Grand Rapids District Office
350 Ottawa Ave NW, Unit 10
Grand Rapids, MI 49503

WSSN: 00600

Drinking Water and Municipal Assistance Division

2018 Water System Sanitary Survey

Benton Harbor Water System

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Sanitary Survey of Community Water Supply - Review Summary

Water Supply: Benton Harbor | WSSN: 00600
County: Berrien | District: 93
Evaluator: Sarkipato | Date: 2018

Category	Comment	N/A	NotEv	NoD/R	Rec	Def	SigDef
Source						X	
Construction & Maintenance	*Inspection and clean intake, restart mussel control*					X	
Standby Power	*Conduct dark testing on all generator facilities*				X		
Isolation				X			
Source Water Protection	*Study contingencies if single intake fails.*				X		
Capacity	*monitor head loss*				X		
Treatment							X
Disinfection	*Optimize chlorination to balance CT & DBP formation*				X		
Fluoride	*Install forced air ventilation for saturator*				X		
Phosphate Addition				X			
Softening		X					
Iron/Manganese Removal		X					
Arsenic Removal		X					
Pretreatment	*Coagulant feed needs ample mixing energy to be effective*						X
Filtration (gravity or membranes)	*Filter to waste valves not functioning*				X		
C*T	*Reassess chlorination practices to reduce DBP*				X		
Other	*Finished water meters not functioning, can't determine CT*					X	
Distribution System							X
Interconnections w/ Other WS	*Obtain formal emergency agreement w/ Township*				X		
Hydrants & Valves	*Formalize program to turn valves & flush hydrants*						X
Service Lines & Metering				X			
General Plan				X			
Cross Connections	*Program needs complete overhaul, has been abandoned*						X
Construction & Maintenance	*Aging water main replacement is lacking*					X	
Capacity	*Many areas of low/no fire flow.*						X
Finished Water Storage						X	
Construction & Maintenance	*Reinspection of the elevated storage tank is overdue*					X	
Controls				X			
Capacity				X			
Pumps (All Pumping Facilities)					X		
Construction & Maintenance				X			
Controls	*Install VFD on high service at WTP*				X		
Capacity				X			
Monitoring & Reporting							X
Bacteriological Monitoring				X			
Chemical Monitoring				X			
MOR or Annual Pumpage Report	*Inaccurate information on treated water*					X	
Consumer Confidence Report				X			
Analytical Capabilities	*Fix continuous chlorine analyzer*						X
System Management & Operations							X
Owner Responsibility	*Must commit to timeline for compliance*						X
Capacity Development	*Financial & Managerial Capacity is not met*						X
Reliability Study	*Hydraulic model calibration indicated areas of low flow*				X		
Operations Oversight	*Hire Separate OIC for treatment & distribution*						X
Permits				X			
Operator Compliance					X		
Operator Certification	*Distribution & Treatment need more certified operators*				X		
Technical Knowledge & Training				X			
Security				X			
Emergency Response Plan				X			
Site Security (Fences, Alarms...)				X			
Financial							X
Rates	*Collection of rates is ineffecient and ineffective*						X
Budget & Capital Imp. Plan	*Rates insufficient to cover capital improvements*						X
Other	*SCADA system needs additional functionality*						X

N/A - Not Applicable
NotEv - Not Evaluated
NoD/R - No Deficiencies/Recommendations Made
Rec - Recommendations Made
Def - Deficiencies Identified
SigDef - Significant Deficiencies Identified

BENTON HARBOR SANITARY SURVEY RECOMMENDATION SUMMARY

The recommendations provided below are intended to be a concise summary of the more detailed discussions which are found in previous sections of the report. Page numbers following the recommendations indicate where the subject material is discussed in more detail in the survey. In addition, we have ranked each by priority.

Each recommendation has been ranked one (1) through four (4), where a ranking of one (1) is most critical to complete. A ranking of one (1) indicates that the item is a straight forward requirement of the DEQ (mainly Act 399, but this may include other DEQ Water Bureau programs such as NPDES or Ground Water discharge) and must be completed to comply with our rules. A ranking of two (2) indicates that our department feels that the recommendation is necessary to remain in compliance with our rules or that noncompliance is likely if the recommendation is not pursued. A ranking of three (3) indicates that our department feels that the recommendation would directly improve the protection of public health. Finally, a ranking of four (4) indicates our department feels that the recommendation should be considered by the city to enhance operation and maintenance. **All priority 1 findings must be addressed within a timeline agreed upon by the department of environmental quality due to potential public health impacts.**

#	Recommendation:	Report Pages	Treatment (T), Distrib. (D), Management (M)	Priority
1	**Optimize revenue collection to fund operational and capital needs**	**46, 47**	**M**	**1**
2	**Allocate adequate managerial personnel to address ongoing violations**	**29**	**M**	**1**
3	**Hire separate distribution operator-in-charge**	**38, 39**	**M**	**1**
4	**Work with a financial consultant to assess financial mechanism**	**46, 47**	**M**	**1**
5	Include lead service line replacement in AMP	47	M	3
6	Calculate non-revenue water (i.e. water loss)	4	M	3
7	Plan for contingencies if single intake fails	8	M	3
8	Formalize emergency interconnect agreement with Township	41	M	3
9	**Utilize rapid mixers to achieve better coagulation**	**10, 18**	**T**	**1**
10	**Repair online chlorine analyzer on plant tap**		**T**	**1**
11	**Install or repair existing finished water meters**	**22, 36**	**T**	**1**
12	**Upgrade SCADA system for data access, automation, and alarming**	**22, 33**	**T**	**1**
13	Inspect and clean intake, and add mussel control chemical	32	T	2
14	Filter to waste valves must be fixed and remain operational.	12, 15	T	2
15	Train staff on VFD operation of Low Service Pumps	9	T	2
16	Develop a coagulation model	18	T	2
17	Monitor corrosion indices daily, maintain consistent water quality	30	T	2
18	Fine-tune treatment practices to minimize DBP formation	30, 31	T	2
19	Install forced air ventilation on the fluoride saturator	20	T	3
20	Install variable frequency drives on high service pumps	9	T	3
21	Some filters are non-operational and subtracted from plant capacity	12, 13	T	3
22	Conduct "dark testing" annual on all emergency power.	24	T	3
23	Conduct secondary standard verification on benchtop turbidimeter	26	T	3
24	Shorten length of feed line to turbidimeters to increase data quality	14	T	3
25	**Cross Connection program has been neglected for years**	**48**	**D**	**1**
26	**Develop hydrant inventory, maintenance and flushing plans**	**43, 44**	**D**	**1**
27	**Develop valve inventory and a routine turning plan**	**44**	**D**	**1**
28	**Prioritize water main replacement using the capital improvement plan**	**42**	**D**	**1**
29	Update sample pool and materials inventory per lead & copper rule	30	D	2
30	Evaluate interconnect capacities, pursue formal agreements	32	D	3
31	Inspect elevated storage tank every 5 years, clean as needed	40	D	3

Basic Data

Name of Supply: City of Benton Harbor

Review Dates: 5/15/2017, 9/18/2017, 12/19/2017, 3/5/2018, 6/21/2018, 8/24/2018

WSSN: 0600

Reviewed By: Ernie Sarkipato, Jon Bloemker, Mike Bolf

Mailing Address:

City of Benton Harbor
200 East Wall Street
Benton Harbor, MI 49022
Phone: (269) 927-8400
Fax: (269) 927-0304

Plant Address

Benton Harbor WTP
601 North Ridgeway Drive
St. Joseph, MI 49085
Phone: (269) 927-8471
Fax: (269) 927-8469

City Officials:

Mayor: Marcus Muhammad

City Manager: Darwin Watson
(269) 927-8400
dwatson@cityofbentonharbormi.gov

Utilities Director: vacant

Operator-In-Charge: Mike O'Malley
(269) 363-0575 cell
momalley@cityofbentonharbormi.gov

Designated Backup Operator: Denny Edwards

Distribution System Superintendent: Stewart Beach

Water Treatment Plant Operators:

	Name	Licenses	Operator ID
1.	Mike O'Malley	F-1, S-1	2634
2.	Denny Edwards	F-4, S-4	4753
3.	Doug Vanderploeg	F-3, S-3	2171
4.	Joe Archibald	F-4	17378
5.	Darwin Watson	S-2, F-4 (exp.)	4710

Backup operator designation??

Retail Customers:	Name	Population
1	City of Benton Harbor	9,970 (2010 census, 2011 adjustment)

Wholesale Customers None

Service Population: 9,970 Year: 2011 Basis: census w/ adjustment*

**Overall, the population trends of the City is declining. Reduction of population from the census was justified in 2011 due to the ~144 apartments at Cogic Village being served by the Township, though they are within the city limits.*

Percent Metered: City – 100%

Percent Unaccounted: ~ 40 % (this estimate is not reliable, note lack of finished water meters)

Water System Construction Features & Dates:

1. Water system construction prior to 1914. Old state records indicate well and pumping station at this time.

2. 1927 Water Filter Plant in service

3. 1930 Additional Kelly well installed.

4. 1937 Water softening plant additions.

5. 1949/50 Construction of 12 MGD rapid sand filter plant including 2 upflow pretreatment units. Design by Consoer, Townsend & Associates.

6. 1951 Fluoridation equipment installed.

7. 1954 Remaining four of twelve filters equipped.

8. 1967 Construction of Grand Blvd. and M-139 booster stations and ground reservoir.

9. 1968 Construction of Euclid Ave. standpipe and booster station.

10. 1989/90 Installation of 6 MGD low service pump, chlorination, and chemical feed upgrades, replacement of switch gear, replaced filter valves and controls, plant metering and instrumentation, and customer meters.

11. 1991 New media and underdrains in six of the twelve filters.

12. 1995 Repair of one filter underdrain (#4) and new media and underdrains in two additional filters (#3, #7)

13. 1997 Installation of chlorine connection in new spool piece on raw water intake; new traveling screens.

14. 1997 Security improvements; fencing around plant, exterior lighting on clarifiers and chemical storage building.

15. 1997 New underdrain and media in filter #8.

16. 1998 Warranty work on filters #1, #2, #5, and #6 (new underdrains)

17. 2002 New media in filters #5 and #6.

18. 2005 Replaced all filter influent and effluent valves.

19. 2010 Large-scale DWRF project to include waterplant and distribution improvements. Includes new plate settling basins with inclined plate settlers, filter-to-waste provisions for all filters, rehabilitation of filters 9-12, a backwash lagoon, and conversion from gas chlorine to liquid chlorine.

20. 2011 Benton Charter Township constructs transmission main to separate the Township distribution system from the City.

21. 2013 St. Joseph Charter Township constructs transmission mains to separate the Fairplain neighborhood (St Joseph Twp.) from the City water system.

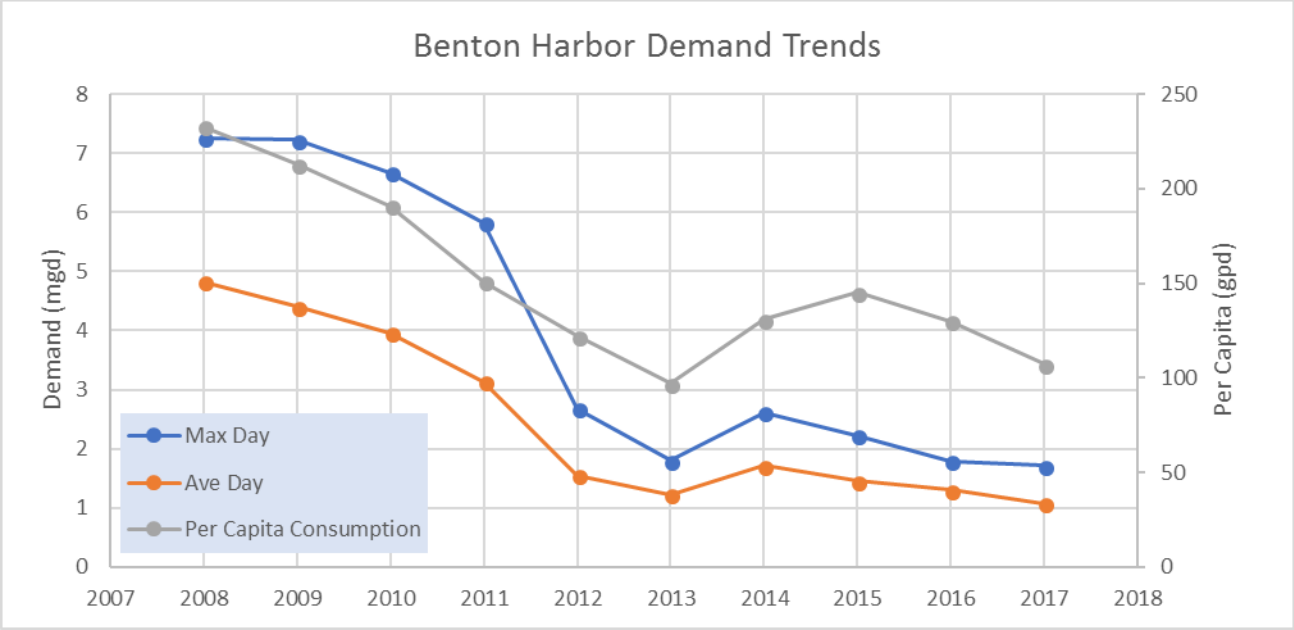
Plant Personnel/Construction/Security Comments: The City of Benton Harbor (City) is classified as an F-1 conventional treatment water plant, and must be attended by an F-licensed shift operator when the water plant is in operation. Plant operation is defined when the plant is treating water to protect public health and operation occurs whenever the low service pumps are running. **The City currently meets the certified operation and oversight requirements in water treatment, and is strongly encouraged to incentivize operators to obtain F-1 licensure.**

Staffing levels at the water plant are insufficient to adequately perform preventative maintenance, and the operator in charge is required to cover operational duties as well as maintenance. A number of simple violations such as reporting violations suggest the operator in charge is unable to spend adequate time on water system management.

