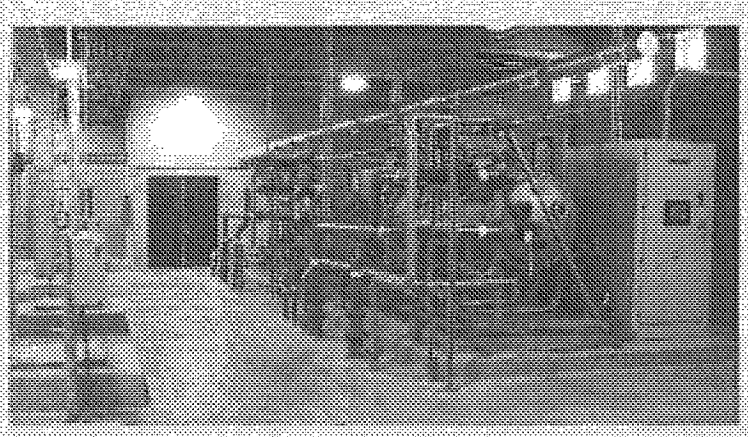
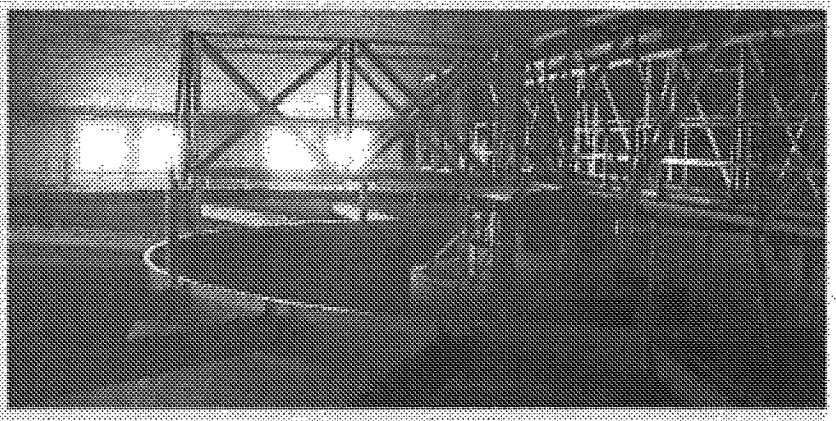
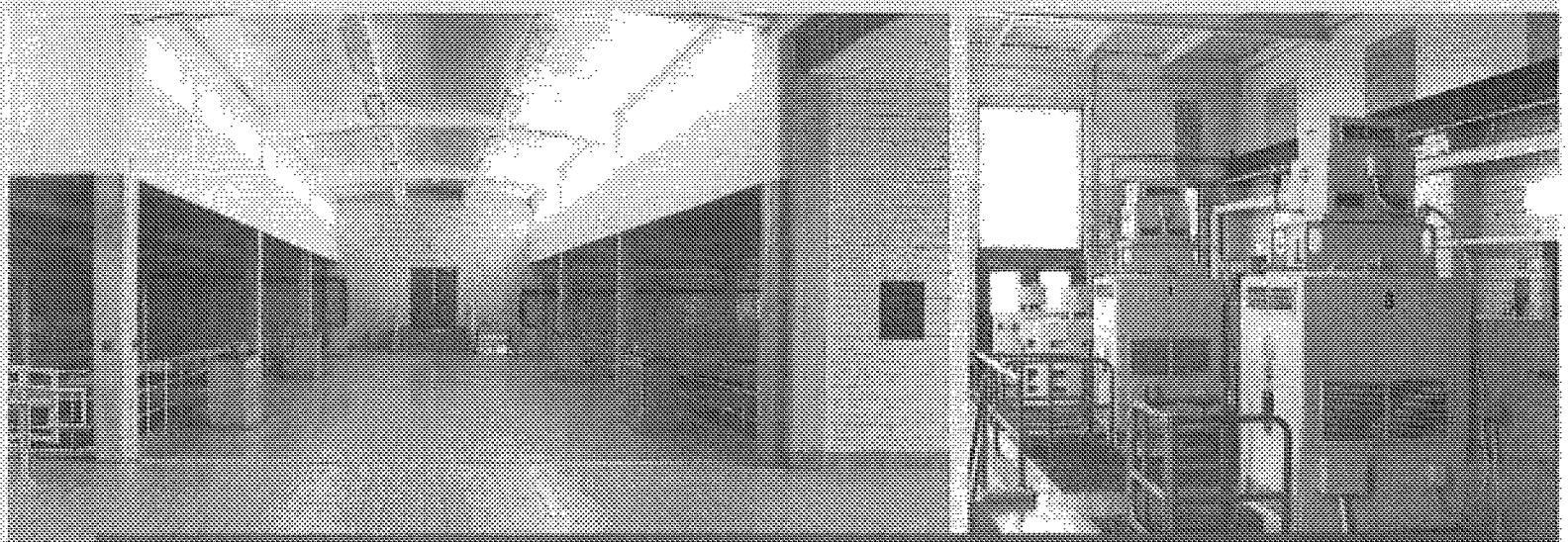
DRAFT

Operational Evaluation Report
City of Flint

Trihalomethane Formation Concern

TTHM
MAX Date
&
MAX Loc

November 2014

Lockwood, Andrews & Newnam, Inc.
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EXECUTIVE SUMMARY

Environmental Protection Agency (EPA) and Michigan Department of Environmental Quality (MDEQ) regulations require that public water suppliers test drinking water quarterly throughout the distribution system for disinfectant by-products (DBP's). Two categories of DBP's, tri-halomethanes (THM) and halo-acetic acids (HAA5), are regulated and must be tested for. The City of Flint began operation of their water treatment plant (WTP) full time with the Flint River as the source on April 25, 2014. Since that time, two quarters of samples taken indicate that future violations are inevitable for total THM without some modifications to the water system. In response, the City hired Lockwood, Andrews & Newnam, Inc. (LAN) to complete this Operational Evaluation Report (OER) in conformance with EPA guidelines with the goal to determine the cause(s) of high levels of THM and evaluate possible solutions.

The EPA promulgated the Stage 2 Disinfectants and Disinfection By-Products Rule (DBPR) in January 2006 which set maximum contaminant levels (MCLs) for total trihalomethanes (TTHM) and HAA5 based on an annual running average, tested quarterly, for a given sampling location. The City of Flint reports levels from 8 sampling test locations. Of the two quarterly sampling cycles since Flint began operating the WTP full time, HAA5 levels have been acceptable but TTHM levels have been high at all 8 sampling sites.

According to the Stage 2 DBPR, the annual average value requires 3 quarters of sampling data with the most current period counting twice. Therefore, the City of Flint has not yet experienced a violation of the TTHM MCL because only 2 quarters of data have been obtained. However, levels recorded indicate the likelihood of an MCL exceedance later this year.

A number of issues have been identified as possibly contributing to the high THM levels measured.

1. Inefficient ozone system functionality which has resulted in increased chlorine feed.
2. Upstream influences in terms of increased chlorine demand.
3. Bypass stream around softening contributed to chlorine demand.
4. Unlined cast iron pipes in the distribution system contributing to chlorine demand.
5. Recirculating water in the distribution system due to less than ideal configuration of Cedar Street and West Side pump stations.
6. Broken valves resulting in stagnant water in some areas.
7. High chlorine demand in filters.
8. High THM formation potential (THMFP) in source water.
9. Less than optimal removal of THM precursors

ACTION PLAN

The City of Flint has signed an agreement with the Karegnondi Water Authority (KWA) to purchase raw water drawn from Lake Huron. The KWA system is currently under construction and expected to be operational by late 2016. The water supply from Lake Huron will have entirely different water quality characteristics from the Flint River and those characteristics are expected to yield drastically reduced DPB formation. With that, non-structural options to help reduce THM levels are much preferred over solutions requiring new construction. Therefore, two categories of actions have been devised: Stage 1 being actions that can be completed relatively quickly without major construction and Stage 2 consisting of either long term actions or solutions requiring major construction. The City has completed or intends to complete Stage 1 Actions by February 16, 2015, the week in which the next quarterly sampling is to be done. Stage 2 actions are to be implemented only if Stage 1

001836

4 NJIR trans. Lost 2 over new wiring and

Call to Brent/Robert 12/16/97 (TTHN reduction meeting)

Soft

* Payroll turnover (off) V retesting
* IPT CS/WS share summer test dist sys
  - 1-2 PT - summer
  - part range -
* Flexby - more practical
* trans mission mec Functional - adding = lost/gains
* part time - payroll acc random - Golden Pay -
* Repeat trans values
  - start value accuracy on spring

LAN to study Probability study - study this week
- cong/flow models

- LAN working on LOAN Broker on Dist Model - done some
  picture study - working on Bonds } study new

Actions

* Task Dept off-line
* Softening copy - Split much as we can when Filing

(< 15 mgd) Out-Boards -

VPO on (Lo: 2 mgd Rep (Bond) → on-off w/ 15 mgd - Nat mecky (Lo 5) ↑ updating driver

* need better estimate (only) for cong (15 to Gated) 10% cong-15 days to Gated test Out 5 days to Later note at Later

= Ozone - Ozone to come out (New year) to diskette - was supposed to start (Oct 20 ?)

= Still intg & Network meeting & eventually not at stations

actions are ineffective in adequately reducing TTHM levels and therefore Stage 2 is contingent upon the outcome of Stage 1.

Stage 1 – Immediate Actions

- Hire ozone system manufacturer to troubleshoot ozone system
- Bench scale jar testing
  - Match existing process and access possible areas of improvement
  - Simulate potential modifications to treatment process
  - Evaluate coagulation and flocculation polymer aid feeds to assist with TOC removal
- WTP operational changes
  - Discontinue softening bypass stream to reduce chlorine demand
  - Disinfection of filter beds to reduce chlorine demand
  - Possibly begin coagulation and flocculation polymer aid feeds to assist with TOC removal depending on bench scale test results
- Increase water main flushing efforts to minimize stagnant water
- Water system modeling to identify areas with high water age and potential solutions
  - Cedar Street Pump Station potential recirculation
  - West Side Pump Station potential recirculation
  - Storage tank volume use
  - Possible broken closed valve locations
  - Locations in need of flushing
  - Lower high water levels in storage tanks

Stage 2 – Contingent Actions

- Fix ozone system
- Start feeding coagulation and flocculation polymer aids to lower TOC, if not completed in Stage 1
- Convert to lime and soda ash softening
- Change disinfectant to chloramine or chlorine dioxide until KWA
- Install pre-oxidant feed at intake to optimize ozone disinfection
- Implement advanced treatment for THM precursor removal
- Increased main flushing based on water modeling results
- Continue valve replacements with water model assistance
- Emphasize cast iron pipes on water main replacement priority list

Model 4 is running
(4th model is overlapping
to DST THIS
→ new eq horizon

- Ozone Reg updated
- ambient tech - next week 1/19
potential for reprogramming

I. BACKGROUND

The City of Detroit Water and Sewer Department (DWSD) has historically provided drinking water for the City of Flint and Genesee County. In the late 1990's growing concern regarding the reliability of the DWSD supply prompted the City of Flint to upgrade their existing water treatment plant (WTP). Those improvements, defined as Phase I, were completed in 2005 and were intended to allow the Flint WTP to operate, using the Flint River as the source, for an extended period of time in the event that supply from the DWSD was temporarily interrupted. Additionally, the Phase I improvements set the stage for Flint to break free from dependence on the DWSD supply and water charges over which they had no control.

A. WATER SUPPLY TRANSITION

1. Detroit Water and Sewer Department (DWSD)

Until recently the Genesee County and Flint region had been provided drinking water by the DWSD. However, due to excessive cost increases and reliability issues with the DWSD system other options had to be explored.

2. Karegnondi Water Authority (KWA)

In 2010 the Karegnondi Water Authority (KWA) was formed for the purpose of developing a new water supply from Lake Huron to serve the region in lieu of the DWSD supply and the City of Flint elected to join. The KWA expects the new system which is currently being constructed to become operational in the fall of 2016.

3. Flint River – Interim Period

With a renewing water supply agreement between Flint and the DWSD being terminated by the DWSD (effective April 30, 2014) and the KWA system not expected to be operational until late 2016, the City of Flint decided to initiate operation of the existing WTP full time utilizing the Flint River as the interim water source. A variety of WTP improvements were necessary for the Flint plant to become a full time plant. For purposes of this report, Phase II improvements to the Flint WTP are improvements which have been made to allow the plant to operate full time with either the Flint River as the source or the KWA supply as the source.

B. TTHM PENDING VIOLATIONS

The calculation for determining if the MCL has been violated for TTHM is:

(2 x current quarter value + previous 2 quarter values) / 4

Flint has completed tests for 2 quarters and therefore has not violated an MCL limit to date. However, the third quarter of sample data is likely to provide MCL exceedances at all 8 sampling sites. Test results are tabulated below.

TABLE 1 – 2014 DBP TEST RESULTS						
Sample Location	TTHM			HAA5		
	1st Qrt 5/21/14	2nd Qrt 8/21/14	3rd Qrt	1st Qrt 5/21/14	2nd Qrt 8/21/14	3rd Qrt
1) 3719 Davison - McDonalds	162.4	145.3		64	43	
2) 822 S. Dort Hwy - BP Gas Sta.	111.6	112.0		52	40	
3) 3302 S. Dort Hwy – Liquor Pal.	96.5	127.2		48	31	
4) 3606 Corunna – Taco Bell	106.4	181.3		55	24	
5) 2501 Flushing – Univ. Market	75.1	196.2		38	17	
6) 3216 MLK – Salem Housing	82.2	112.4		41	25	
7) 5018 Clio – Rite Aid	88.2	144.4		49	30	
8) 6204 N. Saginaw – N. Flint Auto	79.2	118.3		50	37	

TTHM MCL = 80 ug/l
HAA5 MCL = 60 ug/l

C. WATER TREATMENT PLANT RECENT IMPROVEMENTS & STATUS

1. Phase I WTP Improvements

Since 1965, the Flint WTP has remained a secondary or backup supply system to the DWSD primary supply. Typically the secondary supply for a public water system is expected to be needed only during emergency situations and normally is designed for short term operation such as providing the average daily demand for a few days. Conversely, Phase I improvements were designed with the intent to upgrade the Flint WTP in order to allow for an extended short term period (6 weeks) because of the perceived high risk that the DWSD supply would fail and remain out of service for an extended duration. Regardless, the Flint WTP was still intended to serve as a standby plant and as such the Phase I improvements lacked redundancies that would be required for a primary supply WTP.

2. Past Pilot Study & Testing

During design of the Phase I improvements a treatability study was completed by Alvord, Burdick & Howson, LLC (AB&H) in 2002. The Treatability Study evaluated the current treatment processes that are in place at the Flint WTP today with the Flint River as the source. The report recommended the following:

TABLE 2 – 2002 WTP TREATMENT RECOMMENDATIONS			
Treatment	Purpose	Point of Application	Dosage (mg/l)
Sodium permanganate	Zebra mussel control	Intake	0.3
Ozone	Taste & odor removal, disinfection	Diffusor basin	1.5
Ferric chloride	Coagulation	Rapid mix	40
Coag aid polymer	Turbidity & TOC removal	Rapid mix	2.0
Floc aid polymer	Turbidity & TOC removal	Floc basin	0.05
Lime	Softening	Softening basin	175
Soda ash	Softening	Softening basin	52
Carbon dioxide	pH adjustment	Recarb basin	37
Media filters	Filtration	Na	Na
Chlorine	Disinfection	Filter effluent	1.0

Of the recommended items, zebra mussel control, coagulant and flocculation polymer aids, and soda ash feed have not been incorporated into the treatment process.

3. Phase II WTP Improvements for Full Time Operation

Phase II WTP improvements are those needed to convert the Flint WTP from a back-up supply to a primary supply plant. A number of improvements have already been constructed as they were necessary to operate full time, treating water from the Flint River. The improvements under the title of Phase II that have been completed or are nearly complete include upgrades to the lime sludge lagoon, the lime sludge lagoon decant and disposal system, decant pump station and force main, installation of mid-point chlorination before filtration, and upgrade of the electric feed sub-station.

Additional improvements to the Flint WTP that are to be completed to become part of the normal treatment process using water supplied by the KWA are:

- New oxygen and nitrogen storage facilities for the ozone system (under construction)
- New coagulant feed system
- Electrical
  - Pump Station #4 upgrades (under construction)
  - SCADA and controls upgrades
  - Filter transfer pump station feeders
- Installation of the future raw water feed connection point for the KWA (under construction)
- Pump replacements and VFD installation in the low and high service pump station (under construction)
- Filter transfer pump station to Dort Reservoir
- Facility security improvements

II. SOURCE WATER EVALUATION

A. DATA ANALYSIS

Based on past data collected and the 2002 Treatability Study by AB&H, the Flint River water quality varies seasonally with higher hardness and alkalinity experienced in the winter. Higher magnesium concentrations are also experienced in the winter, adding difficulty to the settling process due to neutrally buoyant floc. General water quality average characteristics recorded for the 2002 Treatability Study as compared with average characteristics recorded this year are shown in Table 3 below.

TABLE 3 – FLINT RIVER WATER QUALITY CHARACTERISTICS

Period	Turbidity NTU	TOC Mg/l	Alkalinity Mg/l	Hardness Mg/l as CaCO3	pH	Total Col. Count/day
2001 Apr–Oct	7.9	9.4	215	272	8.1	870-1230 (7300 max)
2014 May–Oct	8.3	10.3 5/22/14	207	252	8.2	1900-9000 (48,300 max)

Other than total Coliform, the Flint River characteristics do not appear to have changed significantly over the past 10+ years. Note that further investigation by City staff revealed a sewer leak upstream of the plant that may have contributed to the total Coliform count. The leak was subsequently repaired.

B. CONCLUSIONS

Considering the minor changes in Flint River water quality, much of the information contained in the 2002 Treatability Study by AB&H remains relevant today. Data from that report assumed to be consistent today include the following:

- Flint River is influenced by groundwater from a dolomitic aquifer
- Hardness varies seasonally with higher hardness and alkalinity in the winter
- Hardness, alkalinity, magnesium concentrations tend to be reduced by run-off
- Total THMFP is likely 380-440 micrograms per liter as measured between April 2001 and January 2002. The City intends to re-test the raw water to confirm the THMFP has not changed. Results are pending.

In development of the 2002 Treatability Study, processes were simulated which resulted in low THMFP. Therefore, information contained in that report will be used to assist with establishing a baseline jar testing procedure as discussed further in Section III.

III. TREATMENT PROCESS EVALUATION

A. EXISTING PROCESS DESCRIPTION

The existing WTP consists of an intake with screening from the Flint River, low lift pumping, ozonation, rapid mix, flocculation, settling, softening, recarbonation, filtration, storage and high service pumping. A process diagram is shown as Figure 1.

1. Intake

A 72" diameter pipe draws water from the Flint River through 2 traveling screens to the low lift pump structure. No chemicals are currently fed for Zebra mussel control or pre-oxidation as recommended by the 2002 Treatability Study. Manual removal of zebra mussels proved to be more economical than installation of chemical feed equipment considering the short term need.

2. Ozone

There are 2 ozone generators designed to provide adequate ozone for a WTP flow of up to 36 mgd. There are 3 ozone contact basins. The ozone generators were designed to produce 900 lbs/day at 10% concentration and up to 1300 lbs/day at 6% concentration each. Recent readings have indicated a production rate of approximately 700 lbs/day at 4% concentration. While serving the purposes of taste and odor control and disinfection, it is possible the current ozone feed might not be optimized to realize additional TOC removal benefits demonstrated by previous tests. Also, less than optimal ozonation has led to increased chlorine feed.

3. Rapid Mix

East and West rapid mix chambers allow chemical feed prior to the flocculation basins. Each rapid mix chamber is equipped with a 5 hp mixer.

4. Coagulation / Flocculation

The WTP contains two equally sized flocculation basins, east and west, and each basin provides tapered or gradually slowed mixing from inlet to outlet. There are fifteen 2 hp mixers for each basin with VFDs to control mixing speed. The 2002 Treatability Study recommended feeding both coagulation and flocculation polymer aids. Neither polymer aid is being used today because turbidity and TOC removals have been sufficient to meet regulatory requirements.

5. Settling

Primary clarification takes place within 3 basins containing plate settlers. The settlers are operating as designed.

6. Softening

Again, there are two basins for softening: east and west. Each basin is 120' in diameter and contains a solids contact softening unit. Each softening basin/unit has a design capacity of 18 mgd. Low lift pumping limitations, flow control to the basins, and fluctuating demands have made it difficult for WTP staff to stabilize the softening process. Softening is accomplished by feeding lime. The decision was made by the City not to feed soda ash in order to remove non-carbonate hardness because acceptable hardness levels could be achieved with lime feed only and softening is short term until Lake Huron water becomes available.

7. Recarbonation
Recarbonation for pH adjustment is accomplished in east and west recarbonation basins between and to the north of the softening basins. Carbon dioxide storage and feed equipment is located west of the recarbonation basins.

8. Filtration
Filtration is accomplished with 12 dual media filters, equally sized and designed to filter 3.0 mgd each. Media consists of 12" of sand and 18" of anthracite. The filters have been operated intermittently over the years due to the standby nature of the WTP and until recently, chlorine injection took place downstream of the filters. It is possible some microbial growth has developed in the filters.

9. Disinfection
Limited disinfection is provided by ozonation, but the primary form of disinfection is chlorine fed prior to filtration and prior to finish water storage / high service pumping. The intermediate chlorine injection location was recently constructed under the Phase II, Segment 1 contract.

10. Clear Well & Pumping
The pump building sits adjacent to a 3 MG clear well and contains both low and high service pumps.

8. JAR TESTS / EXPERIMENTS

1. Approach
There are several well practiced methods by which DBPs can be reduced. First, the disinfectant can be changed to an alternate that has a lower tendency to form DBPs. Second, additional treatment systems such as activated carbon or air stripping (depending on the nature of the precursors) can be added to remove DBP precursors. Lastly, the existing treatment processes can be optimized to remove as much DBP precursor as possible. Of these options, optimizing existing treatment processes is the only strategy that does not require the construction of new and expensive facilities. It is anticipated that Flint will be receiving Lake Huron water in approximately two years and this water will have a completely different chemistry from the Flint River. Major process changes instituted to address THM levels using Flint River water are likely to be unnecessary for Lake Huron water and may even be inappropriate. Therefore, those options which require addition of new treatment processes are undesirable at this time. In recognition of this upcoming change in water source, this study will concentrate on improving the existing processes, rather than adding new ones. New treatment processes will only be recommended if operational changes to the existing treatment train prove ineffective.

Recent sample test results suggest that most of the DBPs are formed in the distribution system rather than within the treatment plant. Therefore, the most logical approach is to reduce the DBP formation potential (DBPFP) rather than simply lowering the levels of DBPs leaving the plant. During bench scale testing, formation potential (FP) levels will be the primary indicator of success or failure of any proposed process modifications.

2. Protocol
Bench scale pilot testing is intended to reflect actual plant operating and hydraulic conditions so the bench scale treatment units will be sized based on various dimensionless factors to ensure the pilot treatment matches the actual system. Bench scale ozonation is not practical due to time and cost limitations. Therefore, water

samples will be withdrawn following the plant ozone basin. These samples will be transported to the laboratory where they will be dispensed into square testing jars. The jars will act as rapid mix, three-stage flocculation, and settling. Rapid mix and flocculation conditions will be matched to the plant based on "Gt" values. The "G" value is a measure of the mixing intensity and is a function of mix time, viscosity of the liquid, and mixing power applied to the water. "Gt" then, is a size scaling factor where time has been accounted for. Settling time will be scaled to match the shorter settling depth of the testing jars. After settling, samples will be decanted from the test jars. The decanted samples will then be lime softened; softening conditions will be similarly matched on the basis of "Gt". Fluoride will be added and carbon dioxide sparged into the samples to reduce the pH. The water will then be vacuum filtered through filter paper, sized to simulate the plant's dual media filters. The samples will be dosed with excess chlorine and allowed to react for seven days before testing for DBPs to determine the formation potential.

