



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

WG-15J

June 24, 2015

MEMORANDUM

SUBJECT: High Lead Levels in Flint, Michigan – Interim Report

FROM: Miguel A. Del Toral *MADT*
Regulations Manager, Ground Water and Drinking Water Branch

TO: Thomas Poy
Chief, Ground Water and Drinking Water Branch

The purpose of this interim report is to summarize the available information regarding activities conducted to date in response to high lead levels in drinking water reported by a resident in the City of Flint, Michigan. The final report will be submitted once additional analyses have been completed on pipe and water samples.

Following a change in the water source, the City of Flint has experienced a number of water quality issues resulting in violations of National Primary Drinking Water Regulations (NPDWR) including acute and non-acute Coliform Maximum Contaminant Level (MCL) violations and Total Trihalomethanes (TTHM) MCL violations as follows:

- Acute Coliform MCL violation in August 2014
- Monthly Coliform MCL violation in August 2014
- Monthly Coliform MCL violation in September 2014
- Average TTHM MCL violation in December 2014
- Average TTHM MCL violation in June 2015

In addition, as of April 30, 2014, when the City of Flint switched from purchasing finished water from the City of Detroit to using the Flint River as their new water source, the City of Flint is no longer providing corrosion control treatment for lead and copper.

A major concern from a public health standpoint is the absence of corrosion control treatment in the City of Flint for mitigating lead and copper levels in the drinking water. Recent drinking water sample results indicate the presence of high lead results

in the drinking water, which is to be expected in a public water system that is not providing corrosion control treatment. The lack of any mitigating treatment for lead is of serious concern for residents that live in homes with lead service lines or partial lead service lines, which are common throughout the City of Flint.

In addition, following the switch to using the Flint River, the City of Flint began adding ferric chloride, a coagulant used to improve the removal of organic matter, as part of the strategy to reduce the TTHM levels. Studies have shown that an increase in the chloride-to-sulfate mass ratio in the water can adversely affect lead levels by increasing the galvanic corrosion of lead in the plumbing network.

Prior to April 30, 2014, the City of Flint purchased finished water from the City of Detroit which contained orthophosphate, a treatment chemical used to control lead and copper levels in the drinking water. When the City of Flint switched to the Flint River as their water source on April 30, 2014, the orthophosphate treatment for lead and copper control was not continued. In effect, the City of Flint stopped providing treatment used to mitigate lead and copper levels in the water. In accordance with the Lead and Copper Rule (LCR), all large systems (serving greater than 50,000 persons) are required to install and maintain corrosion control treatment for lead and copper. In the absence of any corrosion control treatment, lead levels in drinking water can be expected to increase.

The lack of mitigating treatment is especially concerning as the high lead levels will likely not be reflected in the City of Flint's compliance samples due to the sampling procedures used by the City of Flint for collecting compliance samples. The instructions from the City of Flint to residents direct the residents to 'pre-flush' the taps prior to collecting the compliance samples. A copy of the instructions provided by the City of Flint to residents will be included in the final report.

The practice of pre-flushing before collecting compliance samples has been shown to result in the minimization of lead capture and significant underestimation of lead levels in the drinking water. Although this practice is not specifically prohibited by the LCR, it negates the intent of the rule to collect compliance samples under 'worst-case' conditions, which is necessary for statistical validity given the small number of samples collected for lead and copper under the LCR. This is a serious concern as the compliance sampling results which are reported by the City of Flint to residents could provide a false sense of security to the residents of Flint regarding lead levels in the water and may result in residents not taking necessary precautions to protect their families from lead in the drinking water. Our concern regarding the inclusion of 'pre-flushing' in sampling instructions used by public water systems in Michigan has been raised with the Michigan Department of Environmental Quality (MDEQ). The MDEQ has indicated that this practice is not prohibited by the LCR and continues to retain the 'pre-flushing' recommendation in their lead compliance sampling guidance to public water systems in Michigan. A copy of the MDEQ guidance will be included in the final report.

In the case of the Flint resident that contacted U.S. EPA (Ms. Lee-Anne Walters), the initial results from drinking water samples collected by the City of Flint in her home

for lead were 104 ug/L and 397 ug/L. The level of iron in the water also exceeded the capability of the measurement (>3.3 mg/L). The lead results were especially alarming given that the samples were collected using the sampling procedures described above, which minimize the capture of lead. When contacted by U.S. EPA Region 5, the MDEQ indicated that the lead was coming from the Walters' plumbing. Ms. Walters had previously indicated that all of the plumbing in the home was plastic.

