still operational.

4.4.4.8 *Back-up Power Building*

The Back-up Power Building mechanical HVAC systems consist primarily of split system heating and air conditioning units for the electrical and control rooms. Auxiliary heating was supplied by gas fired unit heaters. Ventilation is supplied to the space through roof top exhaust fans and the split air condition and heating units. The HVAC equipment was installed in 2005 and is good working order.

5. Development of Alternatives and Projects

5.1 Introduction

This section presents the development of alternatives and recommendations to address needs identified in the regulatory and water quality assessment (Section 2), capacity evaluation (Section 3), and condition and operational assessments (Section 4). Alternatives and recommendations are presented by areas including process mechanical, electrical/I&C, structural/architectural, and mechanical/HVAC. Opinions of probable construction costs for recommended improvements are included for each. Operational recommendations are also presented and discussed.

5.2 Process Mechanical

Observations and deficiencies from the regulatory, capacity, condition and operational assessments were noted in Sections 2, 3 and 4. These findings were used to develop recommended improvements for the plant facilities. Process mechanical recommendations for each unit process in the sequence of flow through the facility are listed in the sections below.

5.2.1 Raw Water Intake

No process mechanical recommendations were identified for the raw water intake; however, a small number of structural/architectural and operational improvements were recommended and are discussed in Sections 0 and 0, respectively.

5.2.2 Low Service Pumping Station

Several process mechanical improvements were identified for the Low Service Pumping Station and include:

- *Discharge Piping Gallery Improvements.* Complete improvements recommended in the 2001 Pipe Gallery Restoration Project including painting of piping, various pipe support repairs, structural stair stringer repairs, and trench drain repairs. An alternative consideration that was evaluated, but is not recommended, is to insulate the gallery piping to reduce corrosion and sweating.

- *Replace and/or refurbish cone check valves.* A combination of replacing and refurbishing of the cone check valves is recommended to minimize cost and the duration each low service pump is out of service. Beginning with Pump No. 1, a new cone check valve would be installed. The existing valve that would be removed would be transported to a repair facility to undergo a major refurbishment and returned. This re-built valve would then be installed on Pump No. 2. Pump No. 2's cone valve would then be refurbished and installed on Pump No. 3 and so on. Pump No. 4's cone valve would be refurbished and serve as an uninstalled spare.

- *Replace raw water screens and washwater system.* New raw water screens and washwater pumps are needed for proper operation of the screens. While the raw water channel is out of service for the screen replacement, it is recommended that the bar rack upstream of the screen be replaced.

- *Rehabilitate inlet 66" x 66" sluice gates.* It is recommended that the inlet sluice gate be rehabilitated as part of the screens and washwater system improvements mentioned above.
- *Replace oil accumulator system.* Provisions for redundancy should also be considered when replacing the system.
- *Perform a detailed inspection of each low service pump to identify deficiencies, and refurbish accordingly.* While all four low service pumps have been re-built in the last 10-15 years, given the criticality of this equipment and the continuous operational requirements, it is anticipated that a complete refurbishment will be necessary within the 20-year planning period.
- *Replace low service pump motors and install variable frequency drives (VFDs) for each pump.* This improvement will reduce energy consumption and provide greater operational flexibility, addressing the current flow gap between 70 and 90 MGD. See electrical recommendations in Section 5.3 for further details.
- *Refurbish raw water main air/vacuum valves and chambers.* This includes rehabilitation of the raw water main access chambers, air valve chambers, blow off chambers, and cone valve chambers, including structure repairs and valve replacements.
- *Miscellaneous Site Improvements.* This includes replacement of the septic tank and leach field and providing additional well capacity to ensure adequate water supply for the carbon and potassium permanganate feed systems.
- *Potable Water Supply Improvements.* This includes providing a new 2-mile long 12" water main from Seaman to Yondota.

5.2.3 Rapid Mix

As noted in Section 4, it is unlikely that the current alum application method allows for complete mixing throughout the cross section of flow, resulting in inefficient feed and increased chemical usage. As a result, four alternatives were evaluated to improve the mixing and dispersion of alum in the rapid mix channel and include:

- *Alternative 1: Add spargers.* Both alum feeds should have vertical spargers added that would deliver the chemical throughout the entire cross section of flow. Spargers could be added to the existing alum feed lines at the current location. Sufficient structural support would need to be provided to account for forces exerted by water flowing into the channel. The holes in the spargers should be directed upstream to help ensure distribution and mixing of the alum. The holes should be sized so that the total area equals the area of the current pipe opening to help minimize clogging. The sparger should be attached with a union that would allow for easy withdrawal the sparger for inspection. A schematic showing a conceptual configuration of the alum feed sparger is presented in Figure 5-1. The estimated cost for this option is approximately $4,000.

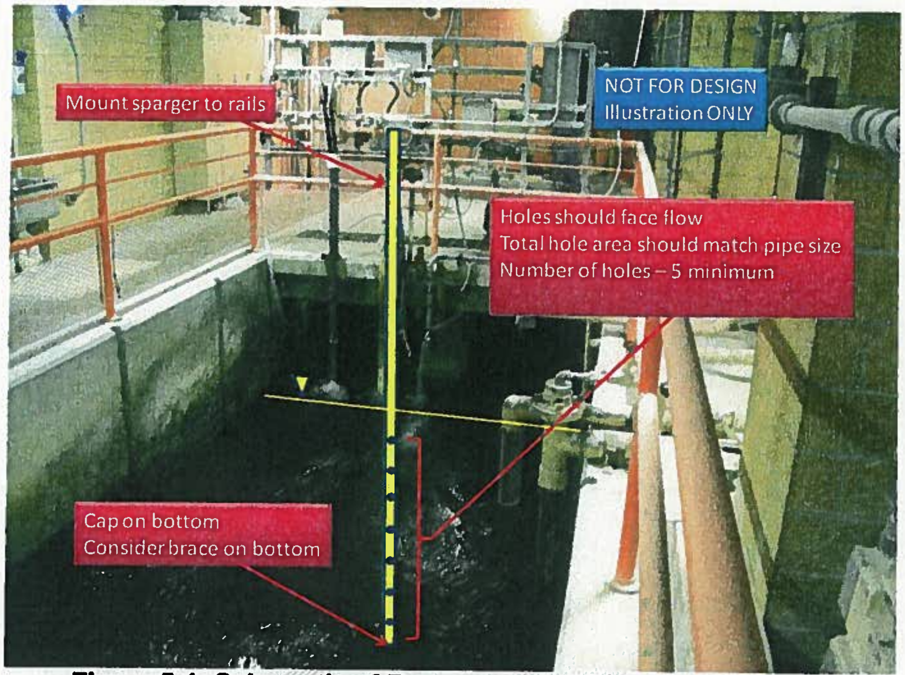

Figure 5-1: Schematic of Recommended Alum Feed Sparger

- *Alternative 2: Install Water Champ induction mixers.* Water Champ mixers could be installed within each rapid mix channel to provide adequate mixing. Preliminary design information indicates that a 15HP Water Champ with an alternate liquid feed assembly would be required in each channel. The mixers would require power and regular maintenance. The estimated capital cost for this option is approximately $263,000.
- *Alternative 3: Install vertical mixers.* Vertically mounted turbines are another consideration to improve mixing within the rapid mix channels. Similar to the Water Champ induction mixers, these would require power and regular maintenance. Preliminary design information indicates that a 10HP mixer would be needed for the 80 MGD channel and a 7.5 HP mixer would be required for the 40 MGD channel. The estimated capital cost for this option is approximately $163,000.
- *Alternative 4: Add baffle walls.* A final alternate to consider is addition of baffle walls within each rapid mix channel to help assure the desired energy is imparted at all flow conditions. While no power or maintenance is required, impacts to imparted headloss should be carefully considered. The estimated capital cost for this option is approximately $36,000.

Advantages and disadvantages to each alternative evaluated are listed in Table 5-1.

Table 5-1: Comparison of Alternatives to Improve Coagulant Application

Alternative	Advantages	Disadvantages
1 – Add Spargers	▪ Low capital cost ▪ Improves dispersion at application point ▪ No power requirements (for the sparger only) ▪ Requires little maintenance	▪ May be less effective as compared to other alternatives

Alternative	Advantages	Disadvantages
2 – Install Water Champ Induction Mixers	▪ Provides instantaneous diffusion and mixing at the application point ▪ Simple retrofit	▪ Highest capital cost ▪ Requires power ▪ Requires regular maintenance
3 – Install Vertical Mixers	▪ Provides improved mixing during all flow conditions	▪ High capital cost ▪ Requires power ▪ Requires additional equipment (e.g., mixer support structures, electrical components; VFDs, etc.) ▪ Requires regular maintenance
4- Add Baffle Walls	▪ Provides improved mixing during all flow conditionsNo power requirements	▪ Moderate capital cost ▪ May result in hydraulic constraints at high flows ▪ Mixing intensity varies with flow

At this time, addition of an alum sparger is recommended since it would improve chemical mixing over current conditions at a significantly lower capital cost than the other mixing alternatives and is also comparatively easier to install. It should be noted, however, that the alum sparger must be implemented with the new peristaltic alum feed system (refer to Section 5.2.7.3 for details) since it will not work with the current gravity Rotadip system. If additional mixing and dispersion of the coagulant is needed in the future, any of the three remaining alternatives could be added.

5.2.4 Flocculation, Sedimentation, and Recarbonation

Several improvements for the flocculation, sedimentation and recarbonation basins are recommended and include:

- *Complete rehabilitation of flocculation/sedimentation and recarbonation.* Complete rehabilitation of the basins is needed and should include the following items:
    - Replace all flocculation equipment (see below).
    - Replace inlet sluice gates.
    - Replace bypass sluice gates.
    - Replace drain valves.
    - Replace wood flocculation partition walls with concrete walls and increase the height of the flocculation walls (40 MGD only).
    - Replace sludge collector drives and mechanisms including drag drives, cross collector drag drives, and sludge pumps.

Options for Replacement of Flocculation Equipment

As mentioned in Section 4, the existing flocculation equipment is past its useful service life and requires replacement. As a result, two alternatives were evaluated to replace the current equipment and include:

- *Alternative 1: Replace wood paddles with FRP horizontal flocculator paddles.* The Ohio EPA discourages the use of wood paddles due to concerns with biological growth on the wood. Therefore, this alternative considers providing new fiberglass paddle blades with polyester resin. Tapered flocculation can still be achieved by reducing the paddle speed from stage 1 to stage 3. Based on a previous study, suggested G values for staged flocculation are 50 sec^{-1} to 60 sec^{-1} for stage 1, 35 sec^{-1} to 45 sec^{-1} for stage 2, and 20 sec^{-1} to 30 sec^{-1} for stage 3 for optimal flocculation. These values are suggested for the current design of the drives, but should be revisited in later design phases if this option is selected. In addition to paddles, new shafts, drives, and appurtenant equipment are recommended. The estimated capital cost for this option is approximately $3,190,000.
- *Alternative 2: Replace horizontal flocculators with vertical turbine flocculators.* Vertical turbine flocculators have gained widespread use in recent years as they eliminate issues with underwater bearings and seals that are typically considered maintenance concerns with horizontal paddle flocculators. The vertical turbine flocculators are considered to be an effective flocculating device and can be easily arranged for tapered flocculation. Preliminary design indicates that 9 mixers would be required for each basin (3 per stage) resulting in a total of 54 mixers for all six basins. The estimated capital cost for this option is approximately $4,000,000.

Advantages and disadvantages to each alternative evaluated are listed in Table 5-2.

Table 5-2: Comparison of Alternatives to Replace Flocculation Equipment

Alternative	Advantages	Disadvantages
1 - Replace Current Wood Paddles with New, FRP Horizontal Flocculator Paddles	▪ Operator familiarity ▪ Multiple shafts can be run from a single drive ▪ Lower capital costs as compared to vertical turbine flocculators	▪ Requires a basin to be taken out of service for repairs/maintenance ▪ If a drive fails, multiple shafts must be taken out of service ▪ Higher maintenance requirements
2 - Replace Current Flocculators with Vertical Turbine Flocculators	▪ Minimal maintenance ▪ Mixers and motors can be repaired and maintained while the basin remains in service since all components are accessible from above the basin ▪ Eliminate issues with underwater bearings and seals ▪ Motors can be fitted with VFDs allowing for a high degree of operational flexibility ▪ Individual mixers can be taken out of service without disrupting the remaining flocculators operating in the basin ▪ Little headloss across the tank ▪ Easy control of mixing intensity	▪ May be difficult to retrofit and support in existing basin ▪ May require installation of baffle walls to provide a length to width ratio between 1.5:1 and 1:1, which is recommended for optimal performance ▪ Multiple units required (9 per basin → 54 total) ▪ Higher capital costs as compared to new horizontal flocculator paddles.

Based on staff preferences and familiarity with the existing equipment, it is recommended that the current wood paddles be replaced with new FRP horizontal flocculator paddles. This alternative also has the lowest capital costs.