The plant is locked during normal business hours. A front door buzzer alerts staff of visitors or deliveries. No trespassing signs are posted in front of the plant, and an entry gate and perimeter fencing has been installed. Security cameras of the water plant grounds transmit to the City police department.

Pumpage Data (Million Gallons)	2008	2009	2010	2011	2012	2013	2014
Maximum Daily Demand:	7.26	7.23	6.67	5.83	2.68	1.80	2.62
Average Day For Maximum Month:	6.11	4.94	4.04	4.21	1.95	1.38	2.17
Average Day Demand For Year:	4.83	4.41	3.96	3.14	1.55	1.23	1.72
Minimum Day Demand	3.2	2.7	2.2	0.11	0.89	0.86	0.15
Average Per Capita Consumption: (gpd)	233	213	191	151	122	97	131

Pumpage Data (Million Gallons)	2015	2016	2017
Maximum Daily Demand:	2.228	1.792	1.72
Average Day For Maximum Month:	1.58	1.515	1.23
Average Day Demand For Year:	1.45	1.3	1.07
Minimum Day Demand	.905	0.834	0.84
Average Per Capita Consumption: (gpd)	145	130	107



Demand Comments: The overall trend for city of Benton Harbor is decreasing. Average day demands have dropped over the past few years, as the City has lost several large industrial users. The Benton Township water plant construction is complete, and Benton Township is no longer a City customer. Further, St. Joseph Township (Fairplain) disconnected from the City and connected their customers to the City of St. Joseph. These separations have resulted in a reduction in the City retail customer population by approximately 35 percent. Even per capita demands have trended downwards, which is an industry-wide trend due to water saving devices and budget-minded consumers. Short term increases in per capita usage could be attributed to large-scale meter replacement, resulting in more accurate readings. **The city should also be determining non-revenue water as a managerial technique. This is done comparing water pumped from the plant to the water billed to customers.**

Water Treatment Plant Capacity

Plant Design Capacity: 12 MGD

State Rated Capacity: 8 MGD

Treatment Classification: F-1

Pumping Capacities:

Low Service	9 MGD
High Service	8 MGD

Pretreatment Capacity 14 MGD

Filtration Capacity: 8 MGD (8 filters @ 1 mgd each)

Plant Metering	Y/N	Type

Raw Water:	Yes	two turbine meters
Finished Water:	No	Two 20-inch venturi meters, one 12” mag, **NONE ARE WORKING**
Backwash Water:	Yes	one turbine meter
Plant Water:	Yes	4-inch sensus (type?)

Total Treated Water Storage MG

Treatment Plant

Clearwell: 30,000 gallons

Ground Storage: 2 MG (two 1 MG abutting reservoirs)

Distribution System

Elevated Storage: 0.65 MG elevated storage tank @ Britain & 8th St.

Total (MG) **2.65 MG**

Percent Of Maximum Day: 50%

Emergency Supply/Interconnections: yes (capacity undefined)
-one interconnection with the City of St. Joseph at M-63 (metered 16-inch main)
-one proposed interconnection with SMRSS&WA at Empire and Woodward (metered 12-inch main)
-interconnections with Benton Charter Township (normally closed and unmetered)

Capacity Comments: After undergoing major renovations to restore the 16 MGD capacity in 2010, the water treatment plant (WTP) was re-rated to 10 MGD in 2015 based on the firm capacity rating of high service pumping and filtration rates. **Currently 4 filters are permanently offline, and with high service pumps 1 & 5 offline since the last survey, the new rating of the water plant is 8 MGD.**

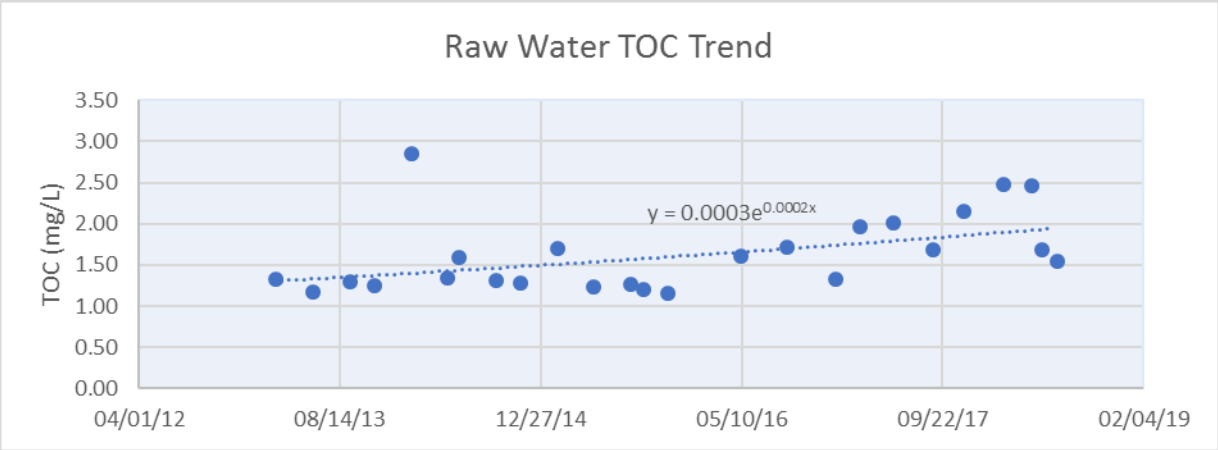
Metering of finished water is not possible at the time of the survey, yet treated water has been reported on the monthly operating reports for years. Finished water meters must be repaired.

Water Quality

Data taken from the 2013 & 2014 Monthly Operation Reports

	Raw		Treated	
	Normal	Range	Normal	Range
Hardness, ppm	110 - 160	98 - 250	110 - 150	94 - 202
Turbidity, NTU	3 - 6	0.2 - 60	0.11 - 0.12	0.04 - 0.21
Alkalinity, ppm	120 - 160	87 - 182	130 - 150	88 - 172
Total col., cts/100 Ml	0 - 1519	0 - 16000	< 1.1	< 1.1

E. coli, cts/100 ml	< 1 - 16	< 1 - 82	< 1.1	< 1.1
TOC, ppm	2.0 - 2.6	1.59 - 3.20	1.5 - 2.1	1.50 - 2.10
Nitrate, ppm	not taken	not taken	0.5	<0.4 – 1.5
Fluoride, ppm	0.12 - 0.24	0.01 - 0.66	0.84 - 1.20	0.03 - 1.88
TTHM, ppb	not taken	not taken	45	37 - 64
HAA5, ppb	not taken	not taken	24	20 - 31
pH	7.9 - 8.1	7.0 - 8.7	7.5 - 7.6	6.8 - 8.2



Comments on Water Quality/Monitoring Requirements:

Lake Michigan is an abundant fresh water source. The intake can be influenced by weather conditions (wind), seasonal turnover, quick thermal changes, and the St. Joseph River. The finished water produced by the plant generally meets all applicable state and federal drinking water standards.

The water plant has no trouble meeting turbidity standards with the addition of the plate settlers. However, runoff conditions and thermal upsets can rapids change and/or degrade source water quality with rapidly changing organics, temperature, and turbidity. In February of 2018 poor water quality led to a spike in filtered turbidity that nearly triggered a treatment technique violation. Several items were identified as necessary improvements to avoid potential violations in the future.

The long term trend appears to be an increasing TOC concentration in the raw water, which requires good pretreatment to achieve adequate removal. The city failed to meet the requirements related to enhanced coagulation, as the running annual average of the treated water rose to above 2.0 mg/L, and the removal ratio running annual average rose above 1.00, resulting in a treatment technique violation with public noticing requirements.

Lake Michigan has a moderate alkalinity concentration that allows stability for coagulant dosages and excellent buffering capacity. Alkalinity levels in both the raw and treated water have seemed to increase by approximately 20 ppm since the last survey, and the hardness has seemed to drop by 20

ppm on average. The slight alkalinity variation does not affect treatment capabilities. The pH does change somewhat in the raw water with limnologic conditions. pH drops during the treatment process slightly (~0.4 units) and the variance seems to follow the lake conditions. The conversion to liquid bleach has resulted in a slightly smaller pH drop during treatment than was experienced using gas.

Natural raw water fluoride levels are characteristic of the Lake Michigan geologic basin and can vary by as much as 0.4 ppm depending on limnologic conditions and influence of the St. Joseph River. This variation can make consistent plant tap fluoride residuals difficult to achieve, but variations are usually adjusted up or down adequately within one day. Fluoride concentration fluctuations do not last long, and at no times has the WTP produced water over 2.0 ppm. Equipment/control failure has historically been common, including one incident of a fluoride release. To avoid working with liquid acid fluoride, a sodium fluoride saturator was installed and is currently running properly.

Occasional positive nitrates occur in source water. It is unknown if there is a strong correlation between spring or local storm run-off and nitrate levels at the intake. The intake has chlorine feed capabilities for zebra mussel control. The intake line has had troubles with clogging from sodium hypochlorite scaling.

The Long Term 2 Surface Water Treatment Rule (LT2SWTR) round 2 requires raw water sampling every two weeks for E. coli, and turbidity, beginning in October 2017. Round 1 sample results placed the City into Bin 1 and no further crypto removal is necessary. It is not anticipated the city will see any surprising results that would change the bin determination.

Odor is not monitored at the water plant, nor are algae counts or algae speciation samples taken.

Intake Facility

Name Of Source:	Lake Michigan
Source Capacity:	Unlimited
Diameter Of Intake Pipe:	36-inch steel
Total Length:	3,950 feet from shorewell
Intake/Crib Capacity:	(24 MGD)
Location (Latitude/Longitude):	N 42^0 07.88' W 86^0 29.10'
Submergence:	3375 ft from shore in 42 ft. of water, 27' to top of crib
Entrance Velocity:	5.25 ft/sec at 24 MGD
Grating:	40 - 2"x12" cedar slats placed radially around opening
Zebra Mussel Control:	3" HDPE leading to diffusion ring in base of intake
Historic Low Water Elevation:	576' above sea level (2013)
Historic Low Water Flow:	no measured change
Historic High Water Elevation:	582.5' above sea level (1986)

Intake Facility

Standby (Emergency) Intake?	2 - 36" emergency risers at 1500' and 2500' from shore
Is SWAP Available?	yes
Backflush Provisions?	Yes, from finished water clearwell

Comments on Intake: The intake and two emergency risers were last inspected in 2008. Both the intake and the risers were reported to be in good condition. The riser location (lat/long) should be kept on record in the ERP to access in case of emergency. Although chlorine can be fed at the intake to control zebra mussels, it is not currently employed for a few reasons. The chlorination line has plugged in the past due to scaling, and there is concern over excessive DBP formation. Zebra mussel infestation may reduce the intake capacity somewhat. **Recommend measuring head loss through the intake by comparing the level of lake Michigan to the level in the wet well while the plant is running. Over time, increases in head loss indicate plugging. Additionally, the intake is due for an inspection and likely needs to be cleaned to remove mussels.**

A wet well (~120,000 gals) is located adjacent to the low service pump room. In 1997, a new traveling screen was installed. The motor/gears were replaced in 1999. Also in 1997, a new spool piece was installed on the 36-inch pipe (upstream of the traveling screen) which allows the cone valve (located in a dry well) to no longer be submerged, and allowed the intake line to be back flushed if needed. However, the blow-back valve has been completely removed from service. Piping from the finished water storage can fill the shore well and backflush the intake if needed. The piping is equipped with an air break.

Given the lack of redundancy of a single intake, the City should consider alternative sources of water should the single intake become unavailable.

Pumps and Pump Locations

Purpose		Location	Capacity (MGD)	Type	Lubricant	Status	Preventative Maintenance	Flooding?
Low Service:								
	#1*	plant – 2nd floor	2.0	vertical turbine	oil	active	annually	no
	#2*	plant – 2nd floor	3.0	vertical turbine	oil	active	annually	no
	#3*	plant – 2nd floor	5.0	vertical turbine	oil	active	annually	no
	#4*	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	6.0	vertical turbine	oil	out of service	no	no
	Firm		9 MGD					

SANITARY SURVEY DATA FORM

Purpose		Location	Capacity	Type	Lubricant	Status	Preventative	Flooding?
High Service:								
	#1	plant – 2nd floor	2.0	vertical turbine	oil	out of service	no	no
	#2	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#3	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#4	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	2.0	vertical turbine	oil	out of service	no	no
	Firm		8 MGD					
Filter Backwash:								
	#1	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
	#2	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
Sludge Disposal:		**by**	**gravity**	**sewer**	**to**	**lagoon**		

Location Of Pump Switch Gear: Located on the second floor and not susceptible to flooding

Comment on Pumps/Pump Maintenance: Low Service pumps take suction from wet well and discharge to rapid mix (24-inch splits to two-20-inch). High Service pumps take suction from finished water suction well which is connected to a 2 MG treated ground storage tank, and discharges to the distribution system via two, 20-inch mains. Backwash pumps take suction from the finished water suction well. (The water plant cannot backwash from the distribution system.) Surface wash pumps take suction from the finished house water line. Most of the Low and High Service pumps have had either the pump or motors rebuilt within the past 13 years. Pump maintenance/overhaul records are kept by plant staff. WTP pump motors have an annual preventative maintenance program by an outside contractor. High service pump # 5 had the foot valve replaced in 2007.

***Low Service pumps have VFD's, yet staff were not trained in their use and were unable to slow treatment during turbidity spikes at the confluence in early 2018. Following communications with the City, staff were trained and are now capable of operating at lower flow rates.**

High Service Pump #1 has been out of service for years, with #5 also having been offline for some time. Without these smaller pumps, the remaining firm pumping capacity of High Service is approximately 8 mgd. The installation of variable frequency drives on the high service pumps would help mitigate the loss of lower capacity pumps, and should allow flexibility in operations to take the elevated storage tank offline for necessary maintenance.