Although these conditions may be refined based on new information, we anticipate the following:

TABLE 4 – BENCH SCALE TEST MIXING INTENSITIES

Process	G	Duration
Ozonation	Plant	-
Rapid Mix	330	25 sec
Flocculation, Stage 1	50	9 min
Flocculation, Stage 1	25	9 min
Flocculation, Stage 1	12	9 min
Settling	na	10 min
Softening	TBD	10 min
Recarbonation	na	na

It is expected that the primary variables during the testing will be chemical additions and chemical dosages. Specific chemicals and dosages used for initial testing conditions will be selected to reflect current plant usage and the recommendations of the 2002 Treatability Study.

TABLE 5 – BENCH SCALE TEST CHEMICAL FEED RATES

Chemical	Current Usage	2002 Study
Ozonation	4.66 mg/l	1.5 mg/l
Ferric Chloride	7.7 mg/l	40 mg/l
Coagulant Aid Polymer	Not used	2.0 mg/l
Flocculation Aid Polymer	Not used	0.05 mg/l
Lime	120 mg/l	175 mg/l
Soda Ash	Not used	52 mg/l
Cationic Softening Polymer	3.13 mg/l	Not used
Anionic Softening Polymer	0.88 mg/l	Not used
Fluoride	0.45 mg/l	1 mg/l
Carbon Dioxide	32 mg/l	37 mg/l
Chlorine	6.3 mg/l	1 mg/l

3. Considerations

The 2002 Treatability Study did not note significant formation of DBPs. This may be a function of different Flint River water chemistry at that time. However, recognizing the considerable differences in chemical usage and dosages between that study and current operations, those differences in chemical use and dosage are an obvious starting point for optimizing treatment to prevent DBP limit exceedance.

Although it is believed that optimization of current treatment can correct the DBP issue, should optimization of present treatment prove insufficient, alternate residual disinfectants (chloramines and chlorine dioxide) will be investigated as additional treatment measures.

4. Results

[To be completed following jar testing and experimentation]

5. Conclusions

[To be completed following jar testing and experimentation]

IV. DISTRIBUTION SYSTEM EVALUATION

EPA guidance for the distribution evaluation portion of an OER is focused on identification and isolation of a specific portion of the distribution system that led to the exceedance. The circumstances of Flint's apparent pending TTHM exeedances are unusual in that a new supply has been implemented which clearly corresponds to the high TTHM sample results. Despite obvious implications to the primary cause of increased TTHM levels, value remains in evaluating the distribution system as there may still be distribution improvements that can be made to help alleviate the problem.

Evaluation of the distribution system, including modeling, was recently added to LAN's scope of services. When finished, information will be provided to complete the following topics in this section.

A. INFRASTRUCTURE

1. Piping

According to the most recent MDEQ Sanitary Survey, the distribution system is estimated to contain 70% cast iron, 20% ductile iron, 2% concrete and 8% steel water mains. Unlined cast iron pipe can become pitted, allowing colonization sites for microorganisms leading to chlorine demand. Additionally, much of the piping in the system is aged and in poor condition. Increased chlorine demand could be resulting from biofilm in older pipes and from main breaks/repairs.

The City utilizes City Point software and GPS equipment to document main breaks and prioritize replacements. Areas that have been targeted for main replacements include Fenton Road, Atherton Road, Dort Highway, Averil Street, and Boulevard Drive. The extent of contribution is not known but any water main replacement project will contribute to decreasing chlorine demand somewhat if constructed properly.

2. Storage

[To be completed]

- *Appropriate capacity*
- *Mixing, baffling, other provided to prevent stagnant water*
- *Condition*

3. Pump Stations

[To be completed]

- *Condition*
- *Pump capacity evaluation*
- *Valve condition and pressure zones*

B. OPERATIONS AND MAINTENANCE

1. Pump Station & Storage Operations

[To be completed]

- *Control of pressure districts*
- *WTP Pump Station (No. 4)*
- *Cedar Street Pump Station*
- *Westside Pump Station*

- *Torrey Road Pump Station*
- *High and low levels in tanks*

2. Booster Disinfection Practices

Booster disinfection is provided at the Cedar Street and Westside pump stations. Sodium hypochlorite is applied while the reservoirs are being filled.

3. Changes in System Demands

[To be competed]

- *Long term decline in demands*
- *Short term fluctuations – max day in winter due to high volume of main breaks*

C. WATER SYSTEM HYDRAULIC MODELING

[To be completed]

1. Simulation of Existing System

Match existing conditions, particularly chlorine residual. We have chlorine feed data at plant and residuals at 10 locations in each MOR, May-October.

2. Identification of Deficiencies

Specific issues to look at:

Worst case at minimum daily demands
Water age in entire system
Recirculating water through pump stations
Use of storage tanks
Indications of broken valves
Effectiveness of booster disinfection

V. RECOMMENDATIONS TO MINIMIZE FUTURE OEL EXCEEDANCES

A. SOURCE

The City of Flint has already committed to the change from the Flint River as the water source to Lake Huron under the KWA system, planned for late 2016. The risk of future TTHM limit violations will decline substantially with the use of water from Lake Huron due to much lower DBP precursors. It is important to recognize that the Flint River will become strictly an emergency supply when the KWA supply becomes available and any investments toward the Flint River should be contemplated accordingly. Recommendations discussed below in this section apply to the Flint River as the source.

Reverting to supply from the DWSD until the KWA supply is available as an option. However, the DWSD has stipulated that a $4 million connection fee would apply and current water rates would include approximately $900,000 / month flat fee plus usage charges. Therefore, utilizing the DWSD for interim supply is cost prohibitive under the terms defined by the DWSD.

1. Watershed Management

A volunteer group entitled the Watershed Coalition performs various tasks related to managing the Flint River watershed such as spring cleanups and annual benthic studies to evaluate the river 'health'. No additional action is recommended at this time.

2. Monitoring

The City documents typical raw water characteristics as part of standard preparation of Monthly Operating Reports (MOR). No changes are recommended at this time.

3. Intake Operations

The 2002 Treatability Study recommended pre-oxidation in the form of sodium permanganate as a feed at the intake. However, pre-oxidation with sodium permanganate is unlikely to provide significant oxidizing of organics beyond that provided by ozonation. It is possible the addition of hydrogen peroxide would enhance the ozone process.

4. Seasonal Strategies

Past data indicates the Flint River is influenced by groundwater and in particular, dolomitic spring water. The result is hard water with high concentrations of magnesium and sulfate. Also, hardness and alkalinity are higher during the winter. Upon initiation of supply from the Flint River, the City made the decision to soften with lime only to focus on removal of carbonate hardness. One potential modification that could assist with TOC removal and thus decrease THMFP would be lime and soda ash softening. If implemented soon, the procedural change would be timely as it would also address increased hardness expected going into this winter.

5. Upstream Contamination Issues

Upstream contamination issues are extremely difficult to prevent and even if detected are difficult to locate. Evaluation of raw water data collected for MORs is the easiest manner in which to detect upstream contamination issues because the data is already collected for treatment purposes. In fact, high total Coliform readings signaled a potential issue recently that the City identified and removed.

An upstream monitoring and warning system could be established to attempt to detect spill event type contamination early enough to cease intake prior to the

contamination reaching the WTP. However, given the imminent conversion to the KWA supply, the period of full time use would likely be far too short to achieve payback on the capital expenditures.

B. TREATMENT PROCESS

1. Operational Recommendations

- Coagulation and flocculation polymer aids: The 2002 Treatability Study suggested the use of coagulation and flocculation polymer aids. These polymer aids were shown in the 2002 Treatability Study to increase TOC removal and thereby reduce THMFP. Further evaluation will be completed during jar testing.
- Discontinue softening bypass: The City was previously bypassing a portion of flow around the softening basins because hardness levels did not warrant softening of the full stream. However, this practice was discontinued because it was believed the bypass stream was contributing to chlorine demand and preliminary data has supported that belief. Chlorine demand dropped 0.5 – 1.0 mg/l following elimination of the bypass stream in early November 2014.
- Soften with lime and soda ash: Research has shown that enhanced softening with both lime and soda ash may provide additional TOC removal. The efficacy of this option will be evaluated during jar testing.
- Disinfection of filter beds: In case there has been microbial growth it is recommended the filters be 'shock' treated with chlorine and rinsed. A chlorine injection point was added upstream of the filters during the first segment of Phase II so future growth in the filters should not be an issue.
- Optimization of all existing treatment processes: Depending on bench scale testing conditions and results, slight modifications to all treatment processes might in order to replicate lower DPBFP.

2. Infrastructure Change Recommendations

- Fix and/or replace faulty ozone equipment: Since the ozone equipment was installed it has not been used extensively so the hope is that major components remain in good condition and the system can be easily modified to restore proper functionality. The City has scheduled the equipment manufacturer to field inspect the system on December 15, 2014.
- Change disinfectant to chloramine or chlorine dioxide: If other options prove to be ineffective, conversion to another disinfectant should be fully evaluated. Various characteristics of chloramination indicate an advantage over chlorine dioxide, but a full analysis would provide clarity as to which would be preferred.
- Install pre-oxidant chemical feed: Hydrogen peroxide as a pre-oxidant can enhance the activity of the ozone. This option is listed as a consideration only if problems continue with ozonation.
- Repair upstream sewer leak: a sewer leak upstream of the WTP intake was discovered and has already been repaired by the City.

C. DISTRIBUTION SYSTEM

Recommendations will be incorporated into this report when available. It is anticipated details will be provided for the following topics. [To be completed]

1. ***Manage Water Age***
   a) ***Storage Tanks***
   b) ***Residence Time in Pipes***

2. ***Reduce Disinfectant Demand***
   a) ***Flushing***
   b) ***Cast Iron Pipes***

3. ***Water Modeling of Recommendations***

Determine best flushing locations to reduce water age
Changes to storage tank operating levels to reduce water age
Valves to close/add to improve pressure zones, reduce recirculation
Optimization of pump station use – smaller pumps? Shut down?
Evaluate booster disinfection

A number of actions have already been taken in terms of the distribution system. Water main flushing efforts were increased until late November when freezing weather became prevalent. Also, numerous valves that were broken in the closed position and believed to have been contributing to stagnant water were replaced.

D. BOOSTER DISINFECTION

Decreasing chlorine feed at the WTP and adding booster disinfection in the distribution system is an alternative intended to reduce the reaction time at higher concentrations of chlorine to reduce DPB formation. Extensive looping and branching within the existing system complicate how to best implement and utilize booster disinfection. Water system modeling is recommended to determine the most effective feed point locations and dosages. Further discussion and details will be provided when the distribution evaluation results are available.

E. CATEGORIZATION OF ACTIONS

Considering that the Flint River is being used as the water source only until the KWA supply is available (expected late 2016), options to address high THM formation that require new construction or extensive time to implement are not preferred. On the other hand, the City understands THM sample results to date dictate that some action is necessary. Two categories have been developed to assist the City in prioritizing actions to take. Stage 1 consists of actions that can be completed relatively quickly without major construction and Stage 2 actions are either long term actions or solutions requiring major construction. Stage 1 actions are to be completed first followed by evaluation of the results prior to consideration of Stage 2 actions. Grouping of actions are shown in the table below.

TABLE 6 – ACTION PLAN		
	Action	Purpose
Stage 1	Troubleshoot ozone feed system	Reduce chlorine feed and increase TOC removal
	Bench scale jar testing	Optimize treatment process and evaluate possible modifications
	Discontinue softening bypass	Reduce chlorine demand
	Disinfect filters	Reduce chlorine demand
	Increased water main flushing	Reduce water age / stagnant water
	Water system modeling evaluation	Determine areas with high water age and reasons
	Implement coag. & floc. polymer aids, if appropriate	Increase TOC removal
	Modify booster disinfection feeds, if appropriate	Decrease water age
Stage 2	Repair ozone system	Reduce chlorine feed and increase TOC removal
	Continue increased water main flushing	Reduce water age / stagnant water
	Convert to lime and soda ash softening	Increase TOC removal
	Continue valve replacements based on water model	Reduce water age / stagnant water
	Change disinfectant to chlorine dioxide	Reduce THMFP
	Install pre-oxidant feed at intake	Optimize ozone disinfection, reduce chlorine
	Place priority on replacing cast iron water mains	Reduce chlorine demand

Samples were taken the week of November 17th for the 3rd quarter of testing. Although the City has begun implementation of Stage 1 actions, THM results are not expected to be noticeably affected since there has not been enough time for a response. The next quarter of sampling is due to be completed the third week in February. It is the City's intent to implement Stage 1 actions prior to the 3rd quarter of THM sampling.

* O3 system needs to be typical, regulars, for treatment & Grant even when in RUN

TTHM Reduction
Action taken by City
December 16, 2014

Flint's 3rd quarter of TTHM monitoring (Nov 20th, 2014) shows a reduction in TTHM levels at all of the sampling locations. The reduced TTHMs are the combined result of seasonal variation of total organic carbon (TTHM precursors) in the raw water and action taken by the city towards reducing TTHM levels. The amount of reduction contributed by each factor cannot be determined; however, the following is a list of proactive measures taken by the city in their effort to reduce TTHM levels.

1. **Removed the 20 MGAL Dort Reservoir from service.**

   The reservoir allowed treated water from the WTP to re-circulate back to high service thus adding up to one week of retention time.

2. **Softening 100% of the WTP flow during normal plant operation.**

   Softening the complete flow reduces the chlorine demand. During high water demands (large main breaks, filling reservoirs), split treatment must be utilized due to VFD control problems with the 20 MGD low service pump; however, this is not the main mode of operation.

3. **Improved turn-over of water in distribution system reservoirs.**

   The operating range of the Cedar Street and Westside reservoirs was increased from 1-2 ft. (summer) to approximately 10 feet. The increased drawdown has reduced the residence time and improved chlorine residuals.

4. **Established a more proactive flushing program.**

   Increased flushing helped to reduce residence time in the distribution system and, especially, at dead-ends.

5. **Optimizing Transmission System Operation w. repair of major valves and confirming proper valve position.**

   Several critical valves were replaced on one of Flint's four major transmission mains and several other valves (found to be closed) were opened. This eliminated stagnation problems in areas near this main, improved chlorine residuals and allows the main to operate in a looped configuration.

Action to be taken soon:

- **LAN treatability study – jar testing (Starting this week)**
- **Trouble shoot Ozone system – early January**
- **Disinfect filters – after the next 'top-off' of system reservoirs**

Prysby, Mike (DEQ)

From: Busch, Stephen (DEQ)
Sent: Wednesday, December 17, 2014 4:29 PM
To: Wurfel, Brad (DEQ)
Cc: Prysby, Mike (DEQ)
Subject: Flint Drinking Water Actions

Brad,

Here are some of the actions Flint has been taking to address the TTHM levels.

1. Removed the 20 Million Gallon Dort storage reservoir from service to prevent stagnant water conditions.
2. Softening 100% of water instead of partial softening to reduce amount of chlorine needed
3. Modified operation of water storage tanks to increase turn over and reduce stagnant water volumes.
4. Increased frequency of water main flushing to reduce detention time and stagnant water conditions.
5. Repair transmission water mains and valves to allow direct flow patterns and reduce detention time.

The City is also working on these additional items:

1. Further optimization of the enhanced coagulation process, possible use of polymer chemicals
2. Optimization of the ozone treatment process
3. Enhanced cleaning of filters to help reduce amounts of chlorine needed for disinfection

Mike Prysby can provide additional information as needed.

Stephen Busch, P.E.
Lansing and Jackson District Supervisor
Office of Drinking Water and Municipal Assistance
MDEQ
517-643-2314

City of Flint Water Plant DBP
Distribution System Sampling Site Locations

Site ID #	Routine Site Name & Address	Up-Stream Site Name & Address	Down-Stream Site Name & Address
DBP #1 (previously DBP 3)	McDonalds Restaurant 3719 Davison Rd. Flint, MI 48506	Arby's Restaurant 3742 Davison Rd. Flint MI 48506	Admiral Gas Station 3802 Davison Rd. Flint, MI 48506
DBP #2	BP Gas Station 822 S. Dort Hwy. Flint, MI 48503	Advasure Insurance 810 S. Dort Hwy. Flint, MI 48507	Rite-Aid Pharmacy 2838 E. Court St. Flint, MI 48506
DBP #3 (previously DBP 2)	Liquor Palace 3302 S. Dort Hwy. Flint, MI 48507	Mattress Savers 3124 S. Dort Hwy. Flint, MI 48507	Premier Insurance 3316 S. Dort Hwy. Flint, MI 48507
DBP #4	Taco Bell 3606 Corunna Rd. Flint, MI 48532	Rite Aid Pharmacy 3521 Corunna Rd. Flint, MI 48532	McFalls Collision 3614 Corunna Rd. Flint, MI. 48532
DBP #5 (previously DBP 4)	University Market 2501 Flushing Rd. Flint, MI. 48504	Consumer Services 2702 Flushing Rd. Flint, MI. 48504	Rube's Bar 1117 N. Chevrolet Ave. Flint, MI. 48504
DBP #6	Salem Housing 3216 M. L. King Blvd. Flint, MI 48505	BP Gas Station 3317 M.L. King Blvd. Flint, MI. 48505	Hinky Dinky Market 3110 M.L. King Blvd. Flint, MI. 48505
DBP #7	Rite-Aid Pharmacy 5018 Clio Rd. Flint, MI 48504	Urban League of Flint 5005 Cloverlawn Dr. Flint, MI. 48504	Clio Coin Laundry 4930 Clio Rd. Flint, MI. 48504
DBP #8 (previously DBP 3)	North Flint Automotive 6204 N. Saginaw St. Flint, MI 48505	Al & Jerry's Mini-mart 6101 N. Saginaw St. Flint, MI 48505	Hutchinson's Food & Drug 6509 N. Saginaw St. Flint, MI 48505

DBP Sampling Frequency – 8 samples quarterly

- Routine samples are collected during the 3rd full week of February, May, August, & November.
- Prior to April 2014, four (4) samples were required under EPA Stage 2 DBP. Those sites are included in our current 8 samples, and are changes in site codes are indicated in red.
- Due to initial high levels of TTHM after full time operation in April, extra samples have been collected from our Cedar St. & West Side pump stations/reservoirs, to help us determine beneficial operational procedures.

Prysby, Mike (DEQ)

From:	Michael Glasgow <mglasgow@cityofflint.com>
Sent:	Wednesday, December 10, 2014 12:42 PM
To:	Prysby, Mike (DEQ)
Subject:	Re: Stage 2 DBP Monitoring Plan
Attachments:	Nov 2014 MOR Scan.pdf; DBP Distribution System Sampling Site Locations.docx

Mike,

Good afternoon. I don't believe we sent a formal copy of our DBP monitoring plan to reflect the change for full time operation. Prior to April 2014, the Stage 2 DBP monitoring sites were: DBP 1 - 3719 Davison Rd, DBP 2 - 3302 S. Dort Hwy., DBP 3 - 6204 N. Saginaw St., DBP 4 - 2501 Flushing Rd. After April, our monitoring schedule showed that we had to collect 8 DBP samples quarterly. With only 8 distribution sites (disregarding the reservoirs) we use every site in Bacteriological Sample Site Plan. Site #1 is now DBP 1, Site #2 is now DBP 2, an so on. We continued on the same sample time schedule as before April: The 3rd full week of February, May, August, & November. I have attached a copy of the "rough" DBP sample monitoring plan.

I have also attached a copy of the November 2014 MOR, a hard copy will be sent out today.

On Tue, Dec 9, 2014 at 11:15 AM, Prysby, Mike (DEQ) <PRYSBYM@michigan.gov> wrote:

Brent, Michael

Can you e-mail us a copy of Flint's most recent Stage 2 DDBP monitoring plan (updated plan to reflect full-time operation of the WTP – after April 25th)? We need to confirm site codes for the various TTHM/HAA5 sampling locations. Thanks…

Michael Prysby, P.E.

District Engineer

Office of Drinking Water and Municipal Assistance

517 290-8817

Current Stage 2 DDBPR Monitoring Schedules

02310 FLINT, CITY OF

DBP1 3719 DAVISON ROAD

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP2 3302 SOUTH DORT HIGHWAY

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP3 6204 NORTH SAGINAW STREET

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP4 2501 FLUSHING ROAD

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP5 3606 CORUNNA RD

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP6 5018 CLIO RD

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP7 3216 MLK BLVD

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DBP8 822 S DORT HWY

1 per QT	Peak: 5/1 - 5/31	TOTAL HALOACETIC ACIDS (HAA5)
1 per QT	Peak: 5/1 - 5/31	TTHM

DISINFECTION BY-PRODUCTS - DEQ Required Testing

MCL for TTHM = 80 ug/L . MCL for HAA5 = 60 ug/L

	May-14		Aug-14		Nov-14		Feb-15		LRAA		MAX	MIN
	TTHM	HAA5	TTHM	HAA5	TTHM	HAA5	TTHM	HAA5	TTHM	HAA5	TTHM	TTHM
Water Plant Tap	56	36	86	36	**33**	36		36	58.3	36.0	86.0	33.0
	*Once Yearly (June 2014)		*Once Yearly (June 2014)		*Once Yearly (June 2014)		*Once Yearly (June 2014)		*Once Yearly (June 2014)			
Site # 1	162.4	64.0	145.3	43.0	58.6	16.0	16.2	9.0	95.6	33.0	162.4	16.2
Site # 2	111.6	52.0	112.0	40.0	36.2	21.0	19.9	9.0	69.9	30.5	112.0	19.9
Site # 3	96.5	48.0	127.2	31.0	33.3	15.0	16.8	9.0	68.5	25.8	127.2	16.8
Site # 4	106.4	55.0	181.3	24.0	33.9	15.0	18.1	9.0	84.9	25.8	181.3	18.1
Site # 5	75.1	38.0	196.2	11.0	93.6	24.0	24.5	9.0	97.4	20.5	196.2	24.5
Site # 6	82.2	41.0	112.4	25.0	50.1	5.0	28.5	2.0	68.3	18.3	112.4	28.5
Site # 7	88.2	49.0	144.4	30.0	53.6	17.0	19.2	9.0	76.4	26.3	144.4	19.2
Site # 8	79.2	50.0	118.3	37.0	41.1	18.0	14.9	9.0	63.4	28.5	118.3	14.9

***Sampled at end of Oct.**

DISINFECTION BY-PRODUCTS - Other TTHM Investigations

	Jul-14	Aug-14	Nov-14
	TTHM	TTHM	TTHM
Dort Reservoir	153.3	n/a	n/a
Cedar Street Reservoir	n/a	163.3	35.2
West Side Reservoir	n/a	134.4	43.9

In house investigation using Parker TTHM Analyzer provided by United Water Affiliate

	10/16/2014	10/17/2014	10/21/2014	10/29/2014
	TTHM	TTHM	TTHM	TTHM
3 MG Well (PS #4)	48.8	49.9	32.2	34.9
+ 1 hour	54.7	52.8	39.2	n/a
+ 48 hours	n/a	n/a	n/a	116.6
+ 170 hours	n/a	n/a	n/a	168.0

Total Organic Carbon (mg/L)

	Raw	Final
May	10.30	4.57
June	9.00	3.63
July	8.44	2.67
August	8.48	4.06
Sept	7.36	3.30
Oct	7.38	2.99
Nov	7.27	3.86
Dec	6.49	2.59
Jan	7.62	3.21
Feb	5.95	2.07

TTHM Media Inquiry
January 5, 2015

I received a media inquiry from Ron Fonger of the Flint Journal concerning the TTHM MCL violation in the city of Flint. Ron was provided with a copy of our December 16, 2014 Violation Notice letter to the city of Flint concerning the TTHM violation. Ron was also provided with a draft press release on Jan 4th concerning measures being taken by the city to address the TTHM violation. Below is a summary of the questions asked by Ron and my response.

- **How common are TTHMS in Michigan and are there other systems in violation?**

  TTHMs are found in systems that disinfect with CL2 due to the reaction between CL2 and naturally occurring organic compounds (total organic carbon - TOC) in the raw water. There is one other system (customer supply of Saginaw) that has exceeded the TTHM standard. Since this is outside of my district, I do not know the details of the violation.