Options to Improve Lime Application

Several lime addition alternatives at the 80 MGD plant were considered to improve mixing as the alum treated flow enters the basins to optimize chemical application and usage and include:

- *Alternative 1: Maintain current surface application at beginning of flocculation first pass.* Based on the water quality review presented in Section 2, effective softening performance is currently achieved. In addition, this option has no capital requirements. However, the current configuration provides minimal hydraulic mixing, and therefore, may result in higher lime usage than necessary.
- *Alternative 2: Submerge feed line closer to inlet of flocculation tank.* One alternative considered is relocating the feed line so it is submerged near the inlet of the flocculation tank. Of concern with this alternative is clogging that may occur in the feed line, particularly during warmer weather when softening reactions rates are faster, which would require frequent line cleaning.
- *Alternative 3: Submerge feed line to inlet of flocculation tank and add carrier water line.* Similar to Alternative 2, this alternative would relocate the feed line so that it is submerged near the inlet of the flocculation tank. However, this option would install a carrier water line to further improve mixing at the application point. Clogging, however, is also likely to occur with this option, but may occur within the feed line immediately after lime is mixed with the carrier water stream.
- *Alternative 4: Add mixer near addition point.* A fourth option considered is adding a mixer near the addition point. However, there is limited space available in this area and scale formation on the mixer, could result in high maintenance requirements and/or reduced mixing performance.

Advantages and disadvantages to each alternative are listed in Table 5-3.

Table 5-3: Comparison of Alternatives to Improve Lime Application

Alternative	Advantages	Disadvantages
1 - Maintain Current Surface Feed	▪ Effective softening performance ▪ Minimizes clogging potential ▪ No capital requirement	▪ Not optimal application method ▪ Minimal hydraulic mixing provided ▪ Increased chemical usage
2 - Submerge Feed Line Near Inlet	▪ Minimal modification required ▪ Improved hydraulic mixing ▪ Reduced chemical usage	▪ High potential for localized clogging
3 - Submerge Feed and Add Carrier Line	▪ Improved hydraulic mixing ▪ Reduced chemical usage	▪ May cause precipitation to occur in feed line when carrier water contacts lime
4 - Add Mixer Near Application Point	▪ Effective chemical mixing ▪ Reduced chemical usage	▪ Mixer may scale quickly ▪ Configuration/space constraints are challenging ▪ Higher cost

The recommended option for the plant is to submerge the feed line closer to the inlet of the flocculation tank. There are no capital costs associated with this option. Close monitoring is initially recommended to determine how much faster the feed line will clog compared to the current surface application to establish the required maintenance frequency. Redundant feed lines should be considered so that one can be removed from service for cleaning while the other is in operation.

Options for Removing Solids in Flocculation Effluent Channel

As noted in Section 4, substantial solids accumulation was observed in the flocculation effluent channel of the 80 MGD plant, which could impact downstream performance. Therefore, several options were evaluated for removing solids from the channel including:

- *Alternative 1: No action.* This option would leave the solids in the existing channel while the basin is in service. Accumulated solids would be removed when a basin is taken out of service for routine maintenance and cleaning. Since the plant has not observed any downstream treatment impacts from solids in the effluent channel, this is considered a viable option and does not require any capital investment. However, if solids become problematic in the future, alternative options should be considered.
- *Alternative 2: Add pump to recirculate solids in effluent channel.* Solids accumulation in the effluent channel prior to the sedimentation basins could be reduced or eliminated with the use of a pump / header system mounted in the channel. The pump could operate continuously or periodically to help minimize solids settling. Care would need to be given in the design to minimize floc shear and clogging of the pump.
- *Alternative 3: Add pump to send solids to sedimentation basin.* Alternatively, a pump could be installed in the effluent channel to continuously or intermittently pump solids from the channel floor to the sedimentation basin. As with the recirculation pump alternative, care would need to be given in the design to minimize floc shear and clogging of the pump.
- *Alternative 4: Reconfigure outlet conduit to eliminate settling.* This option considers reconfiguring the effluent channel so water flows directly from the flocculation basin to the sedimentation basin without an area for solids to accumulate. However, this option would require significant capital costs and must consider impacts on the system hydraulics.

Advantages and disadvantages to each alternative are listed in Table 5-4.

Table 5-4: Comparison of Alternatives for Removing Solids in Flocculation Effluent Channel

Alternative	Advantages	Disadvantages
1 - No Action	▪ No capital costs	▪ Solids may become septic and impact downstream water quality ▪ May cause uneven distribution of flow to sedimentation basins
2 - Add Pump to Recirculate Solids in Outlet Channel	▪ Resuspend solids in the channel so that they are carried to the sedimentation basin	▪ Moderate capital cost ▪ Requires power ▪ Requires regular maintenance ▪ Solids may cause scaling on pump ▪ Pump may break up floc

Alternative	Advantages	Disadvantages
3 - Add Pump to Send Solids to Sedimentation Basin	▪ Provides automatic removal of solids from the outlet conduit to the sedimentation basin	▪ Moderate capital cost ▪ Requires power ▪ Requires regular maintenance ▪ Solids may cause scaling on pump ▪ Pump may break up floc
4 - Reconfigure Outlet Conduit to Eliminate Settling	▪ Eliminates solids accumulation in the flocculation outlet conduit	▪ High capital cost ▪ Need to consider hydraulics

Since the current operation has not lead to any appreciable performance issues and does not require any additional maintenance or capital costs, at this time, the no action alternative (Alternative 1) is recommended. However, if in the future hydraulics or downstream performance are impacted as a result of solids accumulation in the channel, any of the remaining options should be further considered.

Options to Improve Recarbonation Feed System

Plant staff has noted that the current carbon dioxide feed system is inefficient primarily due to the poor condition of feed piping and existing diffusers. An evaluation was conducted to verify the efficiency of the current carbon dioxide feed system by comparing the theoretical carbon dioxide (CO_2) feed that is required to what is actually applied. The theoretical carbon dioxide demand was calculated based on alkalinity data prior to and following recarbonation for 2009. These values were compared to actual carbon dioxide usage for 2009 as shown in Figure 5-2. On average, the actual amount fed was approximately 50% higher than the theoretical demand. While carbon dioxide systems are not 100% efficient, system modifications such as replacement of carbon dioxide piping and diffusers could be implemented to increase the overall efficiency (up to about 85% efficiency can be achieved), thereby reducing carbon dioxide usage and associated costs.

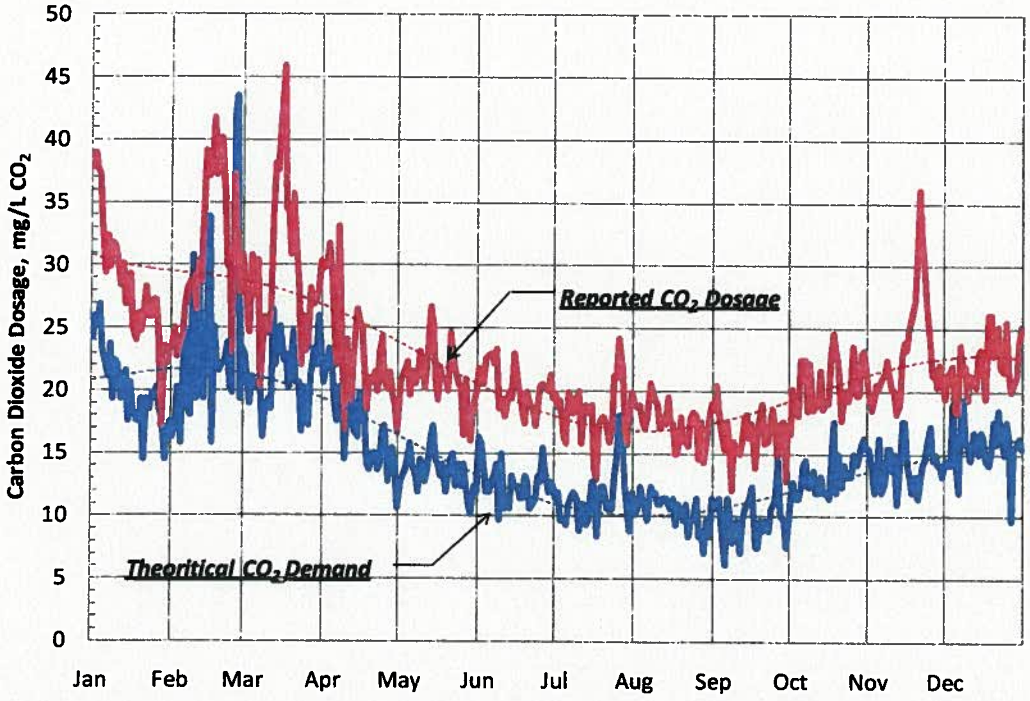

Figure 5-2: Comparison of Theoretical CO_2 Demand versus Reported CO_2 Dosage in 2009

As a result of the analysis described above, two alternative carbon dioxide feed system components or systems were considered to provide for improved efficiency and reliable pH control. The options considered include: (1) replacing the existing feed piping and diffusers and continuing use of CO_2, and (2) converting to a carbonic acid feed system. Replacing the existing feed piping and diffusers could potentially increase the CO_2 transfer efficiency from 50% to approximately 80 to 85%. A new carbonic acid feed system could increase the transfer efficiency up to about 95%, significantly reducing the CO_2 required to meet a target pH.

The carbonic acid feed system would operate by mixing carbon dioxide gas with pressurized carrier water to produce carbonic acid, which would then be fed as a liquid into the water stream to be recarbonated. A carbonic acid system at the Collins Park WTP would utilize the existing CO_2 gas bulk storage tanks. New carrier water booster pumps, pressurized solution feed panels, diffuser assemblies, and instrumentation and controls would be required for each recarbonation basin.

A life cycle assessment was conducted to compare options to improve the recarbonation system efficiency as summarized in Table 5-5.

Table 5-5: Summary of Life Cycle Costs for Recarbonation Feed System Alternatives

Component	Maintain Current Conditions	Replace Current Piping and Diffusers	New Carbonic Acid System
Capital Cost	$0	$253,000	$1,895,000
Annual O&M Costs	$163,000	$136,000	$131,000
Carbon Dioxide (@ $0.031/lb)[1]	*$163,000*	*$136,000*	*$115,000*
Pumping (@ $0.07/kWh)[2]	*$0*	*$0*	*$16,000*
Net Present Value (based on 20-yr life cycle cost estimate)[3,4]	**$2,702,000**	**$2,507,000**	**$4,607,000**

[1] Carbon dioxide costs estimated assuming 50% transfer efficiency if current conditions are maintained, 85% transfer efficiency if piping and diffusers are replaced, and 95% transfer for a new carbonic acid system.
[2] Assumed six carrier water pumps would provide100 gpm to the carbonic acid system at 65% efficiency and 150 feet of head.
[2] Assumed a 3% per year escalation rate for all O&M costs.
[3] All costs are presented in 2011 dollars.
[4] A discount rate of 4.125% was used.

As seen in Table 5-5, replacing the current piping and diffusers and continuing use of CO_2 application for recarbonation provides the lowest life cycle costs of the alternatives considered. Advantages and disadvantages for each alternative evaluated are summarized in Table 5-6.

Table 5-6: Comparison of Alternatives to Improve Recarbonation Feed System

Alternative	Advantages	Disadvantages
1 - Maintain Current Conditions	▪ No capital costs	▪ Low transfer efficiency (approximately 50%) ▪ Higher CO_2 usage
2 - Replace Current Carbon Dioxide Piping and Diffusers	▪ Fewer components ▪ Operator familiarity ▪ Easy to control feed rate ▪ Low capital costs ▪ Lowest life cycle costs	▪ Lower transfer efficiency (approximately 85%) as compared to carbonic acid system ▪ Higher CO_2 usage as compared to carbonic acid system
3- Replace Current Carbon Dioxide System with Carbonic Acid System	▪ High transfer efficiency (approximately 95%) ▪ Reduced CO_2 usage as compared to gas system	▪ Requires pumping ▪ High capital costs ▪ Requires injection into a pipeline (not open basin) for proper mixing ▪ Highest life cycle costs

Based on the lowest life cycle costs, it is recommended that the current carbon dioxide piping and diffusers be replaced and the plant continue to use CO_2 gas for recarbonation.

5.2.5 Filtration

As discussed in the earlier sections, filtration is a critical treatment step for regulatory compliance, and based on historical data, the overall performance has been above average. However, during the site visits, several deficiencies were noted including: 2 -3 inches of media loss, lack of safety railings, and corrosion and leaks in the washwater piping. In addition, various equipment are nearing the end of their useful life including the filter valves and actuators. Surface wash piping in the 40 MGD plant and extensive piping and valves throughout the pipe gallery are in poor condition with severe corrosion and leaks in several areas. Consequently, several major improvements are recommended for filtration and include:

- Replace the surface wash piping in the filters for the 40 MGD plant.
- Evaluate the condition of media and support gravel for the filters in the 40 MGD plant and replace all media if found to be in poor condition. If found to be in good condition, the plant should top off the filters with the necessary amount of media to restore the total design media depth. The plant should also restore the media depth to design conditions for the filters in the 80 MGD plant. For purposes of this report, the costs assume replacement of all the media in the 40 MGD plant.
- Replace and refurbish washwater valves and piping. The washwater piping and valves are in poor condition resulting in significant leaks and corrosion, and should be replaced and/or refurbished in the near future.
- Refurbish backwash pumps.
- Replace surface wash pumps (80 MGD only).
- Refurbish surface wash pumps (40 MGD only).
- Replace filter valves and actuators.
- Pipe gallery rehab and repainting.