Treatment Facilities

Rapid Mix

Number of Units: 2
Volume of Each Unit: 8600 gallons each
Detention Time at Rated Capacity: 0.5 to 2.0 minutes
Mechanical or Static? Mechanical –variable speed propeller
In-line or CSTR: CSTR

Velocity Gradient (G) if Available? 500 sec-1 (per design engineer, but not currently used)

Is Mixing Rate Adjustable? yes

Condition of Equipment: new

Chemicals Added: Aluminum Sulfate (alum), Capable of adding polymer

Comment on Rapid Mix: **As of the 2018 survey, coagulant feed is into the 24" raw water influent without active mixing other than flow velocity. This severely hampers the ability of the treatment plant to combat changes in raw water quality and meet regulatory standards. This is a significant deficiency and must be corrected by constructing a coagulant injection into the pre-designed rapid mix chambers in the new pretreatment building.**

Flocculation Basins

Number of Units: 2

Volume of Each Unit: 168,300 gallons each

Three chambered stages, run in series, with adjustable floc paddle speed

Unit Dimensions: 50' x 30' x 15'

Detention Time at Rated Capacity: 40 minutes

Type Of Units: paddle

Inlet Design: baffled

Is Mechanical Flocculator Used? yes

Condition of Equipment: new

Baffles: yes

Baffling Factor: 0.7

Drain: yes

Overflow: none

Curbing: yes

Does A Preventive Maintenance Program Exist? yes

Comment on Flocculation Basins: The new flocculation basins were put into service in 2011. They are three separate mechanical floculation stages and each is 15-feet long. Each flocculator

paddle has a variable frequency drive motor to adjust the paddle speed. Only alum is being used at this time, but the new floc basins have the capabiltiy to treat using polymer as well. At the time of the survey, one motor drive was out of service and awaiting replacement. Settled water quality was excellent.

Settling Basins

Number of Units: 2
Volume of Each Unit: 134,640 gallons each
Dimensions: 40' x 30' x 15'
Detention Time at Rated Capacity: 27.7 minutes at 7.0 MGD
Types of Units: Stainless Steel Plate Settlers at 55^0 inclination
Clarification Rate (gpm/sq. ft.) 0.3 gpm/ft^2
Number of Weirs per basin: one
Total Weir Length: Awaiting as-built drawings
Weir Loading Rate: (gpd/ft)
Inlet Design: baffle wall
Baffles: perforated walls at inlet and outlet
Outlet Design: Effluent Trough Weir
Baffling Factor: 0.5
Overflow: No
Drains: Yes
Curbing: Yes
Sludge Removal Method: scrapers and annual cleaning
Sludge Disposal: Backwash Lagoon – **Needs to be cleaned out**
Physical Condition: new
Effluent Turbidity, average/range: ~ 0.4 - 1.0

Settling Basin Comments: The new plate settlers were constructed under a DWRF project to replace the old decrepit Accelators, and produce settled water that is less susceptible to thermal inversions. The existing raw water piping was rerouted into the new settling basin building from the old plant. A by-pass valve exists around the settling basins. The raw water enters the rapid (flash) mixing chamber, then the 3 flocculation stages. Baffles exist for the inlet and outlet of each flocculation stage. Floc paddle speeds are adjustable by variable frequency drive motors. The water then enters the settling basins filled with plate settlers. The effluent flow then leaves the settling basins over the weirs, where it is piped back to the existing filter building.

Basins can only be operated in parallel or one at a time (not in series). Basin sludge is collected in the sloped floor where scrapers collect it and it is discharged a newly constructed backwash lagoon.

There is a continuous reading turbidimeter on the common effluent pipe from both basins. One settling train was out due at the time of this survey, due to a motor repair. The settling basins have only been in operation a few months, but treated water exceptionally well during a rare period of very poor raw water quality.

Maintenance on the floc/sed basins is currently needed. Exposed metal is rapidly deteriorating due to the humid environment and presence of chlorine. The water system will need to budget for an overhaul within 10 or 20 years.

Filtration

Type of Filter: declining rate, constant head

Dimension of Each Filter: 18 ft 8 in x 18 ft 8 in

Filtration Area: 349 ft²

Total Filtration Area: 4,200 ft²

Number and Area of Filters: 12 filters total, each has 349 ft² of surface area

NOTE: Filters 1, 2, 3, & 4 were out of service at the time of the DEQ inspection

Design Filtration Rate, gpm/ft^2: 1MGD per filter (2 gpm/ft²)

Approved Filtration Rate, gpm/ft^2: 4 gpm/ft² on clean filter, 2-2.5 gpm/ft² over entire filter run

Maximum Experienced Filtration Rate, gpm/ft^2: 4 gpm/ft²

Is Flow Equalized Through All Filters? yes

Rate Of Flow Device: yes, rate is limited to 4 gpm/ft² by effluent valve in a locked position

Filter To Waste Available? ***Yes, not presently working (valve actuator issues)***

Filter Drain: yes

Filter Hours: Average: 200 Maximum: 200 Minimum: 8

Summer Average ~ 170 hours

Filter Media - Filters No. 9-12 (new)

	Anthracite	Sand	Gravel
Depth – Inches:	<2	21	14
Effective Size (mm):	0.9	0.45-0.55	
Uniformity Coefficient	1.5	1.25	

Filter Media - Filters No. 1-8 (new)

	Anthracite	Sand	IMS cap
Depth – Inches:	6	22	
Effective Size (mm):	0.95-1.05	0.45-0.55	
Uniformity Coefficient	< 1.7	< 1.6	

Date Last Rebuilt or Checked: Filters 3, 4, 7 - 1995, new media and underdrains
Filter 8 – 1997 new media and underdrain
Filters, 1, 2, 5, 6, - 1998, new underdrains

Filters 5, 6 – new media in 2002
Filters 9, 10, 11, 12 – 2011 new underdrains

Underdrain Type: Filter 9-12 Leopold blocks with 1-inch IMS cap
Filters 1-8 Leopold blocks with 1-inch of IMS cap

Curbing: yes; front and back

Filter Overflow: back to settling basins

Surface Wash: Yes (need to observe a b ackwash to verify)

Surface Wash Source of Water: in-plant process (treated) water

Air Scour: no

Depth of Water above Media: 63-inches for old filters, 64-inches for new filters

Filter Performance Records: turbidity records being kept for three years

Turbidimeters

Is There Continuous Turbidimeter For Each Filter? Yes Calibration Frequency: monthly

Is There Continuous Turbidimeter For The Applied? Yes Calibration Frequency: quarterly

Is There Continuous Turbidimeter For Confluence? Yes Calibration Frequency: quarterly

Turbidimeter Used For Combined Compliance: Hach TL2300 Calibration Frequency: monthly

Filter Comments: The number of filters presently offline is due to the water plant's inability to keep up with preventative maintenance. In reality, the capacity of all the filters is not needed. As such, the plant's overall rating will take into account the number of filters that are maintained in good condition and are routinely operated.

Filters are declining rate, constant head and have an effluent valve that is "locked" in position, allowing up to 4 gpm/sq.ft on a clean filter. A spring loaded valve adjustment is located on the filter control panel console where the operators manually initiate the flow rate, usually about 2 gpm/sq.ft. and then adjusted throughout the filter run in order to maintain 2 gpm/sq.ft. as head loss rises.

Filters No. 9, 10, 11, and 12 have been rebuilt with the current DWRF project. The City has replaced all filter influent valves and all 6 filter drain valves (which drains the gullet and media of the entire filter unit).

The on-line turbidimeters are Hach model 1720Es. The plant has two CFE grab sample locations for compliance purposes. The South CFE which includes effluent from Filters No. 3, 4, 7, 8, 11, 12, and the North CFE which includes effluent from Filters No. 1, 2, 5, 6, 9, 10. A single sample tap for both South and North CFE would better represent the effluent from all the applicable filters and reduce compliance monitoring points, however due to buried piping a sampling location is not available.

Feed line length for turbidimeters should be assessed for excessive travel time, which is recommended to be less than 1 minute. Simultaneously, assess the flow rate through turbidimeters periodically to ensure it is within manufacturer's specifications.

Backwash:

Average Run Length Time of Filter: ~ 200 hours

Criteria for Backwash: 200 hours or 1.0 gpm/ft² or 0.3 NTU

Source of Backwash Water: clear well (treated water)

Average Duration of Backwash: 5 – 10 minutes, ~45,000 gallons per wash

Maximum Duration of Backwash: 10 minutes

Average Backwash Flow, gpm: 5200 gpm

Maximum Backwash Flow, gpm: 5500 gpm

Maximum Backwash Rate - gpm/sq.ft: 15.7 gpm/ft²

Rise Rate, in/min: - 253.3 in/min (5500/349 = 15.76 x 12/7.48)

Is Bed Expansion Achieved? Filters 1-8 yes, filters 9-12 yes

Loss of Media during Backwash? minimal

Backwash Disposal

Backwash Water Discharge Location: lagoon with overflow to surface water

Is Backwash Water Recycled? no

Associated Problems With Filters:
(Check All That Apply)

Air Binding - occasionally	Media Growth - no
Cementing - no	Media Attrition - no
Gravel Mounding – no	Bacteria Growth - no
Media Loss - little	Uniform Backwash – no, swelling observed
Adequate Backwash Rate - yes	Mudballs - no

Filters 3 & 4 were backwashed during inspection. The spray arm wash did not activate as apparently the control valves did not work. The spray arm direction flags leaked water during the backwash cycle.

Filter Operation Comments: The filters are backwashed at a maximum of 200-250 hours, 1.0 gpm/sq.ft or 0.3 NTU, which ever comes first. The 200 hour-maximum is the most common criteria. Mandatory filter run limits are imposed during difficult treatment times, i.e., filter runs of only 50 - 60 hours if applied turbidities are high. Also, if a filter has over 50 hours of operation and is shut down for any reason, it must be backwashed prior to being placed back in service. The new plate settlers have provided consistent low applied turbidity and improved filter run times.

Air binding used to be a problem until air release valving was installed on the backwash header in the early 1990's.

Recent construction added filter-to-waste piping. The filter-to-waste piping is controlled by 4-inch automatic butterfly valves that dump filtered water into a drain pipe under each bank of filters. The drain pipe then flows onto an air break before entering the backwash drain under the floor. The air break splashes a bit during backwash operation. **Not currently operational due to valve actuator problems.** Fixing the actuators gives the operators flexibility to quickly run a filter to waste.

Backwash water enters the lagoon for evaporation/soil percolation and sludge accumulation. Sludge removal occurs approximately annually. There is an overflow with NPDES permit to the adjacent golf course pond; however the discharge has not overflowed since construction in 2012.

Plant Treated Water Storage/Clearwell

Location: adjacent to the plant

Size: 2 MG total, divided into two 1 MGD halves

Percent above Grade: 0%, completely buried

Low Water Level: 8-feet from bottom

Isolation Capabilities: each section can be isolated and/or by passed

Vents: yes, all screened

Reservoir Baffling: exit wall diffuser, baffling factor = 0.3

Drains: each section has sloped floors with a slump

Overflow: yes, into high service suction well.

Overflow screened: yes

Access Hatches: yes, overlapping tight covers

Alarms: none

Last Inspection: east half, 2004; west half 2008

C*T Applied or Applicability: reservoir not needed to maintain adequate C*T

Comments on Treated Water Storage/Clearwell: Half of the finished water reservoir (east half) was drained and inspected in 2004. Some sand and alum was evident, but overall the reservoir was in good shape. The west half was inspected in 2008, and found to be in good structural shape. Each half of the reservoir is properly vented, and the vents are screened.

The 12-inch isolation valve was recently replaced to allow isolation of the reservoir halves and should be regularly exercised to ensure future operation.

The inlet/outlet valve vaults fill with water, and plant staff pump the vaults out as necessary. The entry hatches were recently replaced with stainless steel hatches with overlapping covers.

The high-service pump clearwell (suction well) is accessed from the basement of the plant. The entry hatch is rusted, holy, and flat with the floor. Surge valves are being removed with the new project. Pipes that dump into the clearwell will remain and be capped. A possible interconnection between the surge piping may allow transmission reliability outside of the plant.

Backwash Lagoon

The current lagoon system was constructed with the large 2010 project, and consists of cells A & B separated by a wall. Each cell has an overflow with adjustable sluice gate, with about 3 feet of depth from overflow to bottom of the cell. The cells are unlined, which has led to some controversy with nearby neighbors claiming influence on the water table and wet basements. A groundwater study has not been completed.

	Cell A	Cell B	Total
Depth (ft)	3	3	
Bottom Area (sf)	5,870	30,930	36,800
Approx. Volume (cft)	17,610	92,790	110,400
Approx. Volume (mg)	0.132	0.694	0.826

Backwash Volume: Approx. 45,000 gallons

The lagoons can easily hold several backwash volumes prior to overflow (as designed), however as solids accumulate there will be less freeboard. Recommend keeping 2 feet of freeboard and cleaning these out annually to reduce potential of overflow to surface water.

Overflow: yes, to surface water to the east (wetland/stream/pond)

Chemical Feed

Chlorine

Chemical Supplied: sodium hypochlorite 12 ½ % delivered by truck load (5600 gallon delivery)

UL/NSF Approved? yes

Standard 60 Max Dose:

Supplier: Alexander Chemical – Michigan City, Indiana 1 800 348-8827

Chlorine Feed Points:

1) intake – intermittent use **(not since 2014)**
2) raw water – low service pump discharge* **(poor condition at time of 2018 survey)**
2) raw water - rapid mixer
3) applied – each settling basin effluent
4) treated – high service pump discharge header* **(trickled into clear well upstream of HSP)**

*normal feed points

Chlorinators

Chlorine Feed Dosage Determination: (gallons liquid chlorine) x (% of available chlorine) x (density)

Million pounds of water pumped

Chlorine Room

Description: Bulk chlorine storage room is located in a separate building south of the plant. Three bulk tanks of 2,800 gallons each are provided. Two tanks are filled per delivery (5,600 gallons). Transfer pumps provide chlorine to two day tanks; a 50 gallon and a 200 gallon. Transfer pump switches are located next to the day tanks and are equipped with “dead-man” operation (switch has to be held in the on position to work). The chlorine day tanks are equipped with scales.