- **How widespread are the high TTHM levels in Flint?**

  TTHM is monitored at 8 locations throughout the city. Compliance is based on a Locational Running Annual Average (LRAA) meaning that any one location will put the city out of compliance with the TTHM standard if that location fails to meet the standard based on the running annual average (RAA) of 4 quarters of monitoring. The LRAA was exceeded in just 3 quarters at two of the eight locations due to high TTHM concentrations at these locations(May and August quarters).

- **What level of concern should city residents have?**

  TTHMs are a health concern associated with long-term (chronic) exposure as opposed to other contaminants such as pathogenic organisms (fecal coliform, giardia, crypto, etc.) which are short-term concerns…ie…immediate impact to public health. The potential health effects provided in the notice are possible with

long term exposure over a significant portion of the person's lifespan. Consumption of drinking water with TTHMs at this concentration does not pose an immediate threat to public health.

- The most recent test results (November) appear much better; what do residents need to know for the future?

  The decline in TTHMS is two-fold. First, the decline is the result of the city taking pro-active measures in collaboration with the DEQ to address the TTHM concentrations that includes: optimizing current treatment, shortening residence time in water storage reservoirs, optimizing ozone treatment, and improving operation of the distribution system (flushing, repairing valves, and opening valves to eliminate areas of stagnation).

  Next, seasonal variation also contributed to the reduction in TTHM levels as the TOC loading from the Flint River watershed diminishes during the winter months. T

  The city is also pursuing additional treatment options (enhanced coagulation) to help remove TOC and filter cleaning to reduce CL2 demand. Hydraulic modeling of the distribution system will also be performed to further optimize operation of the system reservoirs and pumping stations aimed at reducing stagnation. These efforts combined with steps already taken are expected to dampen higher TTHM levels during the 2015 summer months.

- There has been some criticism regarding the timing of the notice…ie…why weren't residents notified during earlier when high TTHM results were being obtained?

  The city was not in the position to provide a notice since the results obtained last summer did not place the city into a violation status. Also, since TTHMs pose a health concern with term-term exposure ….and in anticipation of exceeding the standard by the end of 2014, the city elected to pursue a proactive approach towards reducing TTHMs (treatment & distribution operation). The city also worked with the DEQ in this effort along with preparation and distribution of the mandatory public notice within 30 days of the start of the violation (December 1, 2014). I

also explained how the LRAA is calculated and why the first two quarters did not constitute a violation.

- **What triggers the TTHM violation?**

As mentioned above, if exceedance of the LRAA (based on 4 quarters of results) occurs at ANY of the eight sampling locations the city is in violation. The LRAA can also be exceeded in less than four quarters (based on a 4-quarter calculation) if the concentration is high enough.

Residents call - Asthetics T/O. DEQ - also direct to DPW to invest Color/TTHM → Asthetic & not related to health standards - TTHM

>55a mid - center areas of pipes / private plumbing most cases asthetic issues

Flint NBC 25 News Interview
Flint TTHMs
January 5, 2015

Walter-Smith Randolth, reporter, from Flint NBC 25 News conducted a telephone interview with me for broadcast on Flint local television concerning the TTHM violation in Flint's drinking water. I led the interview and provided Mr. Randolth an opportunity for follow-up questions. Below is a summary of topics that were presented.

<u>TTHM violation – What does this mean for Flint residents?</u> The TTHM violation notice to residents is not an immediate public health emergency since the health-effects posted in the notice require long-term exposure to TTHMs (over a significant portion of an individual's lifespan). TTHMs commonly occur in public water systems that disinfect with chorine due to the reaction between chlorine and naturally occurring organic compounds (total organic carbon) in the source water. Surface water sources, including the Flint River watershed, typically have higher levels of naturally occurring organic compounds.

→ works proactively / in partnership w. Flint to provide compliance assistance & to ensure

<u>What is the DEQ's Role?</u> The DEQ is working in collaboration with the city to ensure long-term public health protection and to keep the public informed. We are working with the city to help identify improvements in treatment and operation of the distribution system to reduce the levels of TTHMs. We are assisting the city with public notice requirements (when to post/contents). With our assistance, the city has proceeded with an operational evaluation of the water system ahead of state and federal requirements.

<u>DEQ's perspective of the situation:</u> The Flint River source is more difficult to treat since it requires more disinfection to maintain bacteriological intergrity. Increased disinfection; however, when combined with higher levels of naturally occurring organics results in elevated levels of TTHMs that form over time out in the distribution system. The TTHM concentrations that developed in the system were more than anticipated due to several reasons:

70% old CI
5% steel
54% - 6" & less

1. **Flint did not immediately change their mode of distribution system operation after switching sources to account for higher TTHM formation potential of treated water from Flint's WTP.**

I explained that TTHMs require time to form and are not fully developed in the treated water that enters the distribution system from the WTP. Water from Detroit; however, is several days old when it reaches Flint; thus the majority of the TTHMs are developed. TTHMs were also lower given the source water (Lake Huron). Flint's historically operated the distribution system in a manner that created conditions favorable for stagnation. This methodology of operation was not changed (initially) when switching to the Flint River; thus, this condition was one of several factors contributing to higher levels of TTHMs. Other factors included; higher TTHM formation potential in the Flint River (already explained above) and higher chlorine application rates at treatment plant to maintain bacteriological integrity.

I further explained that TTHM levels in the most recent quarter have dropped for two main reasons:

1. **Action taken by the city including; improving dist. system operation to reduce stagnation, treatment changes (complete softening), reduced chorination, system flushing, valving improvements**

2. **Seasonal fluctuation of organic compounds in the Flint River. Less organic loading in the winter months.**

END of MY DISCUSSION

Mr. Smith-Randolf asked for my comment to the following questions/statements....Why this problem is occurring in Flint? Is there a problem with the water system? This was not an issue when Flint was on Detroit water.

I responded by summarizing some of the key points discussed above including:

- **Dist system operation (storage facilities and valving)**
- **TTHM formation potential in Flint River vs. Detroit and age of incoming water**
- **High chlorine dosages to maintain bacteriological integrity**
- **Treatment practices at WTP (partial by-pass of softening)**

SAFE OR NOT SAFE

- City has violated a drw std –
  - to say SAFE OR UNSAFE is not as definitive as a
- Not an immed. public concern since TTHMs are a based on chronic (long-term) exp. Pot. Health
  - Short term exp. to long-term contaminant has diff impact on each indiv based on their background → Med. issue prev. exposure
  - Each indiv is affected & if concerned should seek advice w. Health care provider to take steps to ↓ risk

Meeting with Rep. Neeley and Rep. Phelps
Flint TTHMs
January 6, 2015

Richard Benzie, Sarah Howes, and I met with State Representatives Sheldon Neeley, 34th District and Phil Phelps 49th District to discuss the TTHM violation in Flint's drinking water. Several follow-up questions were asked during and after our discussion. Information provided to Mr. Neeley and Mr. Phelps was in a format similar to that provided in the NBC-25 News interview. We focused on:

What does the TTHM violation mean for Flint residents?

The violation does not pose an immediate public health threat since the health-effects requires long-term exposure to TTHMs (over a significant portion of an individual's lifespan).

TTHMs commonly occur in public water systems that disinfect with chorine due to the reaction between chlorine and naturally occurring organic compounds (total organic carbon) in the source water.

Reason(s) for the violation:

The Flint River source is more difficult to treat since it requires more disinfection to maintain bacteriological integrity; however, this leads to more TTHM formation.

Flint did not immediately change their mode of distribution system operation after switching sources to account for higher TTHM formation potential of treated water from Flint's WTP. Historically, their mode of operation created areas of stagnation in the distribution system which then contributed to the higher levels of TTHMs.

Ongoing Efforts:

The city is working in collaboration with the DEQ towards identifying improvements in treatment to remove TTHM precursors and optimize distribution system operation. The city has already taken action on some of these measures including: complete softening to reduce chlorine dosage and increased turnover of water in the distribution system storage reservoirs to

reduce stagnation. The city is also correcting valving deficiencies to further reduce stagnation.

The city has received scrutiny on the perceived delay to inform residents of the high TTHM levels; however, we stressed that the city has met the state and federal requirements for public notification of this particular contaminant. We explained the rational for determining compliance with the TTHM standard and how this correlates to the public notification requirements. We also informed Mr. Neeley and Mr. Phelps, that TTHM compliance is determined on a RAA (based on 4 quarters); thus, the city will likely remain in violation even with one or two subsequent quarters producing results that are below the MCL.

We also suggested, in addition to meeting our public notification requirements, it may be helpful for the city to explain to their residents how compliance with TTHMS is determined and, more importantly, keep them informed (snapshot in time) of each quarter's results (regardless of compliance status).

Result of On-going Efforts

Efforts taken by the city resulted in a significant reduction of TTHMs in the November 2014 quarter. Seasonal fluctuation of organic loading in the Flint River watershed (less loading in the winter months) also contributed to lower TTHMs.

Questions that were asked:

Can the State become involved with additional TTHM monitoring (third party monitoring)? How would the cost be covered?

The city may elect to conduct additional TTHM monitoring; however, this would be at the city's expense. DEQ staff, depending on availability, may be able to assist in the monitoring. Additional monitoring could be eligible as part of future compliance calculations; however, the monitoring protocol must be approved by the DEQ.

Are the operators at the Flint WTP properly certified?

Yes. The city has an F-1 operator, Mike Glasgow who oversees treatment

operation and is the designated OIC. There are also several F-2 operators including Brent Wright (WTP Supt). The city has also hired additional operators for full-time plant operation. Many of these operators acquired their F-4 certification last fall.

Flint Water Forum
TTHM MCL Violation
January 21, 2015
7:00pm

- **Explanation of violation – What Does this mean?**

Not an Acute public health threat

Regs Long-term exposure

Occs with disinfection

Std is a balancing act

↓ Risk w. microbial — balances w. ↑ Risk TTHM

Std dtm. by Acceptable risk (Factors) Cost Avail. tech

- **Role of the DEQ**

working collaboratively w. city to ensure

- long term Pubic health protection / informed
  - Ed treatment Improves } Op. Eval of
  - Opt. dist. oper. } System

– city has taken Action (ahead of MANDATES) & levels have improved significantly

SAFE?

- City has violated a std.
- Has taken Action to Address Vio
- Working w. DEQ & current levels are Sig. better
- Long term Concern Vs. short term (acute) impact

Std. developed by dtm. of acceptable risk

Factors ↓

cost
tech. Avail
Benefit

Toxicology

Not toxicologists/Med Specialist

It was our understanding – Subgroups more susceptible to Microbial Contam./ Acute nature

Flint Water Forum
TTHM MCL Violation
January 21, 2015
7:00pm

- **Explanation of violation – What Does this mean?**

Not An Acute Public health threat

Long-term exp.

Occurs w. disinfection → Cl_2 + Nat. Organics

Std dtmd by EPA → Acceptable risk vs. Cost vs. Avail tech.

- Std is Black & White
- Risk is Not As line is crossed
  Relative ↑ in Risk as you cross line is Not sig / compared to Microbial Contaminants

- **Role of the DEQ**

- Establish (Provide) guidelines / requirements for city to meet ∑ WQ stds / PN / treatment based on city's choice of source
- Work collaborate / w. city to ensure long term Public Health protection / informed
  - WTP improvements = removal of Organics = alt. disinfectant, ↓ Cl_2
  - Dist imp. – ↓ stag / valving corrections
- City initiated Action

City of Flint

Public Forum

Wednesday January 21, 2015
7:00 pm City Hall Dome

AGENDA

Opening COF – DPW Director - Howard Croft

- Forum Ground Rules (disorderly conduct will not be tolerated)
- Overview of Format (each guest to speak for ~10 minutes with written questions afterword)
- Recognition of Officials
- Introduction of Guests

1st Speaker DEQ – Local Representatives - Mike Prysby, Steve Busch

- Role of DEQ
- Explanation of TTHM violation

2nd Speaker LAN – Lead Engineer - Warren Green

- Discuss Engineering role
- Discuss Operational Evaluation Report

3rd Speaker MSU Microbiologist – Dr. Joan Rose

- Risk Assessment (what do the numbers mean?)
- What to do if someone suspects they are at risk
- What about the elderly and those with a weak immune system
- What will the next violation mean (water is still safe)

4th Speaker GCDC – Jeff Wright

- What to expect from KWA raw water as source
- Update on KWA timeline

Final COF – DPW Director – Howard Croft

- Summary (Next Steps – Action Plans)
  - Hiring an industry expert
  - Tours of Treatment Plant
  - Continued communication
  - Planned steps (CIP built on , Water Reliability Study, Operational Evaluation Report)
  - Funding (researching all sources, state funding, federal opportunities)
  - Water & sewer rates (budgetary evaluation upcoming)
- Questions (Expected to have an hour of panel response time)
- Conclusion - Thank the panel, (Additional follow up at next Public Works Committee meeting)

Department of Environmental Quality (DEQ)

Michael Prysby, P.E.
District Engineer

Stephen Busch, P.E.
Lansing and Jackson District Supervisor

Lockwood, Andrews, and Newnam (LAN)

J. Warren Green, PE
Senior Associate, Director of Engineering

Warren has more than 36 years of experience in engineering management and supervision of complex water treatment and transmission facilities projects. He has successfully guided water system improvements through all necessary phases including feasibility studies, pilot testing, design, financial evaluation, land acquisition, construction, start-up and operation. His expertise is in the areas of facilities design, construction management and contract administration.

He has ~~worked with several~~ works with numerous municipal utility clients throughout ~~Illinois, Mississippi, Michigan and~~ the United States and has been responsible for approx $900M worth of water system improvement. Wisconsin. He worked with the Green Bay Water Utility in Green Bay, Wis., for 12 years, serving as a project manager for a number of design and contract administration tasks. These included the expansion of a 10-mgd raw water pumping station, construction of approximately 17 miles of 54-in. steel water transmission main, and expansion of its water treatment plant in 1997 and 2004. He also oversaw a $376 million project in DuPage County, Ill., where he was responsible for contract administration and construction management of 140 miles of water transmission mains.

MSU Water Quality and Environmental Microbiology Laboratory

Dr. Joan B. Rose, Ph.D.
Laboratory Director/Principal Investigator
Homer Nowlin Chair in Water Research
Co-Director Center for Water Sciences
Co-Director Center for Advancing Microbial Risk Assessment

Joan is an international expert in water microbiology, water quality and public health safety and is a member of the National Academy of Engineering. She has been involved in the investigation of numerous waterborne outbreaks world-wide. Her work addresses the use of new tools for surveying and mapping water pollution for recreational and drinking water; assessment of water treatment technology and use of risk assessment.

Degrees:

- Bachelor's (1976) and Ph.D. (1985), microbiology, University of Arizona
- Master's (1980) microbiology, University of Wyoming

Genesee County Drain Commissioner

Jeff Wright

Past positions include:

- Chief Executive Officer of Karegnondi Water Authority
- Legislative Committee and Executive Board of Michigan Association of County Drain Commissioners
- Northeast District Chairman – Michigan Association of County Drain Commissioners
- Former Secretary/Treasurer – Michigan Association of County Drain Commissioners

- THANK City for Invite
- Thank Residents for Attending
  - opp. to have Q's ANS is important

TAP water
; NMS (copper) Cryptosporidium
; NOT sterile
; CAPE-over the long to all vibs

Community Water Supply

Information Regarding

Total Trihalomethane (TTHM)

Disinfection Byproducts

(1)

DEQ - Community Water Supply

- Regulatory Authority over Public Water Systems
- Michigan Safe Drinking Water Act (Act 399) – Adm Rules
- 1400 Community Supplies in MI (like Flint) — Eg. Unique, RAW well cust source, Dist
- Lansing Jackson Districts – 300 in 13 counties
- Oversight through:
  - Inspection — visits/surveys
  - Monitoring – Provide Stds — Treatment Dist. → TTHM
  - Construction Permitting – Review/Approve design → Act 399 permit
  - Planning – 5yr/20yr needs – R.S./DWRF
- Partnership and Compliance Assistance
  - DEQ works collaboratively w. PWS on solutions to correct WR problems
  - We assist w. compliance on the Alternative chosen by the PWS

What are TTHM's

Trihalomethanes occur when natural organic matter in the water react with chlorine disinfectants. (Byproduct of disinfection process)

4 Chemical Compounds made up of these elements:

- Carbon
- Hydrogen
- Bromine
- Chlorine

Form the 4 main Constituents of TTHMs →

Bromoform
Chloroform
Bromodichloromethane
Chlorodibromomethane

Bromo-Di-chloromethane
Chloro-Di-Bromomethane

Not An Acute Pub. Health Concern that Microbial contam. poses

TTHM Standard

- Based on chronic exposure to low doses
- 80 parts per billion (0.080 ppm) – will be ref. in next slide
- Locational Running Annual Average (LRAA) ← compliance is BASED ON
- Quarterly monitoring at each location ← conducted on
- Location and timing based on highest risk — Longest res time in syst.
- Running = over last 4 quarters, not calendar yr
- Total sum of 4 quarters not to exceed 320 ppb → see table

→ Dist Mon./Not @ WTP due to disinf. byprod. whose conc. varies (↑) with travel time in dist.

Started Same as Acc

DEQ Rec OEL

Flint TTHM Results

TTHM Results (mg/L)					
	5/21/14	8/21/14	11/20/14	LRAA	OEL
DBP1 McDonalds 3719 Davison	**0.162**	**0.145**	0.059	**0.092**	**0.106**
DBP2 Liquor Palace 3302 S. Dort Highway	**0.112**	**0.127**	0.033	0.068	0.076
DBP3 North Flint Auto 6204 N. Saginaw St.	**0.097**	**0.118**	0.041	0.064	0.074
DBP4 University Market 2501 Flushing Road	**0.106**	**0.196**	**0.094** (396)	**0.099**	**0.122**
DBP5 Taco Bell 3606 Corunna Road	0.079	**0.181**	0.034 (294)	0.074	**0.082**
DBP6 Rite-Aid Pharmacy 5018 Clio Road	**0.088**	**0.144**	0.054	0.072	**0.085**
DBP7 Salem Housing 3216 MLK Boulevard	**0.082**	**0.112**	0.050	0.061	0.074
DBP8 BP Gas Station 822 S. Dort Highway	0.075	**0.112**	0.036	0.056	0.065

8 locations

3 monthly sum ↓ LRAA ↓ assume 4th ↓ OEL

INC° Eff

Effort

City proactively starting before Q3

SG ↓ in trying to achieve

Potential Health Effects Related to TTHM

provided by - EPA

- Federal Language
- Some people who drink water containing TTHM in excess of the MCL over many years could experience liver, kidney, or central nervous system problems and increased risk of cancer.

Conveyed to Residents in PN

Explain the Basis

while I'm not a toxicologist

Health Effect Basis

- Toxicology Studies - Uncertainty in using results of high-dose studies in animals to estimate risk to humans from chronic exposure to low doses in drinking water
- Epidemiology – Findings are contradictory. No conclusion of causal link between exposure and health effects.
- EPA determined evidence supports a potential hazard concern and establishment of standard.
- ~~Considered best~~ course of action at this time to reduce potential risks.

- conflicting Basis

correlation of

thus can't

→ Tox studies & Epid

→ Based on what EPA dtms the acceptable ~~cost~~ Risk, compared against cost & Avail technology

Flint took steps proactively to work at
↓ TTHMs After 2nd Round Sept - Nov
Reported 12/1

TTHM Violation Requirements

In Collaborate effort w. DEQ → OEL prep. WTP/Dist Des — upcoming slide

Shown the ability to meet std

Nov samples

- Water supply must take steps to reduce the amount of TTHM so that they are below the standard.
- Water supply must notify customers of the violation within 30 days of after learning of the violation.

~~Dec Mail & Other accepted~~

Via. established after Results of Nov 2014
confirm MCL via. City informed by DEQ on 12/16

Report due every 90 days following estab. of MCL via 12/1 → 3/1

Operational Evaluation

1. System treatment practices
2. System distribution practices
   - Storage tank operations
   - Excess storage capacity

   ↑ drawdown to ↓ stagnation
   - Distribution system flushing — ↓ stag — valving Δcs
   - Source water quality
   - Treatment changes
   - TTHM contributions

   ↑ retract — periods of higher loading
   — Removal of precursors prior to disinfect
9. Steps to minimize future standard violations

Public Notification

objective;

- Designed to provide information to the customer to make more informed decisions
- Short term exposure to long term contaminant has different impact on each individual based on their background
- If health effects had been acute notification would be provided in 24 hours with specific actions for customers

Med issues - Prev exposure

Info on Pot Risk & current time status

Each indiv is diffaent - if concerned - Advice on health care Provider to take steps to ↓ risk

→ on Pot Risk & current time status

Each indiv is different - if concerned - Advice w. health care

[illegible] to take steps to ↓ risk

Prysby, Mike (DEQ)

From: Wurfel, Brad (DEQ)
Sent: Thursday, January 22, 2015 10:43 AM
To: Prysby, Mike (DEQ); Busch, Stephen (DEQ)
Cc: Shekter Smith, Liane (DEQ); Karen Tommasulo
Subject: Fwd: Flint water

Mike, can you please contact Robin Erb at the Free Press?
I provided her and essential briefing, as she had not previously covered this issue.
But my remarks were on background.
Thanks.
b
Sent from my iPhone

Begin forwarded message:

From: "Erb, Robin" <rerb@freepress.com>
Date: January 22, 2015 at 10:39:18 AM EST
To: "WurfelB@michigan.gov" <WurfelB@michigan.gov>
Subject: Flint water

Thanks for the time just now; it was nice to speak to you again.

I'd love to connect with Mike as soon as he has a few minutes. I'm also hoping to nail down a timeline for the boil advisories, the dates of the samples that were problematic, when DEQ notified Flint of the exceedance problems, and the dates of meetings that DEQ has had with residents.

My direct line is 313-222-2708. My cell is PPI

Again, many thanks.

(And really, I don't think you're crazy to hang out on a slab of ice waiting for fish. Nope, not at all. Weirdo.)

