# A Brief Scientific and Regulatory Assessment of Water Quality at the Millville Elementary School

## Prepared for the Town of Millville

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**EXECUTIVE SUMMARY:**

- **Good Water Quality:** Overall, the quality of the treated water at the Millville Elementary School (MES) is quite good and currently meets all of the state and federal regulatory requirements with the sole exception of haloacetic acids (HAA5).
- **Occurrence of haloacetic acids (HAA5):** HAA5 are formed when chlorine used for the treatment process reacts with natural organic water (NOM) in the water, and are considered as a class of disinfection byproducts (DBPs).
  - ✓ At MES chlorine is used as a pre-oxidant for the greensand filters that remove iron and manganese, and is not designed for disinfection.
  - ✓ Periodic overdoses of chlorine well above the target level (~0.5 parts per million in the filter effluent) caused elevated HAAs.
  - ✓ In the 7¾ years since 4$^{th}$ quarter 2015 (when the current compliance calculations started) there have been nine quarterly violations where the HAA5 Locational Running Annual Average (LRAA) exceeded the Maximum Contaminant Level (MCL) of 60 parts per billion (ppb).
  - ✓ The LRAA violations were just slightly above the MCL, with a range from 62 to 71 ppb for 8 of the 9 quarters with violations, with the most recent quarter at 82 ppb.
  - ✓ It is also reassuring that the nine quarters of HAA5 violations over those 7¾ years appear to have resulted from just four very short periods (from only a single day to a few weeks) of excessive chlorine dosing to the greensand filters.
  - ✓ It is possible to have more quarterly violations than actual incidents of high HAA5 since the compliance calculations use a running annual average where each quarterly result is used for four consecutive quarters.
  - ✓ When considering any potential health impact, those concentrations and exposure times should be put into perspective when compared to an MCL that is based on consumption over decades.

**Potential health impacts?**

- ✓ MassDEP has given clear notice that the HAA5 violations are not an emergency and overall the water is safe to drink.
- ✓ MassDEP notes that *"consumption of water with HAA5 levels somewhat above the MCL for limited durations, for example, while corrective actions are being taken to lower the levels, is not likely to significantly increase risks of adverse health effects for most people."*
- ✓ Basically, exceedance of the MCL is cause for corrective action, not for avoiding the water unless someone believes they are particularly sensitive.
- ✓ I believe the potential health risks from these HAA5 violations are relatively nominal and have been overstated by some people.
- ✓ Further, given the short times periods the HAA5 concentration was actually above the MCL level, and that the LRAA concentrations were not far above the MCL, I consider the actual health risk (if any) to be substantially less than is implied by the running annual average results and corresponding violations and related Public Notices.

- **Substitute water?** I believe that an alternative drinking water supply for MES was not necessarily required for health considerations, but is of course the school's own prerogative.
- **Water color problem fixed:** Failure of the greensand filters to effectively removal iron and manganese resulted in periodic water color from 2020 through 2023, and was caused by extended periods of insufficient chlorine dosing. MassDEP issued a Notice of Noncompliance for this treatment technique failure on 10/25/22, and the problem was resolved in February 2023 by replacement of the greensand filter media.
- **Solution for HAA5:** As a means of totally eliminating the formation of chlorinated DBPs, Millville agreed with the original recommendation made by their engineer, Northeast Water Solutions, Inc. (NWSI), to switch from using chlorine to permanganate as the pre-oxidant for the greensand filters. The task of completing the engineering design and required WS-34 application to MassDEP was assigned to NWSI on December 5, 2022.
- **Delay in solution to HAA5 problem:** The WS-34 application has not yet been completed by NWSI, and NWSI now refuses to proceed with it based effectively on their belief in the following three concepts:
    1. The beavers and standing water affect the microbiological water quality in the well,
    2. Chlorine is currently used for disinfection, and
    3. Removing chlorine would require installing other treatment processes to compensate for the loss of disinfection
- **The delay is unfortunate and unnecessary,** as all three of those concepts are not supported:
    1. MassDEP made it clear at the 5/15/23 meeting that they do not consider there to be a connection from the surface water to the water in the well, and that the beavers were not a concern either. Mr. Ferrari himself has wrote to MassDEP in 2020 that *"…there is no direct surface water influence or connectivity with the bedrock fractures, which is consistent with expectations…"*
    2. Chlorine is not used for disinfection at MES (instead UV light is used for disinfection)
    3. According to MassDEP, removal of the chlorine would NOT require any additional action or treatment related to disinfection

**INTRODUCTION:**

- I take this water quality very seriously, and of course there are children involved so caution is especially important. But at the same time it is reasonable and appropriate to keep a sound perspective of the relative safety of this drinking water supply compared to other risks of life.
- Millville and those interested in the Millville Elementary School (MES) are encouraged to look at the overall state of the high quality of MES' water, and at the finer details regarding the problem area of haloacetic acids (HAA5)
- In my opinion, there has been a fair amount of misinformation, exaggeration, fearmongering, and overreaction spoken at some recent School Committee meetings.
- This assessment is intended to clarify the facts of the situation and help allow a realistic and practical perspective of the safety of the water quality at MES.