Scales: yes – calibrated at installation

Minimum Days of Storage: ~ 60

Chlorine Safety Features/Summary: (*Check All That Apply*)
("both" indicates both the bulk storage room located in a separate building and feeder room located in plant)

☒ Panic Hardware
☒ Chlorine Leak Alarm ☒ Haz-Mat Team
☒ Inside Access feed room only
☒ Outside Access yes -
☒ Doors Open Outward ☐ Repair Kit
☒ Heater ☒ Ventilation
☒ Window ☒ Air Supply
☒ Scales ☒ Fan Switches

Chlorine Comments:

The water plant recently switched to liquid chlorine. The bulk liquid chlorine feed system consists of three bulk tanks located in the chemical storage building across from the plant. Fill ports are clearly marked. Chlorine concentration (density) is measured and some degradation is seen during the summer months. On March 11, 2014, the chlorine feed was left on overnight while the plant was shut down causing an overfeed. The problem was discovered the next day at plant start-up, but the settling basin volume has prevented the chlorine concentration from exceeding 3.5 ppm.

In order to ensure adequate mixing the finished water chlorination point would be best injected into a pipe. The supply may also wish to assess chlorination practices to focus more chlorination downstream of the pretreatment process, to reduce formation of disinfection byproducts. This must be balanced between meeting required CT for disinfection purposes.

Alum

Chemical Supplied: Liquid aluminum sulfate

UL/NSF Approved? yes

Standard 60 Max Dose: 150 ppm as product

Chemical Feed Point: raw water rapid mixer

Supplier: General Alum Corporation

Chemical Feeders:

	Model	Max Feed Rate	Min Feed Rate
1	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min
2	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min

Chemical Feed Dosage Determination: usually raw water and applied water turbidity

Alum Dosage Calculation: done properly

Feeder Calibration Frequency: monthly

Scales? No, tank content is determined by sight glass gauge tube and read in inches

Alum Storage

Bulk Storage: two-3,800 gal tanks

Minimum Days of Storage: 45

Transfer Pumps: 2-Thompson Mag pumps, 3/4 Hp, rated 25 gpm @ 20' TDH

Day Tank: 1-300 gallon tank filled manually by operators

Scales:

Level alarms in bulk or day tanks?:

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: Fill line from bulk storage is air-gapped. Dead man fill switch on day tank.

Alum Comments: The alum feed system is currently injected into the raw water influent pipe, upstream of rapid mix tanks in the new pretreatment building. The mixers are therefore turned off. This does not provide adequate mixing and the supply must apply adequate mixing energy to properly disperse the coagulant.

The City should formalize their historic coagulation practices into a standard operating procedure, and/or develop a coagulation model. In addition, during periods of shifting water quality, the City should conduct jar testing to determine the optimal level of coagulation. The city may also wish to study alternative ferric-based coagulants, as the raw water pH is higher than the ideal condition for aluminum sulfate.

Fluoride

Chemical Supplied: Sodium Fluoride (NaF), 100% powder, 4.05% solution in saturator

Chemical Manufacturer: Prayon

UL/NSF Approved? Yes (UL)

Standard 60 Max Dose: 2.6 mg/l as product

Chemical Feed Point: settled water effluent prior to filters

Chemical Feeders:

Two options exist for the fluoride feed system. The first is the new LMI pump, which can pump directly to the system. This system is preferred by the operators for simplicity, and can meet 0.8 mg/L at a plant flow rate of 3.4 MGD.

The second option is to utilize the day tank and previous chem feed pumps. This will be used if the demand for fluoride is greater than the LMI can provide.

	Model	Max Feed Rate	Min Feed Rate
1	1 LMI C131-419SI	8 gph @ 60 psi	
2	Watson Marlow	30 gpd @ 150 psi	

Chemical Feed Dosage Determination: Fluoride dosage calculations were included in the permit application, and are attached to the appendix of this survey.

Fluoride Dosage Calculation: assume 8.34 lbs/gal, 1gal solution has 0.153 lbs F- ion

Scales: Yes on day tank, no on the saturator. Must use volumetric calculations from flow meter

Overflow: saturator overflow is piped to containment.

Fluoride Storage

Bulk Storage: not used

Minimum Days of Storage: 75 gallons of saturated NaF at 4% solution and 4.5 MGD

4.5*8.34=37.53mlbs/day; @0.81mg/L target dose, need 0.81*37.53 = 30.4 lbs/day solution

At 4% solution strength and 46% F ion and 8.34 lbs/gal, *the volume of solution per day is*

30.4 / 8.34 / 0.04 / 0.46 = 198 gallons / day

For 75 gallons, 75 / 198 * 24 = **9 hours of storage**

Transfer Pumps: One-56 gpm @ 56' TDH

Day Tank: 75 gallons filled manually with air gap

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: yes tied to raw water pumps, and flow switch

Fluoride Comments:

The city has a history of sporadic fluoride addition, partially due to leaks in the bulk tank and malfunctioning of pumping equipment. A new sodium fluoride saturator system was permitted and installed, coming online in March of 2018. While this reduces staff exposure to a corrosive chemical, it introduces a new safety concern in NaF dust when filling the tank. **The system was notified via cover letter to the permit that a forced air ventilation system is strongly recommended, as outlined in 10 States Standards.**

In addition, the LMI pump will not produce enough flow to meet the 5-year max day demand of 4.5 mgd. In the event peak operation is anticipated, operators may fill the day tank to help meet those peaks. However, the 75 gallon day tank holds 9 hours of solution at that flow rate. The water plant may need to find a long term solution when these types of flows be encountered.

Other Chemical Additions

Carbon: none

Polymer: newly installed, not yet operational

Lime/Soda Ash: none

Taste and Odor Control: none

Comments on Other Chemicals: No other chemicals besides chlorine, alum and fluoride are currently used at the plant. The water plant is considering polymer addition for the plate settlers per manufacturer recommendation.

Carbon addition was routine operation prior to installation of the old Accelators in the mid-60's. The feed lines are still installed in the low service line to the clarifiers, but are no longer used.

Plant Piping and Miscellaneous

	Pipe Diameter	Length
Intake Pipe:	36 - inch	
Low Service Discharge:	24 – inch (splits into two 20-inch pipes)	
Settled Water Effluent:	36-inch	
Filtered Water Effluent:	30-inch	
High Service Suction Header:	36-inch	
High Service Discharge:	2 @ 20-inch	
Backwash:	24-inch	
Surface Wash:	4-inch	
Wash Water Drain:	24-inch to 30-inch sewer	
Intake Backflush Line:	12-inch REMOVED FROM SERVICE	
Sludge Drain:	24-inch	
Plant Service to Chlorine Feeders	2-inch	
Plant Service Line:	6-inch	

Do Any Roof Drains or Other Drains Enter Treatment Process? no

Pipe Color Coding: all pipes are currently color coded

Plant Cross Connections And Common Walls:

Filter Gullets? Yes, bottom of gullets is the same elevation as bottom of filter media

Common Walls? None (except for the one in the filter gullets)

Chlorine Feed Room? none

Plant Water RPZ? yes

Chemical Feed Areas? none

Surface Wash? RPZ on surface wash header line

Boiler? Removed from Service 2011

Comment on Plant Piping Miscellaneous: Piping is currently color coded (with flow direction arrows); and rusted pipes, flanges, nuts and bolts either replaced or repaired.

A high service discharge pipe burst in September 2007, flooding the basement. A staff person from the Ductile Iron Pipe Research Association (DIPRA) assessed the failed pipe, and the final DIPRA report stated that the pipe was in sound shape and the failure was due to unusual hydraulic conditions.

RPZ's are tested every year by a certified tester. All hose bibs and slop sinks have vacuum breakers installed and the eye wash stations are protected by the RPZ on the plant water service line. There is no dishwasher in the plant. Dehumidifiers are located in the pipe gallery.

All filter wash hoses are rated for potable water (NSF Std. 61).

A WTP valve program has been started. Valves are being inventoried, cataloged, and turned. An automatic valve actuator is available to staff.

Roof drains once dumped onto the filters but were rerouted along the filter room ceiling to the outside. Occasionally the roof drain pipes will leak, but are immediately repaired.

Plant Metering and Controls

Plant Water: meters for backwash water and in-house water use

Raw Water Metering: 2 - one on each settling basin influent line

High Service Metering: *Not functioning*

Backwash Water: one turbine meter

Plant Controls: Pump operation via SCADA from operation room

Chemical Feed: all rates are manually adjusted

Chlorine: manual

Alum: manual

Fluoride: manual

Chemical Transfer Pumps: manual

Filters: starting and stopping filters is done manually at filter control panel

Filter Backwash: done manually according to pre-determined criteria

Low Service Pumps: manual based clearwell levels (level not to drop below 10')

High Service Pumps: manual based on elevated storage tank levels

Elevated Tanks: levels are maintained according to pre-determined criteria

Security: Plant is fenced on 3 sides and staffed 24 hours a day. Doors are locked at all times.

Flexibility In Operation: Pretreatment units (settling basins) can be bypassed or run individually. Filters cannot be bypassed (plant bypass). Filters are piped in pairs and can only be serviced or taken off-line as such.
The entire finished water reservoir (except suction well) can be bypassed. *(must verify C*T is met in this case)*

Plant Alarms *(Check all that apply)*:

- ☐ Basement Flooding
- ☒ Chlorine Leak
- ☒ Chlorine Supply
- ☒ Low Service Intake Well
- ☒ Pretreatment Basin Levels
- ☒ Elevated Storage Tanks
- ☒ Filter Level
- ☒ High Service Pump Discharge Pressure
- ☒ Pretreatment Sump Pump Failure
- ☐ CFE Turbidity
- ☒ Chemical Tank Levels
- ☒ Main Control System Failure
- ☒ UPS Power
- ☒ Finished Water Reservoir
- ☒ Individual Filter Turbidity
- ☒ Elevated Tank Loss of Signal
- ☐ Intrusion Alarms

Comments on Plant Metering and Controls:

The treated water (high service pump discharge) meters have not been calibrated for many, many years and are no longer working as of 2018. The water being pumped out to the distribution system is currently being determined by subtracting the plant usage water from the raw water pumpage.

SCADA system has been upgraded to include turbidity measurements from individual filters that can be observed by the operators in the control room. As an example, an alarm can sound or trip when turbidity from any filter reaches 0.3 NTU. This will alert the operator, who in turn can take corrective action before an individual filter "trigger" is exceeded. Failure to act promptly in this situation could lead to expensive engineering evaluations required by the Interim Enhanced Surface Water Treatment Rule (as nearly happened in early 2018).

The SCADA system needs to be improved to include better access to data, as was discovered during a high filter effluent turbidity event in 2018. In addition, consider more automation to save staff time in certain areas, allowing more focus on maintenance activities. Last, alarm capabilities should be added to give operators the most warning possible.

Valve Operation:
Are Critical Valves Exercised On A Routine Basis?

Valve Location	Exercised?
Intake Valves	Yes

Intake Backflush Valve	no longer in service
High Service Isolation Valves	Yes
Clearwell Valves	Yes
Influent/Effluent Pretreatment Basins Valving	Yes
Effluent Flume Valve	Yes
Low Service Pump Discharge Valving	Yes

Emergency Power:

The water plant technically has two substation feeds from the grid, however they come together at a dedicated substation next to the plant. The plant also can be powered by an onsite generator with the following specifications:

HP: _____
Fuel Type: _____
Fuel Volume: _____
Length of Operation on 1 tank of fuel: _____

Interruptions in Operation:

In November 2000, the plant lost power for about 6 hours when the dedicated substation located next to the plant (not the 2 substations out in the power grid) failed. During May of 2004, a major city-wide power outage lasted 28 hours. The water plant was without power and the distribution system lost pressure for about 18 to 20 hours in several locations even though the distribution interconnection with the City of St. Joseph was in operation. This incident showed that the water plant did not have a reliable power source from the local utility and the water system could operate effectively during power outages. A dedicated auxiliary generator was installed to operate the water plant in the event of a power outage under a DWRF funded water project.

In 2017, a "dark test" was conducted at the water plant to ensure the generator would run all necessary equipment. It failed to properly start and power the plant, which resulted in some repairs. This exercise should be conducted annually to ensure emergency operations run smoothly.

Laboratory

Parameter	*Method	Calibration	Sample Points	Sample Frequency
Alkalinity	Titration (2320)	monthly	1) raw water 2) applied 3) plant tap	twice daily twice daily twice daily
Chlorine	FAS Titration (4500-Cl F) Online Analyzer CL17* DPD Handheld (4500-Cl G)		1) settled 2) applied 3) filtered 4) plant tap 5) dist syst.	every 2 hrs every 2 hrs every 2 hrs continuously* **w/ bacti sample**
Fluoride	SPADNS (4500 D)	twice daily	1) raw 2) plant tap 3) dist syst.	daily daily w/ bactis
Hardness	EDTA titrimetric (2340 C)	monthly	1) raw 2) plant tap	twice daily twice daily
pH	electrode (4500 B)	twice daily	1) raw 2) applied 3) plant tap	twice daily twice daily twice daily
Temp.	elec. thermometer	monthly	1) raw 2) plant tap	continuously twice daily
HPC	Pour Plate (9215B)	monthly	1) raw 2) Plant tap	daily daily
Turbidity	Hach 2100p Hach 2100p Hach 1720E Hach 2100p Hach 2100p	monthly monthly monthly monthly monthly	1) raw 2) applied 3) ind. filter 4) CFE 5) Plant tap	every 2 hours every 2 hours every 10 mins every 2 hrs grab every 2 hrs grab
Coliform	MTF on Raw, Tap colilert on dist. sys (9223 & 9221)	monthly QA/QC	1) raw 2) plant tap 3) dist sys	daily daily per plan

Numbers in parentheses refers to AWWA Standard Methods number

There are continuous monitoring turbidimeters on the low service discharge (raw) and combined settled effluent which are read every 2 hours. Continuous monitoring turbidimeters are located on each of the operating filter effluent lines which record turbidity levels every 15 minutes to a database.