Robin Erb
Detroit Free Press Medical Writer
160 W. Fort Street
Detroit, MI 48226
Metro desk: 313-222-6601
Direct line: 313-222-2708

Follow me on Twitter @Freephealth

TTHM Sample Results - January 2015

Extra sampling not connected with the regulatory sampling schedule

Sample Date	Site ID	Bromoform (ug/L)	Chlorodibromomethane (ug/L)	Chloroform (ug/L)	Dichlorobromomethane (ug/L)	Total Trihalomethanes (ug/L)
1/27/2015	D.S. #1	1.6	9.4	12	12	35
1/27/2015	D.S. #2	1.1	6.5	7.1	7.9	23
1/27/2015	D.S. #3	1.1	6.6	7.0	8.0	23
1/27/2015	D.S. #4	1.2	7.0	7.6	8.2	24
1/27/2015	D.S. #5	1.6	9.5	12	12	35
1/27/2015	D.S. #6	1.7	8.7	12	11	33
1/27/2015	D.S. #7	1.2	7.7	9.9	10	29
1/27/2015	D.S. #8	1.0	6.1	6.3	7.1	21
1/27/2015	C.S.	1.1	6.6	7.5	8.0	23
1/27/2015	W.S.	2.2	14	23	21	60
1/27/2015	City Hall	1.6	11	19	16	48
1/27/2015	W.S.C.	1.7	10	13	13	38
1/27/2015	Plant Tap	0.76	4.3	4.9	5.6	16
1/27/2015	C.F.E. North	<0.50	1.7	2.2	2.4	6.3
1/27/2015	C.F.E. South	<0.50	1.2	1.8	1.8	4.8

Normal Distribution Samples
Water Plant Samples & Reservoirs
Other Distribution System Sites

Minimum Concentration (ug/L):	4.8
Maximum Concentration (ug/L):	60

city supply ON-line TTHM analyzer — 3 min
Oz — pump well — extractor
to one mile 2nd opinion
key elements

1/27 Sub Mkt 2/19/15

001887

Turbidity – 2 units from PAC

Exp. Need – Unable to ~~decrease~~ eliminate WTP

OPT → Floc ↑ Fock ↓ TOM lot

& Floc A.d Polys to ↓ Turb lot (Thru Hy)

Fail PAC ~~@~~ – ↑ F Feelers work

↳ iP good, Now Jack to replacement

Soda Ash – very helpful – Buy cost 500 - 600

800 Lb/Day – Avg Dose

↳ CLOSED

* Any way to get city in explore Private Avg 15 Administrative Ruling

O_3 system Repaired & up & running good

100% softening – Every 5 lb running

KMnO4 – Also – Use lot & d. pre/post T.C

Stage 1 – Immediate Actions

- Hire ozone system manufacturer to troubleshoot ozone system
  - Manufacturer and controls programmers have performed on site evaluations
- Bench scale jar testing
  - Match existing process and assess possible areas of improvement
    - Existing process simulated, evaluation of existing chemical feed dosage adjustments partially complete
  - Simulate potential modifications to treatment process
    - Soda ash softening evaluation partially complete, PAC feed yet to be tested
  - Evaluate coagulation and flocculation polymer aid feeds to assist with TOC removal
    - Evaluation of polymer aids partially complete
- WTP operational changes
  - Discontinue softening bypass stream to reduce chlorine demand
    - Operational directive has been set to soften no less than 90% of flow
  - Disinfection of filter beds to reduce chlorine demand
    - Utility Service Group has been contracted by City and condition assessment is currently underway
  - Possibly begin coagulation and flocculation polymer aid feeds to assist with TOC removal depending on bench scale test results
    - Polymer aids still being evaluated, but increased ferric dose implemented
- Increase water main flushing efforts to minimize stagnant water
  - Flushing efforts ongoing
- Water system modeling to identify areas with high water age and potential solutions
  - Cedar Street Pump Station potential recirculation
  - West Side Pump Station potential recirculation
  - Storage tank volume use
    - Increased reservoir output to reduce detention time
  - Possible broken closed valve locations
    - Model has been updated with known broken valve locations. Model results are being evaluated for indications of other possible broken valves. City has also initiated valve assessment program.
  - Locations in need of flushing
    - High water age areas have been identified in the water model. Further evaluation forthcoming to determine most effective flushing points.
  - Lower high water levels in storage tanks
    - Operating levels of all reservoirs have been lowered to reduce water age

Stage 2 – Contingent Actions

- Fix ozone system
  - Some repairs have been made to gauges and programming and the system is producing adequate ozone. Cleaning and additional minor repairs are forthcoming.
- Start feeding coagulation and flocculation polymer aids to lower TOC, if not completed in Stage 1

- Alternative comparison and cost effectiveness being evaluated
- Convert to lime and soda ash softening
  - Alternative comparison and cost effectiveness being evaluated
- Change disinfectant to chloramine or chlorine dioxide until KWA
- Install pre-oxidant feed at intake to optimize ozone disinfection
- Implement advanced treatment for THM precursor removal
- Increased main flushing based on water modeling results
- Continue valve replacements with water model assistance
- Emphasize cast iron pipes on water main replacement priority list

Tom Henry
858-3678
Apt 1903

FW: TAC — 6 comm. fm GCDC

Prysby, Mike (DEQ)

From: John O'Brien <jfobrien@gcdcwws.com>
Sent: Friday, February 20, 2015 8:43 AM
To: 'Howard Croft'; donna. cole; gdn2@aol.com; Kirk Smith; larry.koehler@mcc.edu; mgavuli1@hurleymc.com; Mike Lane; Prysby, Mike (DEQ); Pete Levine; rosejo@msu.edu; Russell.Hudson@mclaren.org; Brent Wright; Daugherty Johnson; Michael Glasgow; rob.nicholas@veolia.com
Cc: Flint Mayor; Gerald Ambrose; Elizabeth Murphy; David Gadis; Jason Lorenz
Subject: RE: Technical Advisory Committee Update

Howard
In review of both the Veolia and IRM they are both similar recommendations except for one item
Water softening this item needs to be resolved to soften or not
The technical committee can not answer this question
Until this is decided we can not discuss the treatment process
John O'Brien

From: Howard Croft [mailto:hcroft@cityofflint.com]
Sent: Thursday, February 19, 2015 3:52 PM
To: donna. cole; gdn2@aol.com; John O'Brien; Kirk Smith; larry.koehler@mcc.edu; mgavuli1@hurleymc.com; Mike Lane; Mike Prysby (DEQ); Pete Levine; rosejo@msu.edu; Russell.Hudson@mclaren.org; Brent Wright; Daugherty Johnson; Howard Croft; Michael Glasgow; rob.nicholas@veolia.com
Cc: Flint Mayor; Gerald Ambrose; Elizabeth Murphy; David Gadis; Jason Lorenz
Subject: Technical Advisory Committee Update

Team,

I have include a list of all of the current participants in the Technical Advisory Team. We are targeting Wednesday March 4th as the first meeting and the time and place are yet to be determined. I have listed a few items to help craft the direction that we are hoping to go with this team;

1. We will likely have a conference number as well as a physical meeting place in case someone is not able to be there.

2. We will define as we go along how often to hold meetings, but we plan to continue throughout the implementation of the KWA.

2. We will start with a general scope and set of deliverables but will look for open input from the group in order to develop additional specifics as to what each member would like to accomplish.

3. Certainly with this assembled team we would want to develop a set of medical FAQ's that would assist the medical community with current and future details of chemicals and risk assessments.

4. We will discuss the treatment process and look at the national discussion on whether or not to use fluoride as well as what additional regulations are possibly being considered the EPA for the future.

5. We will look at what is upcoming with the KWA and water from Lake Huron. What will the chemical challenges be? What will the final product entail?

6. We will evaluate testing options or partners and determine if there is an avenue or demand for such.

These are some of the topics that I plan to delve into and I believe that we have assembled a professional team that can bring enlightenment to all of us. I look forward to working with each of you.

Respectfully Submitted,

--

Howard Croft
Public Works Director
City of Flint
1101 S. Saginaw Street
Flint, MI 48502
PH# 810.766.7135 Ext.2043
hcroft@cityofflint.com

Prysby, Mike (DEQ)

From: Brent Wright <bwright@cityofflint.com>
Sent: Friday, February 20, 2015 9:11 AM
To: Prysby, Mike (DEQ)
Subject: Re: call

Mike

Marvin Gnagy from Veolia wanted to talk with you about some of the suggestions they were making for treatment here at the plant. He wanted to know what could be implemented right away and what might need permit approval from the MDEQ. They were here running test all week but left yesterday. I have listed his contact number and email below. I would appreciate it if you could get in contact with him so he can finalize his report and send his recommendations to the city administration.

Marvin Gnagy
419-450-2931
marvin.gnagy@veolia.com → called Marvin Gnagy on 2 Feb 2015 → see notes on Back-9

Thank you

On Fri, Feb 20, 2015 at 8:40 AM, Prysby, Mike (DEQ) <PRYSBYM@michigan.gov> wrote:

Brent,

Are we having a conference call today? I am available, give me a time for the call and I will make my-self available.

Michael Prysby, P.E.

District Engineer

Office of Drinking Water and Municipal Assistance

517 290-8817

--
Brent Wright

Water Plant Supervisor
City of Flint
4500 N. Dort Hwy.
Flint, MI. 48505
Ph: 810.787.6537 ext. 3510
Fx: 810.787.3710

001895

(2/20/14)

(1) Remove Front doors & gps — JAR tests

Lower cup to 6 TTHMs

Alum clean Hydrate for Better ↓TOC — CP.

MAY Reduce it

Increased to OEL 1.3

& will likely reduce kg/hr Ferric dosage

(2) Softening, want Mag ↓

may reduce ↓ lime dosage to min. Hardness off Basins

(3) Removal on Anthracite & sgl GAC on Filters

— Maintain GAC or put back in the Anthracite?

(4) Re-looking @ CT in summer months

— CT — summer w. ↑ temp & Elim. CL

Pool portion of Filters

we will need to agree on 4 hr for gp. Δ in summer

(5) 2 stage coag. — most. in clarif.

— & some in

clear pulsator

Sodium permanganate pre oxl

10 mg/l Ferric

Ex — Clarification

2a — just Ahead of softening

(6) kMnO4 (NaMnO4) — point to add — could → more young's modulus allow better use

of O3 — .5 — no mg/l in TAR studies

& Alk, TOC Rem. perhaps 10% — key will it react w. Ozone

CITY OF FLINT

Department of Public Works

Dayne Walling
Mayor

Gerald Ambrose
Emergency Manager

Howard Croft
Director

Technical Advisory Committee Members,

On behalf of the City of Flint, I want to thank you for your willingness to participate in the City of Flint Technical Water Advisory Committee. This committee was formed to address many of the issues related to water that have arisen in our community over the past 10 months.

The first meeting is scheduled for Wednesday March 4th, 2015 from 2:00 – 4:00 pm at Flint City Hall. At our first meeting we will hear an overview from the engineer of record Lockwood Andrews & Newnam, and a review of the assessment findings and recommendations from our consultant Veolia North America.

We welcome the addition of a USEPA Representative that will be present at the first meeting as well as our other distinguished participants. For those that cannot be present in person we have established the ability to participate via a conference line.

For conference access please call PPI conference number PPI.

Regards,

Howard D. Croft
Public Works Director
City of Flint

Prysby, Mike (DEQ)

From: Howard Croft <hcroft@cityofflint.com>
Sent: Friday, February 27, 2015 10:26 AM
To: Brent Wright; Daugherty Johnson; Dayne Walling; donna. cole; gdn2@aol.com; Howard Croft; James Henry; John O'Brien; Kirk Smith; larry.koehler@mcc.edu; Laura Sullivan; mgavuli1@hurleymc.com; Michael Glasgow; Mike Lane; Prysby, Mike (DEQ); Natasha Henderson; Pete Levine; rob.nicholas@veolia.com; rosejo@msu.edu; Russell Hudson; Samir Matta; Warren Green; jmikewright
Subject: First Technical Team Meeting
Attachments: TAC Invitation Letter.pdf

Technical Team Members,

This is a reminder of our first meeting date next Wednesday March 4th at Flint City Hall at 2:00 - 4:00 pm. Please bring any questions or goals that you would like to see developed out of the group as we will create the final overarching agenda in the committee.

On a side note, our February TTHM test results were returned from the state lab this morning and all eight test sites are substantially below the MCL.

I look forward to seeing everyone on Wednesday.

Regards,

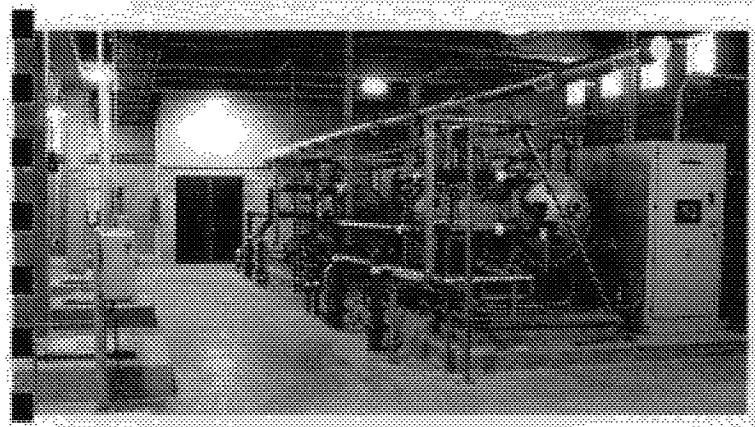
--
Howard Croft
Public Works Director
City of Flint
1101 S. Saginaw Street
Flint, MI 48502
PH# 810.766.7135 Ext.2043
hcroft@cityofflint.com

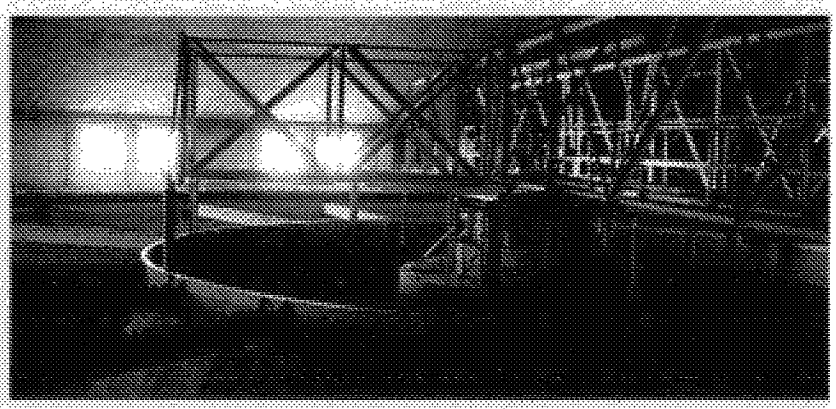
Operational Evaluation Report
City of Flint

FINAL

Trihalomethane Formation Concern

February 27, 2015





Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

City of Flint
Operational Evaluation Report
March 1, 2015
MDEQ Comments

1. Revise Tables 2 and 3 on Page 7 to account for proper alignment of DDBP samples (results, location, site code). Also, revise statement on Page 1 regarding the number of sites exceeding the TTHM MCL following the 4th quarter sample cycle.

2. The ozone system was recently repaired. (Page 10 & 19). What is the ozone system's current production rate?

3. The city's hydraulic model (prepared by Potter Consulting) is being updated (Page 16). Is the model currently sufficient in determining proper sizing for the transmission main replacement in DuPont & Bishop Street corridor? (currently sized at 24-inch) (Pages 5, 16, and 20)

4. Are the potassium permanganate results & conclusions available? (Pages 4 and 17)

5. We agree that some reduction in storage volume could be achieved without compromising reliability; however given high usage, main breaks, and "let runs" during the winter, storage volume remains important. We agree with the need to determine adequate storage volume which will likely differ between summer and winter. (Page 15)

6. We agree with the concern of re-circulation of water pumped from the booster pump stations; however, we were recently informed of existing distribution system check valves to prevent recirculation. These appurtenances and their condition need to be confirmed. The hydraulic model may also need to be updated to include these valves. (Page 15)

7. We concur with the recommendation to provide the ability to monitor raw water TOC and PTAP TTHM. (Pages 17 & 18)

8. Page 20 provides 2 options to manage water age and each option includes reducing the utilized storage volume of the 3 MGAL well to 2 MGAL. The reduction in storage volume limits the WTP's ability to meet CT under worst case conditions (low temp, high pH, 30 MGD pumping rate from reservoir).

9. Table 11 on Page 21 outlines an Action Plan for Stage 1 and Stage 2 actions. Several actions listed in Stage 2 including; repair of ozone system, continued valve replacement, and replacement of deteriorated watermains are longer term solutions; however, they need to proceed regardless of the outcome of TTHM reduction.

Lockwood, Andrews & Newnam, Inc.

PLANNING

ENGINEERING

PROGRAM MANAGEMENT

Est. 1935

AUSTIN, TX
CHICAGO, IL
CLEARWATER, FL
COLLEGE STATION, TX
DALLAS, TX
FLINT, MI
FORT WORTH, TX
HOUSTON, TX
HUNTINGTON BEACH, CA
LAS VEGAS, NV
LOS ANGELES, CA
MIAMI, FL
MILPITAS, CA
PHOENIX, AZ
SACRAMENTO, CA
SAN ANTONIO, TX
SAN MARCOS, TX
WACO, TX

TRANSMITTAL

Filing Data Code 1-07

☐ UPS ☐ FEDEX ☐ DELIVERY SERVICE ☒ HAND DELIVER ☐ OVERNIGHT ☐ REGULAR MAIL ☐ PICK-UP ☐ OTHER Extranet(To PM)

To: Mr. Michael Prysby	**Date** 02-27-15
	Project Number 130-10701-001
Company: MDEQ	**Routing:**
Address: 525 WEST ALLEGAN STREET Lansing, MI 48933	
Project: City of Flint Water OER	

We Are Sending You:

- ☐ Shop Drawings
- ☐ Original Drawings
- ☐ Prints
- ☐ Specifications
- ☒ Reports
- ☐ Submittal Data
- ☐ Proposal
- ☐ As Noted

These Are Transmitted:

- ☐ As Requested
- ☒ For Your Use
- ☐ For Review and Comment
- ☐ For Your Signature

Quantity	Description
2	Final Operational Evaluation Report for THM

Remarks

These updated plans are being issued for bidding and are intended to replace the two sets that were submitted to your office last week.

DEQ
RESOURCE MANAGEMENT DIVISION
MAR 0° 2015
LANSING DISTRICT

Distribution

1- Daugherty Johnson
2- Brent Wright
3- File

Prepared By

Jeffrey Hansen, PE

1311 SOUTH LINDEN ROAD
SUITE B
FLINT, MI 48532
TEL 810.820.2682
FAX 810.820.2703
www.lan-inc.com

If enclosures are not as noted, kindly notify us at once.

8-018-0

EXECUTIVE SUMMARY

Environmental Protection Agency (EPA) and Michigan Department of Environmental Quality (MDEQ) regulations require that public water suppliers test drinking water quarterly throughout the distribution system for disinfectant by-products (DBP's). Two categories of DBP's, tri-halomethanes (THM) and halo-acetic acids (HAA5), are regulated and must be tested for. The City of Flint began operation of their water treatment plant (WTP) full time with the Flint River as the source on April 25, 2014. Since that time, four quarters of samples taken have resulted in an annual average violation for total THM. Prior to the first violation (Nov. 2014), the City hired Lockwood, Andrews & Newnam, Inc. (LAN) to complete this Operational Evaluation Report (OER) in conformance with EPA guidelines with the goal to determine the cause(s) of high levels of THM and evaluate possible solutions.

The EPA promulgated the Stage 2 Disinfectants and Disinfection By-Products Rule (DBPR) in January 2006 which set maximum contaminant levels (MCLs) for total trihalomethanes (TTHM) and HAA5 based on an annual running average, tested quarterly, for a given sampling location. The City of Flint reports levels from 8 sampling test locations. Of the four quarterly sampling cycles since Flint began operating the WTP full time, HAA5 levels have been acceptable but TTHM levels were high at 4 sampling sites following the third sampling cycle. Average THM levels exceeded the MCL at 3 sites following the fourth sampling cycle.

A number of issues have been identified as possibly contributing to the high THM levels measured.

1. Inefficient ozone system functionality which has resulted in increased chlorine feed.
2. Upstream source influences in terms of increased chlorine demand.
3. Bypass stream around softening contributed to chlorine demand and increased total organic carbon (TOC) levels in the effluent.
4. Unlined cast iron pipes in the distribution system contributing to chlorine demand.
5. High water age in the distribution system due to:
   a. Broken valves causing less than ideal flow patterns.
   b. Inefficient pump station pressure zones
   c. Water storage volumes in excess of that needed for today's demands.
   d. Oversized water mains
   e. Low water demands
6. High chlorine demand in filters.
7. High THM formation potential (THMFP) in source water.
8. Less than optimal removal of THM precursors

A graphical representation of how the factors above relate to the timing of THM compliance sampling is shown as Table 1. Compliance sampling dates are hatched. Each row in Table 1 describes a factor than can lead to increased THM levels and the table defines when each of those factors applied. Note the convergence of nearly all factors around the second sampling period on August 21, 2014 to create what appears to be a worst case scenario. The table also shows that the factors listed as those that the City can control have been addressed prior to the February sampling period. Monthly operating report data up to February 1,2015 is depicted on the Table.

TABLE 1 - SUMMARY OF NEGATIVE INFLUENCES ON THM COMPLIANCE SAMPLING

FACTOR	2014								2015	
	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Softening bypass stream over 20% of plant flow										
Ozone system not feeding optimally										
Using full water storage capacity of WSR & CSR										
Chlorine feed at WTP 7.0 mg/l or more										
Ferric chloride feed rate less than 10 mg/l Fe3+										
Raw water temp 23 degrees C or more										
Raw water TOC levels above 8.0 mg/l										
Raw water coliform over 5000 counts/day										
Positive bacteria test in dist. system (boil water notice)										
Water demand less than 15 mgd										

Dates of occurrence
Dates of occurrence and expected to repeat in future years
Compliance sampling date

Factors under Flint staff control
Flint River characteristics
System factors

ACTION PLAN

The City of Flint has signed an agreement with the Karegnondi Water Authority (KWA) to purchase raw water drawn from Lake Huron. The KWA system is currently under construction and expected to be operational by late 2016. The water supply from Lake Huron will have entirely different water quality characteristics from the Flint River and those characteristics are expected to yield drastically reduced DPB formation. With that, non-structural options to help reduce THM levels are much preferred over solutions requiring new construction. Therefore, two categories of actions have been devised: Stage 1 being actions that can be completed relatively quickly without major construction and Stage 2 consisting of either long term actions or solutions requiring major construction. The City is actively working to complete Stage 1 actions as soon as possible. Stage 2 actions are to be implemented only if Stage 1 actions are ineffective in adequately reducing TTHM levels and therefore Stage 2 is contingent upon the outcome of Stage 1. As of the date of this report, status updates for action items are shown in red.

Stage 1 – Immediate Actions

- Hire third party water quality expert to complete independent 'water audit'
  - The City hired Veolia Water to review all water quality related operations, procedures, actions taken and planned responses. Recommendations from Veolia are expected by the first week in March 2015.
- Obtain an in house THM analyzer to allow regular operational monitoring of THM levels
  - THM analyzer was installed 2/17/15.
- Hire ozone system manufacturer to troubleshoot ozone system
  - Manufacturer and controls programmers performed on site evaluations in January 2015. ⟶ Follow up ?
- Bench scale jar testing
  - Match existing process and assess possible areas of improvement
    - Existing process was simulated and an evaluation of existing chemical feed dosages has been completed by LAN.
    - Existing process TOC profile was developed by Veolia.
  - Simulate potential modifications to treatment process
    - Soda ash softening evaluation completed and PAC feed testing completed by LAN.
  - Evaluate coagulation and flocculation polymer aid feeds to assist with TOC removal
    - Evaluations of polymer aids completed by LAN and PVS Technologies.
- WTP operational changes
  - Discontinue softening bypass stream to reduce chlorine demand
    - Operational directive has been set to soften no less than 80% of flow.
  - Disinfection of filter beds to reduce chlorine demand
    - Utility Service Group contracted by City and condition assessment completed. Controls improvements have been completed.
  - Begin coagulation and flocculation polymer aid feeds to assist with TOC removal if bench scale test results are positive
    - Jar testing completed to date has not indicated a useful benefit to feeding coagulation/flocculation polymer aids. Increased ferric doses have been implemented at the WTP based on positive jar test results.

Based on [illegible] w. Maximum [illegible]

- Increase water main flushing efforts to minimize stagnant water
  - Flushing efforts are ongoing as weather permits.
- Water system modeling to identify areas with high water age and potential solutions
  - The water model has been improved and preliminary results, including system wide water age, have been produced. Water demand updates and reconciliation with operator's data are scheduled for March 2015 to complete water modeling analysis.
  - Cedar Street Pump Station potential recirculation
    - Water model analysis to be completed in March 2015.
  - West Side Pump Station potential recirculation
    - Water model analysis to be completed in March 2015.
  - Storage tank volume use
    - Operating levels of West Side and Cedar Street reservoirs have been lowered to reduce water age.
  - Possible broken closed valve locations
    - Model has been updated with known broken valve locations. Model results are being evaluated for indications of other possible broken valves. City has also initiated valve assessment program.
  - Locations in need of flushing
    - High water age areas have been identified in the water model. Further evaluation forthcoming to determine most effective flushing points.

Stage 2 – Contingent Actions

- Fix ozone system
  - Repairs have been made to gauges and programming and the system is producing proper ozone and functioning under manual operation. Further minor repairs are planned for the 1st quarter 2015 to allow automatic operation.
- Start feeding coagulation and flocculation polymer aids to lower TOC, if not completed in Stage 1
  - Polymers evaluated by LAN did not demonstrate notable benefit.
  - PVS Technologies evaluated a proprietary polymer that showed little benefit.
- Convert to lime and soda ash softening
  - Cost effective analysis to be developed, if necessary, based on routine operation THM level monitoring.
- Change disinfectant to chloramine or chlorine dioxide until KWA
  - Cost effective analysis to be developed, if necessary, based on routine operation THM level monitoring.
- Install pre-oxidant feed at intake to optimize ozone disinfection
  - Permanganate feed at intake was evaluated by Veolia the week of 2/16/15 and recommendations are expected by the first week in March 2015.
- Replace filter media with granular activated carbon (GAC) media
  - Cost effective analysis to be developed, if necessary, based on routine operation THM level monitoring.
- Implement advanced treatment for THM precursor removal
  - Cost effective analysis to be developed, if necessary, based on routine operation THM level monitoring.
- Increased main flushing based on water modeling results
  - Water model analysis to be completed in March 2015.

- Continue valve replacements with water model assistance
  - Water model analysis to be completed in March 2015.
- Emphasize cast iron pipes on water main replacement priority list
  - Flint has bid replacement of over 2 miles of 24" cast iron pipe along Dupont and Bishop Streets to be completed this coming construction season. The water main section is considered a critical transmission main, and is expected to contribute to decreases in water age when complete

THM samples have been taken and tested 5 times since the City began using the Flint River for supply. Four sets of samples were taken for official regulatory compliance and one set of samples was taken by the City for operational monitoring. Samples were taken in May 2014, August 2014, November 2014, January 2015, and February 2015. THM levels at all sample sites have declined from August 2014 to February 2015. The average of all sample sites in August was 142.1 ug/l and the most recent average of samples taken in February 2015 was 19.8 ug/l. The MCL defined by the EPA is 80 ug/l.

I. BACKGROUND

The City of Detroit Water and Sewer Department (DWSD) has historically provided drinking water for the City of Flint and Genesee County. In the late 1990's growing concern regarding the reliability of the DWSD supply prompted the City of Flint to upgrade their existing water treatment plant (WTP). Those improvements, defined as Phase I, were completed in 2005 and were intended to allow the Flint WTP to operate, using the Flint River as the source, for an extended period of time in the event that supply from the DWSD was temporarily interrupted. Additionally, the Phase I improvements set the stage for Flint to break free from dependence on the DWSD supply and water charges over which they had no control.

A. WATER SUPPLY TRANSITION

1. Detroit Water and Sewer Department (DWSD)

Until recently the Genesee County and Flint region had been provided drinking water by the DWSD. However, due to excessive cost increases and reliability issues with the DWSD system other options had to be explored.

2. Karegnondi Water Authority (KWA)

In 2010 the Karegnondi Water Authority (KWA) was formed for the purpose of developing a new water supply from Lake Huron to serve the region in lieu of the DWSD supply and the City of Flint elected to join. The KWA expects the new system which is currently being constructed to become operational by the fall of 2016.

3. Flint River – Interim Period

With a renewing water supply agreement between Flint and the DWSD being terminated by the DWSD (effective April 30, 2014) and the KWA system not expected to be operational until late 2016, the City of Flint decided to initiate operation of the existing WTP full time utilizing the Flint River as the interim water source. A variety of WTP improvements were necessary for the Flint plant to become a full time plant. For purposes of this report, Phase II improvements to the Flint WTP are improvements intended to allow the plant to operate full time with either the Flint River as the source or the KWA supply as the source.

B. TTHM VIOLATIONS

The EPA and MDEQ method of determining if TTHM sample results exceed the MCL uses a locational running annual average (LRAA). Flint's first TTHM violation was cited by the MDEQ following the third cycle of sampling completed in November 2014. Of the 8 sampling sites, 4 were in violation. At that time the MDEQ used the following calculation for determining if the MCL had been violated:

(2 x current quarter value + previous 2 quarter values) / 4 = Operational Evaluation Value

Flint has now completed tests for 4 quarters and a straight annual running average applies. Based on samples taken on February 17, 2015 the number of sites in violation of the THM MCL limit has decreased to three. The City also conducted a round of sampling on January 27, 2015 in order to internally monitor the progress of actions taken to address the THM issue. It is worth noting that each round of sampling since August of 2014 has indicated a significant drop (improvement) in THM levels. Test results are tabulated in Table 2. HAA5 sample results are shown in Table 3, of which Flint has had no violations.

TABLE 2 – TTHM TEST RESULTS (ug/L)						
Sample Location	1st Qrt 5/21/14	2nd Qrt 8/21/14	3rd Qrt 11/21/14	Inter. 1/27/15	4rth Qrt 2/17/15	LRAA
WTP Tap	56	86	33	16	-	na
1) 3719 Davison McDonalds	162.4	145.3	58.6	35	16.2	95.6
2) 822 S. Dort Hwy BP Gas Sta.	111.6	112.0	36.2	23	19.9	69.9
3) 3302 S. Dort Hwy Liquor Palace	96.5	127.2	33.3	23	16.8	68.5
4) 3606 Corunna Taco Bell	106.4	181.3	33.9	24	18.1	84.9
5) 2501 Flushing Univ. Market	75.1	196.2	93.6	35	24.5	97.4
6) 3216 MLK Salem Housing	82.2	112.4	50.1	33	28.5	68.3
7) 5018 Clio Rite Aid	88.2	144.4	53.6	29	19.2	76.4
8) 6204 N. Saginaw N. Flint Auto	79.2	118.3	41.1	21	14.9	63.4

TTHM MCL = 80 ug/l

TABLE 3 – HAA5 TEST RESULTS (ug/L)						
Sample Location	1st Qrt 5/21/14	2nd Qrt 8/21/14	3rd Qrt 11/21/14	Inter. 1/27/15	4rth Qrt 2/17/15	LRAA
WTP Tap	36 (taken June 14, 2014)					na
1) 3719 Davison McDonalds	64	43	16	Na	9.0	33.0
2) 822 S. Dort Hwy BP Gas Sta.	52	40	21	Na	9.0	30.5
3) 3302 S. Dort Hwy Liquor Palace	48	31	15	Na	9.0	25.8
4) 3606 Corunna Taco Bell	55	24	15	Na	9.0	25.8
5) 2501 Flushing Univ. Market	38	17	24	Na	9.0	22.0
6) 3216 MLK Salem Housing	41	25	5	Na	2.0	18.3
7) 5018 Clio Rite Aid	49	30	17	Na	9.0	26.3
8) 6204 N. Saginaw N. Flint Auto	50	37	18	Na	9.0	28.5

HAA5 MCL = 60 ug/l

C. WATER TREATMENT PLANT RECENT IMPROVEMENTS & STATUS

1. Phase I WTP Improvements

Since 1965, the Flint WTP has remained a secondary or backup supply system to the DWSD primary supply. Typically the secondary supply for a public water system is expected to be needed only during emergency situations and normally is designed for short term operation such as providing the average daily demand for a few days. Conversely, Phase I improvements were designed with the intent to upgrade the Flint WTP in order to allow for an extended short term period (6 weeks) because of the perceived high risk that the DWSD supply would fail and remain out of service for an

extended duration. Regardless, the Flint WTP was still intended to serve as a standby plant and as such the Phase I improvements lacked redundancies that would be required for a primary supply WTP.

2. Past Pilot Study & Testing

During design of the Phase I improvements a treatability study was completed by Alvord, Burdick & Howson, LLC (AB&H) in 2002. The Treatability Study evaluated the current treatment processes that are in place at the Flint WTP today with the Flint River as the source. The report recommended the following:

TABLE 4 – 2002 WTP TREATMENT RECOMMENDATIONS

Treatment	Purpose	Point of Application	Dosage (mg/l)
Sodium permanganate	Zebra mussel control	Intake	0.3
Ozone	Taste & odor removal, disinfection	Diffusor basin	1.5
Ferric chloride	Coagulation	Rapid mix	40
Coag aid polymer	Turbidity & TOC removal	Rapid mix	2.0
Floc aid polymer	Turbidity & TOC removal	Floc basin	0.05
Lime	Softening	Softening basin	175
Soda ash	Softening	Softening basin	52
Carbon dioxide	pH adjustment	Recarb basin	37
Media filters	Filtration	N/A	Na
Chlorine	Disinfection	Filter effluent	1.0

Of the recommended items, zebra mussel control, coagulant and flocculation polymer aids, and soda ash feed have not been incorporated into the treatment process.

3. Phase II WTP Improvements for Full Time Operation

Phase II WTP improvements are those needed to convert the Flint WTP from a back-up supply to a primary supply plant. A number of improvements have already been constructed as they were necessary to operate full time when treating water from the Flint River. The improvements under the title of Phase II that have been completed or are nearly complete include installation of the future raw water feed connection point and valving for the KWA supply, upgrades to the lime sludge lagoon, the lime sludge lagoon decant and disposal system, decant pump station and force main, installation of mid-point chlorination before filtration, and upgrade of the electric feed sub-station.

Additional improvements to the Flint WTP that are to be completed to become part of the normal treatment process using water supplied by the KWA are:

- New oxygen and nitrogen storage facilities for the ozone system (under construction)
- New coagulant feed system
- Electrical
  - Pump Station #4 upgrades (under construction)
  - SCADA and controls upgrades
  - Filter transfer pump station feeders
- Pump replacements and VFD installation in the low and high service pump station (under construction)
- Filter transfer pump station to Dort Reservoir
- Facility security improvements

II. SOURCE WATER EVALUATION

A. DATA ANALYSIS

Based on past data collected and the 2002 Treatability Study by AB&H, the Flint River water quality varies seasonally with higher hardness and alkalinity experienced in the winter. Higher magnesium concentrations are also experienced in the winter, adding difficulty to the settling process due to neutrally buoyant floc. General water quality average characteristics recorded for the 2002 Treatability Study as compared with average characteristics recorded in 2014 are shown in Table 5 below.

TABLE 5 – FLINT RIVER WATER QUALITY CHARACTERISTICS

Period	Turbidity NTU	TOC Mg/l	Alk. Mg/l	Hardness Mg/l as CaCO3	pH	Total Col. Count/day	THMFP Mg/l
2001 Apr–Oct	7.9	9.4	215	272	8.1	870-1230 (7300 max)	410
2014 May–Oct	8.3	10.3 5/22/14	207	252	8.2	1900-9000 (48,300 max)	187

The Flint River characteristics do not appear to have changed significantly over the past 10+ years. Note that further investigation by City staff revealed a sewer leak upstream of the plant that may have contributed to the total Coliform count. The leak was subsequently repaired.

B. CONCLUSIONS

Considering the minor changes in Flint River water quality, much of the information contained in the 2002 Treatability Study by AB&H remains relevant today. Data from that report assumed to be consistent today include the following:

- Flint River is influenced by groundwater from a dolomitic aquifer
- Hardness varies seasonally with higher hardness and alkalinity in the winter
- Hardness, alkalinity, magnesium concentrations tend to be reduced by run-off

In development of the 2002 Treatability Study, processes were simulated which resulted in low THM levels. Therefore, information contained in that report will be used to assist with establishing a baseline jar testing procedure as discussed further in Section III.

III. TREATMENT PROCESS EVALUATION

A. EXISTING PROCESS DESCRIPTION

The existing WTP consists of an intake with screening from the Flint River, low lift pumping, ozonation, rapid mix, flocculation, settling, softening, recarbonation, filtration, storage and high service pumping. A process diagram is shown as Figure 1.

1. Intake

A 72" diameter pipe draws water from the Flint River through 2 traveling screens to the low lift pump structure. No chemicals are currently fed for Zebra mussel control or pre-oxidation as recommended by the 2002 Treatability Study. Manual removal of zebra mussels is more economical than installation of chemical feed equipment considering the short term need.

2. Ozone

There are 2 ozone generators designed to provide adequate ozone for a WTP flow of up to 36 mgd. There are 3 ozone contact basins. The ozone generators were designed to produce 900 lbs/day at 10% concentration and up to 1300 lbs/day at 6% concentration each. Prior to recent repairs, readings indicated a production rate of approximately 700 lbs/day at 4% concentration. It is possible that before the recent improvements the ozone feed might not have been optimized. In fact, it is known that less than optimal ozonation previously led to increased chlorine feed which would have contributed to THM formation.

3. Rapid Mix

East and West rapid mix chambers allow chemical feed prior to the flocculation basins. Each rapid mix chamber is equipped with a 5 hp mixer.

4. Coagulation / Flocculation

The WTP contains two equally sized flocculation basins, east and west, and each basin provides tapered or gradually slowed mixing from inlet to outlet. There are fifteen 2 hp mixers for each basin with VFDs to control mixing speed. The 2002 Treatability Study recommended feeding both coagulation and flocculation polymer aids. Neither polymer aid is being used today because turbidity and TOC removals have been sufficient to meet regulatory requirements.

5. Settling

Primary clarification takes place within 3 basins containing plate settlers. The settlers are operating as designed.

6. Softening

Again, there are two basins for softening: east and west. Each basin is 120' in diameter and contains a solids contact softening unit. Each softening basin/unit has a design capacity of 18 mgd. The east clarifier has an effluent weir imbalance that the City intends to fix when low demands allow for construction. Low lift pumping limitations, flow control to the basins, control restrictions on residuals removal, and fluctuating demands have made it difficult for WTP staff to stabilize the softening process. Softening is accomplished by feeding lime. The decision was made by the City not to feed soda ash in order to remove non-carbonate hardness because acceptable hardness levels could be achieved with lime feed only and softening is short term until Lake Huron water becomes available. Lime and soda ash softening is a possible consideration to assist with TOC removal and thus reduce THM formation.

7. Recarbonation

Recarbonation for pH adjustment is accomplished in east and west recarbonation basins between and to the north of the softening basins. Carbon dioxide storage and feed equipment is located west of the recarbonation basins.

8. Filtration

Filtration is accomplished with 12 dual media filters, equally sized and designed to filter 3.0 mgd each. Media consists of 12" of sand and 18" of anthracite. The filters have been operated intermittently over the years due to the standby nature of the WTP and until recently, chlorine injection took place downstream of the filters. It is possible some microbial growth had developed in the filters leading to increased chlorine demand. The City recently hired a contractor to upgrade the electrical controls for the filters and that work has been completed.

9. Disinfection

Disinfection is provided by ozonation and by feeding chlorine. Ozonation occurs at the front end of the WTP. Chlorine is fed prior to filtration and prior to finish water storage / high service pumping. The intermediate chlorine injection location was recently constructed under the Phase II, Segment 1 contract.

10. Clear Well & Pumping

The pump building sits adjacent to a 3 MG clear well and contains both low and high service pumps.

B. JAR TESTS / EXPERIMENTS

1. Approach

There are several well practiced methods by which DBPs can be reduced. First, the disinfectant can be changed to an alternate that has a lower tendency to form DBPs. Second, additional treatment systems such as activated carbon or air stripping (depending on the nature of the precursors) can be added to remove DBP precursors. Lastly, the existing treatment processes can be optimized to remove as much DBP precursor as possible. Of these options, optimizing existing treatment processes is the only strategy that does not require the construction of new and expensive facilities. It is anticipated that Flint will be receiving Lake Huron water in approximately two years and this water will have a completely different chemistry from the Flint River. Major process changes instituted to address THM levels using Flint River water are likely to be unnecessary for Lake Huron water and may even be inappropriate. Therefore, those options which require addition of new treatment processes are undesirable at this time. In recognition of this upcoming change in water source, efforts for this study have concentrated on improving the existing processes, rather than adding new ones. New treatment processes will only be recommended if operational changes to the existing treatment train prove ineffective.

Recent sample test results suggest that most of the DBPs are formed in the distribution system rather than within the treatment plant. Therefore, the most logical approach is to reduce the DBP formation potential (DBPFP) rather than simply lowering the levels of DBPs leaving the plant. During bench scale testing, formation potential (FP) levels were the primary indicator of success or failure of proposed process modifications.

2. Protocol

Bench scale pilot testing is intended to reflect actual plant operating and hydraulic conditions so the bench scale treatment units were sized based on various dimensionless factors to ensure the pilot treatment matched the actual system. Bench

scale ozonation was not practical due to time and cost limitations. Therefore, water samples were withdrawn from the plant ozone basin effluent. These samples were transported to the laboratory and dispensed into square testing jars. The jars were used to simulate rapid mix, three-stage flocculation, and settling. Rapid mix and flocculation conditions were matched to the plant based on "Gt" values. The "G" value is a measure of the mixing intensity and is a function of mix time, viscosity of the liquid, and mixing power applied to the water. "Gt" then, is a size scaling factor where time has been accounted for. Settling time was scaled to match the shorter settling depth of the testing jars. After settling, samples were decanted from the test jars. The decanted samples were then lime softened; softening conditions were similarly matched on the basis of "Gt". Carbon dioxide was sparged into the samples to reduce the pH. The water was then vacuum filtered through filter paper, sized to simulate the plant's dual media filters. The samples were dosed with excess chlorine and allowed to react for seven days at 25° C before testing for DBPs to determine the formation potential.

The following conditions were applied during testing to properly match small scale testing to actual plant processes.

TABLE 6 – BENCH SCALE TEST MIXING INTENSITIES

Process	G	Duration	Mix RPM
Ozonation	Plant	-	-
Rapid Mix	200	44 sec	160
Flocculation, Stage 1	50	9 min	55
Flocculation, Stage 1	25	9 min	30
Flocculation, Stage 1	12	9 min	19
Settling	N/A	10 min	-
Softening	TBD	10 min	-
Recarbonation	N/A	N/A	-

The primary variables during testing were chemical additions and chemical dosages. Specific chemicals and dosages used for initial testing conditions were selected to reflect current plant usage and the recommendations of the 2002 Treatability Study:

TABLE 7 – BENCH SCALE TEST CHEMICAL FEED RATES

Chemical	Current Usage	2002 Study	Test Values
Ozonation	4.66 mg/l	1.5 mg/l	
Ferric Chloride	7.7 mg/l Fe3+	40 mg/l Fe3+	7.7 – 80 mg/l Fe3+
Coagulant Aid Polymer	Not used	2.0 mg/l	1 – 2 mg/l
Flocculation Aid Polymer	Not used	0.05 mg/l	0 – 0.05 mg/l
Powdered Acuvated Carbon	Not used	N/A	20 – 100 mg/l
Lime	120 mg/l	175 mg/l	120 – 175 mg/l
Soda Ash	Not used	52 mg/l	0 – 52 mg/l
Cationic Softening Polymer	3.13 mg/l	Not used	3.13 mg/l
Anionic Softening Polymer	0.88 mg/l	Not used	0.88 mg/l
Fluoride	0.45 mg/l	1 mg/l	Not used
Carbon Dioxide	32 mg/l	37 mg/l	Fed to reach pH of 7.5 +- 0.3
Chlorine	6.3 mg/l	3 mg/l	10 mg/l

3. Considerations

The 2002 Treatability Study did not note significant formation of DBPs. This may be a function of different Flint River water chemistry at that time. However, recognizing the considerable differences in chemical usage and dosages between that study and current operations, those differences in chemical use and dosage are an obvious starting point for optimizing treatment to prevent DBP limit exceedance.

Although it is believed that optimization of current treatment can correct the DBP issue, should optimization of present treatment prove insufficient, alternate residual disinfectants (chloramines and chlorine dioxide) will be investigated as additional treatment measures.

4. LAN Test Results

Two rounds of jar testing were completed by LAN during the weeks of December 15, 2014 and January 26, 2015.Detailed test data is included in Appendix A. Testing results can be summarized as follows:

- Increased dosages of ferric chloride resulted in higher reduction of THMFP.
- The currently utilized feed rate of lime at 120 mg/l is appropriate
- Softening with soda ash in addition to lime resulted in minor additional THMFP reduction – in the range of 0% - 10%.
- The benefits of using a cationic polymer during softening at a dosage range of 0.31 - 3.13 mg/l to help reduce THM's are unclear
- The benefits of using an anionic polymer during softening at a dosage range of 0.09 – 0.88 mg/l to help reduce THM's are unclear
- Feeding PAC was ineffective in reducing THMFP within the dosage range of 20 – 100 mg/l.

5. Testing by Others

In addition to jar testing completed by LAN, the chemical supplier who provides ferric chloride for the City, PVS Technologies, ran tests using their recommended flocculant polymer aid. Plus, Veolia Water completed jars testing of their own the week of February 16th to analyze other process details and current WTP parameters. Experiments completed by PVS Technologies showed very little TOC removal beyond that obtained with straight ferric chloride feed.

6. Conclusions

Increasing the dose rate of ferric chloride is an operational change that can easily be implemented without the need for any additional equipment. Test results show that over 40% THMFP removal can be obtained with a dosage of 60 mg/l Fe3+ or higher. Increased dosing of ferric chloride would be most ideal coupled with regular raw water TOC monitoring so that TOC levels would dictate the appropriate ferric chloride feed rate.

Softening with soda ash in addition to lime is another option the City should consider if increased ferric chloride doses are not adequate to maintain THM levels under the MCL, particularly during warmer months. Again, monitoring of TOC in the raw water could provide useful information of when lime/soda ash softening is necessary.

IV. DISTRIBUTION SYSTEM EVALUATION

EPA guidance for the distribution evaluation portion of an OER is focused on identification and isolation of a specific portion of the distribution system that led to the exceedance. The circumstances of Flint's apparent pending TTHM exceedances are unusual in that a new supply has been implemented which clearly corresponds to the high TTHM sample results. Although the new source is one element in increased TTHM levels, value remains in evaluating the distribution system since water age is also a critical factor. Additionally, there may be distribution improvements that can be made to help alleviate the problem.

A. INFRASTRUCTURE

1. Piping

According to the most recent MDEQ Sanitary Survey, the distribution system is estimated to contain 70% cast iron, 20% ductile iron, 2% concrete and 8% steel water mains. Unlined cast iron pipe can become pitted, allowing colonization sites for microorganisms leading to chlorine demand. Additionally, much of the piping in the system is aged and in poor condition. Increased chlorine demand could be resulting from biofilm in older pipes and from main breaks/repairs. The extent of contribution is not known but any water main replacement project will decrease chlorine demand somewhat if constructed properly. Unfortunately, water main breaks may also assist with decreasing water age by providing unintentional flushing. All things considered, it is impossible to quantify the impact existing piping has on THM formation.

The City utilizes City Point software and GPS equipment to document main breaks and prioritize replacements. However, main break information is more pertinent to rusty water complaints and has little relevance to THM levels. Areas that have been targeted for main replacements include the transmission main from the WTP west to Dupont and south to the West Side reservoir, Fenton Road, Atherton Road, Dort Highway, Averil Street, and Boulevard Drive.

2. Storage

There are 4 finish water storage tanks and 1 raw water tank as tabulated below:

TABLE 8 – STORAGE TANKS

Name	Type	Water	Volume (MG)	Operating		Absolute	
				LWL	HWL	Bottom	OF
Dort Reservoir	Ground	Raw	20	-	-	730	750
WTP Tank	Elevated	Finished	2	883.0	896.0	863.0	898.0
WTP Clear Well – PS #4	Ground	Finished	3	11'	15'	708.5	726.0
Cedar Street Reservoir	Ground	Finished	20	-	11'	737.2	757.2
Westside Reservoir	Ground	Finished	12	-	12'	761.8	779.0

The MDEQ typically recommends providing a minimum finish water storage volume of 1/3 the maximum daily demand (MDD). According to the 2013 MDEQ Sanitary Survey, the 5 and 10 year MDDs are 21.57 mgd and 30.05 mgd respectively. A common rule of thumb for clear well storage volume at a WTP is 10% of the design flow rate. Another general guideline for reliability is to provide total storage to allow for 2 X the average daily demand plus fire flow demand. For this analysis, fire flow is assumed to be 2,500 gpm for either one industrial fire (2,500 gpm) or a combination of one residential (1,000 gpm) and one commercial (1,500 gpm) fire at a 4 hour duration which results in a total volume of 600,000 gallons. These go-by

approximations are summarized below with the applicable flow rates and are compared to the existing storage volumes currently being utilized.

Common Practice	Flow Rate	Recommended Volume by ROT	Volume In Use
Clear well 10% of Design Flow	18 MGD	1.8 MG	3.0 MG
Finish Storage = 1/3 MDD	30.05 MGD	10.0 MG	37 MG
Total Storage = 2 * ADD + FFD	13.87 MGD	28.3 MG	57 MG

Based on the values above, it appears the storage volume used in the Flint system could be decreased without negatively effecting reliability. The appropriate volumes of individual tanks will be further evaluated using the water system model and discussed in Section V (C).