Most of the characteristics of the water quality at MES are quite good. The following list includes important water quality parameters that meet all regulatory requirements and for which there have been no water-quality related violations that we are aware of over at least the past 10 years:

- Bacteria and other microorganisms (Revised Total Coliform Rule, Groundwater Rule)
- Total trihalomethanes (TTHM; a type of disinfectant byproduct, DBP)
- Lead and copper (no Action Level exceedances for the Lead and Copper Rule)
- Synthetic organic chemicals (SOCs)
- Volatile organic chemicals (VOCs)
- Heavy metals (mercury, cadmium, etc.)
- Per- and polyfluoroalkyl substances (PFAS)
- Radiological substances
- Nitrate and nitrite
- Pesticides (insecticides, herbicides, rodenticides, etc.)
- Algae and algal toxins
- Taste and odor

There are currently two parameters of concern with regulatory compliance violations (occasionally or periodically):

1. HAA5 (haloacetic acids - a type of DBP)
2. Iron and manganese

Iron and manganese are essential human nutrients, and are not a health hazard at the concentrations encountered in MES' treated water. Both have Secondary Maximum Contaminant Levels (SMCLs) that are for aesthetic reasons (e.g., color) and not health concerns.

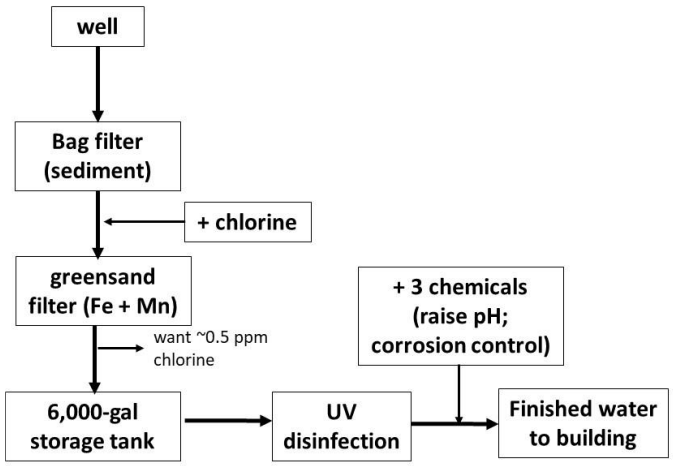
Both iron and manganese have been well-removed at times, but at other times the greensand filters have not been fully effective and that was the cause of the water color and 10/25/22 Notice of NonCompliance from the Massachusetts Department of Environmental Protection (MassDEP). The problem was solved by replacing the greensand filter media in February 2023, and the filters are now working satisfactorily.

So in terms of the regulatory requirements there is currently only one potential health issue to address, the HAA5. Though not yet a regulatory compliance issue, the total trihalomethanes are also higher than desired and should be addressed simultaneously.

It is noted that, as a precaution by the school leadership, MES' water is not consumed for drinking and hasn't been for many years. Exposure to the water has only been for food preparation and hand washing.

**WATER TREATMENT AT MES:**

The MES drinking water treatment system operates as shown in Figure 1. Iron and manganese are removed via chlorine oxidation and greensand filtration. After a storage tank the water is disinfected using ultraviolet UV light. The water is then treated for corrosion control (soda ash, phosphate and silica are added).




- Chlorine oxidizes most dissolved Fe + some Mn which is then captured by the filter media
- Greensand effluent requires consistent chlorine residual of 0.5 to 1.0 ppm (lower levels used at MES to minimize DBPs)
- That creates coating on media that adsorbs remaining dissolved Fe/Mn, allowing it to be oxidized (especially important for Mn)
- Chlorine in GSF effluent is monitored continuously
- Want [Mn] ≤ 0.015 ppm

**Figure 1. MES water treatment system**

The corrosion control system is working well, as MES' water has consistently tested below the Lead and Copper Rule's Action Levels for over a decade. However, the level of chlorine residual in the greensand filter effluent (the water coming out of the filters) has not always been maintained by the operator within the necessary target range.

When the chlorine residual was too low for extended periods the greensand filters no longer worked well, and there was substantial breakthrough of iron and manganese with resulting water color. When the chlorine residual was too high – even for short periods such as a few days – elevated levels of haloacetic acids were formed and caused exceedances of the regulatory limit for HAA5.

**FORMATION OF DBPs (HAA5 and TTHM):**

HAA5 and TTHM are compounds formed by the chlorination of natural organic matter (NOM) in water, and are typically referred to as disinfection byproducts (DBPs) since chlorine is often used for disinfection. The rate of DBP formation is related (among other factors) to the amount of NOM in the water and the dose of chlorine applied. Increasing chlorine doses results in higher levels of HAAs and THM, and the reverse is true also as lower chlorine doses result in lower HAAs and THMs.