In addition, several operational improvements are recommended to optimize filtration performance and are discussed in Section 0.

5.2.6 Flocculation/Sedimentation Basin and Filter Addition

Redundancy is not available during high flow periods as all basins are required to be in service during the summer to meet current peak demands. Construction of two additional flocculation and sedimentation basins (including recarbonation), similar to those in the 40 MGD plant, is recommended to provide additional operational flexibility. Ten additional filters, similar to those in the existing 40 MGD plant, would also need to be constructed to accommodate this expansion. These additional treatment trains would allow the plant to maintain a basin out of service on a year round basis, while reducing the loading rates on the other basins in service (since there would be an additional operational basin). The additional filters would also allow the plant to reduce filter loading rates and/or maintain additional filters on standby in the event of a poor raw water quality event.

This work would need to be completed prior to any rehabilitation work on the existing flocculation/ sedimentation basins and filters. Additional capacity is needed before any major rehabilitation work can be completed since there are periods when poor raw water quality requires all filters to be online to meet the turbidity standards. In addition, all flocculation/sedimentation basins must be cleaned out in a year. Without additional redundancy from the plant addition, there would be periods during a basin rehabilitation when two basins may be out of service: one for cleaning and one for rehabilitation. Based on the current capacity, this would have to occur during low flow periods, which would be very difficult to perform/coordinate and would present several risks associated with meeting water quality requirements and peak demands.

5.2.7 Chemical Storage and Feed Systems

The following sections present recommendations for each chemical storage and feed system.

5.2.7.1 Potassium Permanganate

It was noted during the site visits that the permanganate storage and feed system is new and in good condition. As a result, no process mechanical capital recommendations were identified. However, several operational improvements are recommended and are discussed in Section 0.

5.2.7.2 Powdered Activated Carbon

The PAC system is reliable, but is approaching the end of its useful life. As a result, the following items are recommended:

- Replace bulk carbon slurry tank mixers.
- Replace carbon feeders and carrier water booster pumps within the planning period of this report.

Several operational improvements are also recommended and are discussed in Section 0.

5.2.7.3 Alum

Based on discussions with plant staff, providing containment walls for the bulk storage tanks in their existing location would create inconveniently high containment walls. Staff also noted that the existing bulk storage capacity is insufficient since refilling occasionally occurs every few days. While this has not been a major issue since alum is readily available from a nearby manufacturer, this supplier may not be able to provide the required volume in the future. In addition, Ten States Standards requires 30-days of storage under average conditions. As a result, the following improvements to the alum system are recommended:

- *Install four new 18,100 gallon bulk storage tanks including proper spill containment within a new dedicated storage facility.* This will provide 30-days of storage under average conditions, and will also involve relocation of the existing transfer pumps to the new dedicated storage facility.
- *Install two 600 gallon day tanks to replace the existing tanks.* This will provide approximately 12 hours of storage under average flow and average dosage or approximately 6 hours of storage under peak flow and average dosage. The current day tanks are not configured to prevent accidental chemical overfeeds because they are set to automatically refill when a preset level is reached. Day tank filling should be

controlled locally by an operator to ensure chemical application is monitored and ensure that the maximum amount of chemical that can be overfed is that of the day tank. It should be noted, however, that the current day tanks do not provide adequate storage and would require operator refilling multiple times per shift.

- *Replace Rotodips with peristaltic pumps.* Replace the current Rotadip system with 3 peristaltic type pumps (2 duty, 1 standby) each with a capacity of 12,500 gpd and a minimum turndown ratio of 65:1. This system will provide the necessary turndown to meet all required alum dosages and provide adequate backup. All associated piping, valves and appurtenances are also included.
- *Provide low capacity peristaltic pumps for filter aid application.* Add a second alum application point in the influent channels immediately ahead of the filters as a filter aid to prevent turbidity spikes resulting from poor raw water quality events. Typical dosages for this type of application range between 1 – 3 mg/L as alum. This would require 2 pumps (1 duty, 1 standby) each with a capacity of about 700 gpd and a minimum turndown ratio of approximately10:1.
- *Provide spill containment for bulk storage tanks.* Provide containment walls to contain 110% of the total storage capacity since the tanks would be manifolded together. Ten States Standards requires that sufficient containment volume be provided to prevent an accidental release of liquid chemicals.

5.2.7.4 Lime and Soda Ash

Lime and Soda Ash Storage and Conveyance Improvements

Lime and soda ash are added in the flocculation basins for hardness removal. It was noted during the site visits that the existing lime and soda ash storage and conveyance equipment is in poor condition and application is not optimal. As a result, several major improvements are recommended to properly rehabilitate the current vacuum system. Installation of a new pressure system was also considered; however, plant preference is to stay with a vacuum system. As a result, the following improvements are recommended for a full rehabilitation of the existing system (refer to the 2001 Chemical Handling Study for additional information):

- *Replace vacuum system conveyance piping.* Includes new piping and valves in the chemical storage building and piping between the chemical storage building and chemical building receiving station.
- *Replace/upgrade chemical building conveyance system.* Includes new storage hoppers with gate valves and level probes, new rotary valves, replacement of the fifth floor conveyors, replacement of the second floor conveyors and chutes, and automated operating capabilities including controls, alarms, and level displays.
- *Replace chemical building dust collector.* The existing dust collectors should be replaced with continuous, high efficiency cartridge dust collectors.
- *Replace chemical storage building dust collector.* The existing dust collectors should be replaced with continuous, high efficiency cartridge dust collectors. In addition, modifications to the bin filling procedures are needed for a proper dust collection system.
- *Replace chemical storage building heating system.* Includes replacement of the unit heaters, underground and aboveground steam supply and condensate return piping, piping insulation, valves and fittings, appurtenances, and vacuum pump.
- *Replace Vacuum Pumps.* Includes replacement of the existing lime and soda ash vacuum pumps.

Replacement of the soda ash feeders is currently in progress.

Options for Handling of Lime Reject

As discussed in Section 4, plant staff must manually remove lime reject, which is a labor intensive operation. Therefore, several options for handling of the lime solids were evaluated and include:

- *Alternative 1: Maintain current manual removal.* While this option is time consuming, it is relatively simple and does not require any additional capital costs. However, if this option becomes too labor intensive, alternatives for handling of the lime rejects should be considered.
- *Alternative 2: Provide conveyor for automated removal.* An alternative option to the current removal method is installation of a conveyor belt, which will automatically remove reject to a dumpster. Consideration would need to be given to operation of the belt (e.g., continuously or periodically) and the additional maintenance requirements.
- *Alterative 3: Water injection system and holding tank.* This option includes the installation of a water injector capable of discharging grit particles to a holding tank. This option requires high capital costs and regular maintenance including disposal of the holding tank. Additionally, large particles could easily clog the sludge pumps.

Advantages and disadvantages to each alternative are listed in Table 5-7.

Table 5-7: Comparison of Alternatives for Handling of Lime Reject

Alternative	Advantages	Disadvantages
1 - Continued Manual Removal	▪ No capital costs ▪ Simple system with no additional equipment requirements	▪ Time consuming and manually intensive
2 - Add Conveyor Belt from Slacker to Dumpster	▪ Provides automatic removal of lime solids to dumpster	▪ Moderate capital cost ▪ Requires power ▪ Requires regular maintenance
3 - Add Water Injection System and Holding Tank	▪ Provides automatic removal of lime solids to holding tank or sludge lagoons	▪ High capital cost ▪ Requires power ▪ May require sludge pumps ▪ Large pieces of grit may clog sludge pumps ▪ Requires regular maintenance

Based on staff preference, it is recommended that a conveyor belt be installed to automatically transfer the solids to a dumpster.

5.2.7.5 Polyphosphate

The current polyphosphate system is adequate and reliable. As a result, no process mechanical recommendations were identified for the polyphosphate system.

5.2.7.6 Chlorine

The major issue with the current system is that it does not have adequate capacity to meet peak flow and dosage conditions. As a result, construction of a new chlorination facility is recommended. The City of Toledo is currently requesting proposals for the design of a new chlorination facility. The plant anticipates converting the existing chlorination facility into a storage area.

5.2.7.7 Fluoride

As discussed in Section 4, the existing fluoride feed system is located in an unrestricted area and is currently under consideration for replacement. As a result, a new dedicated room with adequate ventilation is recommended to house the fluoride storage equipment. This could be located in the new dedicated chemical facility for alum storage.

5.2.7.8 Chlorine Dioxide

The current chlorine dioxide system was determined to be adequate and reliable during the site visits; however, the feed pumps are old and will require replacement during the planning period. Several operational improvements are recommended and are discussed in Section 0.

5.2.8 Finished Water Storage

For the finished water storage, it is recommended that the clearwell gate actuators be replaced.

5.2.9 Miscellaneous Water Treatment Plant Improvements

During the site visits, several other capital improvement requirements were identified. As a result, a number of miscellaneous improvements are recommended and include:

- Resurface, paint and provide proper identification to process water piping and miscellaneous small piping in both the 80 and 40 MGD plants.
- Replace portions of the plant water piping including fittings and valves in both the 80 and 40 MGD plants.
- Replace the 60” raw water flow splitting valve in the 40 MGD plant.

5.2.10 High Service Pumping Station

Several capital improvements are recommended and include:

- *Discharge piping gallery improvements.* Complete improvements recommended in the 2001 Pipe Gallery Restoration Project including painting of the piping, various pipe support repairs, structural stair stringer repairs, and trench drain repairs. In addition, inspection of the piping and valves in the valve vaults on the west side of the station is recommended to verify the condition. For planning purposes, it is assumed that these valve vaults will require refurbishment.

- *Replace and/or refurbish cone check valves.* A combination of replacing and refurbishment is recommended to minimize cost and the duration each high service pump is out of service. Beginning with Pump No. 1, a new cone check valve would be installed. The existing valve that was removed would be transported to a repair facility to undergo a major refurbishment and returned. This re-built valve would then be installed on Pump No. 2. Pump No. 2's cone valve would then be refurbished and installed on Pump No. 3 and so on. Pump No. 6's cone valve would be re-built and serve as an uninstalled spare.
- *Perform a detailed inspection on each high service pump and refurbish accordingly.* Given the criticality of this equipment and the continuous operational requirements, it is anticipated that repairs will be necessary within the planning period of this report.
- *Replace oil accumulator system.* The existing system is over 70 years old. It serves all six pump check valve hydraulic actuators.
- *Install an addition oil accumulator system.* Provisions for redundancy should be considered when replacing the system.
- *Refurbish valve vault nos. 1 and 2 on west side of station including structural repairs, painting, and miscellaneous improvements.* The condition of piping and valves in the valve vaults on the west side of the station was not inspected during the condition assessment but their condition is suspect given that they are over 70 years old. Inspection of these valve vaults is recommended to verify the condition of the piping and valves. For planning purposes, it is assumed that these valve vaults will require refurbishment.

Other items evaluated, but not included in the recommended improvements, include insulating the gallery piping to reduce sweating and corrosion. The probable cost to insulate the gallery piping is approximately $264,000.

5.2.11 Residuals Handling and Dewatering Facility

Several deficiencies were noted during the site visits. As a result, a complete rehabilitation of the residuals handling facilities is recommended and generally includes the following improvements:

- *Rehabilitate thickeners and filter presses.* Re-paint the thickener mechanisms, re-build thickener drives, and re-waterproof thickener tanks. Rehabilitate filter presses including recoating plates and replacing clothes, and providing a spare set of plates to aid in maintenance activities. Replace thickened sludge, quick fill, and high pressure pumps. Replace valves including press ball valves and pneumatic actuators.
- *Add a third sludge press in a new dedicated sludge dewatering building.* The third press and appurtenances would need to be housed in a new building adjacent to existing facility because insufficient space is available in the existing facility for an additional press.
- *Add a new sludge thickener.* A new thickener is recommended to provide additional solids storage prior to dewatering. This will help address overloading of the existing thickeners during peak solids production periods and when there is limited dewatering/offloading capacity.
- Replace the 40 and 80 mgd plant sludge pumps with the same type of pumps.
- *Complete miscellaneous improvements.* This includes press control modifications, lighting and HVAC improvements and replacement of the floor door with a larger unit.

5.2.12 Waste Washwater Pumping Station

During the site visits, it was noted that the pump check valves and discharge header at the wall penetration are leaking. As a result, it is recommended that the washwater pumps and check valves be replaced. In addition, sump pump discharge modifications are recommended and include replacing the existing sump pump and piping and a new connection to the existing sanitary manhole.