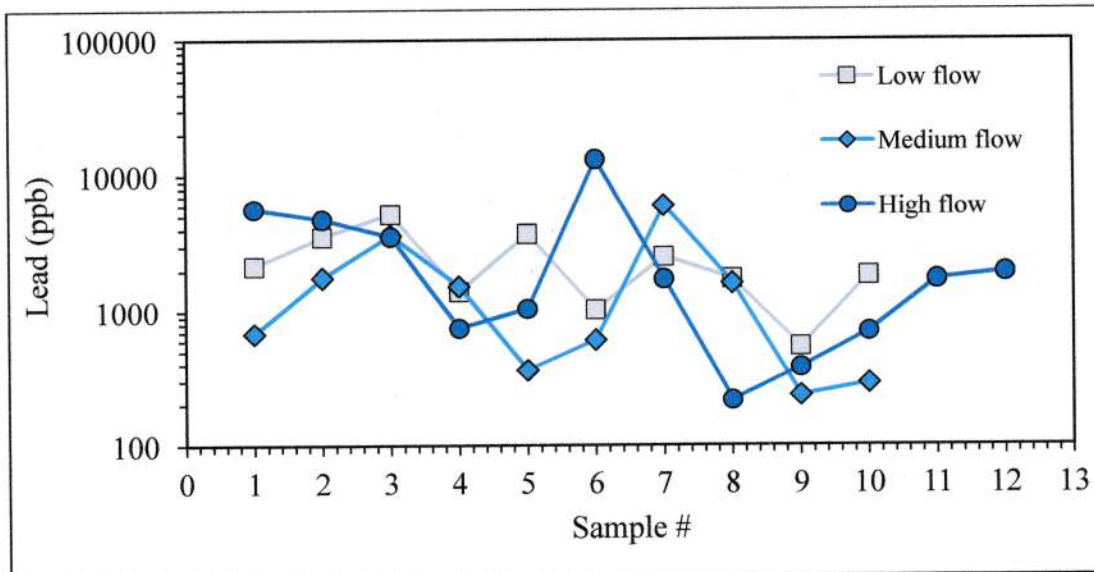
Following the confirmation of the initial high lead results, U.S. EPA Region 5 conducted two visits to the Walters' home on April 27, 2015 and May 6, 2015. Based on an inspection of the plumbing and subsequent sampling conducted at the Walters' residence, it was determined that except for a few minor metallic connectors, all interior plumbing, including the pipes, valves and connectors are made of plastic certified by the National Sanitation Foundation (NSF) for use in drinking water applications. Subsequent sampling showed that the faucets in the home appear to be compliant with the new lead-free requirements and are also not the source for the high lead levels. Our inspection of the interior plumbing and analysis of follow-up sampling results demonstrate that the home plumbing network is not the source of the high lead levels found at the Walters' residence. The photographs and all sampling results will be included in the final report.

Based on the U.S. EPA inspection and documentation of the plastic plumbing at the Walters' residence, it was suspected that the high lead was being introduced into the Walters' home plumbing from outside the home, likely from a lead service line. Three portions of the service line were extracted during a subsequent trip on May 6, 2015 and sent for analysis, when the Walters' service line was replaced. Analyses performed to date indicate that a portion of the service line is made of galvanized iron pipe. Inspection of the remaining portion from the water main to the external shut-off valve confirmed that the portion from the water main to the external shut-off valve is a lead service line.

Ms. Walters has also provided U.S. EPA with medical reports on her child's blood lead testing indicating that the child had a low blood lead level (2 ug/dL) prior to the source water switch and an elevated blood lead level following the switch (6.5 ug/dL). Redacted copies of these reports will also be included in the final report.

Subsequent to the discovery of high lead levels in the Walters' drinking water, the water to the Walters' home was shut off on April 3, 2015. The water was briefly turned back on to collect additional samples on April 28, 2015. Since the water had stagnated for an extended period of time, the kitchen tap was flushed for 25 minutes the night before collecting the samples. Three sets of samples were collected at different flow rates (10 at low flow, 10 at medium flow and 10 at high flow).

The drinking water samples collected from the Walters' residence on April 28, 2015 contained extremely high lead levels, ranging in value from 200 ug/L to 13,200 ug/L (see below).



Sample results and graph are provided courtesy of Virginia Tech

Additional sample results from resident-requested samples have also shown lead levels in excess of the lead action level. As with the samples collected by the City of Flint for compliance, the resident-requested samples are also being collected using the 'pre-flushing', so the lead levels captured in these samples likely do not represent the worst-case lead levels in the water and the actual lead levels at these homes may be much higher.