In the case of Millville, chlorine is not applied for disinfection, and is instead used as a pre-oxidant for iron and manganese removal by the greensand media filters. Ultraviolet light is used for disinfection at MES. The chlorine dose is supposed to be set to result in a chlorine residual of ~0.5 mg/L (ppm) in the greensand filter effluent (which is water coming out of the filtration media used for removal of iron and manganese).

The chlorine levels used are not high enough or for long enough time to count as regulatory credit for disinfection. Regardless of the purpose of the chlorine, chlorinated organic byproducts are formed when the chlorine reacts with natural organic matter in the water, and the water is subject to the DBP rules.

**REGULATORY COMPLIANCE:**

Millville's history regarding violations of the Safe Drinking Water Act (SDWA) regulations over approximately the past ten (10) years are listed in Tables 1 and 2, according to Millville's current knowledge. MassDEP was contacted on July 15, 2023 to confirm this list is complete and identify any potential additional violations (a response has not yet been received as of July 22, 2023).

The only health-related violations were for HAA5 (Table 1), a consequence of using chlorine as the preoxidant for the greensand filters. The nine quarters of violations for HAA5 are divided into four different 'event' groups for later discussion of their causes.

**Table 1. HAA5 violations (LRAA > MCL of 60 ppb)**

| Event # | Sample location | Quarter | LRAA (ppb) | ENF # (Stage 2 D/DBPR) |
|---|---|---|---|---|
| 1 | Nurse's Station | 1st quarter 2016 | 62 | NA |
| 2 | Teacher's Lounge | 4th quarter 2018 | 63 | NA |
| | Nurse's Station + Teacher's Lounge | 1st quarter 2019 | 62, 66 | NA |
| | Nurse's Station + Teacher's Lounge | 2nd quarter 2019 | 65, 65 | NA |
| | Nurse's Station + Teacher's Lounge | 3rd quarter 2019 | 68, 67 | NA |
| 3 | Nurse's Station | 2nd quarter 2022 | 64 | NON-CE-19-5D00014118 |
| | Nurse's Station | 3rd quarter 2022 | 65 | NON-CE-19-5D00014118 |
| 4 | Nurse's Station + Teacher's Lounge | 1st quarter 2023 | 71, 71 | NA |
| | Nurse's Station + Teacher's Lounge | 2nd quarter 2023 | 82, 66 | NA |

On 10/25/22 a Notice of Noncompliance (NON) was issued to Millville by MassDEP for a treatment technique failure to satisfactorily remove iron and manganese (Table 2). That problem was resolved in February 2023 by replacing the greensand filter media. None of the other violations that occurred are active or are directly related to water quality (Table 2). Instead these violations were for (1) the operator missing a required sample for perchlorate (where the required frequency had changed based on a previous sample's result), (2) not providing notice of lead and copper monitoring results to the public as soon as required after one particular round of sampling, (3) a monitoring/reporting violation regarding iron and manganese samples one quarter, and (4) treatment system alarm and staffing issues that were quickly resolved.

**Table 2. Other SDWA regulatory compliance violations (non-HAA5)**

| Regulation | Date | Description | ENF # |
|---|---|---|---|
| Iron and Manganese | 10/25/2022 | Treatment Technique violation due to high manganese | NON-CE-22-5D00014119 |
| Monitoring and Reporting Violation | 6/28/2023 | Notice of Noncompliance for failing to sample for perchlorate in 4th quarter 2022 | NON-CE-23-5D00015805-CSA |
| Monitoring and Reporting Violation | 8/26/2021 | Failure to properly test for and/or report iron and manganese results to MassDEP within required period (for 4th quarter 2020) | NON-CE-21-5D00012068-CSA |
| Lead and Copper Rule | 7/11/2023 | Notice of Noncompliance for failing to provide notice of the lead and copper monitorng results in the 1st half of 2022 to the people served within the 30-day deadline (it was delivered 63 days after receiving the results) | NON-CE-23-00015813 |
| Sanitary Survey<br>(5 violations)<br>July 30, 2020 | 1. Written alarm protocols not established for critical chemicals<br>2. Alarms and interlocks are tested periodically but are not noted in an alarm testing log book<br>3. The system does not automatically shut down when an alarm is triggered on a critical chemical<br>4. A critical chemical feed shut down does not require manual on-site reset<br>5. The treatment plant is visited only once per week, which is less frequently than the minimum allowed for a 2-T plant. | | |

For DBP compliance purposes, the Locational Running Annual Average (LRAA) concentrations (average of four consecutive quarters of results) for both HAA5 and TTHM are compared to their respective Maximum Contaminant Levels (MCLs) of 60 and 80 ppb (part per billion, similar to microgram per liter, µg/L). Quarterly results may be an average of multiple individual samples during the quarter (e.g., monthly). Individual sample HAA5 results are not subject to regulation other than how they impact quarterly averages and the LRAA.

Figures 2 and 3 present the HAA5 quarterly results and LRAA for the two MES sampling sites.

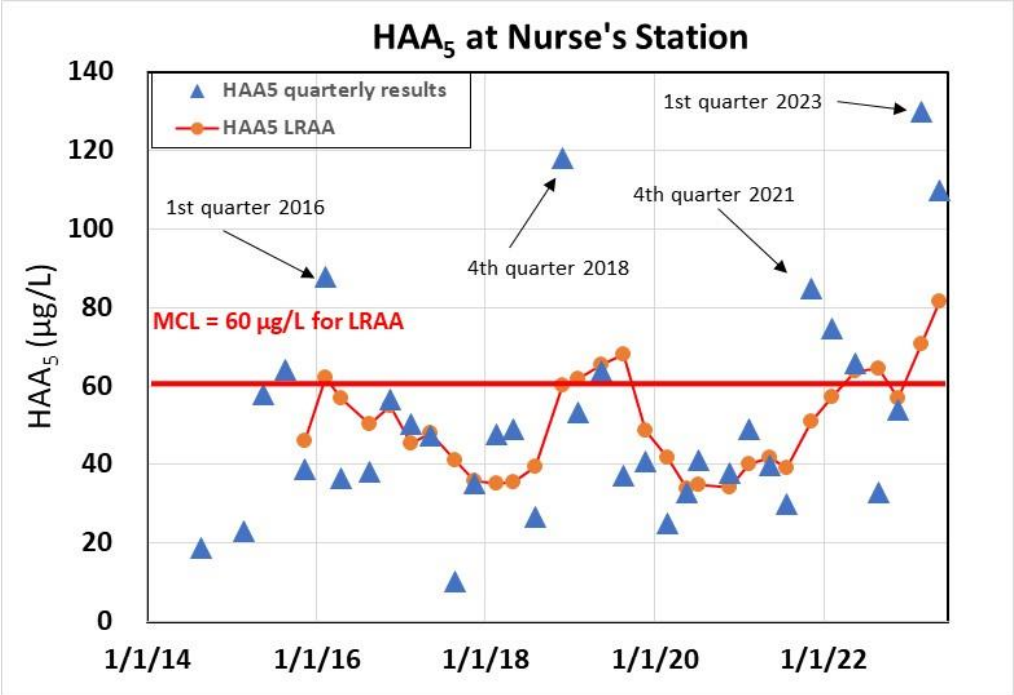



**Figure 2. HAA5 quarterly results and LRAA at Nurse's Station**

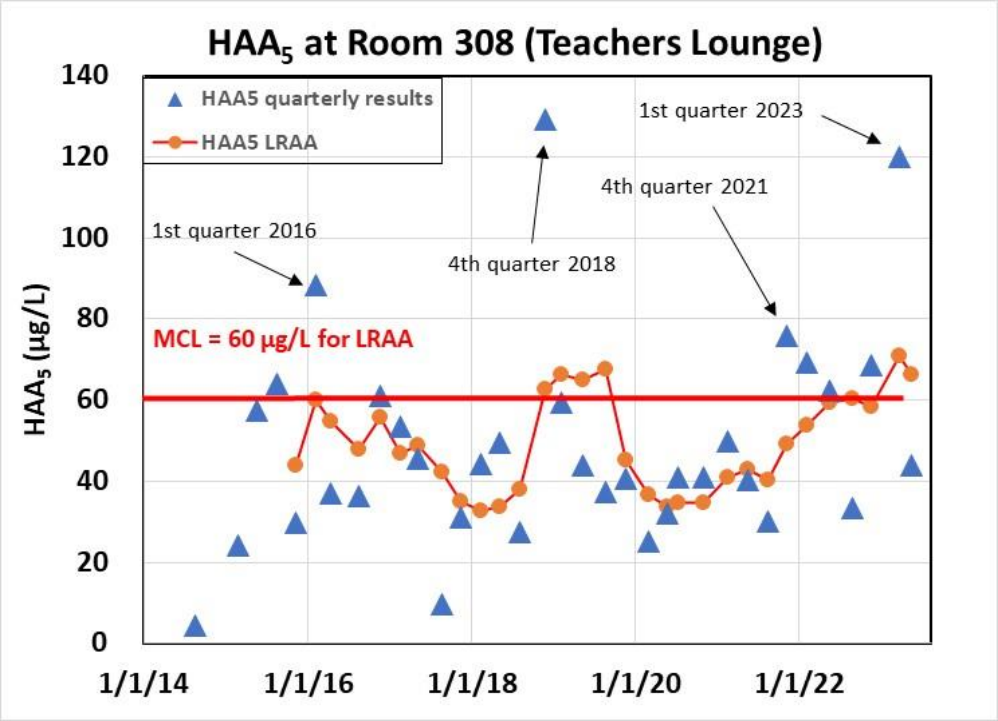



**Figure 3. HAA5 quarterly results and LRAA at Teachers Lounge**

**TOO LITTLE CHLORINE, AND TOO MUCH CHLORINE**:

As is discussed in more detail later, short-term overdoses of chlorine caused the HAA violations (e.g., 11/29/18). NWSI's response strategy to that 2018 DBP violation was to lower the chlorine target level. Instead, the operator should have kept the necessary existing target and done an improved job of meeting it. NWSI further let the chlorine levels get even lower than the target range, and below the levels necessary for proper greensand function. The lack of chlorine caused the greensand to fail and it could no longer remove all of the dissolved iron and manganese, and thus required replacement in February 2023.

Then on other occasions the operator overdosed the chlorine, creating excess HAA5. Some of those high chlorine occasions happened to occur shortly before collecting HAA5 compliance samples. In fact, four specific MES water samples over the past 7¾ years caused all nine quarters that exceeded the MCL for HAA5 (details are provided later). The continued violations in quarters after an anomalous high result is due to the use of a running annual average for comparison to the MCL for determining compliance.

In summary, the HAA5 violations (Table 1) were primarily caused by overdoses of chlorine that occurred for very short periods just before quarterly HAA5 sampling events. The iron and manganese treatment violations (Table 2) were caused by underfeeding of chlorine for extended periods.

**POSSIBLE HEALTH EFFECTS:**

Some of the wording in the Public Notices required by MassDEP to be distributed after an HAA5 violation can be alarming, frightening and quite daunting. At least if you want to be scared. But those notices also contain reassuring passages, as quoted below.

MassDEP's Public Notice about the HAA5 MCL exceedance says *"This is not an immediate risk. If it had been, you would have been notified right away".* Also, *"Although this is* not an emergency (emphasis by MassDEP)*, you have a right to know what happened, what you should do, and what we are doing to correct this situation*."

As noted by MassDEP, potential risks from HAA5 require long-term exposure (decades): *"Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer."* They also note that *"pregnant women and women of childbearing age may be at increased risk and should seek advice from their health care providers if they have any concerns."*

Regarding the concentration of HAA5, MassDEP notes that *"**consumption of water with HAA5 levels somewhat above the MCL for limited durations**, for example, while corrective actions are being taken to lower the levels, **is not likely to significantly increase risks of adverse health effects for most people**."*

MassDEP has also written the following specifically about the water at MES with HAA5 violations: *"Overall the water is safe to drink. The MCL is development (sic) for those that have been exposed to elevated haloacetic acids over many years… Those in the sensitive population (pregnant women and women of childbearing age) may be at increased risk and should seek advice from their health care provider if they have any concerns."* (source: 8/2/19 e-mail from MassDEP Central Region Drinking Water Chief Robert Bostwick to MES).

The following is quoted from a MassDEP Fact Sheet regarding exposure to HAA5 in drinking water:

- ***"What are the health risks associated with using water containing HAA5?*** *HAA5 are possibly carcinogenic to humans based on evidence of carcinogenicity in laboratory animals and limited evidence in people.*
- *Other effects have been reported in experimental animals exposed to high levels of HAA5 and other disinfection byproducts. These include effects on the liver, kidneys, and reproductive system and on development.*
- *The significance of these effects is uncertain as some studies of people have reported similar effects while others have not. Scientists are working to address these differences.*
- *However, pregnant women and women of childbearing age may be at increased risk and should seek advice from their health care providers if they have any concerns.*
- ***What about breastfeeding infants?*** *Breast milk can also be a source of HAA5 exposure for infants. However, those infants will benefit from any exposure reductions experienced by the mother, and they also gain a substantial health benefit from breastfeeding. The Centers for Disease Control and Prevention recommend that nursing mothers continue to breastfeed their babies because of the numerous protective health benefits despite the potential presence of environmental contaminants."*
- MassDEP suggests that if someone is concerned they may use bottled water or a home treatment system. Brita pitchers with activated carbon filters work fine for removing HAAs. MassDEP also notes that *"An effective way to reduce exposures is to also use bottled water for preparing formula, beverages, or food that retains water (e.g., hot cereals, rice, or pasta). This approach also lessens the exposure for bottle-fed infants."*

*Summary of the HAA5 violations:*

It is essential to meet the regulatory requirements. That is a key indicator that a water system is well operated and protecting public health. Unfortunately, poor operation of the greensand treatment system has caused violations of the HAA5 MCL and also inadequate removal of iron and manganese.

The observed HAA5 levels are not a short-term emergency, but are something to address operationally. Basically, exceedance of the MCL is cause for corrective action, not for running away.

The violations serve as a *"wake-up call"* that something needs to be done so that the situation does not continue for years. That's why Millville is changing the treatment process – to totally eliminate formation of the chlorination byproducts that result in HAA5 violations.

Apparently MES is not using the building's water supply for drinking. The school shut down the drinking water fountains (bubblers) many years ago. Bottled water has been provided since, and delivered bulk water was used during the last part of the 2022-2023 school year.

**DATA-BASED EVALUATION OF ACTUAL HAA5 EXPOSURE:**

Examining the details of these HAA5 MCL violations is informative and revealing. To understand the potential health risk (or lack thereof), one should look beyond the regulatory compliance record and into the chemistry of the regulations and MES' water.

As important as regulatory compliance is, the actual potential health risk for consuming HAA5 depends on the duration of exposure time and the concentrations of HAA5 to which someone is exposed, along with the sensitivity of the person drinking the water. The duration of exposure time is key for there to be an impact. That is regardless of the regulatory compliance interpretation of the analytical results. Accordingly, a complete evaluation of potential public health risk is based on science and not just on the regulations.

Consider the following critical facts and mitigating factors for Millville's situation related to the concentration of HAA5 in the water:

- Most of the time Millville's HAA5 LRAA results were well below the MCL level of 60 ppb. For example, since 4$^{th}$ quarter 2015 when HAA5 LRAAs started, a total of 22 of the 31 quarters (71%) at the Nurse's Station were below the MCL while nine quarters (29%) were above the MCL.
- When HAA5 violations did occur, the LRAA exceeded the MCL by just a few parts per billion
- The range of HAA5 LRAA was within 62 to 71 ppb for 8 of the 9 quarters with violations, with the most recent quarter at 82 ppb.
- During those 9 quarters of MCL exceedances, the LRAA for HAA5 averaged 67 ppb at the Nurse's Station and 66 ppb at the Teacher's Lounge
- Per MassDEP at the 5/15/23 meeting, the MCLs were developed assuming consumption of two liters of the water per day for 70 years.
- Additionally, the DBP regulations are rather conservative, and safety factors are built into the MCLs

In addition, the LRAA calculation method can overemphasize single-sample results (see Figures 2 and 3):

- The LRAA calculations use each result for four consecutive quarters. As such, one high sample result can cause a full year of violations (one each quarter), even if that one high result only lasted for a few days or weeks. And that has happened at MES.
- A total of only four individual HAA5 samples caused the nine MCL quarterly violations and resulting Public Notices
- Recently, the high HAA5 result during February 2023 (and corresponding high 1st quarter result) has caused two quarterly LRAA violations with two more likely to come for the next two quarters. The February sampling event for HAA5 was conducted shortly following greensand filter media replacement when particularly high doses of chlorine were used by the operator for a few days.
- Those individual high HAA5 results were known to be caused by short-term operational overdosing of chlorine that occurred for only one day, 4-6 days, and then perhaps a few weeks for two occasions. That correspondingly suggests for each chlorine overdose the high HAA5 may have lasted for only a few days or weeks instead of throughout the whole quarter that the result represents.
- There would have been many fewer compliance violations if not for the quirk of the LRAA calculations where each sample result is used for four quarters.

None of that is said to diminish the importance of meeting all the SDWA regulations, completing Millville's Corrective Action Plan for eliminating formation of HAA5, and implementing that plan to address the violations. Nonetheless, the time periods with actual high levels of HAA5 were relatively few and fairly short in duration, especially in comparison to the poor regulatory compliance history.

**CAUSES OF THE HAA5 VIOLATIONS:**

This situation with the HAA5 MCL exceedances has not been an emergency, and has not been an acute health risk. MassDEP bluntly states in the Public Notice that "*this is not an emergency*." And the above considerations make that even more so the case. I believe the poor public perception due to the repeated series of HAA5 Public Notices is overexaggerated when the actual HAA5 monitoring results are taken into consideration.

There have been four periods with an exceedance of the MCL for HAA5 (Table 1). In at least three of those (and probably all four), short-term chlorine overdoses shortly before the HAA5 sampling day were the apparent cause of the high HAA5 results, which in turn have resulted in from one to four quarters of MCL violations with related violation Public Notices being sent out. These outlier results that caused the violations can be seen in Figures 2 and 3. Each case is described in some detail below.

It is noted there have also been times with relatively high chlorine levels during which there was no HAA5 compliance sampling, and so those occasions did not result in violations.

*HAA5 event #1 (one quarter of violation):*

This HAA5 MCL exceedance was the result of a single sample taken on 2/10/16 with a result of 88 ppb. The HAA5 result from the previous sample on 11/10/15 was only 39 ppb and

subsequently on 4/15/16 was only 39 ppb (see Figure 2). The result of 88 ppb caused the LRAA to increase to 62 ppb at the Nurse's Station for that one quarter, just over the MCL of 60 ppb. At the Teachers Lounge the MCL was met that quarter with an LRAA of 60 ppb.

*HAA5 event #2 (four quarters of violations):*

In this case the chlorine for the greensand filters was overdosed for three weeks, and NWSI has recognized it was their fault. During period the 4th quarter DBP samples were collected. They claim the iron concentration in the well water went up and they then increased the concentration to compensate for the additional oxidant demand. Then the iron level went down and NWSI did not adjust the chlorine dose in response, thus overdosing the chlorine and causing a very high HAA5 result. Per NWSI, the overfeed occurred from 11/15/18 to 12/6/18.

The HAA5 result for 11/29/18 at the Nurse's Station was 118 ppb, while the preceding 10 quarters of HAA5 results averaged only 40 ppb with a range of 10 to 57 ppb. The high chlorine level was soon discovered and reduced, and the HAA5 level would then have decreased to normal lower levels. The HAA5 results for that time period are provided in Table 3, showing the anomaly that the 11/29/18 sampling event was.

Importantly, that one short-term period of high chlorine resulted in a single high HAA5 result (118 ppb) that basically by itself caused four quarters of HAA5 violations. And that was even despite the much lower HAA5 results that occurred for the rest of that year. Had the HAA5 result for 11/29/18 been 87 ppb or lower (instead of 118 ppb) then there would have been no MCL exceedances or violations at that time (assuming the other quarters' results were the same).

**Table 3. 2018–2019 DBP results and recent chlorine levels (including Event #2)**

| MES Disinfection Byproduct Monitoring Results | | | | | | | |
|---|---|---|---|---|---|---|---|
| DBP Sample Period | Sample Date | 3-Day Precursor Cl Residual | 1-Day Precursor Cl Residual | Nurses Station HAA5 | Nurses Station TTHM | Room #308 HAA5 | Room #308 TTHM |
| Q2 - 2018 | 5/4/2018 | 0.76 | 1.04 | 49 | 61 | 49 | 60 |
| Q3 – 2018 | 8/7/2018 | 0.13 | 0.13 | 27 | ----- | 27 | ----- |
| Q3 - 2018 | 8/23/2018 | 0.34 | 0.32 | ----- | 24 | ----- | 25 |
| Q4 – 2018 | 11/29/2018 | 1.61 | 1.44 | 118 | 90 | 129 | 91 |
| Q1 - 2019 | 2/7/2019 | 0.22 | 0.27 | 53 | 48 | 59 | 47 |
| Q2 - 2019 | 5/1/2019 | 0.13 | 0.13 | ----- | 25 | ----- | 21 |
| Q2 – 2019 | 5/3/2019 | 0.67 | 0.65 | 72 | 40 | 20 | 41 |
| Q2 – 2019 | 5/4/2019 | 0.53 | 0.35 | 49 | ----- | 8.5 | ----- |
| Q2 – 2019 | 5/7/2019 | 0.32 | 0.4 | ----- | 40 | ----- | 41 |
| Q2 – 2019 | 5/16/2019 | 0.16 | 0.19 | 30 | 27 | 31 | 27 |

*Source of table: NWSI*

*HAA5 event #3 (two quarters of violations):*

In November 2021 the average daily chlorine level for the greensand effluent jumped from an average of 0.23 mg/L up to 1.33 mg/L for a single day on 11/6/21 (Table 4). The target for the chlorine residual is normally ~0.5 mg/L. Sampling for HAA5 two days later had a very high result of 132 ppb. So even though the chlorine level was reduced the day after completing the HAA5 sampling (Table 4), that one day of a high chlorine level just before HAA5 sampling appears to have caused the high HAA5 result of 132 ppb and two quarters of violations.

**Table 4. Daily average chlorine surrounding DBP event #3 (11/8/21)**

| **Impact of one single outlier chlorine result** | | |
|---|---|---|
| **Date** | **avg. Cl2 (mg/L)** | |
| 10/25/21 | 0.11 | |
| 10/26/21 | 0.30 | |
| 10/27/21 | 0.29 | |
| 10/28/21 | 0.24 | |
| 10/29/21 | 0.39 | |
| 10/30/21 | NA | |
| 10/31/21 | 0.20 | |
| 11/1/21 | NA | |
| 11/2/21 | 0.14 | |
| 11/3/21 | 0.27 | |
| 11/4/21 | 0.03 | |
| 11/5/21 | 0.38 | avg. Oct. 25 - Nov. 5 = 0.23 mg/L |
| 11/6/21 | 1.33 | then this one high outlier |
| 11/7/21 | NA | |
| 11/8/21 | 0.59 | sampled for HAA5 = 132 ppb |
| 11/9/21 | 0.39 | avg. thru Nov. 9 -18 = 0.27 mg/L |
| 11/10/21 | 0.35 | |
| 11/11/21 | NA | |
| 11/12/21 | 0.26 | |
| 11/13/21 | 0.19 | |
| 11/14/21 | 0.23 | |
| 11/15/21 | 0.21 | |
| 11/16/21 | 0.20 | |
| 11/17/21 | 0.35 | |
| 11/18/21 | 0.29 | |

*HAA5 event #4 (two quarters of violations, with maybe two more to come):*

In February 2023, sampling for HAA5 was conducted a few days after the operator replaced the greensand filter media and while they were using very high chlorine concentrations (Table 5). The corresponding HAA5 sample result was 250 ppb, which so far has contributed to two quarterly violations, with two more most likely yet to come due to the use of that result for four quarters of calculating the LRAA.

**Table 5. Daily average chlorine in greensand effluent surrounding DBP event #4 (2/27/23)**

| Impact of poor sample timing | | |
|---|---|---|
| **Date** | **avg. Cl2 (mg/L)** | **Notes** |
| 2/19/23 | replaced greensand | |
| 2/21/23 | 4.44 | |
| 2/22/23 | 2.57 | |
| 2/23/23 | 1.58 | |
| 2/24/23 | 0.78 | avg. 2.3 mg/L (Feb 21-14) |
| 2/25/23 | NA | |
| 2/26/23 | NA | |
| 2/27/23 | 0.61 | sampled for HAA5 = 250 ppb compared to 23 ppb on 1/10/23 |
| 2/28/23 | NA | |
| 3/1/23 | 0.32 | avg. March 1 - 15 = 0.31 mg/L |
| 3/2/23 | 0.53 | |
| 3/3/23 | 0.52 | |
| 3/4/23 | NA | |
| 3/5/23 | NA | |
| 3/6/23 | 0.47 | |
| 3/7/23 | 0.46 | |
| 3/8/23 | 0.45 | |
| 3/9/23 | 0.35 | |
| 3/10/23 | 0.30 | |
| 3/11/23 | 0.03 | |
| 3/12/23 | 0.02 | |
| 3/13/23 | 0.15 | |
| 3/14/23 | 0.17 | |
| 3/15/23 | 0.23 | |

**CONCLUSIONS AND COMMENTARY:**

Despite the poor reputation the water quality at MES may have, there really is no acute health hazard. Typically, the HAA5 levels are fine in terms of regulatory compliance. The nine quarters of HAA5 violations that occurred were primarily caused by only four incidents of overdosing chlorine for the greensand filters that occurred for very short periods of time just before quarterly HAA5 sampling events. If the chlorine had not been overdosed on those four occasions, there most likely would have been no HAA5 violations.

Based on chlorine residual data which correlates with HAA5 formation, the actual time period with elevated HAA5 that caused the nine quarterly violations over 7 ¾ years may have been for only a total of a few weeks. The time periods for three of those chlorine overdoses are known from chlorine data to involve a single day in one case (2022), less than a week in another case (2023), and three weeks in another (2018), each time shortly before or during HAA5 sampling. That's a total of 28 days for those three overdose events over a monitoring period of 7¾ years that resulted in 8 quarters (2 years) of HAA5 violations. Chlorine data are not available to WCS to determine the length of the chlorine overdose that caused the first HAA5 violation in 2016.

It is also reassuring the exposure levels (per LRAAs) were barely above the MCL. When considering any potential health impact, those concentrations and exposure times should be put into perspective when compared to an MCL that is based on consumption for decades.

For those reasons, I consider the actual health threat (if any) to be much less than is implied by the running annual average results and corresponding violations and related Public Notices.

One does not need to think of the water as though it was radioactive or had high levels of lead or arsenic or had any microbial pathogens. Instead the water occasionally has had short periods of trace levels of a treatment process byproduct that could take decades of exposure to potentially have an adverse impact. All else is fine with the water quality.

I do not believe the water quality at MES warranted the water being avoided, despite the violations, and yes – even with this being an elementary school – given the data evaluation discussed above. I believe that an alternative drinking water supply was not necessarily required, but is of course the school's (and any customer's) own prerogative. Anyone concerned about potential short-term health hazards can use an alternate water source such as bottled water.

Granular activated carbon (GAC) filters could potentially have been installed onto the drinking water fountains instead of shutting them down. Then the water quality would have been fine at those designated drinking water stations, even if the HAA5 violations continued in the overall supply. The drinking water fountains could (and should) also become part of the HAA5 monitoring program. A granular activated carbon (GAC) water filtration system could also be placed in the kitchen, perhaps a point-of-use treatment system under a sink or some Brita-type filters.

Millville wanted the switchover completed before now, and had tasked NWSI with this responsibility on December 5, 2022. Since then there has been plenty of time (over seven months) for an engineer to complete the WS-34 application and system upgrade, but that has not been accomplished.

In my opinion, the urgency of switching to permanganate this summer or else threatening to move the schoolchildren to another building could be considered as an exaggerated narrative since the water quality is not nearly as poor or unhealthy as has been portrayed by school officials and is not nearly the threat that has been described by Mr. Ferrari.

I do not believe it is appropriate to scare a generation of children away from drinking public tap water supplies in America and impart this needless kind of worry and alarm to their parents. The level of potential health risk from this water does not warrant such extreme action.

MassDEP has come right out and said that "*Overall the water is safe to drink*". MassDEP assures us the HAA5 MCL exceedances *are NOT an emergency*, and yet the school is treating it as such.