5.2.13 Basin Drain Pumping Station

Recommended improvements to the Basin Drain Pumping Station include miscellaneous modifications/improvements to the sludge pumping pit, plumbing, piping, HVAC, electrical and sanitary sewer systems.,

5.2.14 Heatherdowns Pumping Station

Several improvements are recommended for the Heatherdowns Pumping Station and include:

- Re-build pumps no.'s 1 – 3.
- Re-build cone check valves.
- Replace oil accumulator.
- Install a 4th pump.

A potential improvement evaluated, but not included in the recommended improvements and costs, is the relocation of the vertical turbine pumps beyond the limits of the storage reservoir in a new building expansion located within the existing asphalt drive. With the pumps currently located within the storage reservoir, when a pump is removed for repair, the entire reservoir must be taken out of service and bacteria tested. Removing the pumps from the reservoir and locating them in individual wet wells or "cans" would address this issue. The probable cost to relocate the pumps is about $7.1 million dollars. Due to the high capital cost, relocation of the pumps is not recommended at this time.

5.2.15 Opinion of Probable Costs for Process Mechanical Improvements

Table 5-8 presents opinions of probable costs for recommended process mechanical improvements by area. Opinions of probable construction cost are based on competitive bid prices for similar work, recent price quotations from material and equipment suppliers, and construction cost guides. The costs were prepared based on 2011 dollars and include an allowance of 15 percent of the associated bare costs for contractor overhead and profit. The costs presented also include a 25 percent provision for construction contingency and a 15 percent provision for engineering, administration and management. A more detailed breakdown of each of these costs is provided in Appendix G.

Table 5-8: Opinion of Probable Costs for Process Mechanical Improvements

Item No.	Item	Total Cost
Low Service Pump Station Improvements		
P001	Discharge Piping Gallery Improvements	$95,000
P002	Replace and/or Refurbish 36" Cone Check Valves (includes one new and four refurbished valves plus actuators and appurtenances)	$1,480,000
P003	Replace Raw Water Screens and Washwater System	$2,183,000
P004	Rehabilitate Inlet Sluice Gates	$106,000
P005	Replace Oil Accumulator System (includes additional oil accumulator)	$415,000
P006	Refurbish Low Service Pumps	$3,113,000
P007	Refurbish Raw Water Main Air/Vacuum Valves and Chambers	$1,107,000
P008	Miscellaneous Site Improvements (includes replacement of septic tank and leach field and additional well capacity)	$80,000
P009	Potable Water Supply Improvements (includes new 2-mile 12" water main from Seaman to Yondota)	$1,938,000
Rapid Mix Improvements		
P010	Coagulant Chemical Application System Improvements	$4,000
Flocculation and Sedimentation Basin Rehabilitation		
P011	Replace Flocculators, Drives, Valves and Associated Equipment	$4,335,000
P012	Concrete Walls between Floc Basins (40 mgd plant)	$254,000
P013	Extend Flocculation Walls (40 mgd plant)	$14,000
P014	Replace Sludge Collector Drives and Mechanisms (all basins)	$7,680,000
P015	Recarbonation Feed System Improvements (if necessary)	$252,000
Filter System Improvements		
P016	Replace Surface Wash Piping (40 mgd plant)	$320,000
P017	Replace Dual Media and Support Gravel for 10 Filters (40 mgd plant)	$1,199,000
P018	Replace and Refurbish Washwater Valves and Piping (surface & backwash piping &valves in 40 and 80 mgd filter galleries)	$15,663,000
P019	Refurbish Backwash Pumps	$263,000
P020	Replace Backwash Pump Cone Check Valves	$422,000
P021	Replace Washwater Cone Check Valves (40 mgd plant)	$422,000
P022/023	Replace Surface Wash Pumps (includes replacement of pumps in 40 and 80 mgd plants)	$187,000
P024	Replace Wash Water Rate-of-Flow Controllers	$168,000
P025	Replace Surface Wash Rate-of-Flow Controller	$84,000
P026	Replace Filter Valves and Actuators (includes all influent, effluent and drain valves and actuators in both the 40 and 80 mgd plants)	$10,980,000
P027	Pipe Gallery Rehabilitation and Repainting	$295,000
P028	Refurbish Elevated Storage Tank Fill Pump near Backwash Pumps	$130,000
P029	Elevated Storage Tank Repainting	$712,000
Floc/Sed Basin and Filter Addition		
P030	Add new Flocculation/Sedimentation Basin Train(s) & Associated Filters	$96,600,000

Item No.	Item	Total Cost
Chemical Storage and Feed Systems Improvements		
P031	Carbon Storage and Feed System Improvements	$220,000
P032	Lime/Soda Ash Storage and Feed System Improvements	$3,295,000
P033	Provide Automatic Removal of Lime Rejects	$49,000
P034	Alum Feed System Improvements	$243,000
P035	New Chemical Building for Alum Storage	$4,073,000
P036	Chlorination System Facilities	$5,827,000
Finished Water Storage Improvements		
P037	Replace Clearwell Gate Actuators	$227,000
Water Treatment Plant General Modifications		
P038	Process Piping Painting and Identification	$529,000
P039	Replace Plant Water Piping	$1,180,000
P040	Raw Water Flow Splitting Valve Replacement (40 mgd plant)	$161,000
High Service Pump Station Improvements		
P041	Discharge Piping Gallery Improvements	$270,000
P042	Replace and/or Refurbish Cone Check Valves	$1,003,000
P043	Refurbish High Service Pumps (includes refurbishment of six high service pumps)	$7,702,000
P044	Replace Oil Accumulator System	$216,000
P045	Additional Oil Accumulator System	$199,000
Residuals Handling and Dewatering Improvements		
P046	Filter Press and Thickening Systems Rehabilitation	$6,895,000
P047	Thickener System Expansion – Dewatering Building and Press	$10,577,000
P048	Thickener System Expansion – Additional Sludge Thickening Tank	$2,393,000
P049	Replace Sludge Pumps (40 and 80 mgd plants)	$216,000
P050	Miscellaneous Sludge Dewatering Facility Improvements (includes process control, lighting and HVAC improvements)	$271,000
Waste Washwater Pumping Station Improvements		
P051	Washwater Pump Replacement	$403,000
P052	Sump Pump Piping Discharge Modifications (includes replacement of sump pump and piping and new connection to sanitary sewer)	$56,000
Basin Drain Pumping Station Improvements		
P053	Basin Drain Pumping Station Improvements (includes miscellaneous modifications/improvements to sludge pumping pit, plumbing, piping, HVAC, electrical and sanitary sewer systems)	$2,070,000
Heatherdowns Pumping Station Improvements		
P054	Refurbish Pumps	$1,146,000
P055	Refurbish Cone Check Valves	$424,000
P056	Replace Oil Accumulator System	$216,000
P057	Additional Pump	$1,340,000
	Process Mechanical Total	**$201,702,000**

5.3 Electrical/I&C

Observations and deficiencies from the capacity, condition and operational assessments were noted in Section 4. These findings were used to develop recommended improvements for the plant facilities. Electrical/I&C recommendations for several areas are listed in the sections below.

5.3.1 Low Service Pumping Station

Several electrical improvements are recommended for the Low Service Pumping Station and include:

- *Replace energy recovery drive Pump No. 1 and resistor banks for Pump Nos 2, 3, and 4, and wound rotor motors with new variable speed drives and induction motors.* A new drive would improve performance and reliability. This improvement will reduce energy consumption and provide greater operational flexibility, addressing the current flow gap between 70 and 90 MGD.
- Install a 1,500 kW standby generator for back-up power.
- *Change service voltage from 2,400 Volts to 4,160 Volts.* 4,160 Volt systems are more common and equipment availability is greater. This would include replacing the existing switchgear, transformers, drives and generators. This would also include replacement of the transformers in the substation feeding the pumping station. A building addition would be required for the new equipment. The addition would allow the existing system to remain in service until the new equipment is installed and ready to put in service.

5.3.2 Water Treatment Plant

Several electrical improvements are recommended for the general water treatment plant area and include:

- *Upgrade electrical distribution equipment in the plant.* This includes removal and replacement of panel boards, circuit breakers and motor control centers.
- *Replace existing unit substation.* Additional unit substation capacity is needed at this location.

5.3.3 Chemical Building

Due to the age of the substation feeding the existing Chemical Building, replacement of the outdoor substation is recommended within the planning period of this report.

5.3.4 High Service Pumping Station

Electrical improvements are recommended for the High Service Pumping Station and include:

- *Replace the existing switchgear.* A new electrical room addition would be required for the new switchgear. The addition would allow the existing equipment to remain in service until the new switchgear is installed and ready for operation.
- *Replace existing 480 volt distribution panels.* This also includes removal and replacement of various panel boards and circuit breakers.

- *Upgrade the outdoor substation.* Due to the age of the substation, it is likely that it will need repairs in within the planning period of this report.

5.3.5 Residuals Handling and Dewatering Facility

The existing electrical service for the Residuals Handling and Dewatering Facility is separate from the plant and there is no backup power; therefore, the facility cannot operate during a power outage. As such, installation of a 500kW standby generator is recommended.

5.3.6 Basin Drain Pumping Station

Upgrade of the electrical distribution equipment in the Basin Drain Pumping Station is recommended. This includes removal and replacement of motor control centers and capacitors.

5.3.7 Heatherdowns Pumping Station

During the site visits, several electrical needs were identified for the Heatherdowns Pumping Station. As a result, the following improvements are recommended:

- Replace miscellaneous electrical panels and equipment. This includes removal and replacement of existing switchgear and motor control centers.
- Install a 1,500 kW standby generator for back-up power.
- Replace the existing obsolete drives with variable frequency drives on all pumps.

5.3.8 Miscellaneous Improvements

Installation of a new underground fiber optic cable between the plant and the Low Service Pumping Station is recommended.

5.3.9 Plant Control System

Several I&C improvements are recommended for the plant and include:

- *Replace the obsolete control system equipment.* This includes older programmable controllers and telemetry equipment.
- *Replace outdated field instrumentation.* The pressure transmitters and flow meters are operational but due to the age of the equipment it is likely they will have to be replaced in the next 20 years.

5.3.10 Opinion of Probable Costs for Electrical/I&C Improvements

Table 5-9 present opinions of probable costs for recommended electrical and I&C improvements. As described above, opinions of probable construction cost are based on competitive bid prices for similar work, recent price quotations from material and equipment suppliers, and construction cost guides. The costs were prepared based on 2011 dollars and include an allowance of 15 percent of the associated bare costs for contractor overhead and profit. The costs presented also include a 25 percent provision for construction contingency and a 15 percent provision for engineering, administration and management. A more detailed breakdown of each of these costs is provided in Appendix G.

Table 5-9: Opinion of Probable Costs for Electrical/I&C Improvements

Item No.	Item	Total Cost
Low Service Pumping Station Improvements		
E001	Electrical System	$1,656,000
E002	Variable Frequency Drives	$2,384,000
E003	Backup Power	$1,789,000
E004	Substation	$1,091,000
Water Treatment Plant Improvements		
E005	Miscellaneous Electrical Panels and Equipment	$1,033,000
E006	Unit Substation	$338,000
Chemical Building		
E007	Outdoor Substation	$782,000
High Service Pumping Station Improvements		
E008	Electrical System	$2,407,000
E009	Miscellaneous Electrical Panels and Equipment	$173,000
E010	Outdoor Substation	$740,000
Residuals Handling and Dewatering Improvements		
E011	Backup Power	$282,000
Basin Drain Pumping Station (Old Washwater Facility)		
E012	Miscellaneous Electrical Panels and Equipment	$174,000
Heatherdowns Pumping Station Improvements		
E013	Miscellaneous Electrical Panels and Equipment	$455,000
E014	Backup Power	$896,000
E015	Variable Frequency Drives	$1,638,000
Fiber Optic Cable		
E016	Underground Fiber Optic Cable	$1,506,000
	Electrical Total	**$17,344,000**
New SCADA System		
I001	Differential Pressure Transmitters	$520,000
I002	SCADA System	$7,788,000
	Instrumentation and Controls Total	**$8,308,000**

5.4 Structural/Architectural

Observations and deficiencies from the condition assessment were noted in Section 4. These findings were used to develop recommended improvements for the plant facilities. Structural/architectural recommendations and associated costs are summarized in the sections below.