Pending completion of the final report, my interim recommendations are as follows:

1. The U.S. EPA should follow up with the MDEQ and the City of Flint on the recommendation made by U.S. EPA to MDEQ on June 10, 2015 to offer the City of Flint technical assistance on managing the different water quality issues in Flint, including lead in the drinking water. Although there have been two written assessments regarding water quality and operational issues in Flint at the time of this report, they do not address lead in drinking water. The first is an Operational Evaluation Report (OER) produced in November 2014 by Lockwood, Andrews and Newnam, Inc. to assess the factors contributing to high Total Trihalomethane (TTHM) levels in Flint following the source change. The focus of this report is to identify potential causes and remedial actions for lowering TTHM levels. The second report (Water Quality Report) produced by Veolia for the City of Flint on March 12, 2015, is an assessment of Flint's water quality and operations which provides advice to the City of Flint primarily focused on TTHM control and other operational issues. Both reports were written prior to the recent discovery of high lead results in Flint drinking water. As such, the reports do not take into account the potential effects on lead levels in drinking water.

As previously mentioned, the City of Flint currently has no mitigating treatment for lead and is also planning another source water change in the near future. U.S. EPA's Office of Research and Development in Cincinnati has extensive experience in corrosion and corrosion control treatment and distribution system issues and would be a valuable addition to the drinking water advisory group for the City of Flint. Copies of the qualifications and experience for Michael Schock and Darren Lytle have been forwarded to MDEQ.

2. U.S. EPA should review the compliance status of the City of Flint with respect to whether the system is in violation of the LCR requirement to install and maintain optimal corrosion control and whether the MDEQ is properly implementing the LCR provisions regarding optimal corrosion control treatment requirements for large systems. Pursuant to 40 CFR Section 141.82(i), the EPA Regional Administrator may review treatment determinations made by a State and issue federal treatment determinations consistent with the requirements of the LCR where the Regional Administrator finds: (1) A state has failed to issue a treatment determination by the applicable deadlines; (2) A State has abused its discretion in a substantial number of cases or in cases affecting a substantial population; or (3) The technical aspects of a State's determination would be indefensible in an expected Federal enforcement action taken against a system.
3. The U.S. EPA should review whether relevant resident-requested samples are being included by the City of Flint in calculating the 90th percentile compliance value for lead. Recent drinking water tests conducted at homes in Flint for lead that are not part of the compliance sampling pool have revealed high lead levels in the drinking water. The U.S. EPA memorandum signed on December 23, 2004 provides clarification on compliance determinations and states that customer-requested samples are to be included in the 90th percentile lead compliance calculation where the sampling is conducted during the monitoring period from sites and sampling procedures meeting the LCR criteria. Given the prevalence of lead service lines in the City of Flint, should these sample results be from homes with lead service lines, the sample results would be considered compliance samples under the LCR.

Also attached is a timeline of events for Flint, Michigan. Should you have any questions regarding the information or recommendations provided, please let me know.

cc: Liane Shekter-Smith (MDEQ)
Pat Cook (MDEQ)
Stephen Busch (MDEQ)
Michael Prysby (MDEQ)
Marc Edwards (Virginia Tech)
Michael Schock, EPA-ORD
Darren Lytle, EPA-ORD