Laboratory Certification: Lab is certified for Total Coliform, *E. coli* and HPC analysis.

Comments on Laboratory:

Online chlorine meter was not functioning at time of survey, resulting in a violation of Act 399 Rule 720(3)(a). In addition there are the following recommendations:

1. The newly purchased benchtop turbidimeter has an internal calibration verification done daily, **however the operators should conduct secondary standard checks periodically as well.**

2. Once a year, all lab equipment is inspected and calibrated in accordance with the QA/QC plan by a third party. **Include the titrator used for chlorine analysis in this calibration.**

3. Consider adjusting the endpoint pH for the expected alkalinity, according to standard methods.

WATER PLANT - OBSERVATIONS, CONCLUSIONS

Basic Data:
The City's Treatment Plant is a conventional treatment plant practicing coagulation, flocculation, sedimentation (via plate settlers), filtration and disinfection. The rated capacity is based on the limiting factors of high service firm capacity and maximum approved filtration rates. At the time of the survey, ***two filters were not operational, nor was low service pump #5 (6.0 MGD) and high service pump #1 (2.0 MGD), yielding an effective treatment rate of 10 MGD.***

The majority of the plant was constructed in 1950, with several improvement projects completed since the original plant went on-line. The City recently improved treatment by constructing plate settlers in two separate treatment trains, installing filter-to-waste piping, rehabilitated filters 9 – 12, and installed a stand-by generator that can operate the entire plant during interrupted utility power. The City also constructed a backwash lagoon for backwash disposal, and converted to liquid chlorine from gas for safety reasons. Most recently, the City switched from fluorosilicic acid to sodium fluoride by installing a fluoride saturator, again largely for safety reasons.

The plant process description starts with raw water flowing via gravity from the intake to the low service wet well, where low service pumps lift the water (after flowing through traveling screens) to the two parallel flocculation basins and settling basins. Liquid chlorine is injected at the low service pump discharge line and alum is added in the same discharge pipe prior to the flocculation tanks and settling basins. **As of 2018, the rapid mix chambers are not being used.** The settling basins

provide sedimentation through inclined plate settlers. Fluoride is added to the settled water which then flows to the filters. Filtered water then flows via gravity to a 2 million gallon finished water reservoir. High service pumps then pump treated water from a suction well which is adjacent to the reservoir, where chlorine is added again before being sent to the distribution system.

The old the pretreatment units (clarifiers) have been removed from service and replaced, hopefully eliminating the plant's vulnerability to thermal inversions. Good success has been achieved by similar plate settling installation at other Lake Michigan water plants.

Rules and Regulations: Since the late 1980's the Federal Safe Drinking Water Act has been amended several times to include rules that specifically apply to water plants using surface water or groundwater under the direct influence of surface water. These rules and the years they were promulgated are:

- Surface Water Treatment Rule (SWTR) - 1989
- Interim Enhanced Surface Water Treatment Rule (IESWTR) - 1998
- Filter Backwash Recycling Rule (FBRR) - 2001
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) - 2002
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) - 2005

These rules and subsequent rules promulgated by the DEQ under the authority of the Michigan Safe Drinking Water Act, 1976 PA 399, as Amended, require the following of surface water treatment plants:

1. Maintain a disinfectant residual through the treatment process sufficient to inactivate Giardia and viruses. As currently operated, the plant complies with disinfectant residual contact time (C*T) requirements. The C*T calculation was updated as part of this survey to include the extra detention time in the settling basins. The C*T calculation was updated with new and revised parameters related to source water and chlorination practices. Current C*T calculations are included in Appendix C.

2. Rule 325.10720 requires that a residual disinfectant concentration entering the distribution system be no less than 0.2 mg/L. Water suppliers must report to the DEQ by the end of the next business day if the residual was below 0.2 mg/L. Though the city has been measuring chlorine with a benchtop analysis during operations, they have not maintained the chlorine analyzer to verify chlorine levels during periods of non-operation when the high service pumps operate unattended.

3. As further noted by Rule 325.10720, equipment must be provided to continuously monitor the chlorine residual leaving the plant and minimum values recorded daily. The required equipment is installed, but was found to be operating inaccurately at the time of the survey, and reading below the above required value of 0.2 mg/L.

4. Residual disinfectant in the distribution system measured as total chlorine shall not be undetectable in more than 5 percent of the samples each month, or HPC counts must be no more than 500. Distribution residuals must be measured and reported whenever coliform samples are collected. This requirement is also being met with chlorine.

5. Again, as noted by Rule 325.10720, turbidity determinations must be made at least once every 4 hours on samples representative of filtered water while the plant is in operation. A single monitoring

point at a location containing effluent from all filters, but prior to storage is ideal for compliance purposes. The compliance points are the North Filter Flume (Filters 1, 2, 5, 6, 9, 10) and the South Filter Flume (Filters 3, 4, 7, 8, 11, 12) because piping is not provided such that a single filter confluence sampling tap may be installed. For compliance purposes, turbidity samples are collected from each of these two CFE locations once every 2 hours. Both compliance points must be less than or equal to 0.3 NTU in 95 percent of samples each month, and at no time exceed 1 NTU. On two past occasions, July 2002 and July 2003, the plant has exceeded the 1 NTU requirement. In 2018, poor raw waternearly resulted in exceedance of 95% of samples below 0.3 NTU.

6. Finally, the MSDWA requires that individual filter turbidity be monitored and recorded every 15 minutes. This information must be recorded and maintained for three years to determine compliance with “triggers." The individual filter monitoring is operating and performing satisfactorily, but the data retention system is poorly designed making accessing and displaying the data difficult.

7. The Stage 1 of the Disinfectants/Disinfection Byproducts Rule (DBPR) also became effective January 1, 2002, for surface water plant serving over 10,000 people. This rule reduced the maximum contaminant level (MCL) for total trihalomethanes (TTHM) to 0.080 mg/L and set a MCL of 0.060 mg/L for total haloacetic acids (HAA5). In addition, a maximum disinfectant residual level (MDRL) for chlorine was established. A review of the MORs and chemical sample results indicate that these water quality standards are being met.

8. The Stage 2 DBPR requires MCL compliance at each TTHM and HAA5 sampling location rather than averaging results across the system. The city is following the TTHM and HAA5 sampling protocol specified starting in October, 2013. See below section for details on compliance data.

9. The LT2ESWTR requires *Cryptosporidium* treatment for certain vulnerable plants. Based on the *Cryptosporidium* monitoring completed at the plant from April 2008 to March 2010, the water treatment plant was classified as Bin 1 and does not have to install additional treatment. The city missed a sample for E. coli during the second round, which will result in an extra sample collected beyond what is identified in the approved sample site plan.

REGULATORY SUMMARY:

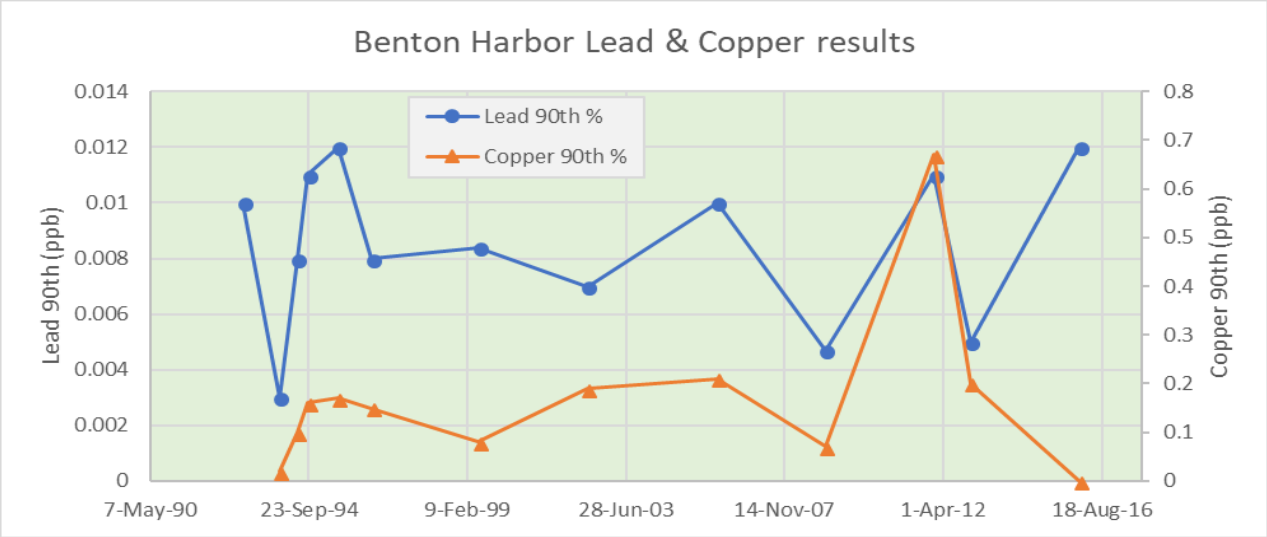
Below is a summary table of violations for the water supply within the last 4 years. The trend appears to be increasing with numerous violations occurring in the last year. Due to the complexity of surface water treatment regulations, significant attention is needed to ensure compliance and protect public health.

Date	Description	Type	Public Notice Required
8/1/2018	TOC monitoring error - thermal	Monitoring & Reporting	Tier 3 (2018 CCR)
7/1/2018	TOC Removal insufficient (continued)	Treatment Technique	Tier 2 (due 9/10/18)
8/1/2018	LT2 - missed E. coli sample, lack of reporting	Monitoring & Reporting	Tier 3 (2018 CCR)
5/19/2018	Failure to issue Public Notice	Monitoring & Reporting	Tier 3 (2018 CCR)
1/1/2018	TOC Removal insufficient	Treatment Technique	Tier 2 (completed, late)
1/1/2017	Missed Samples: Partial Chem, VOC, Cyanide	Monitoring & Reporting	Tier 3 (2017 CCR)
1/1/2016	Missed Sample: TOC	Monitoring & Reporting	Tier 3 (2016 CCR)
10/1/2014	MCL violation for HAA's	Treatment Technique	Tier 2 (completed)

Lead & Copper Rule

Historically, the City of Benton Harbor conducted lead and copper testing as a group with two surrounding townships under an approved modified consecutive systems approach (letter dated 6/18/1993). Each system took a portion of the total 60 samples (BH 38, BCT 12, SJT 10) for the routine monitoring. St. Joseph Township was dropped from the agreement in 1995 due to lack of participation. The City finally became independent when the townships left after Benton Township built a separate treatment facility.

The data indicates a history of 90th percentiles for lead and copper that are under the previously designated action levels of 15 ppb and 1300 ppb, respectively. However, recent revisions in 2018 lowered the lead action level to 12 ppb, which is closer to some of the historic 90th percentiles in the City. The presence of lead in the distribution system is notable, with the majority of the service lines being lead gooseneck with galvanized pipes. The city must ensure they are continually optimizing the treatment system and the distribution system operations to minimize lead release.



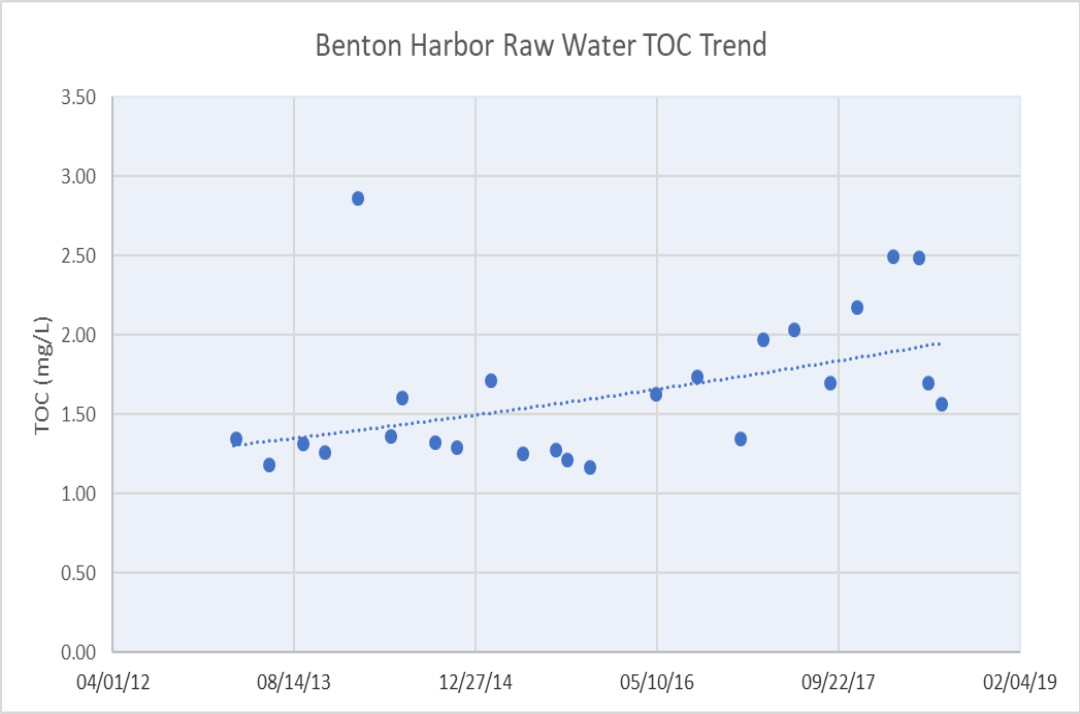
Based on the presence of lead in the historic sample set, please follow these recommendations to an accurate dataset and to mitigate lead exposure:

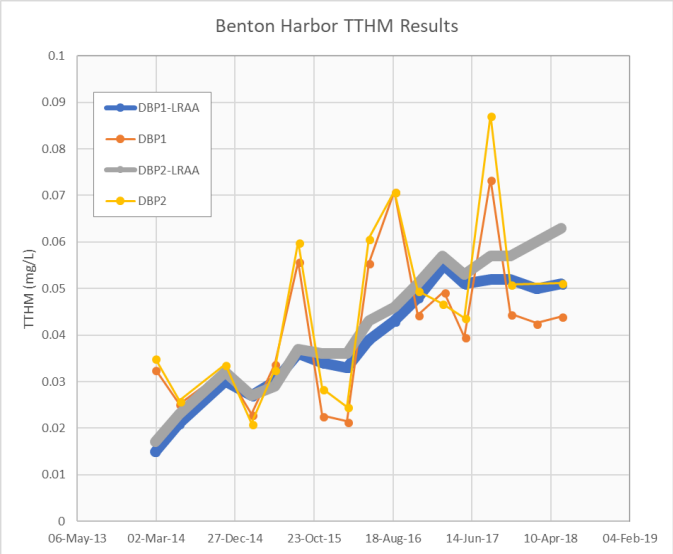
1. Verify the accuracy of your sample pool.
2. Update the materials inventory.
3. Do not conduct partial lead service line replacement.
4. Avoid any disturbances to service lines.
5. Budget for replacement of lead service lines at 5% or 7% annual rate.
6. Communicate to affected customers about lead exposure, and the importance of flushing
7. Maintain consistent water parameters at the treatment plant, paying close attention to stability indices such as the Chloride to Sulfate Mass Ratio (CSMR), Langelier Index (LI), and Larson-Skold Index (LSI).
8. Many changes occurred in the recent lead and copper rule revision in Michigan. Follow continued DEQ guidance as it becomes available.