5.4.1 General

Several structural/architectural improvements are recommended and include:

- *Replace Flocculation, Sedimentation and Filtration Roof Panels.* Based on the structural deterioration and safety concerns with the compromised roof structure, immediate replacement of the entire built-up roofing assembly on top of the concrete decking in the flocculation, sedimentation and filtration areas is recommended. In addition, the supporting steel framework should be recoated with a protective quality paint system and the roof runoff should be rerouted to new drain piping where discharge into the treatment process train is eliminated.
- *Replace doors and windows at the WTP.* Replacement of doors and windows in the existing 80 MGD and 40 MGD buildings is recommended. Many have head, jamb and frame corrosion problems. This work can be phased with the nearby masonry and lintel repairs.
- *Rehabilitate the Finished Water Reservoir.* Replacement of the concrete risers that frame the access hatches and frame gate operators is recommended. Their replacement should coincide with access hatch replacement and gate operator refurbishment.
- *Replace aggregate panels at the Heatherdowns Pumping Station.* Panels may be repaired, but more likely need to be replaced with a different more readily available material in lieu of the exposed aggregate panels. Examples might include metal panels or contrasting masonry.
- *Clean and repaint steel hopper anchors in the Residuals Handling and Dewatering Facility.* Anchors that hold the large steel hopper to concrete framing are corroding; however, these anchors are embedded in the bottom of the large concrete beams framing the slab openings for the sludge presses. Replacement would be difficult so it is recommended that they be maintained properly.
- *Replace roofing and complete general masonry improvements to various WTP buildings.* Roofing assemblies on all buildings have about a 20 year expected service life and will therefore require replacement within the master planning period. Also, the steel columns, beams and lintels in the WTP are all buried within the masonry walls and may have some level of corrosion. Recommended rehabilitation includes:
    - Replacement of roofing on all WTP buildings. For planning purposes, it is assumed that 25% of the roofs would be replaced every 5 years, effectively replacing all roofing assemblies at the WTP within the 20-year planning period.
    - Removal of brick masonry, recoating of steel members, and re-installing brick with proper flashings and weeps on all WTP buildings.
    - Rehabilitation of copings when the neighboring masonry is reworked, since coping materials at the tops of parapet walls are notorious for allowing water penetration into the wall structure.
    - Re-sealing of caulked joints in the masonry in order to maintain the required flexibility and weathertighness.
- *Raw Water Intake Improvements.* Recommended structural and architectural improvements to the raw water intake include the following:

  - Replacement of walkways, ladders and stairways.
  - Dock accessibility improvements. This includes new bumpers, fenders, wales, mooring rings, mooring posts, mooring cleats and minor security improvements.
  - Miscellaneous interior improvements including demolition and removal of interior items and furnishings and chemical feed equipment, and flaking plaster repair and cleanup.
- *Repair concrete beams and slabs in the piping gallery.* Some of the concrete beams and slabs in the piping gallery have spalling concrete and corroded bars on the underside. These areas need to be repaired by removing loose concrete, cleaning excessive corrosion from the steel bars, and providing a quality concrete product around the reinforcing steel.
- Install fall protection railings in the flocculation and filtration areas.
- Provide concrete and door hatch replacement with grating for the sedimentation basins in both the 40 and 80 MGD plants.
- *Expand the Administration Building.* This includes a 5,000 square foot expansion of the existing Administration Building to provide dedicated office, meeting and storage space in a single area that is separate to the existing process and chemical rooms. It is recommended that the Administration Building expansion be completed at the same time as the Flocculation/Sedimentation Basin and Filter Addition, described in Section 5.2.6.

5.4.2 Opinion of Probable Costs for Structural/Architectural Improvements

Table 5-10 presents opinions of probable costs for recommended structural/architectural improvements. As described above, opinions of probable construction cost are based on competitive bid prices for similar work, recent price quotations from material and equipment suppliers, and construction cost guides. The costs were prepared based on 2011 dollars and include an allowance of 15 percent of the associated bare costs for contractor overhead and profit. The costs presented also include a 25 percent provision for construction contingency and a 15 percent provision for engineering, administration and management. A more detailed breakdown of each of these costs is provided in Appendix G.

Table 5-10: Opinion of Probable Costs for Structural/Architectural Improvements

Item No.	Item	Total Cost
Water Treatment Plant Immediate Rehabilitation		
A001	Concrete Roof Panel Replacement	$4,950,000
Water Treatment Plant Rehabilitation Within 10 Years		
A002	Replace Doors and Windows	$1,926,000
A003	Replace Reservoir Access and Gate Chambers	$86,000
Heatherdowns Pump Station Rehabilitation Within 5 Years		
A004	Aggregate Panel Replacement	$206,000
Rehabilitation of Roofing, Insulation and Copings		
A005	Raw Water Intake	$71,000
A006	Low Service Pumping Station	$218,000
A007	40 MGD Sedimentation Basins Above Ground Structure	$113,000
A008	Chemical / Administration Building	$517,000

Item No.	Item	Total Cost
A009	High Service Pumping Station	$202,000
A010	Residuals Handling and Dewatering Facility	$124,000
A011	Standby Power Generator Facility	$109,000
A012	Heatherdowns Pumping Station	$56,000
A013	Heatherdowns Pumping Station Reservoir Fill Structure	$16,000
Raw Water Intake Improvements		
A014	Miscellaneous Interior Improvements (Demolitions and Removals)	$1,483,000
A015	Replace Walkways, Ladders and Stairways	$65,000
A016	Dock Accessibility Improvements	$156,000
Water Treatment Plant Improvements		
A017	Piping Gallery(s) - Concrete Repairs of Spalling and Cracking Concrete	$445,000
A018	Floc and Filter Area - Fall Protection Railings	$1,307,000
A019	Sedimentation Basins - Concrete and Door Hatch Replacement with Grating	$139,000
Administration Building Expansion / Improvements		
A020	Existing Building Addition	$1,854,000
	Structural/Architectural Total	**$14,043,000**

5.5 Mechanical/HVAC

Observations and deficiencies from condition assessment were noted in Section 4. These findings were used to develop recommended improvements for the plant facilities. Mechanical/HVAC recommendations for several areas are listed in the sections below.

5.5.1 Low Service Pumping Station

Several HVAC improvements are recommended for the Low Service Pumping Station and include:

- *Replace entire heating, cooling and ventilation system equipment.* This includes replacement of the existing steam boiler with a newer high efficiency model. In addition, replacement of the boiler associated condensate/feed pumps and steam unit heaters is recommended. Air conditioner units should be replaced with newer high efficiency models. Replacement of ventilation equipment which includes all local and general exhaust fans is also recommended. In addition, any associated local equipment controls should be replaced with new. Replacement of the electrical domestic water heater and sump pump system should also be included.
- Provide random pipe wall thickness testing at various locations on all plumbing and heating piping systems to ensure pipe corrosion / erosion is not severe.
- Clean remaining ductwork systems.

5.5.2 Water Treatment Plant

Several capital improvements are recommended for the general water treatment plant area and include:

- Replace steam boiler heating system piping and valves.
- Replace entire ancillary heating equipment such as steam / gas fired unit heaters and make-up air units.
- Replace all package air conditioning units with newer high efficiency units.
- Install a ventilation and dehumidification system for the 80 MGD and 40 MGD filter galleries to eliminate interior corrosion due to high humidity levels.
- Clean existing supply and return air ductwork systems.

5.5.3 Residuals Handling and Dewatering Facility

Since much of the HVAC equipment in the Residuals Handling and Dewatering Facility is nearing the end of its useful life, several improvements are recommended and include:

- *Replace entire hot water boiler heating system equipment.* This includes the existing boiler, circulation pumps, hot water unit heaters and control valves. The new hot water boiler should be a high efficiency model. Replacement of the existing gas fired domestic water heater with a newer high efficiency model should also be included.
- Provide random pipe wall thickness testing at various locations on all plumbing and heating piping systems to ensure pipe corrosion / erosion is not severe.

5.5.4 Waste Washwater Pumping Station

Much of the HVAC equipment in the Waste Washwater Pumping Station is operational, but is dated. Therefore, it is recommended that the electric unit heater and exhaust fan be replaced.

5.5.5 Heatherdowns Pumping Station

Several HVAC improvements are recommended for the Heatherdowns Pumping Station and include:

- Replace existing gas fired unit heater with newer high efficiency model.
- Replace existing electrical unit heater.
- Replace existing electrical domestic water heater.
- Replace existing exhaust fans.

5.5.6 Opinion of Probable Costs for Mechanical/HVAC Improvements

Table 5-11 presents opinions of probable costs for recommended mechanical/HVAC improvements by area. As described above, opinions of probable construction cost are based on competitive bid prices for similar work, recent price quotations from material and equipment suppliers, and construction cost guides. The costs were prepared based on 2011 dollars and include an allowance of 15 percent of the associated bare costs for contractor overhead and profit. The costs presented also include a 25 percent provision for construction contingency and a 15 percent provision for engineering, administration and management. A more detailed breakdown of each of these costs is provided in Appendix G.

Table 5-11: Opinion of Probable Costs for Mechanical/HVAC Improvements

Item No.	Item	Total Cost
Low Service Pumping Station Improvements		
M001	Heating System	$222,000
Water Treatment Plant Improvements		
M002	Boiler Piping and Valves	$632,000
M003	Unit Heater / Makeup Air Units	$83,000
M004	Air Conditioning Unit	$214,000
M005	HVAC Replacements	$940,000
Washwater Handling Facility Improvements		
M006	Heating and Ventilation Systems	$6,000
Residuals Handling and Dewatering Improvements		
M007	Heating System	$66,000
Heatherdowns Pumping Station Improvements		
M008	Unit Heaters and Exhaust Fans	$33,000
	Mechanical/HVAC Total	**$2,196,000**

5.6 Operational Recommendations

As mentioned in Section 4, an operational assessment was performed to identify administrative, design, operational and maintenance aspects that may limit optimal performance. Operational recommendations will not be included in the CIP, but are recommended to improve treatment, operations and maintenance efficiencies and performance. Recommendations are summarized by process area below (refer to Appendix F for additional information on the operational assessment results and recommendations).

5.6.1 Low Service Pumping Station

The following operational recommendations are provided for the low service pumping station:

- *Add wipers to PAC feed pumps.* Wipers should be added to the PAC Rotadip feeders to help assure continuous feed of the chemical to the permanganate treated raw water.
- *Monitor raw water quality parameters on-line.* An APA 6000 unit exists at the low service pump station that was mounted near the sampling station but was never commissioned. This analyzer and its associated equipment should be commissioned to enable raw water hardness monitoring for better process control. Automated monitoring of raw water pH, turbidity, conductivity and alkalinity should also be considered. It is recommended that HACH be contacted to review the analyzer and provide a fee estimate to commission the analyzer and provide a one year service contract for the initial year of operation. Staff noted that sufficient bandwidth is available for telemetry of this additional raw water quality data to the WTP.

5.6.2 Rapid Mix

The plant should routinely monitor for residual aluminum to verify that alum is not being overfed.

5.6.3 Filtration

The following operational recommendations are provided for filtration:

- *Implement a routine filter monitoring program.* The plant should implement a routine filter monitoring program to track the condition of the filter media. The filter monitoring program should include: (1) loss of mass upon acidification tests, (2) sieve analysis, and (3) routine inspection of the bottom of the filters to check if there is media carry over.
- *Lower filter levels prior to backwash.* Filter levels should be lowered to within 6" of the media surface prior to initiating a backwash. This will maximize the energy imparted on the media surface compared to the current water level that is equal to the top of the backwash troughs.
- *Maintain at least two filters as backup filters during normal operation.* The plant currently operates with all filters on-line for all flow conditions. It is recommended that the plant maintain at least two clean filters as standby units during normal operating conditions. These standby filters could be quickly placed in service in case of a water quality excursion or equipment failure on one or more filters, minimizing the potential impact on treatment performance. It should be noted, however, that all filters may need to be on-line during peak flow periods in the summer.
- *Evaluate options to eliminate filter backwash limitations.* Alternatives to increase the loading capacity of the washwater lagoon and reclaim system should be evaluated to allow backwashing of more than one filter at a time. This would provide additional flexibility in filter operations and minimize impacts from potential water quality excursions.

5.6.4 Chemical Storage and Feed Systems

The following operational recommendations are provided for the chemical storage and feed systems:

- *Flow pace treatment chemicals.* All chemicals should be flow paced to help assure consistent dosing at all WTP flows. This is especially important when WTP flows substantially fluctuate during summer periods. Flow pacing could be provided by connecting the equipment to a local programmable logic controller that could then communicate with the WTP's SCADA system.
- *Evaluate separating chlorine dioxide feed from chlorine.* The plant should consider separating the chlorine dioxide feed form the chlorine feed for the purposes of improved T&O control and overall water quality control. For instance, chlorine dioxide could be added prior to alum addition to help effect additional oxidation of source water constituents for improved organics removal.

5.6.5 General

Poor mixing and inadequate volume turnover in storage facilities can result in significant increases in water age and degradation of distributed water quality. Therefore, the City of Toledo should consider modeling distribution system operations to identify areas in the distribution system with high water age relative to the majority of the distribution system and evaluate options to reduce water age and improve distributed water quality in those areas. If DBPs are still problematic, implementation of granular activated carbon (GAC) or chloramines should be considered. It is also recommended that the City of Toledo review the adequacy of their current cross-connection and backflow prevention programs and consider developing a Distribution Water Quality Master Plan. These activities could help to identify potential compliance issues with upcoming regulations including the RTCR and LCR revisions.

5.7 Summary

Table 5-12 presents a summary of the opinions of probable costs for each discipline area, which total $257.4M (in 2011 dollars). Capital costs were developed for a total of 103 recommended improvements in all disciplines including process mechanical, electrical, I&C, structural/architectural and mechanical/HVAC.