All reservoirs have baffling to minimize stagnant water. Also, all tanks have been maintained and are in reasonable condition. The Westside reservoir has an exposed roof that is in need of rehabilitation, but its current condition has no influence on THM formation.

3. Pump Stations

All pump stations are in good condition but pumps are generally oversized. As an independent consideration, oversized pumps are not a contributing factor to high THM levels. Control of pumps and pressure zones are discussed in detail below.

B. OPERATIONS AND MAINTENANCE

1. Pump Station & Storage Operations

Pump stations and storage tank levels are controlled as shown in Table 9.

TABLE 9 – PUMP STATION CONTROLS

PS Name	Control Point	On Point	Off Point
PS No. 4 Raw	Operator	-	-
PS No. 4 Finish	Match plant flow	-	-
Westside	System pressure (elevated tank)	22.5'	33'
Cedar Street	System pressure (elevated tank)	22.5'	33'
Torrey Road	Distr. – Brown/Bradley	< 45 psi	≥ 45 psi

Cedar Street and Westside pump stations are operated as needed and they are alternated. Typically, Cedar Street is run in the morning and Westside is run in the evening and reservoirs for each are filled during low demand periods at night.

Westside, Cedar Street and Torrey Road pump stations are used to boost system pressure when high demands warrant it, but there are not well defined pressure zones within the system. Therefore, the possibility exists that water is being recirculated allowing for increased water age.

2. Booster Disinfection Practices

Booster disinfection is provided at the Cedar Street and Westside pump stations. When sustained residuals are not provided by chlorine feed at the WTP, sodium hypochlorite is applied at the reservoirs while being filled.

3. Changes in System Demands

Water demands in the City have been declining since the 1960's as the population has dropped. As a result, many of the water system components are oversized including storage tanks and water mains which both increase the time for water to reach the user.

From a short term perspective, Flint demands tend to increase in summer as is ordinarily expected but also in the winter due to water main breaks. The MDD for Flint often occurs in winter. Regarding THM formation, with lower temperatures and higher flows in the winter, THM levels taken at the distribution sample points are expected to be lower than at other times of the year.

C. WATER SYSTEM HYDRAULIC MODELING

As part of this report, the City provided a hydraulic water model, originally developed by Potter Consulting, for LAN to update. Thus far, LAN has modified the model to be capable of extended period simulations, modified controls to reflect current operations, revised the piping to include known broken valve locations, and developed preliminary water age results throughout the entire system. Water age shown in the updated model corresponds well to TTHM levels at 6 of the 8 sampling sites. However, LAN has also identified several deficiencies within the model that require further adjustments to allow for usable and reliable results. Those model deficiencies include outdated demands, improperly located appurtenances, and incorrect flow patterns. Preliminary water age results are presented in Table 10. Revised results will be provided when the hydraulic model has been fully updated.

Fine tuning model

TABLE 10 – PRELIMINARY WATER AGE FROM WATER MODEL

Sample Point	Location	Address	Water Age (Hrs)	Aug 2014 THM (ug/l)
1	McDonalds	3719 Davison	23	145
2	BP Gas Station	822 S. Dort Hwy	18	112
3	Liquor Palace	3302 S. Dort Hwy	15	127
4	Taco Bell	3606 Corunna	128	181
5	Univ. Market	2501 Flushing	178	196
6	Salem Housing	3216 MLK	50	112
7	Rite Aid	5018 Clio	78	144
8	N. Flint Auto	6204 N. Saginaw	71	118

It is anticipated that topics shown below in italicized font will be detailed after the model is updated in March 2015.

1. Simulation of Existing System

Match existing conditions. Chlorine and THM data may be used to verify model results. We have chlorine feed data at plant and residuals at 10 locations in each MOR, May 2014 – January 2015.

2. Identification of Water System Deficiencies

Specific issues to look at:

- *Worst case at minimum daily demands*
- *Water age in entire system*
- *Recirculating water through pump stations*
- *Use of storage tanks – volumes in particular*
- *Indications of broken valves*
- *Effectiveness of booster disinfection*

Study of worst case hour most in May 2014 vs. 16?

V. RECOMMENDATIONS TO MINIMIZE FUTURE OEL EXCEEDANCES

A. SOURCE

The City of Flint has already committed to the change from the Flint River as the water source to Lake Huron under the KWA system, planned for late 2016. The risk of future TTHM limit violations will decline substantially with the use of water from Lake Huron due to much lower DBP precursors. It is important to recognize that the Flint River will become strictly an emergency supply when the KWA supply becomes available and any investments toward the Flint River should be contemplated accordingly. Recommendations discussed below in this section apply to the Flint River as the source.

Reverting to supply from the DWSD until the KWA supply is available as an option. However, based on information provided by the City of Flint, the annual cost to receive water from the DWSD would be at least $16,000,000/year or $1,333,000/month. Therefore, utilizing the DWSD for interim supply is cost prohibitive under the terms defined by the DWSD.

1. Watershed Management

A volunteer group entitled the Watershed Coalition performs various tasks related to managing the Flint River watershed such as spring cleanups and annual benthic studies to evaluate the river 'health'. No additional action is recommended at this time.

2. Monitoring

The City documents daily raw water flow, pH, alkalinity, carbonate and non-carbonate hardness, chloride, temperature, turbidity and coliform count as part of standard preparation of Monthly Operating Reports (MOR). It is recommended to add raw water TOC and plant tap THM values to daily documented measurements which would provide staff the data needed to establish correlations to predict distribution system THM formation.

3. Intake Operations

The 2002 Treatability Study recommended pre-oxidation in the form of sodium permanganate as a feed at the intake. It is possible the addition of a pre-oxidant such as hydrogen peroxide or some type of permanganate could enhance the ozone process. Veolia evaluated permanganate demand during jar testing the week of February 16th, 2014 and further recommendations will be incorporated when results become available.

4. Seasonal Strategies

Past data indicates the Flint River is influenced by groundwater and in particular, dolomitic spring water. The result is hard water with high concentrations of magnesium and sulfate. Also, hardness and alkalinity are higher during the winter. Upon initiation of supply from the Flint River, the City made the decision to soften with just lime to focus on removal of carbonate hardness. One potential modification that could assist with TOC removal and thus decrease THMFP would be lime and soda ash softening. A temporary caustic soda feed system is recommended to be put in place in case the need for optimized softening arises.

5. Upstream Contamination Issues

Upstream contamination issues are extremely difficult to prevent and even if detected are difficult to locate. Evaluation of raw water data collected for MORs is the easiest

manner in which to detect upstream contamination issues because the data is already collected for treatment purposes. In fact, high total Coliform readings signaled a potential issue recently that the City identified and removed.

An upstream monitoring and warning system could be established to attempt to detect water quality issues or spill event type contamination early enough to adjust treatment procedures or cease intake prior to the contamination reaching the WTP. However, given the imminent conversion to the KWA supply, the period of full time use would likely be far too short to achieve payback on the capital expenditures.

B. TREATMENT PROCESS

1. Operational Recommendations

- Increase ferric chloride dosage: Previous testing in the 2002 Treatability Study, jar testing completed by LAN, and a review of 2014 ferric chloride dosages compared to THM levels leaving the WTP support that increasing the ferric chloride dosage would help reduce THM formation.
- Increased monitoring: Currently, the MDEQ does not require daily reporting of raw water TOC or finished water TTHM levels. However, daily tracking of such levels would allow the City to develop a correlation between the two, thus providing a predictive tool to help manage TTHM levels.
- Coagulation and flocculation polymer aids: The 2002 Treatability Study suggested the use of coagulation and flocculation polymer aids. These polymer aids were shown in the 2002 Treatability Study to increase TOC removal and thereby reduce THMFP. Further evaluation will be completed during jar testing.
- Discontinue softening bypass: The City was previously bypassing a portion of flow around the softening basins because hardness levels did not warrant softening of the full stream. However, this practice was discontinued because it was believed the bypass stream was contributing to chlorine demand and preliminary data has supported that belief. Chlorine demand dropped 0.5 – 1.0 mg/l following elimination of the bypass stream in early November 2014.
- Soften with lime and soda ash: Research has shown that enhanced softening with both lime and soda ash may provide additional TOC removal. The efficacy of this option will be evaluated during jar testing.
- Disinfection of filter beds: In case there has been microbial growth it is recommended the filters be 'shock' treated with chlorine and rinsed. A chlorine injection point was added upstream of the filters during the first segment of Phase II so future growth in the filters should not be an issue.
- Optimization of all existing treatment processes: Depending on bench scale testing conditions and results, slight modifications to all treatment processes might in order to replicate lower DPBFP.
- Discontinue or adjust softening anionic polymer feed: Some anionic polymers have been found to increase TOC. Veolia evaluated the anionic polymer currently being fed during their jar testing and depending on the results, when available, the softening anionic polymer feed should be adjusted accordingly.

2. Infrastructure Change Recommendations

- Fix and/or replace faulty ozone equipment: Since the ozone equipment was installed it has not been used extensively so the hope is that major components remain in good condition and the system can be easily modified to restore proper functionality. The City has scheduled the equipment manufacturer to field inspect the system on December 15, 2014.
- Replace filter media with GAC media: GAC media could help reduce THM levels by reducing both TOC and chlorine demand. For this consideration, the recommended approach would be to first complete small scale testing to verify efficacy. Upon positive results, the next step would be replacement of media in a fraction of the filters following by sampling to measure water quality. Those results would determine the need to replace media in additional filters.
- Change disinfectant to chloramine or chlorine dioxide: If other options prove to be ineffective, conversion to another disinfectant should be fully evaluated. Various characteristics of chloramination indicate an advantage over chlorine dioxide, but a full analysis would provide clarity as to which would be preferred.
- Install pre-oxidant chemical feed: Hydrogen peroxide or a form of permanganate as a pre-oxidant can enhance the activity of the ozone. Chemical feed could be installed at the intake structure or low service pump station, depending on the reaction time required. Use of a pre-oxidant at the intake might also provide the additional benefit of disinfection credit for ozonation with the MDEQ if an ozone residual can be obtained at the ozone process effluent as a result.
- Repair upstream sewer leak: a sewer leak upstream of the WTP intake was discovered and has already been repaired by the City.

C. DISTRIBUTION SYSTEM

Potential distribution issues related to water quality issues discussed in Section IV included old cast iron pipe, oversized infrastructure, and remote storage/pump station locations and operations that might be less than ideal. Recommendations to address those issues are offered in this section.

1. Manage Water Age

a) Storage Tanks

Considering the excess storage capacity discussed in Section IV, in the short term it is recommended that operational changes be implemented immediately to reduce the overall volume of water stored to decrease water age. Immediate operational recommendations include lowering high water levels of reservoirs other than the elevated tank, to reduce the total system wide usable storage volume to 30-36 MG.

In the long term, LAN recommends development of the most ideal options for water model evaluation. Excess storage volume and tank locations within the water system afford Flint numerous options to reduce the amount of storage volume utilized. As a starting point, two recommendations are presented below.

Option 1
- Take West Side reservoir and pump station out of service
- Cut storage volume used in half at Cedar Street reservoir
- Reduce the utilized storage volume of the WTP clearwell from 3 MG to 2 MG
- Adjusted system wide storage volume would be 34 MG

Option 2
- Take Cedar Street reservoir and pump station out of service
- Reduce the utilized storage volume of the WTP clearwell from 3 MG to 2 MG
- Adjusted system wide storage volume would be 36 MG

b) Residence Time in Pipes

Completely redesigning and replacing the water system to match today's demands is not feasible financially and would be a waste of infrastructure with remaining useful life. Going forward, it is recommended that any future main replacement projects be evaluated for possible downsizing. When the water model is fully updated, it will provide a valuable tool in determining which mains can be downsized and to what extent. Replacement of broken valves and valve exercising are also recommended, which are programs that have already been implemented into Flint's regular operations.

Operationally, hydrant flushing is recommended as needed to minimize water age in low flow areas. Again, the updated water model should be used to locate high water age areas and optimal flushing points.

2. Reduce Disinfectant Demand

Recommendations to reduce disinfectant demand are similar to those described above to reduce water age. Replacement of old cast iron pipes would lead to a reduction of disinfectant demand on the distribution side, but realistically can only be accomplished over a prolonged period of time. In the meantime, hydrant flushing is the most viable means of reducing disinfectant demand in piping. From a storage standpoint, all reservoirs and tanks should be regularly inspected and maintained to prevent entrance of any outside contamination that would contribute to disinfectant demand.

3. Water Modeling of Recommendations (yet to be completed)

Determine best flushing locations to reduce water age
Evaluate changes in storage tank operations to reduce water age
Valves to close/add to improve pressure zones, reduce recirculation
Optimization of pump station use – smaller pumps? Shut down?
Evaluate booster disinfection

D. BOOSTER DISINFECTION

Decreasing chlorine feed at the WTP and adding booster disinfection in the distribution system is an alternative intended to reduce the reaction time at higher concentrations of chlorine to reduce DPB formation. Extensive looping and branching within the existing system complicate how to best implement and utilize booster disinfection. Water system modeling is recommended to gage the effectiveness of existing feed point locations and dosages. Further discussion and details will be provided when the distribution evaluation results are available.

E. CATEGORIZATION OF ACTIONS

Considering that the Flint River is being used as the water source only until the KWA supply is available (expected late 2016), options to address high THM formation that require new construction or extensive time to implement are not preferred. On the other hand, the City understands THM sample results to date dictate that some action is necessary. Two categories have been developed to assist the City in prioritizing actions to take. Stage 1 consists of actions that can be completed relatively quickly without major construction and Stage 2 actions are either long term actions or solutions requiring major construction. Stage 1 actions are to be completed first followed by evaluation of the results prior to consideration of Stage 2 actions. Grouping of actions are shown in the table below.

TABLE 11 – ACTION PLAN

	Action	Purpose
Stage 1	Hire water consultant to complete 'water audit'	Third party review of actions and operations to make sure no options are being missed
	Increased water quality monitoring – obtain THM and TOC analyzers	Provide information needed to adjust WTP operations to match changing raw water quality
	Troubleshoot ozone feed system	Reduce chlorine feed and increase TOC removal
	Bench scale jar testing	Optimize treatment process and evaluate possible modifications
	Discontinue softening bypass	Reduce chlorine demand
	Disinfect filters	Reduce chlorine demand
	Increased water main flushing	Reduce water age / stagnant water
	Water system modeling evaluation	Determine areas with high water age and reasons
	Implement coag. & floc. polymer aids, if appropriate	Increase TOC removal
	Modify booster disinfection feeds, if appropriate	Decrease water age
Stage 2	Repair ozone system	Reduce chlorine feed and increase TOC removal
	Continue increased water main flushing	Reduce water age / stagnant water
	Convert to lime and soda ash softening	Increase TOC removal
	Continue valve replacements based on water model	Reduce water age / stagnant water
	Replace filter media with GAC	Reduce TOC and chlorine demand
	Change disinfectant to chlorine dioxide	Reduce THMFP
	Install pre-oxidant feed at intake	Optimize ozone disinfection, reduce chlorine
	Place priority on replacing cast iron water mains	Reduce chlorine demand

Samples were taken the week of February 16th for the 4th round of quarterly testing. The City has implemented many of the Stage 1 actions and THM test results have significantly improved (decreased) each time samples have been taken since August 2014. In addition to the regular compliance monitoring, the City performed a round of sampling on January 27, 2015. All sampling results are shown on Chart 1.

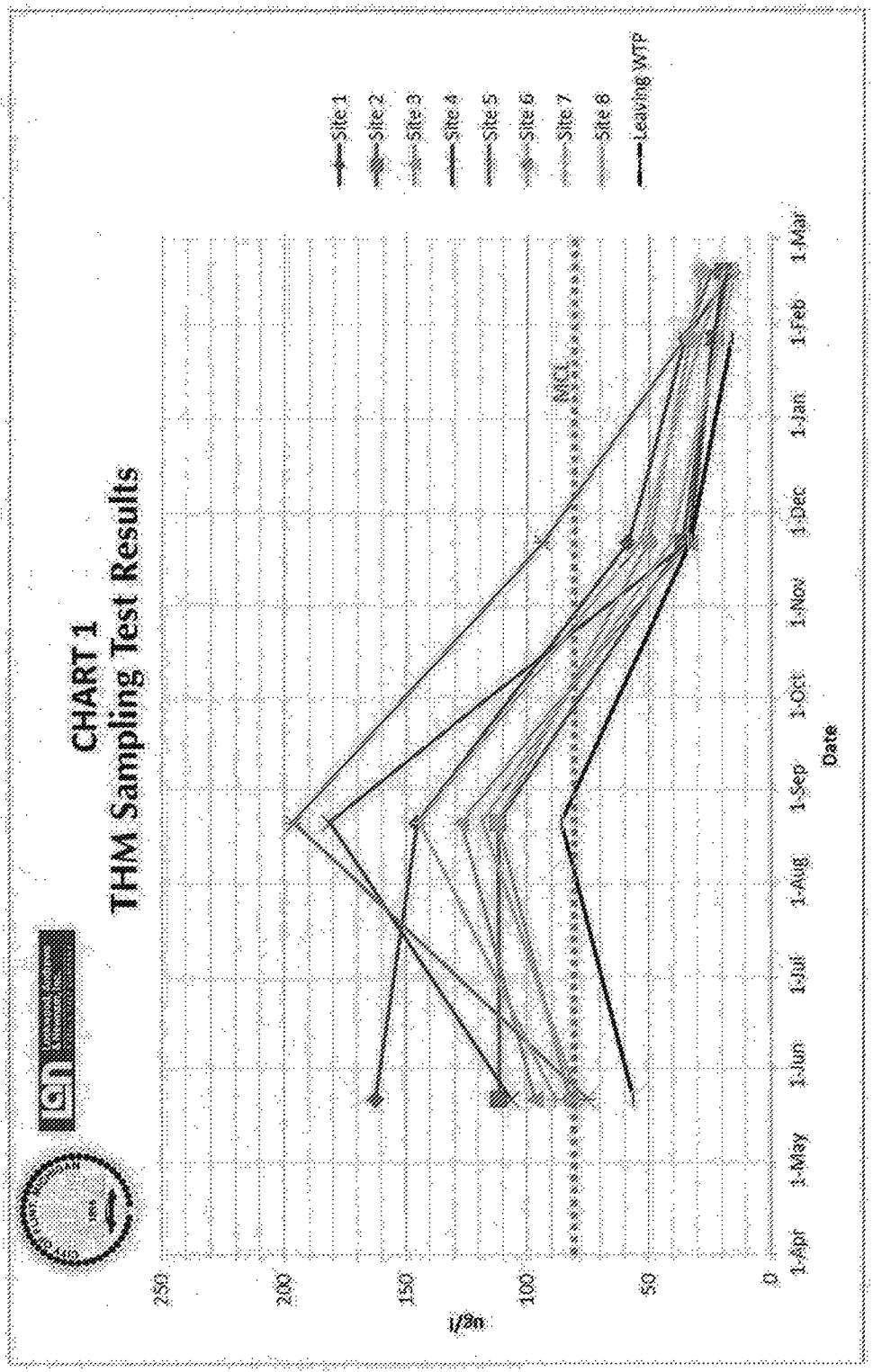
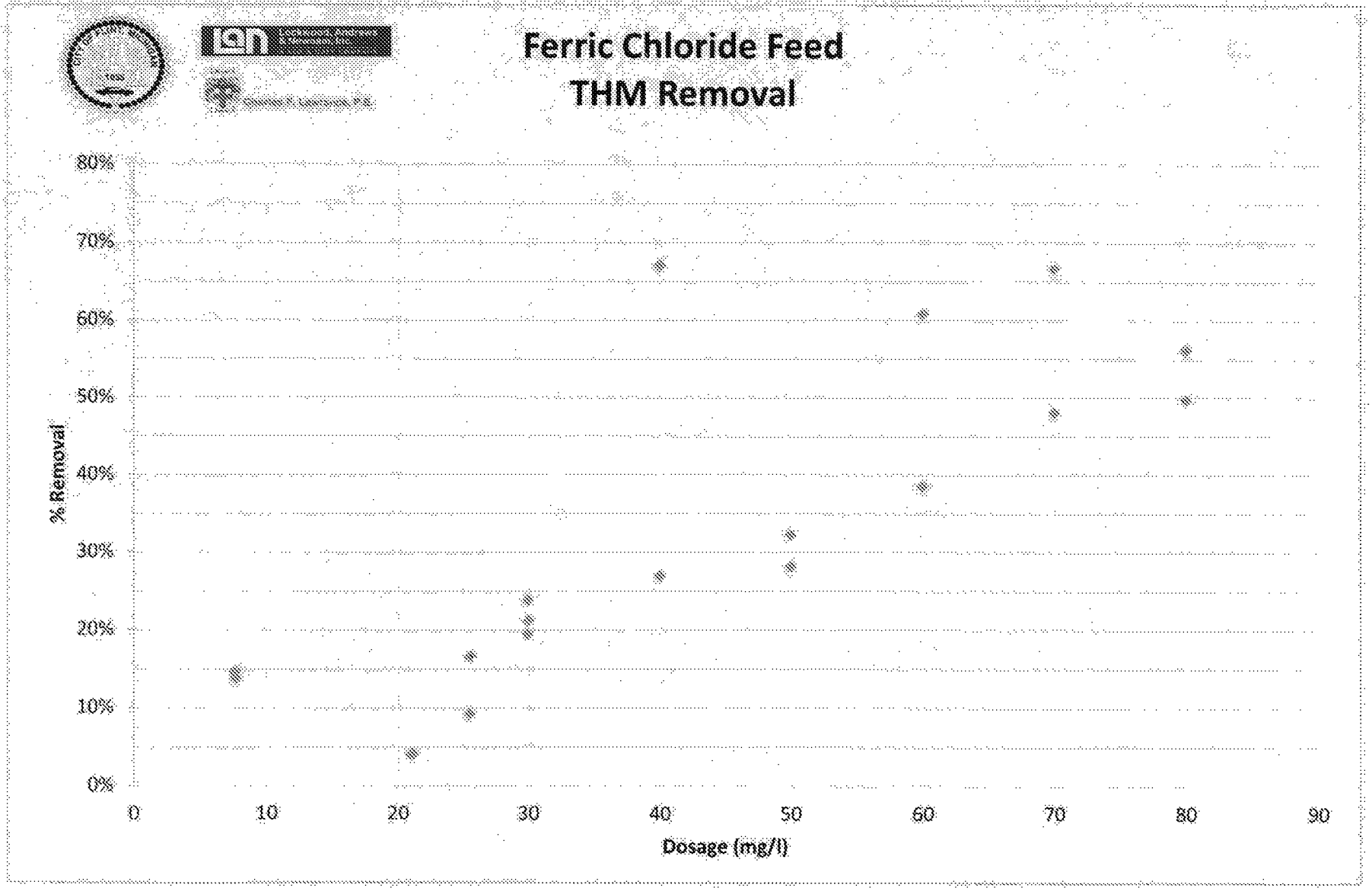
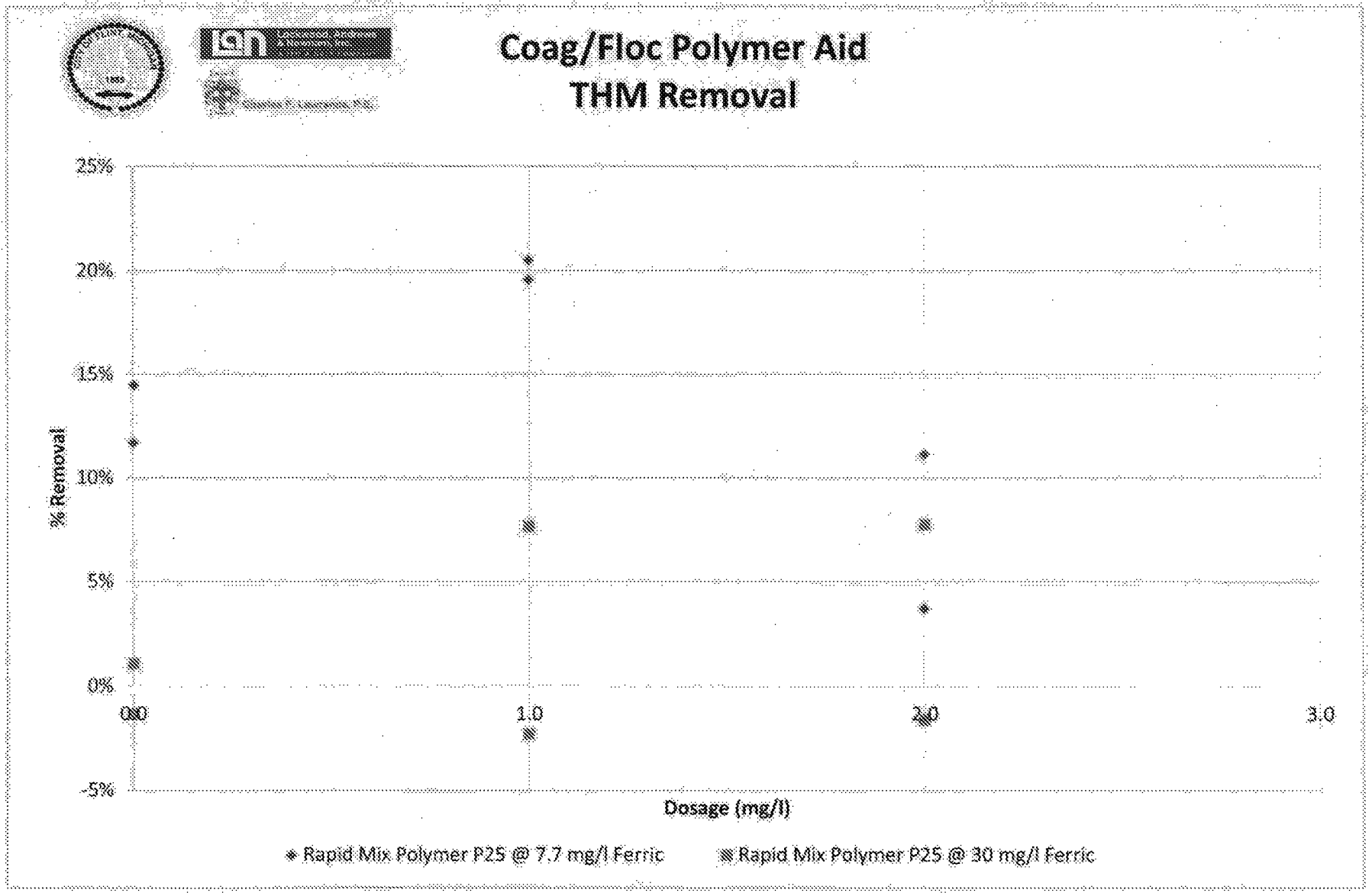
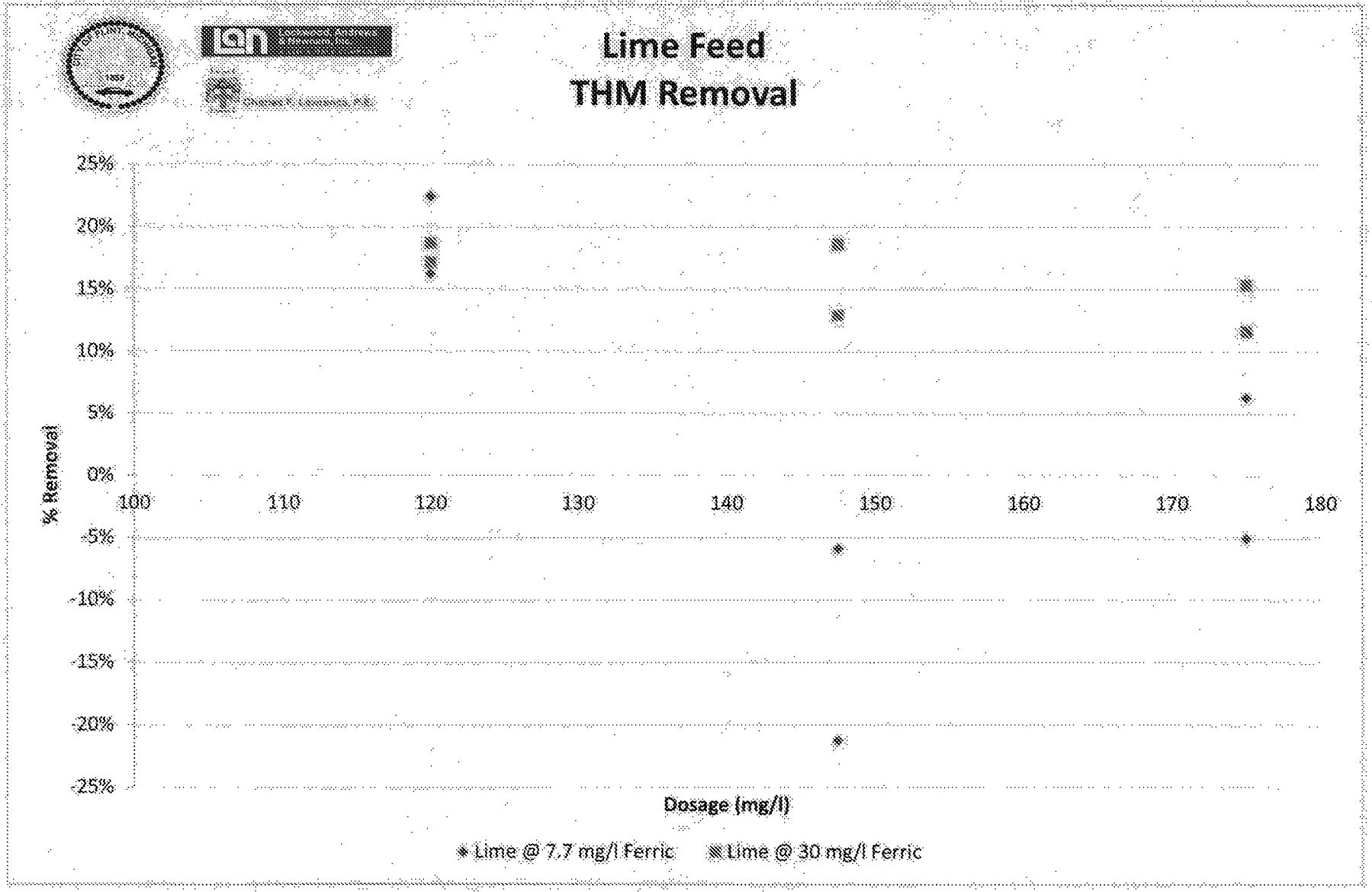


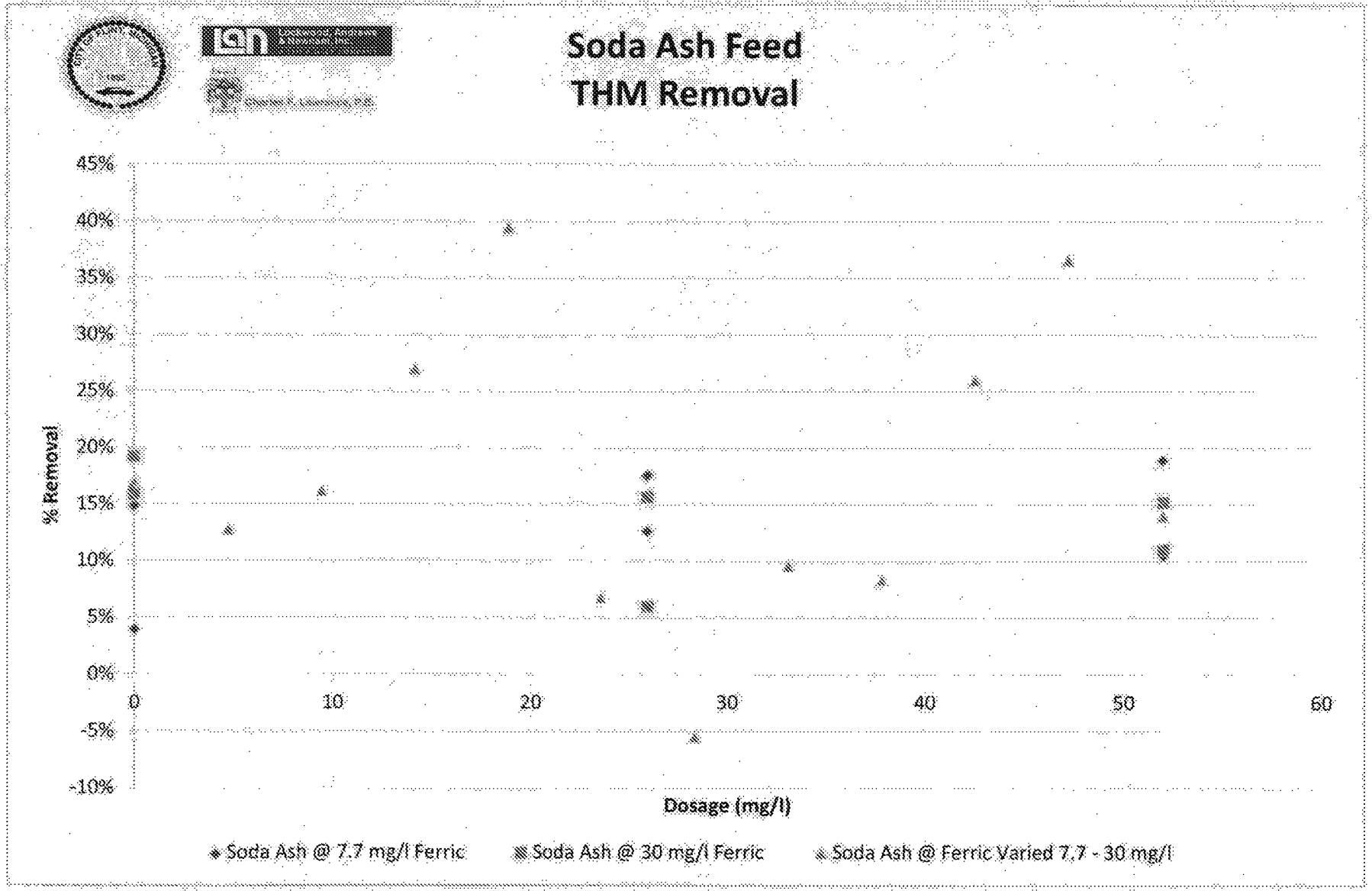
CHART 1
THM Sampling Test Results
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Leaving WTP
MCL
ug/l
250
200
150
100
50
0
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
Date

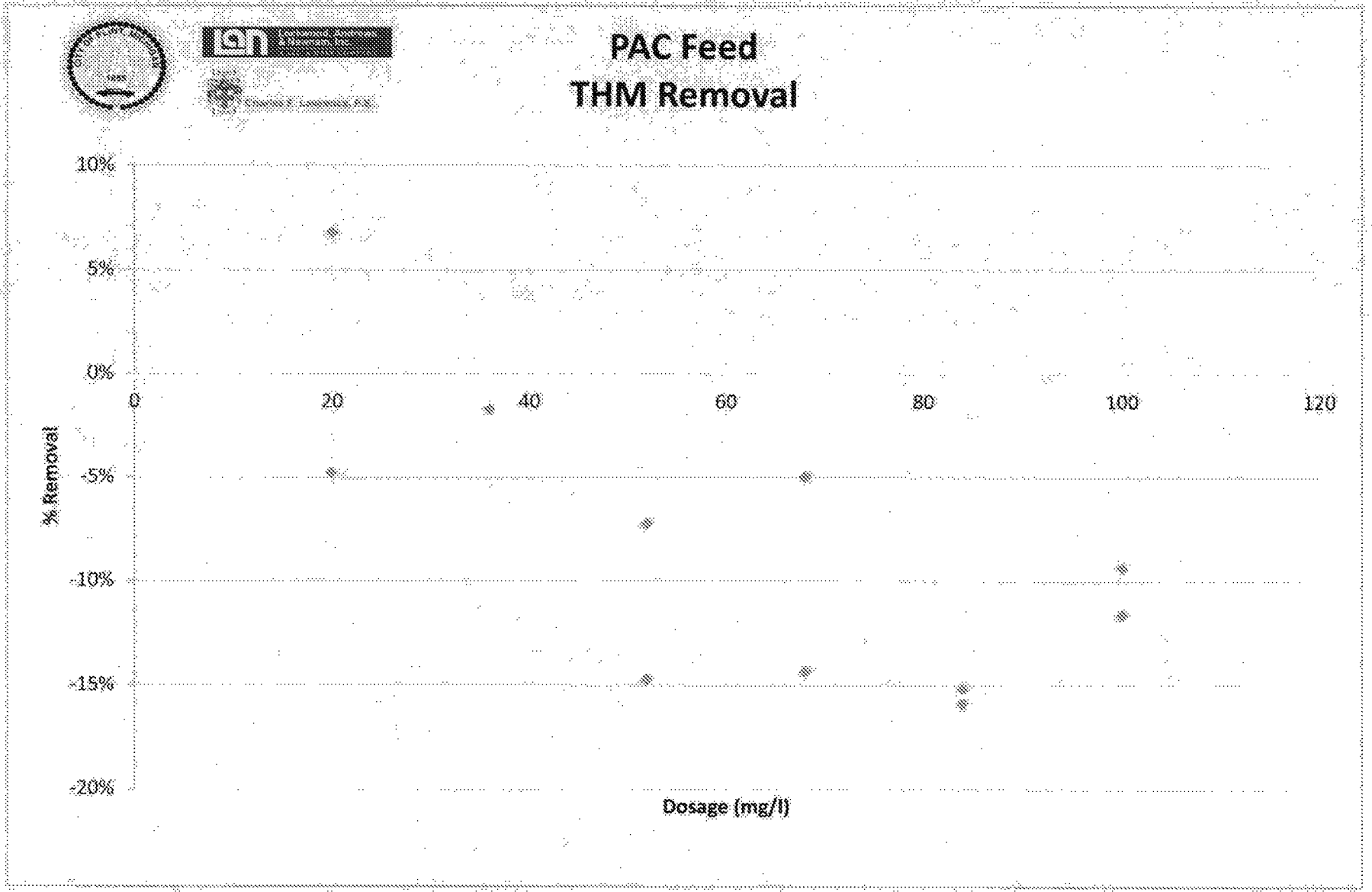
APPENDIX A
JAR TEST DATA


Ferric Chloride Feed
THM Removal
% Removal
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
70
80
90
Dosage (mg/l)


Coag/Floc Polymer Aid
THM Removal
25%
20%
15%
10%
5%
0%
-5%
% Removal
0.0
1.0
2.0
3.0
Dosage (mg/l)
Rapid Mix Polymer P25 @ 7.7 mg/l Ferric
Rapid Mix Polymer P25 @ 30 mg/l Ferric

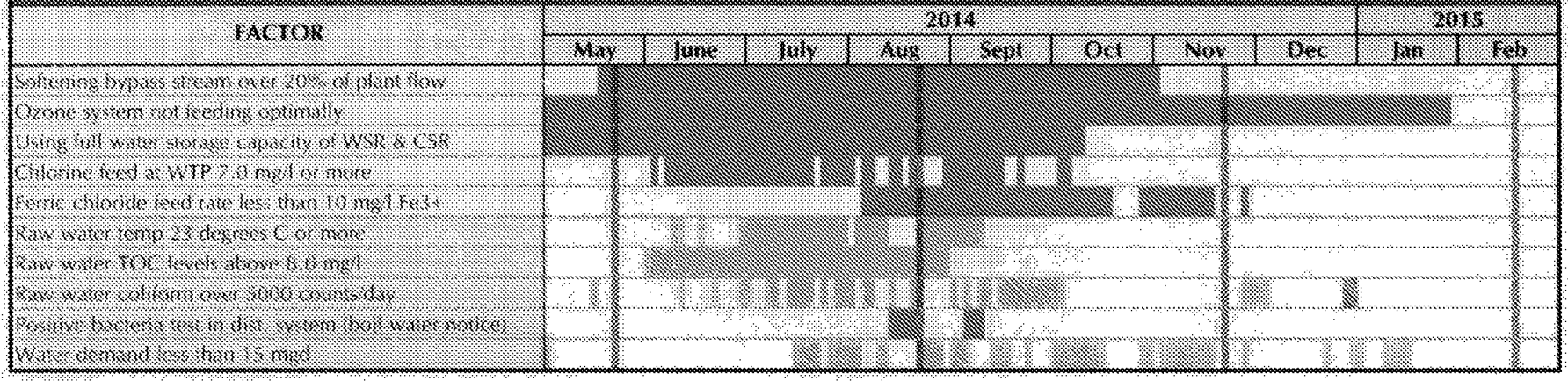

Lime Feed
THM Removal
25%
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
-25%
% Removal
100
110
120
130
140
150
160
170
180
Dosage (mg/l)
Lime @ 7.7 mg/l Ferric
Lime @ 30 mg/l Ferric


Soda Ash Feed
THM Removal
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
-5%
-10%
% Removal
0
10
20
30
40
50
60
Dosage (mg/l)
Soda Ash @ 7.7 mg/l Ferric
Soda Ash @ 30 mg/l Ferric
Soda Ash @ Ferric Varied 7.7 - 30 mg/l


PAC Feed
THM Removal
10%
5%
0%
-5%
-10%
-15%
-20%
0
20
40
60
80
100
120
% Removal
Dosage (mg/l)

APPENDIX B
WTP DATA

TABLE 1 - SUMMARY OF NEGATIVE INFLUENCES ON THM COMPLIANCE SAMPLING



Dates of occurrence

Dates of occurrence and expected to repeat in future years

Compliance sampling date

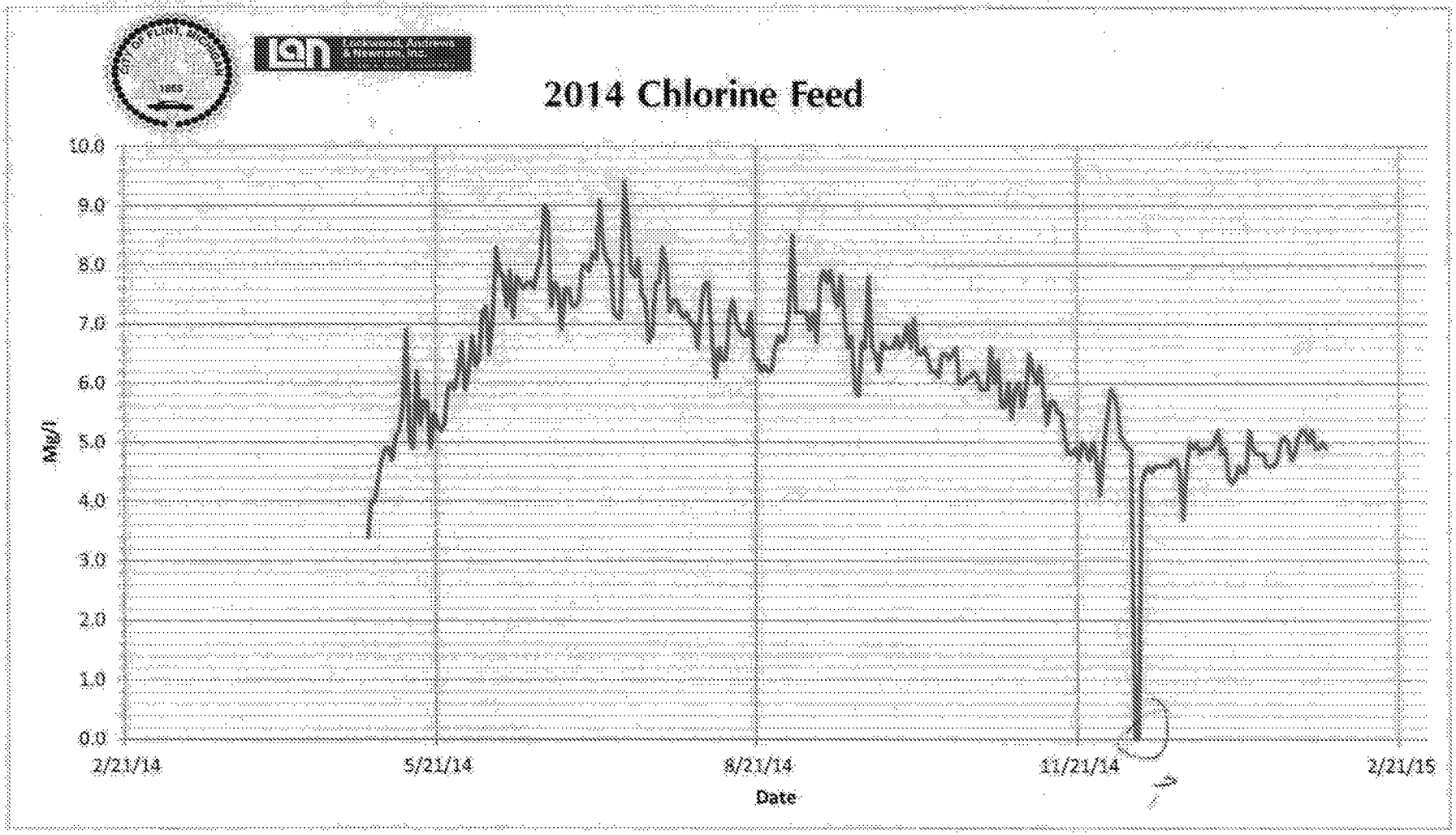
Factors under Flint staff control

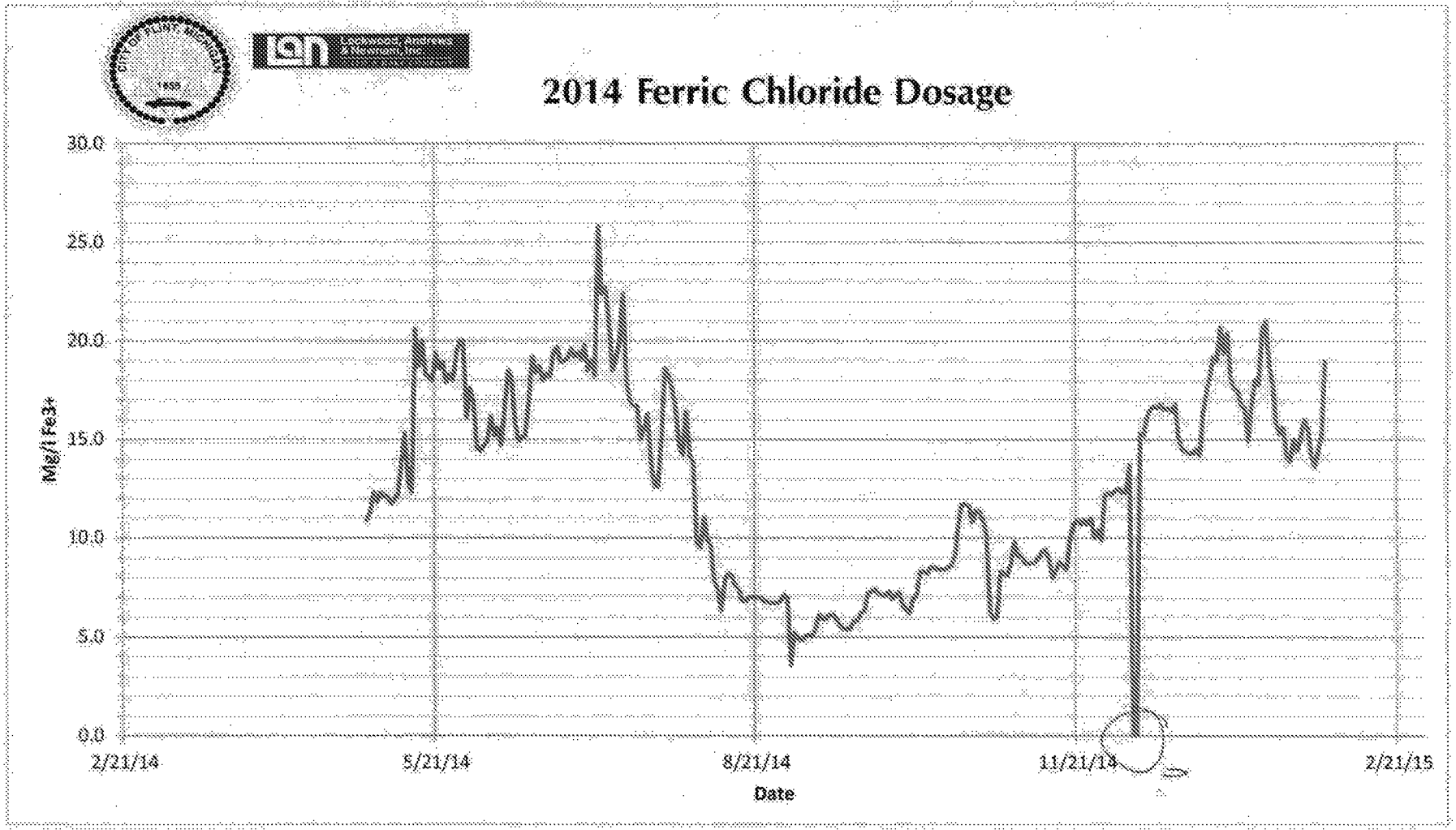
Flint River characteristics

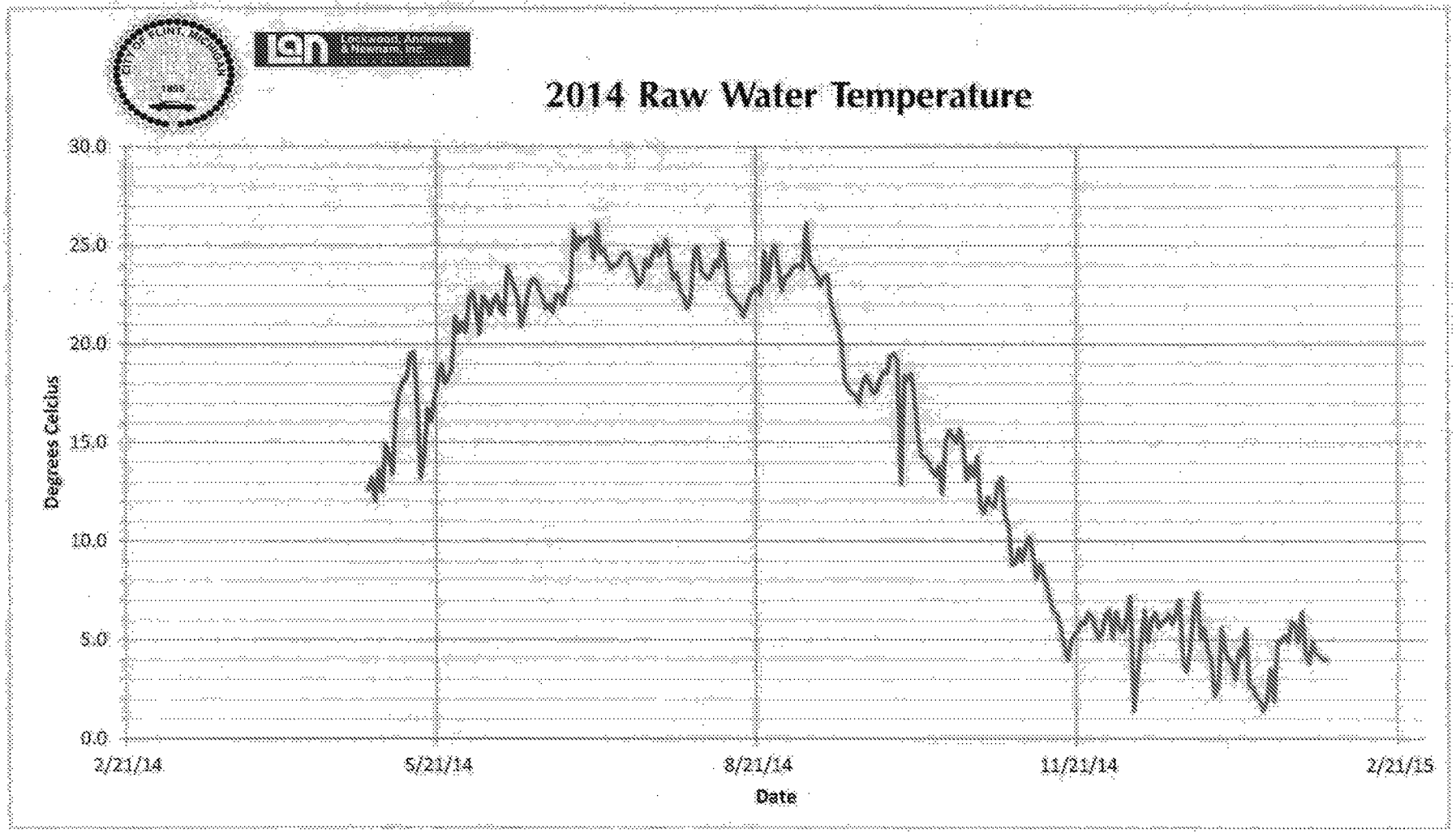
System factors

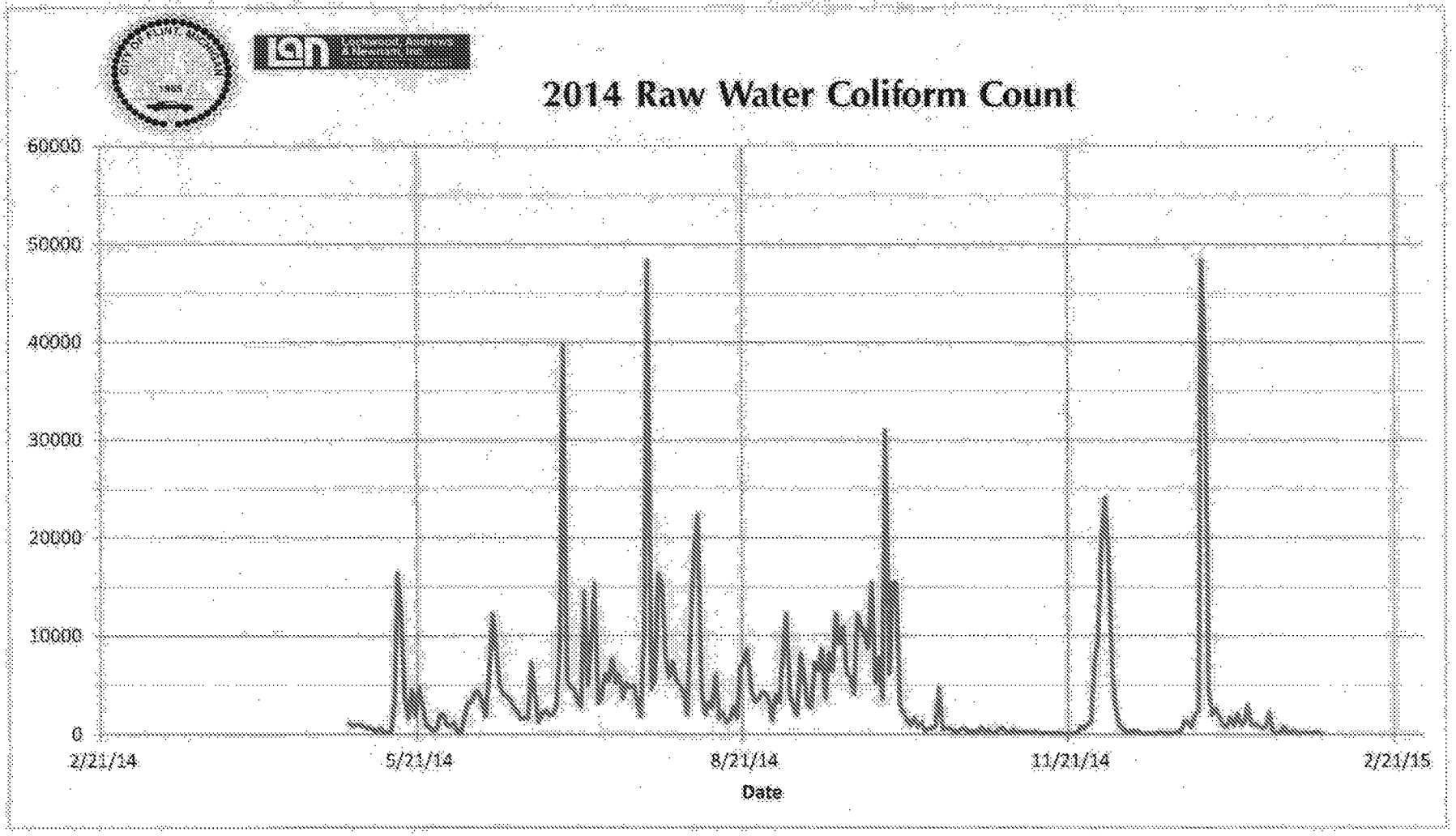
Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

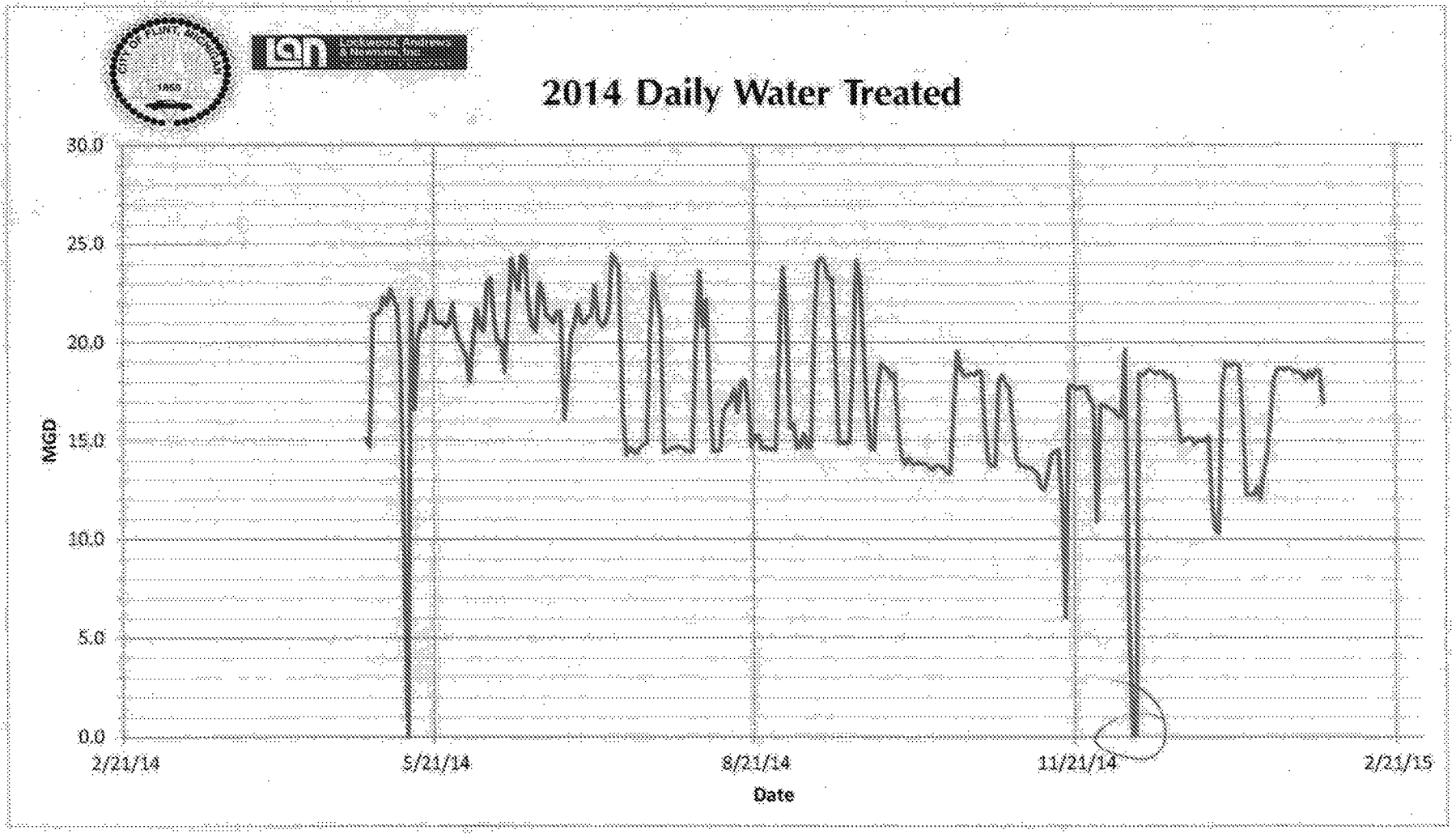
PLANNING
ENGINEERING
PROGRAM MANAGEMENT

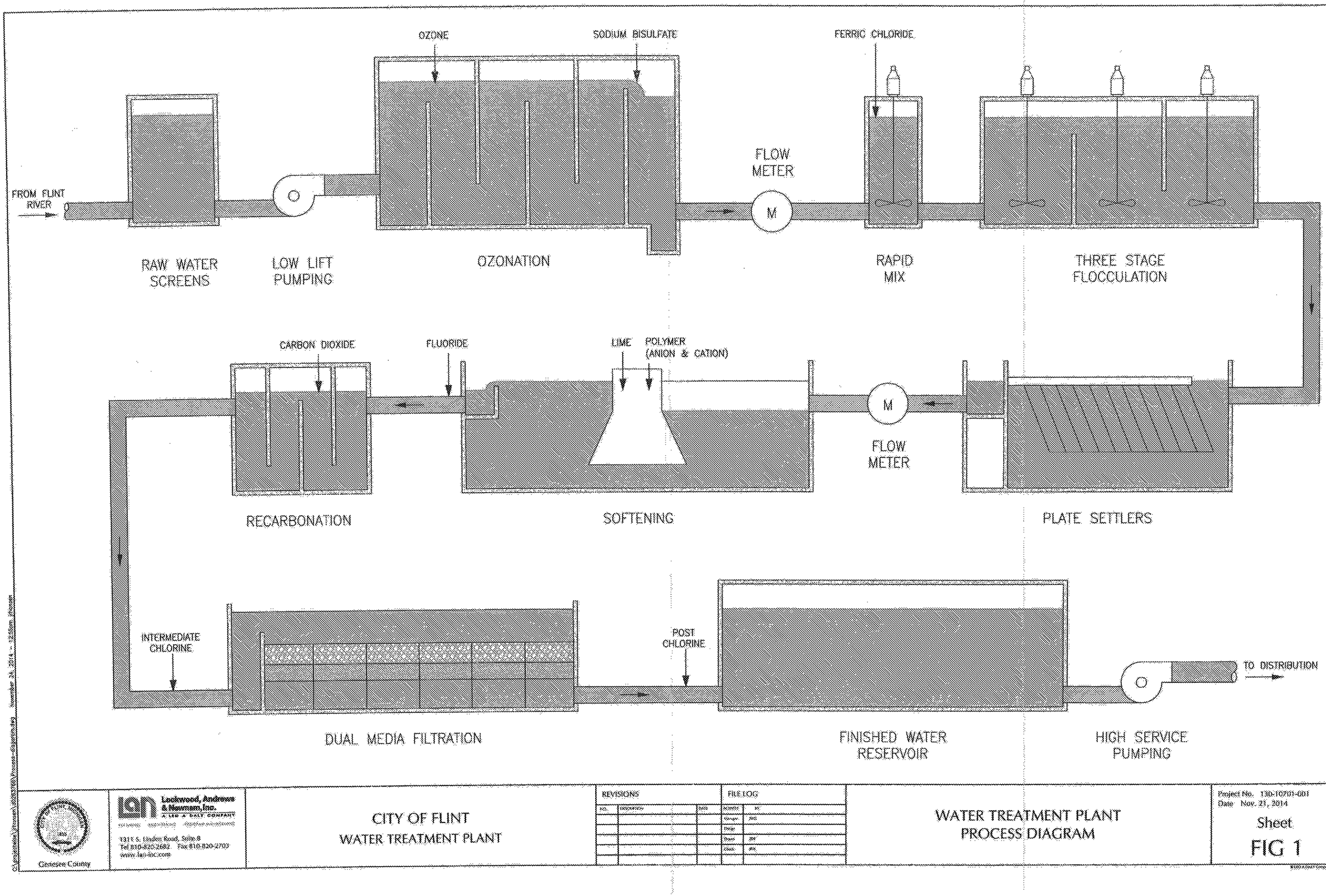

2014 Chlorine Feed
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Mg/l
2/21/14
5/21/14
8/21/14
11/21/14
2/21/15
Date


2014 Ferric Chloride Dosage
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Mg/l Fe3+
2/21/14
5/21/14
8/21/14
11/21/14
2/21/15
Date


2014 Raw Water Temperature
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Degrees Celcius
2/21/14
5/21/14
8/21/14
11/21/14
2/21/15
Date


2014 Raw Water Coliform Count
60000
50000
40000
30000
20000
10000
0
2/21/14
5/21/14
8/21/14
11/21/14
2/21/15
Date


2014 Daily Water Treated
30.0
25.0
20.0
15.0
10.0
5.0
0.0
MGD
2/21/14
5/21/14
8/21/14
11/21/14
2/21/15
Date



Genesee County

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY
1311 S. Linden Road, Suite 8
Tel 810-820-2682 Fax 810-820-2703
www.lan-inc.com

CITY OF FLINT
WATER TREATMENT PLANT

REVISIONS

NO.	DESCRIPTION	DATE

FILE LOG

SCREEN	BY
Manager	JWE
Design	
Drawn	BM
Check	JWA

WATER TREATMENT PLANT
PROCESS DIAGRAM

Project No. 130-10701-001
Date Nov. 21, 2014
Sheet
FIG 1

001937

Two Water Co. Formed

3/4/15 Plant TAC Meeting

2 Committees formed

1 Technical Committee – RFP

2 Community Committee

CIP – future cost est

WTP upgrades

Eng Consy – Sam R

Eng. Ass – short term / maintenance / long-term to get permit for w/s/ DEQ reqts

- Bray RD (Lime Sludge)
- Electrod. feed. Sys / – SCR Str. fountains / New feed
- Mod Pt Cl2
- Bypass conn / raw water
- Lock & Lock 30 day / storage
- Long Ass to meet → 10-14 MGD – ADD

TMDL

Dist / Treatment Ass

BTSD
30
35240
67FLM
04

121875

001938

① TTHM — UTF ↑
O.M ↑
PR ↑ — 1.8x conventional case to need MF if very cost conv.

{ color
Inorganics
TOC

GAC lifetime fnx of removal — Cl2 to

KMnO4 → UV abs vs. Dosage
use for sudden Δ in raw water Qual.

O3 Dosage ↑ Bromate ↑
Max O3 here @ 5 mg/l

Perox → 100 mg/l Dosage gives best removal
@ 5°C

Low Dose → optimal 1 mg Dose (230 mg/l
can't get rid of 1 mg by overdosing in
time — optimal appears 190 mg/l as CaCO3

only aware - hardness w skin irritations

- Map of water age
- Map of WM complaints
- website of WQ events
- Ctz Consumer Pmnt - 10K emp/homes in city
- Ctz Rebate Water Program - meet/assess MGT

001939

Other exposure routes for TTHM,
- inhalation ?
- absorption via skin ?

what is EQ bath cfg. & good & bathing
procedure under-for scenarios.

Vn to issue to CH/ next 2 wks work
open for 1.0 hrs. → what would 2.0 hrs
mean for EQ Intg?

Further Dest. II hdlg efforts into Long
for FAQs CCR

Slide ?s - not clearly rel. Hdlk comm.

MORE on Intro -
CCR
only UR in Vis. ? not tech/

Next Meeting Set for 6 April

Prysby, Mike (DEQ)

From:	Howard Croft <hcroft@cityofflint.com>
Sent:	Tuesday, May 19, 2015 9:40 AM
To:	Brent Wright; donna. cole; Elizabeth Murphy; gdn2@aol.com; Gerald Ambrose; Howard Croft; James Henry; Jason Lorenz; jmikewright; JoAnne Herman; John O'Brien; Kirk Smith; larry.koehler@mcc.edu; Laura Sullivan; Michael Glasgow; Michael Wright; Mike Lane; Prysby, Mike (DEQ); Norb Birchmeier; Pete Levine; Robert Bincsik; Robert Nicholas; rosejo@msu.edu; Russell Hudson; Samir Matta; Warren Green
Cc:	Dayne Walling; Natasha Henderson
Subject:	Technical Advisory Team Meeting _ May
Attachments:	2015-05-20 TAC Agenda.pdf

All,

I am sending everyone the TAC team agenda for Wednesday's meeting, there is room left for general conversation regarding next steps and future agenda's. We look forward to seeing everyone that can make it to City Hall tomorrow.

Thank you,

--

Howard Croft
Public Works Director
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Flint Water
Technical Advisory Committee
May 20, 2015
Flint City Hall

Agenda

2:00 pm **Welcome**

Purpose of the Technical Advisory Committee: Provide a respectful means of sharing factual information and having dialogue around the City of Flint water.

2:05 pm **Introductions**

2:10pm **Current water status information – M. Glasgow, Operator In Charge (F-1)**

2:20 pm **Improvements Information – H. Croft, Director Department of Public Works**

New filter media installation
Leak detection
New pipe installation
Water meter installation
New water page on City website

2:40 pm **Discussion on next TTHM testing expectations**

2:50pm **Discussion on current health concerns, including lead and copper testing**

3:30pm **Next Steps**
Next meeting, one month or two months?

3:35 pm **Adjourn**

Sources of Information:

City Website: CityofFlint.com See Residents: WATER or Departments: Public Works: Utilities - many links to reports, Q&A and other useful information.

If you, or another Flint resident, would like to have their water tested: call 810-766-7135 ext 2606

001942

5/29/15 7 AC Mtg

Max O_3 → 5 mg/l Annual Average Limits
Fare → 191 mg/l Acute to AT Tox Rem
Cmo → 190 mg/l Acute

Appl Mar - Fence 165 mg/l Avg
O_2 2+ mg/l Min
Cr 124 mg/l Avg
Gen Ca: mod Scott
Cooper FNT Hc-196 ORC ASTN
OR Michael W. ST - EPA, CAN
- Mike G. Accepted Position of Duffy
Natasha Henderson
Jim Henry
Larry Fuller Matt
McClure
Hurley
Warren Green
Kirksmith
H Enpt

Agenda

WTP Status Update

Cnscan

- Hardness 160 - 180 Some last fall
- Rock Hardness 250 - 300
- Tox - Sangen 5 - 10 RAM - Jerk Spring
- 2 - 3 PTAP

Quantec Tox weekly - 65% Rom

TTHM → 2 - 35 Loonyg wtr

Sonar

CAC

Calgon - Stop installing in June

Bringer - 4 filters - 8 days by Mid-July

or 4-6 wks prior to Aug sampling

Sex sto feathers - Clean / w GAC may not be as bad

MOEQ

11 tracks w MOEQ Assay & w Control

Beyond GAC - WTP → Cx/Cw 36 days

Tanks in place / Pipes

* w-Colonel support - baby to connect

* Send Sand/GAC to Calgon for column tests

Y/N testing on GAC → Longevity

Lack Selection - RFQ in place

4 wk Assessment on major trans mains

Up-Dar to Mobile on June - 10/14 weeks

Hyd model continues to evolve

001944

24" Transmain - bids higher than expected
Phase one - Challenge
Water meter - 3mg needs
16000 new meters next 2 years
- Outside - water page - WQ/QA
timeline
Review IT & give Hawsel feedback
CCR Decide - tell the story - [Mobile mobile test by capability]
Discussed IN Portsea for
MCC valves - TC, EC
Connectivity - Public wifi & Social media
£400,000 to reduce funding

IA Draft - updated was RS Dec 2013 - WAM to see
- 5 YR CIP

Next meeting? - After SMC installed
Late July / Aug
After Aug begin looking @ new FCA use / new esp