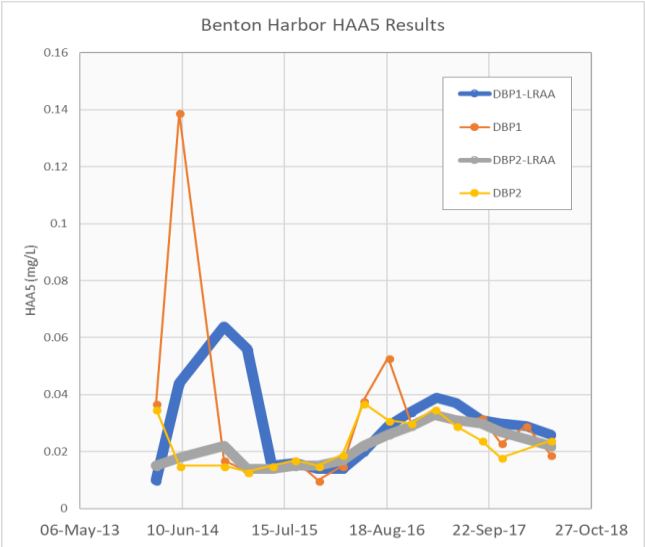
Disinfection Byproducts Rule, Enhanced Coagulation

Disinfection Byproducts form over time in both the treatment plant and the distribution system. The reactions depend on the level of organic matter in the source water, the type and amount of disinfectant used, other water conditions such as temperature, and time.

There are two factors that are in the City's favor: the distribution system is fairly small in areathe source water for Benton Harbor is Lake Michigan, which typically has varying organic content with influence from the St. Joseph River. The data below show a recent increasing trend in TOC in the source water. In addition, there is an increasing trend in disinfection byproducts shown below.







With increasing trends identified in each of these areas, it is vital for the water system to follow these recommendations to minimize DBP formation:

1. Construct adequate rapid mix facilities. This should help remove more TOC and reduce DBP formation.
2. Assess and optimize chlorine feed to minimize reaction with organics, while meeting other disinfection goals such as CT and keeping a residual in the distribution system.
3. Assess and optimize storage tank operations, including set points and potential for stratification.
4. Conduct routine valve turning to help identify closed or broken valves that may be affecting flow through the system.
5. Assess the need for routine flushing if water age and stagnation is suspected in the distribution system. Alternatively, conduct water age modeling using computer software.

Long Term 2 Enhanced Surface Water Treatment Rule (LT2)

LT2 is expected to require Cryptosporidium treatment for certain vulnerable plants. Lake Michigan is not typically suspected to contain high levels of of E. Coli or Crypto, however riverine influences can be significant in certain cases. Following the first round of monitoring, the City was notified of it's Bin classification as Bin 1. The City then began round 2 of LT2 in October of 2017, sampling for E. Coli instead of cryptosporidium.

As a reminder, LT2 sampling must occur outside the presence of disinfectant. In particular, any mussel control feed must be shut down for the sampling.

SURVEY NARRATIVE

Source of Supply:

Lake Michigan has been a consistent source of good quality water for many water treatment facilities. The lake generally has low bacterial and turbidity counts, and fairly low organic content (though it has increased recently). Fluctuations in water quality can be due to either wind & lake turnover, or riverine influence during rainfall/runoff.

There is one interconnection with the City of St. Joseph that will provide some limited reliability in emergencies. Another interconnection has been removed from service. Interconnections exist with Benton Charter Township, and the Township now has it's own source. The amount of water that can be delivered through the existing St. Joseph interconnection is unknown and should be evaluated. The interconnections with Benton Township should be evaluated hydraulically and an emergency use agreement formed. Also, the valves at the interconnections should be exercised annually to make sure they are in adequate working condition.

A source water assessment for the water supply has been completed by the USGS and the DEQ. A final draft report entitled "Source Water Assessment Report for the City of Benton Harbor Water Supply" was completed in the April 2002. The report determined the source water to be "moderately sensitive".

Intake Facility and Wet Well:

The intake draws water 3,375-feet from shore, under about 27-feet of water (from the top of the crib), making it a moderately sensitive intake. There are two, 36-inch diameter emergency risers, located 2,500-feet and 1,500-feet from shore, 23.5-feet and 12.5-feet below the surface, respectively. The capacity of the intake is 24 mgd at an entrance velocity of 5.25-feet/sec. **Lack of zebra mussel control has reduced the intake capacity somewhat, but not enough to interfere with water system demands. This should be measured by checking the drawdown in the raw water wet well, and calculating the head loss through the intake.**

The crib and emergency riser closest to the intake are inspected approximately every other year, with the last inspection being completed in 2007. Both the crib and riser are believed to be in good condition. **The intake should be inspected again soon, and the emergency risers should be located and verified to be accessible during emergencies.**

Chlorine was historically applied at the intake crib via a 3-inch HDPE feed pipe to prevent zebra and quaaga mussel infestation. Mussel infestation is reportedly evident at the intake. No infestation is visible in the wet well. In 1997, a valve and spool piece was installed on the 30-inch raw water line which allowed the intake pipe to be backflushed. However, backflushing of the line has not been necessary, and the valve between the intake and high service line was removed. More recently, the chlorination system has not been used due to plugging. **The chlorination line should be cleaned, and the supply may wish to add a phosphate product to the carrier water in order to prevent scaling.**

The traveling screens in the wet well were replaced in 1997 and new motors/gears for the screens were installed in 1999.

Information and Control System:

Most, if not all of the plant functions are manually operated and/or controlled. The main control room and panels in the plant currently allow operators to adequately control and monitor the plant and distribution system. Alarms are present which will notify operators of potential problems throughout the plant. The main control room has some limited supervisory control and data acquisition (SCADA) systems. Individual filter turbidities measurements are recorded via a SCADA system.

Improvements were identified during the survey in the lack of accessible data through the SCADA system. For instance, a filter profile was difficult to access though it was eventually produced when required. A historian component to the SCADA system should be added to allow for better data retention and access. In addition, more automation may be possible which could allow operators to focus more time on maintenance activities. Lastly, the system should have full alarm capabilities integrated including low chlorine tied to the plant tap analyzer.

The implementation of a preventative maintenance/work order system would also be very helpful to track and organize necessary maintenance. The city has begun to implement CitiWorks for this purpose.

Pumps and Pump Locations:

Proper functioning pumps are essential to the efficient operation of the plant. Pumps that fail to operate, or do not operate as designed, waste operator time and system resources. It is important that the pumps be tested, serviced, and maintained. Detailed records should be kept for these activities. While a majority of the pumps have either had the motor or pumps rebuilt in the past 10 years, a preventative maintenance program should be established for each pump. As a minimum, the plan should include, but not be limited to, all of the following:

1) Basic pump information including the make, manufacturer, pump operating speed, design capacity including pump curves, horsepower of the motor, and pump and motor efficiencies.

2) Actual pump capacity, alone and in combination with other similar use pumps. This information should be recorded and maintained by plant staff so that system demands can be met using the most efficient combination of pumps. This information should be updated at least once per year.

3) A record of all work performed on the pump, including scheduled as well as unscheduled maintenance. The record should indicate the date the work was performed, the nature of the work, and the name of the individual performing the work.

4) An evaluation of the actual current draw for each motor and comparison with original installation or design conditions. Motor efficiencies should be verified at least once per year with appropriate records maintained.

Five low service pumps with a 14 MGD firm capacity lift the raw water from the low service wet well and discharge to a 24-inch pipe which then splits to two, 20-inch pipes that flow to the settling basins. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain and not subject to flooding. Adequate valving is provided which allows each low service pump to be isolated for maintenance or other purposes. Low service # 5 is out of

service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

Five high service pumps with a 12 MGD firm capacity pump treated water from the finished water suction well adjacent to the treated water reservoir and discharge to two, 20-inch mains that lead to the distribution system. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain are not subject to flooding. A catastrophic pipe failure in 2005 flooded the basement but the water did not rise enough to affect the switch gear or prevent pump operation. Adequate valving is provided which allows each high service pump to be isolated for maintenance or other purposes. High service # 1 is out of service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

The plant relies on two backwash pumps to backwash the filters. These pumps take suction from the finished water suction well. The backwash rate available from either pump is adequate to clean the filters. These pump motors and electrical switch gear are also located on the second floor of the plant and are not susceptible to flooding.

Pretreatment:

The two circular Infilco Accelators pretreatment basins have been removed from service due to the poor physical condition of the steel and inability to properly prevent floc from entering the treatment train during thermal inversions. Plant pretreatment now consists of rapid mixing (not currently used as of 2018), 3-stage flocculation, baffling, and settling basins with inclined plate settlers. Currently the only coagulant being used is alum, but has the capability to add both polymer and alum. The new pretreatment process has demonstrated the settled water quality to date is excellent.

Filtration:

The plant has 6 filtration units, each with two cells for a total of 12 "filters". For ease of numbering and explanation, the plant is considered to have 12 filters. The filters are declining rate, constant head and each unit has an effluent valve which allows a maximum filtration rate of 4 gpm/sq.ft. The normal or average filtration rate is 2 gpm/sq.ft, which equals 1 MGD for each filter.

Filters No. 9 - 12 underdrains and media have been recently replaced and were out of service at the time of this project. Filters No. 1 - 8 have Leopold filter underdrains with a 1-inch IMS caps that were installed in either 1995 or 1997. New media was installed in Filters No. 3, 4, 7 in 1995, in Filter No. 8 in 1998 and Filters No. 5 and No. 6 in 2002. Filters No. 1 and No. 2 have original media.

The City has replaced all the filter influent and filter drain valves located in the filter piping gallery and has installed filter-to-waste piping for each filter. Also, the paint on the ceiling in the filter gallery has been repainted.

Treated Water Storage:

The 2 million gallon ground storage reservoir consists of two one-million gallon compartments or sections. Each section can be individually isolated or the entire reservoir can be by-passed if needed. Under normal operation, finished water from the reservoir flows to the suction well where the high service pumps then deliver the water to the distribution system.

The east half of the reservoir was inspected in 2004 and the west half in 2008. Both were found to be in generally good shape. All vents, screens and access hatches are in adequate condition and do not allow insects, bugs or drainage water into the reservoir.

Chlorine Feed:
The chlorine feed system consists of bulk liquid chemical storage (three 2500-gallon tanks) located in a separate building and displacement feeders located on the first floor of the plant. Normal application of chlorine is to the low service pump and high service pump discharge lines. Other feed points are available, but rarely used.

The city should assess the chlorination practices to balance the need to meet CT analysis along with the need to minimize disinfection byproduct formation. One potential option is to chlorinate after pretreatment, which would then rely on the reservoir/clear well for CT credit.

Alum Feed:
The alum feed system consists of two 3,800 gallon bulk storage tanks, two transfer pumps, one 300 gallon day tank (no scale) and two chemical feeders and is operating satisfactorily. The transfer pumps are operated manually by a switch within the chemical feed room in the plant. Switch automatically turns off when the day tank float control indicates a full tank.

The alum feed pumps are interconnected with the low service pump circuitry and there is an anti-siphon valve on the discharge line of the feed pump. Normal alum feed point is in the rapid mixer to the new settling basins, but they still can add alum on the raw water line just prior to entering the settling basins. Dosages are manually adjusted by the operators and are calculated by a formula which is based on inches of drawdown in the bulk storage tank via a sight glass. The calculations have been reviewed and appear to be accurate. It may be beneficial to place the day tank on scales to more accurately measure and calculate alum dosages. The day tank overflow drains to surface water. A dead-man switch was recently installed to prevent alum overflow in the event the float control switch fails.

Alum needs to be fed at the rapid mix to impart sufficient energy to disperse the coagulant and achieve effective pretreatment.

Fluoride Feed:
The fluoride feed system consists of an LMI sodium fluoride saturator that utilizes the existing 75 gallon day tank (with scale) and a chemical feed pump. The LMI saturator pump is able to pump direct to the finished water, but is limited in capacity. The operators now have an inhalation risk from the granular NaF during filling of the saturator. **Appropriate PPE is a minimum, but the City should install forced air ventilation as outlined in 10 States Standards.**

The fluoride feed point is on the settling basin effluent line just prior to entering the filters. Dosages are manually adjusted by the operators and are calculated by a formula which is based on scale readings. The calculations have been reviewed and appear to be accurate.