Table 5-12: Summary of Opinion of Probable Costs

Discipline	No. of Projects	Total Estimated Construction Cost
Process Mechanical	57	$205,375,000
Electrical	16	$17,344,000
Instrumentation & Controls	2	$8,308,000
Architectural/ Structural	20	$24,246,213
Mechanical/ HVAC	8	$2,196,000

6. Capital Improvements Program

6.1 Introduction

The Collins Park WTP requires major capital improvements to keep pace with increasingly stringent water quality requirements, address redundancy needs, and provide for rehabilitation or replacement of equipment that has exceeded its useful service life. As discussed in Section 5, several capital improvements were identified and associated costs were prepared based on the findings of the water quality and regulatory review, capacity evaluation, and condition and operational assessments. Each recommended improvement was reviewed and grouped together with other improvements to form several major capital improvement projects. Projects were then prioritized and ultimately used to develop a 20-Year Capital Improvements Plan (CIP) for the planning period from 2012 through 2032.

This section discusses the approach used to group and prioritize projects and develop the 20-Year CIP for the Collins Park WTP. A recommended list of prioritized projects and CIP implementation schedule are also presented.

6.2 CIP Prioritization

The approach used to group and prioritize projects is discussed below. The results of the prioritization including a single list of prioritized projects are also presented.

6.2.1 Prioritization Approach

Recommended capital improvements from Section 5 were reviewed to determine their relative importance and priority. Each item was assigned a priority based on the risk score assigned to each asset during the condition assessment (refer to Section 4 for scoring details) and input from plant staff. The risk priority score considered the physical and performance conditions and overall criticality of the equipment. The age of the equipment was also taken into consideration in estimating the priority score for each piece of equipment. As detailed in Section 4, the performance and criticality criteria used to develop the risk scores considered the assets':

- Ability to meet current and future average and peak capacity requirements.
- Ability to meet current and future regulatory requirements.
- Reliability and frequency of O&M issues.
- Obsolescence.
- Relative impact of asset failure on level of service, safety and security, regulatory compliance, O&M impacts and available system redundancy.

Each priority corresponds to a recommend range of implementation years over the 20-year planning period as shown in Table 6-1. For example, items assigned a priority score of 1 are in need of immediate attention and should be addressed in years 0 to 2 of the 20-year CIP.

Table 6-1: Recommended CIP Implementation Years by Priority

Priority Score	Priority	CIP Implementation Years
1	Immediate	Yrs 0 - 2
2	High	Yrs 2 - 5
3	Medium	Yrs 6 - 10
4	Low	Yrs 11 - 15
5	Lowest	Yrs 16 - 20

Items were then grouped based on location and priority to form several capital projects. Projects were arranged in order of importance based on the priorities assigned to each item and staff preferences. Project durations were estimated based on project experience for similar projects and include all phases from planning and design through construction. Projects were then used to create a 20-year CIP implementation schedule, with costs distributed based on the estimated project durations.

When distributing costs over the duration of the project, it is unrealistic to expect that an equal expenditure of funds will occur in each year. Instead, there is typically an S-curve distribution where there is a "ramp-up" period at the beginning followed by increased expenditures in the middle of the project, and a decrease in expenditures as the project comes to a close. The following assumptions were used in developing the annual expenditures for each project in the CIP:

- Planning and design phases together were assumed to account for 15 percent of the total investment cost of the project. This initial expenditure includes all fees paid to consultants for the study and design.
- The length of the planning and design phases was set according to the durations of the project. The cost for these phases was distributed evenly across their duration.
- The remaining funds (85 percent) were assumed to be spent during the bid, construction, and start-up phases of the project. The allocation of funds was distributed according to an S-curve.
- The overall distribution of funds depends on the length of the project.

Table 6-2 shows the estimated percent of project funds spent each year of the project, with the shaded cells representing expenditures during the planning and design phases and unshaded cells showing expenditures during the construction phase. For example, in a 6 year project, 15 percent of the costs are spent on planning and design evenly during the first two years, and the remaining 85 percent is distributed in an S-curve in the final four years.

Table 6-2: 20-Year CIP Cost Distribution

Project Duration (Years)	Percent of Costs Expended in Year						
	1	2	3	4	5	6	7
1	100	–	–	–	–	–	–
2	15	85	–	–	–	–	–
3	15	50	35	–	–	–	–
4	7	8	50	35	–	–	–
5	7	8	25	45	15	–	–
6	7	8	15	40	20	10	–
7	5	5	5	20	35	20	10

1. Shaded cells indicate planning and design phase expenditures.
2. Several projects assume one basin out of service per year. For these projects, 15% of the costs for planning/design are incurred the first year. The remaining costs were distributed evenly throughout the remaining years.

6.2.2 Prioritization Results

Capital costs were developed for 103 recommended capital improvements, which together total approximately $257.4M (in 2011 dollars). The individual improvements were grouped into a total of 23 projects based on location and priority. The highest priority projects recommended for immediate implementation include: (1) immediate structural improvements to the roofs of the flocculation/sedimentation and filter areas (2) a new chlorination facility (proposals for design are currently under review), (3) a new SCADA system, (4) the flocculation/ sedimentation and filter addition, and (5) the administration building expansion. Although improvements to the existing flocculation/sedimentation basins and filters are also needed in the near-term, plant staff has indicated that they are currently unable to remove any basin from service during high flow periods to make the necessary improvements due to a lack of redundancy. In addition, all filters and associated systems must be in service to meet stringent turbidity requirements during poor raw water quality periods, which constrains rehabilitation work that can be performed on the current filters due to insufficient redundancy. As such, the flocculation/ sedimentation and filter addition will occur early in the CIP schedule to provide adequate redundancy so that improvements to the current equipment, basins and filters can be completed once the new basins/filters are operational.

The total estimated construction costs are summarized by location and shown in Figure 6-1. The majority of the costs are associated with improvements and/or additions to the rapid mix channels, flocculation/ sedimentation/recarbonation basins and filters. This is not surprising given that the construction of new flocculation/sedimentation basin trains and associated filters for a 40 MGD expansion is approximately $96M, approximately 40%of the total estimated construction costs (in 2011 dollars) for the entire 20-year CIP. Costs associated with the remaining projects range from 1% to 9% of the total 20-year CIP costs. The total estimated construction costs were also grouped by process area and are shown in Figure 6-2. Similar to the grouping by location, the largest percentage of costs are associated with filtration followed by flocculation/sedimentation. Major pumping and residuals handling also make up a significant portion of the remaining costs. The total estimated construction costs were also grouped by discipline and are shown in Figure 6-3. Also, not surprisingly, the majority of the costs are needed for process mechanical improvements since the majority of plant equipment falls into this category. Process mechanical was followed by electrical, architectural/structural, instrumentation and controls, and finally, mechanical/HVAC. The prioritized list of CIP projects are summarized in Table 6-3.