Interim Report on High Lead Levels in Flint Michigan Timeline of Events

1. June 2011
 - a. The Walters' home was renovated in 2011 and had no plumbing when purchased. Plastic water pipes and plumbing components were installed by the Walters throughout the home. The Walters family moved into the home at 212 Browning Avenue in June 2011.
 - b. A whole-home iron filter installed for aesthetic reasons. The iron filter cartridge was changed every 6 months during the time when Flint purchased finished water from Detroit. Subsequent to the switch to the Flint River source on April 30, 2014, the filter was required to be changed every 2-3 weeks and eventually required replacement every 6-14 days due to much higher iron levels.
 - c. Tap water treated by the refrigerator filter was consumed in the household from April 2014 through late November/early December 2014. The filters used were not NSF certified to remove lead.
2. October 2012
 - a. The Walters had their twin boys' blood lead levels (BLLs) tested and the result for each child was 2 ug/dL.
3. April 30, 2014
 - a. The City of Flint switches from purchased Detroit water to treating raw water from the Flint River.
 - b. Michigan Department of Environment Quality requires City of Flint to conduct two six-month rounds of monitoring for lead and copper (July-December 2014 and January-June 2015).
4. August 2014
 - a. The City of Flint Violates the National Primary Drinking Water Regulations Maximum Contaminant Level (MCL) for E. Coli bacteria (Acute Coliform MCL violation)
5. August 2014
 - a. The City of Flint Violates the National Primary Drinking Water Regulations MCL for Coliform bacteria (Monthly Coliform MCL violation)
6. September 2014
 - a. The City of Flint Violates the National Primary Drinking Water Regulations MCL for Coliform bacteria (Monthly Coliform MCL violation)
7. Later November/Early December 2014
 - a. The Walters family stops drinking water from the tap due to water quality.
8. November 2014
 - a. Lockwood, Andrews and Newnam, Inc. produces an "Operational Evaluation Report" to assess the factors contributing to high TTHM levels in Flint following the source change. This report is required by the National Primary Drinking Water Regulations when water tests show TTHM or HAA5 levels in excess of 80 percent of the MCL. The focus of this report is to identify potential causes and remedial actions for lowering TTHM levels.
9. December 2014
 - a. The City of Flint Violates the National Primary Drinking Water Regulations MCL for Total Trihalomethanes (Average TTHM MCL violation)
10. February 4, 2015
 - a. Walters' child develops skin rashes over entire body after bathing. The video is shown to City of Flint by Ms. Walters.
11. February 11, 2015
 - a. The City of Flint tests drinking water iron level at Walters' residence and the level exceeds the capability of the measurement (>3.3 mg/L).
12. February 18, 2015
 - a. The City of Flint tests the drinking water at the Walters residence for lead and iron.
 - b. Tests reveal high lead in the drinking water (104 ug/L) and iron level once again exceeds the limit of the test (>3.3 mg/L).
 - c. The Walters' water is tested after pre-flushing for "3-4 minutes" the night before (see sampling instructions). The sample was collected from the kitchen tap with the iron filter in place.
13. February 25, 2015
 - a. EPA Region 5 receives a call from Ms. Walters regarding high lead levels discovered in her home.

- b. The City of Flint once again tests the drinking water iron level at the Walters' residence and the result is once again beyond the measurement capability (>3.3 mg/L).
14. February 26, 2015
 - a. The Walters have their children's blood lead levels tested and their child's blood lead level is 3 ug/dL.
15. March 2015
 - a. The City of Flint increases the Ferric Chloride dosage used in the filtration process to improve the removal of disinfection byproduct precursor material, in an effort to lower the TTHM levels.
16. March 03, 2015
 - a. The City of Flint re-tests lead levels in drinking water at Walters' residence. The lead level measured is 397 ug/L. The water is once again tested after pre-flushing for 3-4 minutes the night before but this time with the iron filter removed (see sampling instructions).
17. March 11, 2015
 - a. The City of Flint re-tests the iron levels in drinking water at Walters' residence The iron level once again exceeds the limit of the test (>3.3 mg/L).
18. March 12, 2015
 - a. Veolia (hired as a consultant by City of Flint) to assess water quality issues, submits "Water Quality Report" to City of Flint which provides recommendations and a roadmap for water quality and operational improvements, primarily focused on lowering TTHMs.
19. March 19, 2015
 - a. EPA Region 5 calls MDEQ expressing concern regarding the high lead levels found.
 - b. The MDEQ response received via voicemail states that the high lead levels at the Walters' home are due to lead sources in the homeowner's plumbing. In previous and subsequent conversations with Ms. Walters, she stated that the plumbing has always been all plastic. An inspection conducted by EPA Region on April 27, 2015, confirmed that all pipes, fittings and valves in the Walters' home are NSF-approved CPVC pipe (certified for drinking water use) and sequential sampling results following the replacement of the service line found that there are no sources of lead in the home plumbing.
20. March 26, 2015
 - a. EPA R5 learns that the local Health Department is looking at whether there is a potential uptick in cases of Legionella in the County, which includes the City of Flint.
 - b. Due to recent bacteriological and other distribution system water quality issues, EPA Region 5 contacts EPA ORD (Cincinnati) to discuss possible support for assessing whether the potential uptick in Legionella being assessed by Genesee County, which includes the City of Flint, could be caused by or related to the distribution system upsets from the water quality changes and subsequent flushing events by the City of Flint which can mobilize sediment from within the water mains and dislodge microbial contaminants, including Legionella bacteria from biofilm within the water mains.
 - c. EPA ORD indicates that they are available and willing to provide support to the local health department and City of Flint should they conclude there has been an increase in Legionella cases in the county.
21. March 27, 2015
 - a. Based on a suspected conflict of interest at the local health department that conducted the February 2015 BLL testing, the Walters' take their child to a healthcare facility in a different location to have his blood lead re-tested. The result from this BLL test (6.5 ug/dL) is significantly higher than the February BLL test (3 ug/dL) and he is found to also be iron deficient as well (anemic).
22. April 3, 2015
 - a. The water is shut off at Walters' residence due to the high lead levels.
 - b. The Walters' home is provided water via garden hose from neighboring home (hose spigot to hose spigot). The Walters use this water only for bathing, washing dishes and washing clothes.
23. April 27, 2015
 - a. EPA Region 5 visits the Walters' home and reviews the internal plumbing, bringing back water samples, iron filter cartridges and relevant photographs.
 - b. The internal plumbing at the Walters' residence is confirmed as all plastic as had been stated by Ms. Walters.
24. April 28, 2015
 - a. The water at the Walters' residence was turned back on temporarily to collect additional water samples. The water in the service line had been shut off since April 3, 2015.