The fluoride feed system has a redundant electrical activation mechanism to prevent over feed. Fluoride overfeeds have occurred at other water plants because of failure of a single electrical activation mechanism. Redundant fluoride feed activation mechanisms must be provided because of the hazardous nature of high concentrations of fluoride. The fluoride feed pumps are interconnected

with the low service pump circuitry. However, a redundant safety mechanism, such as a flow switch must also be interconnected with the feed pump circuitry. This should assure that no chemical feed pumps will operate unless water is flowing and the low service pumps are energized.

Also, anti-siphon valves should be installed not only on the chemical feed pump discharge lines, but also at the point of application to prevent overfeeds from occurring due to siphoning.

Plant Piping and Miscellaneous: The piping within the plant is cast iron and steel. Chemical piping is primarily PVC. The majority of the piping within the plant is rusting, and some severely. Many of the nuts and bolts securing the flanged joints are also severely corroded. While some nuts and bolts have been replaced in the past few years, staff needs to be diligent in replacing these items on a consistent basis. Also, all pipes, drains, and chemical feed lines are being repainted and they will be color coded in accordance with "Recommended Standards for Waterworks, 2007 Edition." Flow direction arrows will also be labeled on the pipes.

The City has recently replaced all the filter influent and filter drain valves located in the filter piping gallery, and recently installed filter-to-waste piping for each filter. The City is encouraged to award the bid to a qualified contractor and proceed with the filter-to-waste project as soon as possible.

Cross connections were found to exist in the chemical feed room and at the filter gullets as a result of the survey. All have been discussed with suggested remedies in other parts of the survey and will not be repeated here.

Plant Metering and Controls: The high service pump meters were out of service at the time of the survey due to construction. Currently, finished water pumpage is calculated by subtracting in-plant water use from raw water meter data. The high service pumps have lacked routine calibration in the past and need to be calibrated routinely.

A routine plant and yard valve exercise program has been started. Each valve has been inventoried and given a number, location, type and function. Each valve should be tagged to identify its function. Plant staff have access to an automatic valve actuator and should be familiar with the location and operation of all yard valves.

Laboratory: The laboratory at the water treatment plant has been certified for analysis of total coliform, *E. coli* and HPC in the past, but the certificate was not on display, and the staff did not know the certification status. The analyses, equipment, and monitoring frequencies have been presented earlier in the report. Since the laboratory is inspected by DEQ RRD, no evaluation of the equipment and procedures currently employed will be undertaken here.

Monitoring frequencies for the various parameters are adequate. Currently, fluoride residual testing in done twice per day. The program for routine disposal of laboratory wastes appears adequate by autoclaving the material and then disposing liquids in the sink and all other material in the trash.

Staff does not test for nor speciate algae or taste and odor. A Quebec colony counter is available for lab staff to use. Staff should be familiar with algae counting and speciation and should perform such routinely.

Treatment Optimization:
It is important to optimize treatment practices to minimize the potential for contamination from microorganisms such as Cryptosporidium and Giardia or other unforeseen contaminants. Appendix D contains a copy of "Recommended Practices for Treatment Optimization". This document prepared by this office in association with industry was provided to all water plants in May of 1995. It is recommended that these practices be studied to determine ways in which treatment may be further optimized. While the details of the document will not be reiterated here, certain practices have proven useful for other water plants. It is hoped that as many optimization practices as possible will be implemented.

Reliability: There are two emergency risers located on the raw water intake line for situations when the crib is unavailable. The riser closest to the intake crib is inspected every other year as part of the biennial crib and intake line inspection. The second riser was located in 2006 and inspected. Bolts on the second riser were replaced.

A generator has recently been installed to provide auxiliary power to the entire water plant during a power outage. It has been exercised and tested and is working satisfactorily. Generator is ran once a month. Fuel is refreshed annually.

There is one metered emergency distribution interconnection with the City of St. Joseph water system. This interconnection can help during emergency pressure problems or to aid during a fire. The interconnection should be defined hydraulically to determine available flow rate. Several connections to the Benton Township distribution exist, but at the time of this survey an emergency interconnection agreement was not in place. The interconnection with St. Joseph Township is proposed to be metered.

At the time of the survey, all controls were working. All adjustments to the chlorine, alum, fluorosilicic acid are made manually by plant operators. Filter backwash is initiated at the filter control console by a plant operator.

Most of the controls, switch gear and breakers are located on the 2nd floor and are not subject to flooding. There is a sump in the basement and a drain through the ceiling in the first floor which leads to surface water. However, certain equipment located in the lower level (all the pumps) may be subject to flooding in the event of a catastrophic pipe/pump failure where if the sump is not capable of removing all the water to prevent flooding.

An update to the previous reliability study was completed in 2017. A hydraulic analysis of the distribution system was included and seemed to indicate the likelihood of closed valves in the water distribution system.

Operators: Although the water plant currently meets regulations and DEQ policy regarding operator certification, we recommend another F-1 operator be provided for to provide additional oversight of plant operations. A dedicated maintenance staff would help extend the useful life of components and equipment in the plant. A separate distribution operator would similarly afford more time and focus on maintaining an old and deteriorating distribution system.

SANITARY SURVEY DATA FORM

DISTRIBUTION SYSTEM

GENERAL

Primary Contact: Mike O'Malley
Title: Utilities Director
Telephone: 269 927 8471
Cell Phone: 269 363 0575
Pager:
Fax: 269 927 8469
e-mail: momalley@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street

Benton Harbor, MI 49023-0648

Copy To: Darwin Watson
Title: City Manager
Telephone: 269 927 8400 ext. 9
Cell Phone:
Pager:
Fax: 269 927 0304
e-mail: dwatson@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street
Benton Harbor, MI 49023-0648

Population: 9,970 Year: 2011 Basis: census w/ adjustment*

**Overall, the population trends of the City is declining. Reduction of population from the census was justified in 2011 due to the ~144 apartments at Cogic Village being served by the Township, though they are within the city limits.*

Water Purchased From/Supplier: NO WSSN of Supplier: NA

Operator Certification

Distribution Classification: S-2

Operator-in-Charge:	Mike O'Malley	Cert: S-1, F-1	Oper ID: 2634
Designated Back-Up:	Demetrius Meeks, DPW Foreman	Cert: S-4 **exp**	Oper ID: 9658
Other Operators:	Darwin Watson	Cert. S-2 / F-4 **exp**	Oper ID: 4710
	Denny Edwards	Cert. S-4 / F-4	Oper ID: 4753
	Douglas Vanderploeg	Cert. F-3 / S-3	
	Dennis Hudson	Cert. none	Oper ID: none
	Henry Clayton	Cert. none	Oper ID: none
	Richard Woods	Cert. none	Oper ID: 18606
	Eddie Ellis (meter reader)	Cert. none	Oper. ID: none
	Eddie Davis	Cert. none	Oper ID: 13771
	Steve Forbear	Cert. none	Oper. ID. None
	Patrick Patterson	Cert. none	Oper. ID. None

Comments on staffing: **Additional staff are needed to complete valve/hydrant maintenance and cross connection inspection activities.**

Managing the operations and maintenance of the significantly aging water distribution system requires a full-time operator in charge. The city must secure an operator in charge of the distribution system separately from the treatment plant, based on the number of deficiencies found in the 2018 sanitary survey.

Ownership

Ownership: City – council / manager

Consent Agreement: NA

Escrow Account: NA

Annual Fee: active
Comments: Darwin Watson, City Manager

STORAGE

Construction, Controls & Maintenance

	Location: Britain Street	Location: Water Treatment Plant
Volume	650,000 gal	2,000,000 gal
Type	steel elevated	concrete ground
O.F. Elevation	768.5	above grade
Date Constructed	1938	c 1950
Date Inspected	2008	’04, ‘08
Date Painted Inside	1991	NA
NSF Std 61 (Y/N)	Yes	NA
	Note: lead primer	
Date Painted Outside	1991	NA
Cathodic Protection	yes	NA
Tank Isolation Valve	yes	yes
Tank Drain (Hydrant)	yes	none
Altitude Valve	yes	no
Mud Valve	yes	
High Alarm	yes	yes
Low Alarm	yes	yes
Chart recorder	SCADA	SCADA
Telemetering System	SCADA	SCADA

	Location: Britain Street	Location: Water Treatment Plant
Vents Screened	¼" holes	yes
Overflow Screened	unknown	unknown
Hatches Locked	unknown	yes
Site Fenced/Locked	yes	yes
Capacity		
Usable Storage:	650,000	2,000,000

Total Usable Storage: 2,650,000 gal 2.65 MG

Storage/Max Day: ~ 40% Storage/Avg. Day: ~ 67%

Source of +/- Flows	Amount of flow	
Firm pumping	8 mgd	333,333 gph
Ave Day Demand	1.2 mgd	50,000 gph
3 hour fire 1500 gpm	6.48 mgd	270,000 gph

Based on the above, the high service pumps can push out more flow than a 3 hour 1500 gpm fire would require. Therefore, the volume of storage in the system is not a huge concern. The only remaining issue is then how limiting is the hydraulic transmission in the networks of old 4" pipes. The hydraulic model and reliability study indicates some limitations in this regard.

Storage Comments: Benton Township recently completed water plant and transmission main construction, and the Township is no longer a City customer. This separation has reduced the City customer population by approximately 30 percent. Consequently, the Euclid standpipe and M-139 ground reservoir are no longer available for routine use by the City. Additional elevated storage would be helpful to increase flows and pressures. In the absence of additional elevated storage, an emergency agreement with Benton Charter Township and a hydraulic definition of the St. Joseph interconnect should be obtained to help provide reliable fire protection to the City and the remaining customers.

The 2008 inspection of the elevated storage tank identified necessary maintenance and repairs, including exterior/interior recoating, along with various structural repairs. **While most are not imminently impacting public health, holes in the vent and cathodic caps can allow contaminants to enter the tank and must be repaired.** The tower should be on a regular inspection frequency, and likely is now overdue for a cleaning.

DISTRIBUTION

Interconnections with Other Supplies

Name of Principle Supplier(s)/Wholesaler(s): NA

List WSSN number(s): NA

No. of Emergency Connections: 1 (not including Benton Charter Township)

Location	Main Size	Est.Cap.	Metered?	Status (Regular/Emergency)	Connection w/WSSN
M-63	12-inch	unknown	yes	emergency	6310
Main St.	12-inch	unknown	no	out of order	6310
Woodruff & Empire	12-inch		yes	Proposed emergency	6310 & 3726

If emergency, are valves exercised annually? yes

Flushed? no

Comments on Interconnections with Other Supplies: The City is not planning to repair Main Street emergency interconnection. The main was dislodged in a shipping accident under the river and repairs are costly.

The St. Joseph distribution system is on a higher hydraulic grade line than the City, and the City has benefitted from the connection in the recent past. A two-way meter installed in a walk-in chamber along the M63 right-of-way embankment provides the only interconnect at this time. Plans made and a permit obtained to connect the Benton Harbor system with St. Joseph at Empire and Woodruff Streets.

Interconnections with Benton Charter Township exist, but an emergency service agreement does not currently exist between the City and the Township. Without an agreement in place to open the normally closed valves, capacity between the water systems cannot be considered as available.

Distribution Piping

Identify distribution piping materials - estimate percentages:

Cast Iron	80%
Ductile Iron	20%
PVC	0%
AC	0%
HDPE	0%
Galvanized	<1%
Concrete	0%
Lead	<1%

Estimated percent of piping with coal tar lining 10%

Identify distribution pipe sizes - estimate percentages:

2 & 4"	24.2%
6"	33.9%
8"	12.4%
10"	2.0%
12"	16.2%
16"	2.9%
18"	0.3%
20"	8.1%

Main amounts are per Abonmarche 2017 Reliability Study. 345,923 total feet.

Distribution system dates back prior to State program of 1913 (c1890). Earliest state record on file is dated 1914. Water main amounts should be updated with a new general plan as they are revealed. City should plan for elimination of all undersized, galvanized, and lead main.

Due to the sheer amount of undersized cast iron main, the city must prioritize replacement of these old pipes and the lead service lines that are commonly attached to them. Benefits include increased flow and pressure, increased reliability, and reduced exposure to lead.

Operational Concerns & Maintenance

Are there areas where water main breaks are frequent? no

If yes, identify locations: NA

Are there areas where aesthetic water quality complaints are frequent? no

Do you receive complaints alleging illness due to the water? no

Is a procedure in place to respond to and track these complaints? yes

Are there areas where customers complain of low pressure? no

If yes, identify locations:

Comments on Main Breaks, Aesthetic Problems, Complaints: Early 20th Century 2-inch lead main on McAlister Road serves one block and leaks at isolation valve. City needs to replace the rest of small diameter and lead main. All complaints regarding illness from drinking water should be reported to the DEQ.

Are there areas where fire flows cannot be maintained? Yes.

If yes, list locations: Robbins Street, Thresher west of McCord.

Last ISO report date? 9/18/1990 Rating: 5

Which, if any, of the above listed areas has the supply prioritized for main replacement, upgrading, or looping? Also, if a definite schedule for capital improvement has been established, list the proposed completion date:

Location:	Estimated Completion Date:
McAlister – replace lead main	unknown

Hydrant replacement program currently out for bid, targets one hydrant in each area.

Comment on Capital Improvements, ISO Rating: Fire flows tested frequently. City intends to pursue project to replace 4-inch main simultaneously with sewer upgrades. Cherry Street and Summit Street are both slated for replacement, upsizing, and looping this year.

Priority should be given to the <500 gpm fire flow sites identified in the 2018 reliability study. However, contrary to the reliability study's recommendation, 6" water main might be the best solution for distribution mains to help maintain lower pipe volume and avoid water quality problems.

Hydrants

Number of Hydrants: 509

Number Without Auxiliary Shut-Off Valves: 30

Number that are Self-Draining: 99%

Number of Inoperable Hydrants: ~100 **some identified from hydraulic modeling calibration, likely many more that are not known.*

Frequency of Hydrant inspection: annually *(flow them annually?)*

Are there areas where additional hydrants are needed? no

If yes, list locations:

Hydrant location system: maps Accurate?