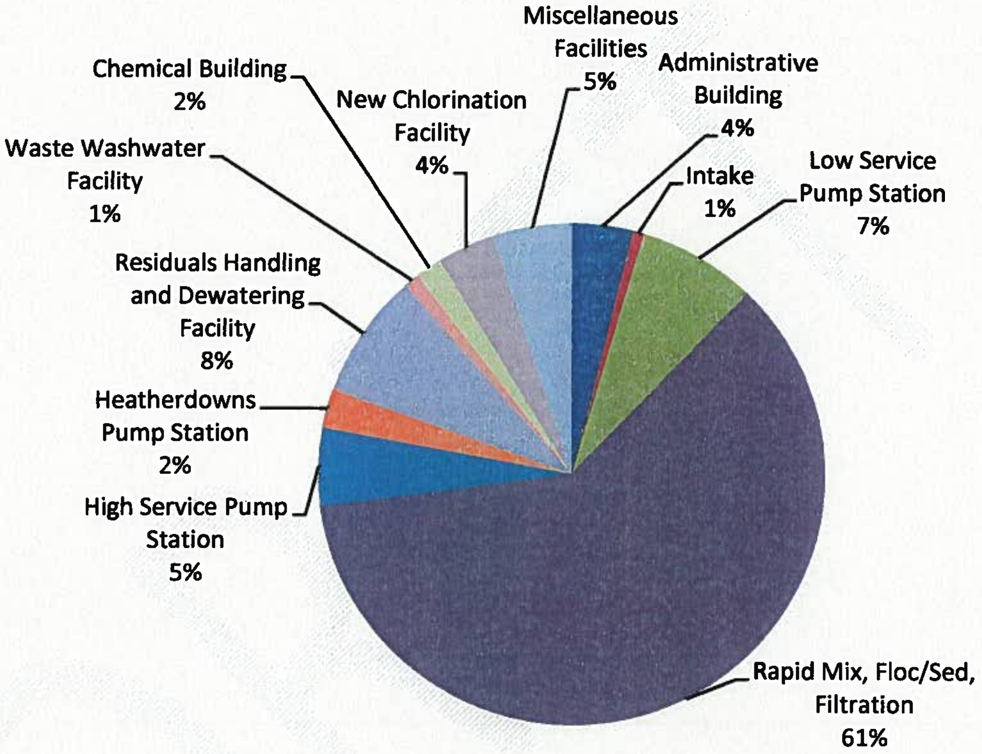

Figure 6-1: Project Costs by Location

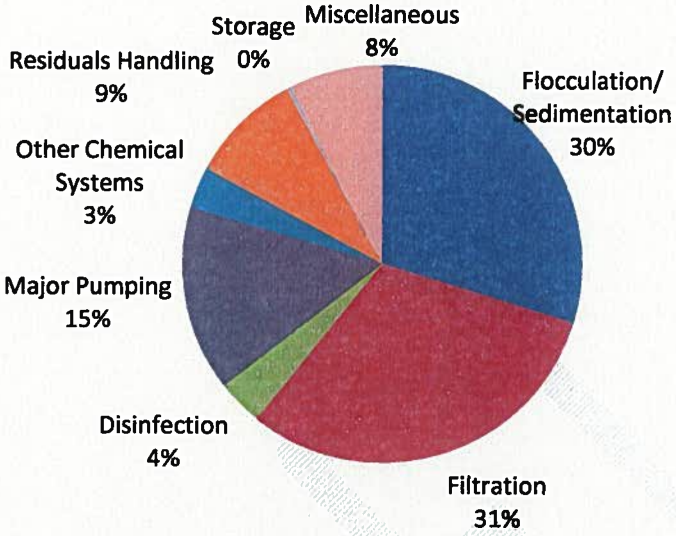

Figure 6-2: Project Costs by Process Area

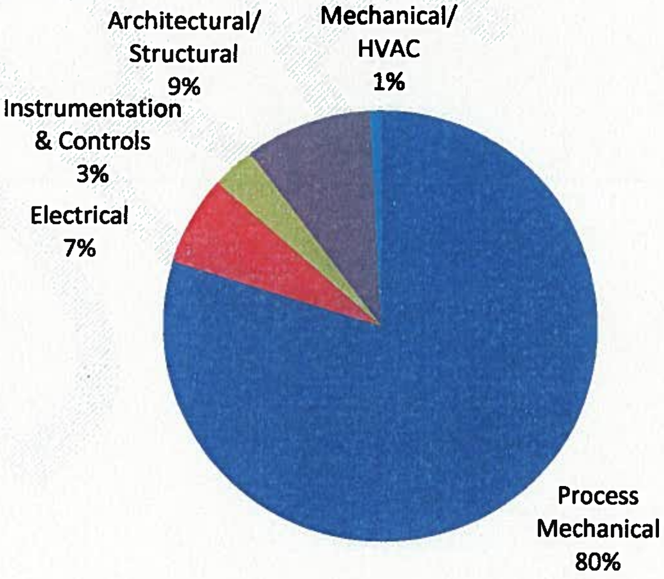

Figure 6-3: Project Costs by Discipline

COLLINS PARK WATER TREATMENT PLANT - 20 YEAR MASTER PLAN AND NEEDS ASSESSMENT
TOLEDO, OHIO

PRIORITIZED LIST OF CIP PROJECTS

Item No.	Item	Location	Description	Priority	CIP Impl. Years	Total Estimated Construction Cost (2011 dollars)
Project 1 - Floc/Sed and Filter Area Roof Immediate Structural Improvements						
A001	Concrete roof panel replacement	Floc/Sed Basins	Includes replacement of concrete roof panel in floc/sed and filter areas.	1	Yrs 0 - 2	$14,653,213
				PROJECT SUBTOTAL		**$14,653,213**
Project 2 - Chlorination System Improvements						
P036	Chlorination system facilities	New Chlorination Facility	Includes redundant facility and miscellaneous improvements.	1	Yrs 0 - 2	$9,500,000
				PROJECT SUBTOTAL		**$9,500,000**
Project 3 - New SCADA System						
I002	SCADA system	Administrative Building	Install new SCADA system.	1	Yrs 0 - 2	$7,788,000
I001	Differential pressure transmitters	Filter Building	Includes differential pressure transmitters.	1	Yrs 0 - 2	$520,000
				PROJECT SUBTOTAL		**$8,308,000**
Project 4 - Flocculation/Sedimentation and Filter Addition						
P030	Add new flocculation/sedimentation basin train(s) and associated filters	Plant Addition	40 MGD water treatment plant expansion.	1	Yrs 0 - 2	$96,600,000
				PROJECT SUBTOTAL		**$96,600,000**
Project 5 - Administration Building Expansion/Improvements						
A020	Existing building addition	Administrative Building	Includes 5,000 square foot addition.	3	Yrs 6 - 10	$1,854,000
A021	Property Acquisition	Near Water Treatment Plant	Acquire property for future WTP processes	3	Yrs 6 - 10	$500,000
				PROJECT SUBTOTAL		**$2,354,000**
Project 6 - Heatherdowns Pump Station Immediate Improvements						
P054	Refurbish or relocate pumps	Heatherdowns Pump Station	Refurbish 3 pumps.	1	Yrs 0 - 2	$1,146,000
P055	Refurbish cone check valves	Heatherdowns Pump Station	Refurbish cone check valves.	1	Yrs 0 - 2	$424,000
P056	Replace oil accumulator system	Heatherdowns Pump Station	Replacement of oil accumulator system.	2	Yrs 2 - 5	$216,000
E013	Miscellaneous electrical panels and equipment	Heatherdowns Pump Station	Includes removal and replacement of electrical panels and equipment.	1	Yrs 0 - 2	$455,000
A004	Aggregate panel replacement	Heatherdowns Pump Station	Replacement of aggregate panel.	2	Yrs 2 - 5	$206,000
A012	Heatherdowns pumping station structural improvements	Heatherdowns Pump Station	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$56,000
A013	Heatherdowns pumping station reservoir fill structure improvements	Heatherdowns Pump Station	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$16,000
M008	Unit heaters and exhaust fans	Heatherdowns Pump Station	Replacement of unit heaters and exhaust fans.	1	Yrs 0 - 2	$33,000
				PROJECT SUBTOTAL		**$2,552,000**
Project 7 - Low Service Pump Station Short-Term Improvements						
P001	Discharge piping gallery improvements	Low Service Pump Station	Includes painting and miscellaneous improvements.	2	Yrs 2 - 5	$95,000
P002	Replace and/or refurbish cone check valves	Low Service Pump Station	Replacement and/or refurbishment of cone check valves and actuators.	2	Yrs 2 - 5	$1,480,000
P005	Replace oil accumulator system	Low Service Pump Station	Includes replacement of current oil accumulator system and additional oil accumulator system.	2	Yrs 2 - 5	$415,000
P006	Refurbish low service pumps	Low Service Pump Station	Refurbish 4 low service pumps.	2	Yrs 2 - 5	$3,113,000
P007	Refurbish raw water main air/vacuum valves and chambers	Low Service Pump Station	Includes refurbishment of access, air valve, blowoff, and cone valve chambers.	1	Yrs 0 - 2	$1,107,000
P008	Miscellaneous site improvements	Low Service Pump Station	Includes replacement of septic tank and leach field in addition to well improvements.	2	Yrs 2 - 5	$80,000
P009	Potable water supply	Low Service Pump Station	Includes 12" water main.	1	Yrs 0 - 2	$1,938,000
E001	Electrical system	Low Service Pump Station	Includes new switchgear and motors.	1	Yrs 0 - 2	$1,656,000
E002	Variable frequency drives	Low Service Pump Station	Includes 4 new VFDs.	2	Yrs 2 - 5	$2,384,000
E003	Backup power	Low Service Pump Station	Includes 2 generators.	1	Yrs 0 - 2	$1,789,000
E004	Substation	Low Service Pump Station	Replacement of substation.	1	Yrs 0 - 2	$1,091,000
E016	Underground fiber optic cable	Low Service Pump Station	Fiber optic cable installation between WTP and LSPS.	2	Yrs 2 - 5	$1,506,000
A006	Low service pumping station structural improvements	Low Service Pump Station	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$218,000
M001	Heating system	Low Service Pump Station	Replace heating system.	2	Yrs 2 - 5	$222,000
				PROJECT SUBTOTAL		**$17,094,000**
Project 8 - General Water Treatment Plant HVAC Improvements						
M002	Boiler piping and valves	Miscellaneous Facilities	Includes replacement of piping including valves.	1	Yrs 0 - 2	$632,000
M003	Unit heater/ makeup air units	Miscellaneous Facilities	Includes replacement of unit heater/makeup air units.	2	Yrs 2 - 5	$83,000
M004	Air conditioning unit	Miscellaneous Facilities	Includes replacement of air conditioning unit.	2	Yrs 2 - 5	$214,000
M005	HVAC replacements	Miscellaneous Facilities	Includes dehumidification of basement areas.	2	Yrs 2 - 5	$940,000
				PROJECT SUBTOTAL		**$1,869,000**
Project 9 - Lime/Soda Ash Storage and Feed System Rehabilitation and Improvements						
P032	Lime/soda ash storage and feed system improvements	Chemical Building	Includes lime/soda ash storage and conveyance system rehab and improvements, dust collector improvements and replacement of lime/soda ash vacuum pumps.	2	Yrs 2 - 5	$3,295,000
P033	Provide automatic removal of lime rejects	Chemical Building	Conveyor belt for automatic removal of lime rejects.	2	Yrs 2 - 5	$49,000
				PROJECT SUBTOTAL		**$3,344,000**
Project 10 - High Service Pump Station Miscellaneous Improvements						

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COLLINS PARK WATER TREATMENT PLANT - 20 YEAR MASTER PLAN AND NEEDS ASSESSMENT
TOLEDO, OHIO

PRIORITIZED LIST OF CIP PROJECTS

Item No.	Item	Location	Description	Priority	CIP Impl. Years	Total Estimated Construction Cost (2011 dollars)
P041	Discharge piping gallery improvements	High Service Pump Station	Includes painting, miscellaneous improvements, and valve vault nos. 1 and 2 improvements.	2	Yrs 2 - 5	$270,000
P042	Replace and/or refurbish cone check valves	High Service Pump Station	Replacement and/or refurbishment of cone check valves.	1	Yrs 0 - 2	$1,003,000
P044	Replace oil accumulator system	High Service Pump Station	Includes replacement of current oil accumulator system.	2	Yrs 2 - 5	$216,000
P045	Additional oil accumulator system	High Service Pump Station	Includes additional oil accumulator system.	2	Yrs 2 - 5	$199,000
E008	Electrical system	High Service Pump Station	Includes new transformers and switchgear.	1	Yrs 0 - 2	$2,407,000
E009	Miscellaneous electrical panels and equipment	High Service Pump Station	Includes removal and replacement of electrical panels and equipment.	1	Yrs 0 - 2	$173,000
A009	High service pumping station structural improvements	High Service Pump Station	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$202,000
				PROJECT SUBTOTAL		$4,470,000
Project 11 - Waste Washwater Facility Short-Term Improvements						
P052	Sump pump piping discharge modifications	Waste Washwater Facility	Includes modifications to existing sump pump and piping.	1	Yrs 0 - 2	$56,000
P053	Basin drain pumping station improvements	Waste Washwater Facility	Rehabilitation of old washwater facility.	2	Yrs 2 - 5	$2,070,000
M006	Heating and ventilating system	Waste Washwater Facility	Replacement of unit heater and exhaust fan.	1	Yrs 0 - 2	$6,000
				PROJECT SUBTOTAL		$2,132,000
Project 12 - Plant-Wide Power Improvements						
E005	Miscellaneous electrical panels and equipment	Facility Grounds	Includes removal and replacement of electrical panels and equipment.	1	Yrs 0 - 2	$1,033,000
E006	Unit substation	Facility Grounds	Replace unit substation.	2	Yrs 2 - 5	$338,000
E007	Outdoor substation	Chemical Building	Replace outdoor substation.	2	Yrs 2 - 5	$782,000
E010	Outdoor substation	High Service Pump Station	Replace outdoor substation.	1	Yrs 0 - 2	$740,000
E011	Backup power	Residuals Handling and Dewatering Facility	Includes new generator.	2	Yrs 2 - 5	$282,000
E012	Miscellaneous electrical panels and equipment	Basin Drain Pumping Station	Includes removal and replacement of electrical panels and equipment at old washwater facility.	2	Yrs 2 - 5	$174,000
E014	Backup power	Heatherdowns Pump Station	Includes new generator.	2	Yrs 2 - 5	$896,000
				PROJECT SUBTOTAL		$4,245,000
Project 13 - Raw Water Intake Improvements						
A005	Raw water intake structural improvements	Intake	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$71,000
A014	Miscellaneous interior improvements (demolitions and removals)	Intake	Demolition/removal of interior items/furnishings, chemical feed equipment, and flaking plaster.	2	Yrs 2 - 5	$1,483,000
A015	Replace walkways, ladders and stairways	Intake	Includes replacement of walkways, ladders and stairways.	2	Yrs 2 - 5	$65,000
A016	Dock accessibility improvements	Intake	Includes permanent bumper system and security improvements.	2	Yrs 2 - 5	$156,000
				PROJECT SUBTOTAL		$1,775,000

PRIORITIZED LIST OF CIP PROJECTS

Item No.	Item	Location	Description	Priority	CIP Impl. Years	Total Estimated Construction Cost (2011 dollars)
Project 14 - Residuals Handling and Dewatering Rehabilitation and Improvements						
P046	Filter press and thickening systems rehabilitation	Residuals Handling and Dewatering Facility	Includes filter press rehabilitation; spare plates and carriages; replacement of SDF thickened sludge pumps, SDF overflow pumps, SDF high pressure pumps, and SDF quick fill pumps; valve replacement; painting of thickener mechanism; thickener tank waterproofing; rebuilding thickener drives; and replacement of acid wash transfer pump, pre-fill tank mixer, and seal water system.	2	Yrs 2 - 5	$6,895,000
P048	Thickener system expansion - additional sludge thickening tank	Residuals Handling and Dewatering Facility	Addition of 1 thickener.	2	Yrs 2 - 5	$2,393,000
P049	Replace sludge pumps (80 and 40 mgd plants)	Residuals Handling and Dewatering Facility	Replacement of 4 sludge pumps.	2	Yrs 2 - 5	$216,000
P050	SDF improvements	Residuals Handling and Dewatering Facility	Miscellaneous improvements to process control, lighting and HVAC and replacement of floor door with larger unit.	3	Yrs 6 - 10	$271,000
A010	Sludge dewatering facility structural improvements	Residuals Handling and Dewatering Facility	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$124,000
M007	Heating system	Residuals Handling and Dewatering Facility	Includes boiler, pump and hot water heaters.	3	Yrs 6 - 10	$66,000
				PROJECT SUBTOTAL		**$9,965,000**
Project 15 - Miscellaneous Chemical Storage and Feed System Improvements						
P010	Coagulant chemical application system improvements	Rapid Mix	Installation of alum sparger in rapid mix channel.	2	Yrs 2 - 5	$4,000
P031	Carbon storage and feed system improvements	Low Service Pump Station	Includes replacement of carbon feeders, booster pumps and mixers.	2	Yrs 2 - 5	$220,000
P034	Alum feed system improvements	Facility Grounds	Includes low and high capacity peristaltic pumps; miscellaneous piping, valves and appurtenances for the new metering pumps; new day tanks; and spill containment for the day tanks.	2	Yrs 2 - 5	$243,000
P035	New chemical building	Facility Grounds	New chemical building for alum and fluoride chemical storage and feed systems includes bulk storage tanks for alum, fluoride storage and feed equipment, chemical piping, miscellaneous piping, HVAC, and electrical.	2	Yrs 2 - 5	$4,073,000
				PROJECT SUBTOTAL		**$4,540,000**
Project 16 - Filter and Pipe Gallery Short-Term Improvements						
P016	Replace surface wash piping (40 mgd plant)	Filter Building	Includes replacement of surface wash piping for 10 filters.	1	Yrs 0 - 2	$320,000
P017	Replace dual media and support gravel for 10 filters (40 mgd plant)	Filter Building	Includes replacement of all filter media (sand, anthracite and support gravel) for 10 filters.	1	Yrs 0 - 2	$1,199,000
P018	Replace and refurbish washwater valves and piping (40 and 80 mgd plants)	Filter Building	Includes all surface and backwash piping and valves in the filter gallery.	2	Yrs 2 - 5	$15,663,000
P019	Refurbish backwash pumps	Filter Building	Refurbish two backwash pumps.	2	Yrs 2 - 5	$263,000
P020	Replace backwash pump cone check valves	Filter Building	Replace 2 backwash pump cone check valves.	2	Yrs 2 - 5	$422,000
P021	Replace washwater cone check valves (40 mgd plant)	Filter Building	Replace 2 washwater cone check valves.	2	Yrs 2 - 5	$422,000
P024	Replace washwater rate-of-flow controllers	Filter Building	Replacement of washwater rate-of-flow controllers.	3	Yrs 6 - 10	$168,000
P025	Replace surface wash rate-of-flow controller	Filter Building	Replacement of surface wash rate-of-flow controller.	3	Yrs 6 - 10	$84,000
P026	Replace filter valves and actuators (40 and 80 mgd plant)	Filter Building	Includes all influent, effluent and drain valves and actuators.	3	Yrs 6 - 10	$10,980,000
P027	Pipe gallery rehabilitation and repainting	Filter Building	Rehab and repaint piping in the filter gallery.	2	Yrs 2 - 5	$295,000
P028	Refurbish elevated storage tank fill pump near backwash pumps	Filter Building	Refurbish elevated storage tank fill pump.	2	Yrs 2 - 5	$130,000
P029	Elevated storage tank repainting	Facility Grounds	Repaint 1 MG elevated storage tank.	2	Yrs 2 - 5	$712,000
P038	Process piping painting and identification	WTP Pipe Gallery	Includes painting and identification for both the 40 and 80 MGD plants.	2	Yrs 2 - 5	$529,000
P039	Replace plant water piping	WTP Pipe Gallery	Replacement of plant water piping for both the 40 and 80 MGD plants.	1	Yrs 0 - 2	$1,180,000
P040	Raw water flow splitting valve replacement (40 mgd plant)	WTP Pipe Gallery	Replacement of 60" butterfly valve.	2	Yrs 2 - 5	$161,000
A017	Piping gallery(s) - concrete repairs of spalling and cracking concrete	WTP Pipe Gallery	Concrete repairs.	2	Yrs 2 - 5	$445,000
				PROJECT SUBTOTAL		**$32,973,000**
Project 17 - Flocculation/Sedimentation Basin and Clearwell Rehabilitation						
P011	Replace flocculators, drives, valves and associated equipment (all basins)	Floc/Sed Basins	Includes horizontal fiberglass paddle flocculators and associated equipment, inlet sluice gates, bypass sluice gates, and drain valves.	2	Yrs 2 - 5	$4,335,000
P012	Concrete walls between floc basins (40 mgd plant)	Floc/Sed Basins	Replace wood baffles with concrete walls in 40 MGD plant only.	2	Yrs 2 - 5	$254,000
P013	Extend flocculation walls (40 mgd plant)	Floc/Sed Basins	Increase height of flocculation walls 12 inches.	2	Yrs 2 - 5	$14,000
P014	Replace sludge collector drives and mechanisms (all basins)	Floc/Sed Basins	Includes drag drives and cross collector drag drives.	2	Yrs 2 - 5	$7,680,000
P015	Recarbonation feed system improvements (all basins)	Floc/Sed Basins	Includes replacement of carbon dioxide piping and diffusers.	2	Yrs 2 - 5	$252,000
P037	Replace clearwell gate actuators	Clearwell	Replace sluice gate motors.	2	Yrs 2 - 5	$227,000
A007	40 mgd sedimentation basins above ground structure improvements	Floc/Sed Basins	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$113,000
A018	Floc and filter area - fall protection railings	Floc/Sed Basins and Filter Building	Includes both 40 and 80 MGD plants.	2	Yrs 2 - 5	$1,307,000
A019	Sedimentation basins - concrete and door hatch replacement with grating	Floc/Sed Basins	Includes both 40 and 80 MGD plants.	2	Yrs 2 - 5	$139,000
				PROJECT SUBTOTAL		**$14,321,000**
Project 18 - Low Service Pump Station Mid-Term Improvements						

COLLINS PARK WATER TREATMENT PLANT - 20 YEAR MASTER PLAN AND NEEDS ASSESSMENT
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PRIORITIZED LIST OF CIP PROJECTS

Item No.	Item	Location	Description	Priority	CIP Impl. Years	Total Estimated Construction Cost (2011 dollars)
P003	Replace raw water screens and washwater system	Low Service Pump Station	Replacement of raw water screens, washwater supply pumps, and surface wash piping.	3	Yrs 6 - 10	$2,183,000
P004	Rehabilitate inlet sluice gates	Low Service Pump Station	Rehab two sluice gates.	3	Yrs 6 - 10	$106,000
				PROJECT SUBTOTAL		$2,289,000
Project 19 - Intermediate Architectural/Structural Repairs						
A002	Replace doors and windows	Miscellaneous Facilities	Includes replacement of doors and windows.	3	Yrs 6 - 10	$1,926,000
A003	Replace reservoir access and gate chambers	Miscellaneous Facilities	Includes replacement of reservoirs access and gate chambers.	3	Yrs 6 - 10	$86,000
A008	Chemical/administration building structural improvements	Chemical and Administrative Buildings	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$517,000
A011	Standby power generator facility structural improvements	Standby Power Generator Facility	Includes roofing, insulation and copings.	2	Yrs 2 - 5	$109,000
				PROJECT SUBTOTAL		$2,638,000
Project 20 - Filter System Long-Term Improvements						
P022	Replace surface wash pumps (80 mgd plant)	Filter Building	Replace two surface wash pumps.	4	Yrs 11 - 15	$98,000
P023	Replace surface wash pumps (40 mgd plant)	Filter Building	Replace two surface wash pumps.	4	Yrs 11 - 15	$89,000
				PROJECT SUBTOTAL		$187,000
Project 21 - Residuals Handling and Dewatering Facility Expansion						
P047	Thickener system expansion - dewatering building and press	Residuals Handling and Dewatering Facility	Addition of 1 press in new building.	4	Yrs 11 - 15	$10,577,000
				PROJECT SUBTOTAL		$10,577,000
Project 22 - Pumping Equipment Improvements						
P043	Refurbish high service pumps	High Service Pump Station	Refurbish 6 high service pumps.	4	Yrs 11 - 15	$7,702,000
P051	Washwater pump replacement	Waste Washwater Facility	Replacement of 3 pumps and 3 check valves.	4	Yrs 11 - 15	$403,000
				PROJECT SUBTOTAL		$8,105,000
Project 23 - Heatherdowns Pump Station Long-Term Improvements						
P057	Additional pump	Heatherdowns Pump Station	Install 4th pump with VFD.	5	Yrs 16 - 20	$1,340,000
E015	Variable frequency drives	Heatherdowns Pump Station	Includes replacement of VFDs and new electrical room.	4	Yrs 11 - 15	$1,638,000
				PROJECT SUBTOTAL		$2,978,000

Table 6-3: Prioritized List of CIP Projects

[Insert page 1 of 2 of table]

[Insert page 1 of 2 of table]

Table 6-4 summarizes the 23 projects by priority. Although only five of the projects were assigned a priority score of 1 (highest priority), these projects make up nearly 50% of the total estimated construction costs. Ten projects were assigned a priority score of 2 with the remaining eight projects divided between the lowest three priorities.

Table 6-4: Recommended Projects by Priority

Group	Risk	Priority	No. of Projects	Percent of Projects	Total Costs of Projects	Percent of All Project Costs
1	Highest	Yrs 0 - 2	4	17%	$129,061,213	50%
2	High	Yrs 2 - 5	11	48%	$54,340,000	21%
3	Medium	Yrs 6 - 10	4	17%	$52,221,000	20%
4	Low	Yrs 11 - 15	3	13%	$18,869,000	7%
5	Lowest	Yrs 16 - 20	1	4%	$2,978,000	1%

6.3 20-Year CIP Schedule

The 20-year CIP schedule is shown in Table 6-5. The total estimated capital costs over the 20-year planning period are $257.4M. Figure 6-4 shows the annual and cumulative capital expenditures over the 20-year planning period from 2012 through 2032. The majority of the costs occur within the first half of the 20-year period as a result of the large costs associated with the plant addition project, which is scheduled to begin within the next 5 years.

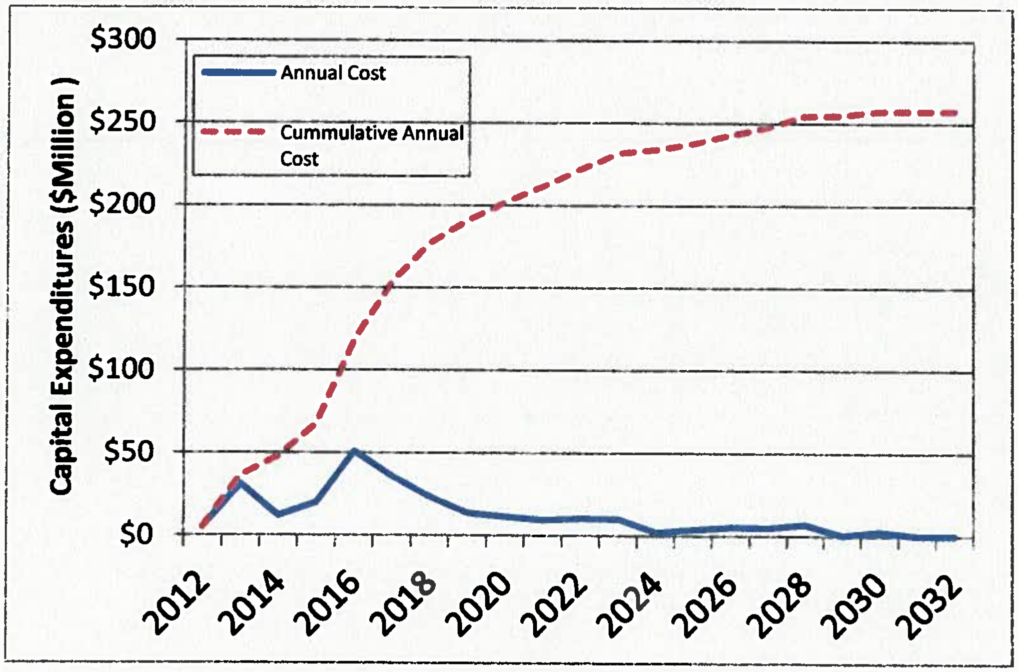

Figure 6-4: 20-Year Capital Expenditures

COLLINS PARK WATER TREATMENT PLANT - 20 YEAR MASTER PLAN AND NEEDS ASSESSMENT
TOLEDO, OHIO

20-Year CIP Implementation Schedule

Item	Item Description	Priority	Project Duration (years)	Total Estimated Project Cost (2011 dollars)	Year												
					2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 - 2027	2028 - 2032
					0	1	2	3	4	5	6	7	8	9	10	11 - 15	16 - 20
1	Floc/Sed and Filter Area Roof Immediate Structural Improvements	1	2	$14,653,213	$2,197,982	$12,455,231											
2	Chlorination System Improvements	1	3	$9,500,000	$1,425,000	$4,750,000	$3,325,000										
3	New SCADA System	1	2	$8,308,000	$1,246,200	$7,061,800											
4	Flocculation/Sedimentation and Filter Addition	1	6	$96,600,000		$6,762,000	$7,728,000	$14,490,000	$38,640,000	$19,320,000	$9,660,000						
5	Administration Building Expansion/Improvements	2	3	$2,354,000			$353,100	$1,177,000	$823,900								
6	Heatherdowns Pump Station Immediate Improvements	2	3	$2,552,000			$382,800	$1,276,000	$893,200								
7	Low Service Pump Station Short-Term Improvements	2	3	$17,094,000				$2,564,100	$8,547,000	$5,982,900							
8	General Water Treatment Plant HVAC Improvements	2	2	$1,869,000					$280,350	$1,588,650							
9	Lime/Soda Ash Storage and Feed System Rehabilitation and Improvements	2	3	$3,344,000					$501,600	$1,672,000	$1,170,400						
10	High Service Pump Station Miscellaneous Improvements	2	3	$4,470,000					$670,500	$2,235,000	$1,564,500						
11	Waste Washwater Facility Short-Term Improvements	2	2	$2,132,000					$319,800	$1,812,200							
12	Plant-Wide Power Improvements	2	3	$4,245,000						$636,750	$2,122,500	$1,485,750					
13	Raw Water Intake Improvements	2	2	$1,775,000						$266,250	$1,508,750						
14	Residuals Handling and Dewatering Rehabilitation and Improvements	2	3	$9,965,000						$1,494,750	$4,982,500	$3,487,750					
15	Miscellaneous Chemical Storage and Feed System Improvements	2	3	$4,540,000						$681,000	$2,270,000	$1,589,000					
16	Filter and Pipe Gallery Short-Term Improvements	3	5	$32,973,000								$4,945,950	$7,006,763	$7,006,763	$7,006,763	$7,006,763	
17	Flocculation/Sedimentation Basin and Clearwell Rehabilitation	3	7	$14,321,000								$2,148,150	$2,028,808	$2,028,808	$2,028,808	$6,086,425	
18	Low Service Pump Station Mid-Term Improvements	3	1	$2,289,000									$2,289,000				
19	Intermediate Architectural/Structural Repairs	3	3	$2,638,000										$395,700	$1,319,000	$923,300	
20	Filter System Long-Term Improvements	4	4	$187,000												$187,000	
21	Residuals Handling and Dewatering Facility Expansion	4	3	$10,577,000												$10,577,000	
22	Pumping Equipment Improvements	4	2	$8,105,000												$1,215,750	$6,889,250
23	Heatherdowns Pump Station Long-Term Improvements	5	2	$2,978,000													$2,978,000
			TOTALS	$257,469,213	$4,869,182	$31,029,031	$11,788,900	$19,507,100	$50,676,350	$35,689,500	$23,278,650	$13,656,600	$11,324,571	$9,431,271	$10,354,571	$25,996,238	$9,867,250