- b. The kitchen tap was flushed at low flow for 25 minutes the night before (on April 27, 2015) the sequential sampling conducted on April 28, 2015.
 - c. On April 28, 2015, 30 Sequential samples were collected at Walters residence
 - d. The drinking water samples are sent to Virginia Tech for analysis. All samples are analyzed for Ag, Al, As, Ba, Ca, Cd, Cl, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sn, Sr, Ti, U V, and Zn.
 - e. Extremely high lead levels were found in all samples. The minimum lead value was 200 ug/L; the average lead value was 2,429 ug/L; and the maximum lead value was 13,200 ug/L.
 - f. A review of the analytical results by Virginia Tech shows lead levels in all water samples correlated with phosphate levels, cadmium levels and uranium levels found in the samples and most of the lead was found to be in particulate form.
 - g. The correlation between lead and phosphate would be consistent with the dislodging of the pipe scale from the service line outside the home containing lead and phosphate which would have formed during the period of time when Flint was purchasing water from the City of Detroit that was treated with orthophosphate. Additional analyses are being conducted to confirm the chemical compositions.
25. May 6, 2015
- a. EPA Region 5 visits Walters' home to collect pipe samples from service line. Three sections of the service line were extracted and sent to Virginia Tech for analysis.
 - b. EPA inspection reveals that the portion of the Walters' service line from the water main to the external shut-off valve on the corner of Bryant Street and Browning Avenue is made of lead. EPA's inspection also confirms that the portion of the Walters' service line from the home to the external shut-off valve appears to be galvanized iron pipe. Additional analyses are underway at Virginia Tech on the third piece of service line extracted.
 - c. The service line to the Walters' residence is replaced with a new copper service to the water main in front of the Walters' residence on Browning Avenue.
 - d. Sample bottles are left with Ms. Walters for collecting sequential samples following the replacement of the service line to the Walters' home.
 - e. EPA Region 5 collects a set of sequential samples from each of two residences on Bryant Street which are connected to the same main as the Walters' old service line. These samples were analyzed by Chicago Regional Laboratory. The results indicate that home #1 (4526 Bryant Street) does not appear to have a lead service line and lead results in all samples are low. The results from home #2 (4614 Bryant Street) indicate that the portion of the service line from the external shut-off valve to the water main is likely made of lead, which is consistent with the historical practice in Flint. The sampling had a high lead result (peak value) of 22 ug/L.
26. May 6, 2015
- a. The City of Flint tests the water at 216 Browning Avenue at resident's request, again using a first-draw, pre-flushed sampling protocol, which yielded a high lead result (22 ug/L).
 - b. The City of Flint tests the water at 631 Alvord Avenue, yielding a high lead result (42 ug/L).
27. May 13, 2015
- a. Water samples are collected at Walters' residence following the replacement of the service line.
 - b. 15 sequential samples were collected from kitchen tap, 1 sample was collected from the bathroom tap and 2 samples were collected from the water heater.
 - c. The samples were shipped to the EPA CRL and received on May 14, 2015.
 - d. All kitchen tap and bathroom tap results for lead and copper were low, confirming that the sources of lead were external to the home. Residual lead was found in the water heater samples (31.7 ug/L), very likely from deposition of lead-containing particulate coming into the home via the old service line which was disconnected and replaced on May 6, 2015.
28. June 2015
- a. The City of Flint Violates the National Primary Drinking Water Regulations MCL for Total Trihalomethanes (Average TTHM MCL violation)