Are hydrants color coded for capacity? yes*

Has this information been provided to the fire department? yes

Frequency and seasons of hydrant flushing: annually ?

Purpose of flushing: maintenance

Is the public notified prior to flushing? no

Does flushing follow a specific format? Yes ?

Is the volume of water used during flushing estimated? no

Is a record maintained of hydrant activities? no

Comments on Hydrants: Significant attention is needed to properly assess, inventory, and maintain the City's fire hydrants. Inability to use a fire hydrant may endanger public safety. Many hydrants are known to have no/low flow, yet investigations into these take time, staff, and funds. To mitigate potential public safety risk and create a path forward to good maintenance practices, the following steps must be taken:

1. **A full assessment and inventory of the City's hydrants is needed.** hydrant number, location of the hydrant, type of hydrant, size of barrel, size of bottom valve, size of lead, direction of turn, operable or inoperable, auxiliary valve type and size, weep holes plugged or unplugged, condition of hydrant (caps, chains, valve operation, operating nut, leakage & etc.), color coded capacity, flow data (gpm & psi), flushing dates, inspection dates.
2. **Develop and implement a routine flushing plan.**
3. **Develop and implement a routine hydrant maintenance plan.**

Valves

Number of Valves: 2,500

Are there areas where additional valves are needed? yes

If yes, list locations: Lake Street area – from Empire to Main Street
Lake Street area – from Colfax to Pipestone

Valve location system: master map & books Accurate? questionable

Valve Turning Frequencies: none

Primary: none

Others: none

Records Maintained? NO

Comments on Valves: **Significant attention is needed to properly assess, inventory, and maintain the City's valves. Inability to utilize valves during emergency may endager public health, and closed valves may restrict fire flows which may endanger public safety.** The City distribution crew does not turn valves regularly or have a program for such. Several valves (~25) were found closed without record during the Township / City separation transmission project. Similar problems were found during recent winter frost penetration. Closed valves can result in increased power costs and pump wear and tear. **To mitigate potential public safety risk and create a path forward to good maintenance practices, the following steps must be taken:**

1. **A full assessment and inventory of the City's valves is needed.** Information may include valve number, location of the valve, size of pipe/valve, direction of turn, operable or inoperable, condition of valve box (date cleaned, accessible), inspection dates.
2. **Develop and Implement a routine valve turning program to identify closed valves and ensure working condition of known valves.**

SANITARY SURVEY DATA FORM

Customer Service Information

Number of service connections: ~ 3476

Number of metered service connections: 2844 (82%)

City Hall, Police & Fire Station, several Parks unmetered. More unmetered services are being discovered due to poor record keeping.

Identify service line materials and estimate percentages:

Copper: 30 %

PVC/PE/HDPE: <1%

Galvanized: 70 %

Lead: ? % **lead services exist but poor records cannot verify amounts**

Ownership of Service (City/Customer)

From Corp Stop to Curb Stop: City

From Curb Stop to Property Line: City

From Property Line to Meter: customer

Meter: City

Customer Meters

Types of meters Used: Sensus

Meter Testing/Maintenance Program: unknown

Criteria for Changeout: FAILURE

Number or Percent Changeout per Year: ~ 100 (2-3%)

Master Meter Locations: WTP

Calibration of Master Meters: quarterly

% Large Users - List

Whirlpool 175,000 gallons per day

Comment on Metering System: Compound meters are Trident and Rockwell. Several customers have non-working, or old and slipping meters according to staff. Slipping meters may be a large portion of lost water. Water theft and tampering (by-passing) is common. Many water bills are in arrears. Poor customer metering practice in the past has hurt the system. City replaced approx.. 2612 meters using grant dollars.

Water Rates

What is your current rate schedule? $3.80/100 ft³

Are current rates adequate to support O&M and CIPS? ***no***

When was the last time rates were adjusted? 2013

Has a water rate study been performed? 2012 – Abonmarche

Is there a meter charge or ready to serve charge? Yes - 5/8-inch meter $9.03

Is there a capital improvements base charge per meter? Yes – 5/8" is $4.60

Is a copy of the rate schedule and ordinance available? yes

Comment on Water Rates: In 2011, the emergency City manager set up a schedule for rates to increase to cover the cost of inflation, operations, maintenance and replacements to the system, and debt service cost on bonds. In 2013, a different emergency City manager approved a 5% reduction in this rate to reduce the financial burden placed on the residents who were facing economic hardships as the City was in a fiscal position to reduce the rates.

Out of ~3000 water customers in the city, approximately 1100-1200 are notified each month for non-payment. From there, approximately 57 shut-offs are actually done each month which is a significant drain on staff time. In addition, shut-off notices include a $1.00 surcharge to the account.

The city faces a significant challenge in the coming decades relative to funding the operations, maintenance, and improvement of a water system that has been neglected over decades. Current revenues are not sufficient. The collection of water fees is one area for necessary improvement. In order to protect public health, a water system must strive to implement an efficient and effective rate collection system. As part of this, the city council should be educated on the financial outlook of the water system and the importance of revenue collection and paying your water bill.

PROGRAM COMPLIANCE

Asset Management Program

Each AMP should cover 5 elements. Updates should be conducted as necessary, and may be requested as part of an update to the General Plan. A major focus needs to be whether there are gaps in the revenue/rate methodology; in other words, will the water supply have adequate funding to support necessary projects.

The AMP is included in the Appendix to this sanitary survey.

Submitted Date: 2018

Asset Inventory Section: Adequate? **Somewhat**. *A detailed description of the Water Plant is included, but offers no clarity on how items are tracked in the AMP. Distribution system is broken down and properly accounted for.*

Criticality Assessment: Adequate? **Somewhat**. Probability of failure was assigned a numerical value based on age and expected life span (for water mains). Consequence of failure also focused on distribution assets, and didn't describe the process for water plant assets. Again, the distribution materials are covered in more detail but the water plant is left vague. Last, *the AMP criticality assessment will soon need to incorporate lead service lines with added priority.*

Level of Service Goals: Adequate? **Yes**.

Capital Improvement Plan: Adequate? **Yes**. The question remains whether the source/treatment plant assets are appropriately ranked relative to the distribution assets. *However, the big picture is there are many items needing attention in both locations.*

Funding/Rate Method.: Adequate? **NO.** Gaps in the operations revenues and expenses were not identified. However, insufficient detail is provided to verify the revenue stream such as rate structure.

Comments:

The AMP must be revised in three ways. *First*, the AMP should give added weight (i.e. consequence of failure) to projects that contain or would eliminate lead service lines (LSLs). *Second*, the city will be required to remove service lines at a certain rate, which may be added as a line item to the finance spreadsheet. *Third*, the program must include specific calculations for operating revenues generated.

Due to the age of the distribution system and sheer volume of assets, this is likely the biggest area for needed improvements. However, continual upgrades at the water plant are also necessary to keep it in good working condition. A good AMP will be able to weight these two categories independently, and prioritize improvements accordingly.

The asset management program concludes that, due in part to water rate reductions in 2013 with claims of affordability, the city may not be able to meet current and future debt payments from capital projects. In fact, a rate increase of 15% could be necessary to close the funding gap simply for current debt. In addition, annual increases of 2.5-6.5% would be needed for the next 4 years, and a 37% increase to fund the 5-year capital project list. **The study finds that a significant increase of the rates over 5 years is needed to pay current debt and to afford necessary capital improvements.**

Given the large amount of capital improvements needed, the city must consider rate increases as inevitable. In addition, with operating budgets so close, there will be foreseeable challenges meeting the requirements of this sanitary survey such as hiring additional staff and incentivizing their development**. To achieve these improvements, the city must prioritize the drinking water system and dedicate the necessary resources to protect public health.** Education of the city council and the general public must be done to stress the importance of investing in the water system through efficient and effective rate paying

Cross Connection Programs

Ordinance No. 44.38 NEED TO SUBMIT A COPY! Date: 6/29/1977

Approved Program? yes Date:

Staff Assigned to Program, (No., Dept and/or who) DPW crew

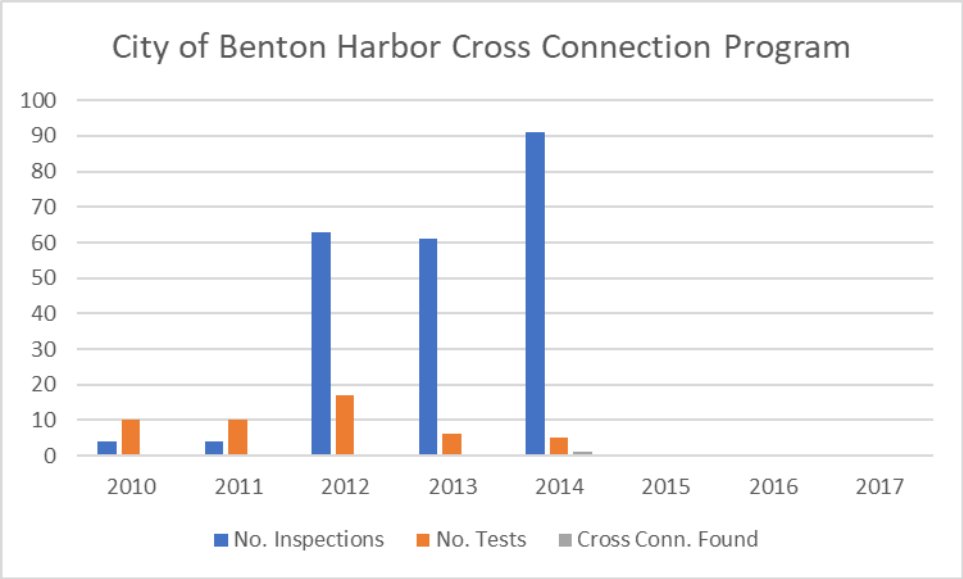
Was previous year's annual report acceptable (Y/N)? missing reports from 2015-2017

Inspection Status: significantly deficient

Device Testing Frequency: significantly deficient

Recordkeeping Adequate? significantly deficient

Comment on Cross Connection Program: Hydro Designs was under contract for cross connection administration until 2009. A couple years of very low inspections occurred from 2010-2011, and from 2012 – 2014 a decent effort was made to inspect and test non-residential accounts.



The lack of staff availability to administer the local program, and failure to do so over the years of 2015 – 2018, has resulted in a significant deficiency. Failure to identify and correct cross connections is an indirect threat to public health.

Monthly Operation Reports

Are Monthly Operation Reports required (Y/N)? yes

Are previous year's reports acceptable (Y/N)? yes

If no, describe problems:

Comment on MOR's: Water usage unrelated to normal demands, such as construction, fire fighting, leaks, tank filling, flushing, should be dated on MOR.

Consumer Confidence Reports

Is the annual CCR required? (Y/N) yes

Was the previous year's acceptable? (Y/N) Yes

Was the previous year's certification form received? Yes Timely? Yes

Comments on CCR:

Emergency Response Plan

Date of Most Recent Plan: 3/1/2005 Acceptable? yes

Filed Where? Water Plant

Comments on ERP: EPA Vulnerability Study and Emergency Response Plan are available.

General Plan

Date of Most Recent Plan: 2017 Acceptable? NO

Filed Where?

Comments on General Plan: Recently updated map as part of DWRF project planning. Hydraulic grade line, flow capacity from interconnect(s), and computer modeling still required. 2008 has several inaccuracies. New requirements due in 2016.

Reliability Study

Date of Most Recent Study: 2017 Acceptable? yes

Filed Where?

Comment on Reliability Study: Hydraulic modeling suggested the city spend time assessing the valves and hydrants in the system to ensure working condition. It also identified many areas with insufficient fire flow that should be replaced.

Permits

Applies for and obtains permits prior to construction (Y/N): yes

Reviews plans prior to submittal to DEQ (Y/N): yes

Standard specifications on file at CWS (Y/N): **2006, needs updating**

Date of Last Master Plan: unknown

Follows master plan for any construction (Y/N):

Actually follows plans as permitted (Y/N): yes

Develops as-built plans (Y/N):

Updates general plans (Y/N): Currently updating portions of system maps

Bacteriological

Date of Approved Site Sampling Plan:

Name of Certified Lab Used: City of Benton Harbor Water Treatment Plant 0600

MCL, Monitoring or Reporting Violation(s)? (Y/N) No

Number & Type of Violations in past 12 months: none

Public Notice Issued according to regulations? (Y/N) NA

Bacti Plan Comments: Bacteriological samples are being collected in accordance with the approved Sampling Site Plan (Plan).

Chemical

Date of Monitoring Schedule: 2018

If nitrite detect, what is concentration? 1.5 mg/l

Detects for metals > 50% of MCL? (Y/N) none

Metals (list):

Detects for VOCs (Y/N) only DBPs within range of disinfection

Detects for SOCs (Y/N) none

Date of Disinfection Byproduct Monitoring Plan: Stage I DBP 12/4/01 Stage II DBP 4/19/2010

DBP Sampling Done according to plan? (Y/N)

Lead and Copper Monitoring

No. of Samples Required: 30

☐ Semi Annual ☐ Annual ☒ Triennial

Exceedance of lead or copper action level (Y/N) no

If yes, was public education issued (Y/N) NA

Next Monitoring Period: summer 2021

Corrosion Control Program, if applicable: NA

Lead service line replacement status, if applicable: NA

Chemical Monitoring Comments: The new Michigan Lead and Copper Rule contains many changes and while the new regulation was immediately effective June 14, 2018, it is slated for full implementation by January 1, 2019. Continue to follow DEQ guidance as it becomes available.

Radiological Monitoring

Samples being collected in accordance with the schedule? (Y/N) yes

Alpha, beta, radium, uranium	yes
Radon	NA
Tritium	NA

Detects for Rads > 50% of MCL? (Y/N) no

If yes, list: