



NJ Department of Environmental Protection and Energy  
Division of Science and Research  
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## RESEARCH PROJECT SUMMARY

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### **LEAD IN NEW JERSEY SCHOOL DRINKING WATER: RESULTS OF A MONITORING STUDY**

Research Project Summary Prepared By:

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#### **ABSTRACT**

In 1990 and 1991, water samples from 100 drinking water fountains in 50 school buildings were collected and analyzed for lead, copper, hardness, alkalinity, pH, and temperature. Fountains were sampled first thing in the morning, after flushing the fountain for 10 minutes, and just before the first lunch break at the school.

The results show that one-time, morning flushing may not be effective as a means of reducing children's exposure to lead via drinking water in some schools. Schools which currently use flushing as a remediation for lead in drinking water should flush more than once a day. An effective flushing scheme includes periodic flushing (every 2-3 hours) of 5-10 minutes throughout the school day.

Highly corrosive waters were associated with more lead and copper leaching than low or moderately corrosive waters.

School buildings constructed from 1980 through 1987 had a higher percentage of elevated lead levels in drinking water fountains than schools constructed in other years.

#### **INTRODUCTION**

Young children under the age of six years are reported to be most susceptible to lead poisoning (Bellinger et al., 1987; Chisolm & O'Hara, 1982; and Mahaffey, 1977; Martin, 1991; Needleman et al., 1990; and Needleman & Gatsonis, 1990), although all children are more vulnerable overall to the detrimental effects of lead in the body than are adults.

There are many studies investigating the correlations between blood lead level in human beings with the quantity of lead in drinking water (Cosgrove et al., 1989; Elwood et al., 1984; and Worth et al., 1981); however, there is no information in the literature examining lead in the drinking water that children consume while at school, although some states have taken action to monitor school drinking water (Minnesota, Nebraska, New Mexico and Rhode Island). Since children spend a large amount of time at school, their lead intake through school drinking water may significantly contribute to their overall body burden. This study focuses on quantifying the amount of lead in school drinking water fountains in NJ and correlating these levels with other water quality parameters such as pH and corrosivity. By so doing, the Department of Environmental Protection and Energy (DEPE) will be able to assess the extent of the problem of lead exposure to children via school drinking water.

#### **OBJECTIVES**

The monitoring project was conducted to determine: 1) if flushing is effective to reduce lead and copper levels all day in a school building; and 2) if water quality parameters like

corrosivity can be used to predict potential problem areas for lead contamination in NJ.

### **PROJECT DESIGN/METHODS**

Fifty schools were selected from four NJ counties based upon responses to a survey (a separate report is available on survey responses). Water sampling in schools began in January, 1991.

Two drinking water fountains in each school were sampled. Almost every school had a drinking water fountain in the gymnasium or cafeteria. These were selected as high use fountains. The second fountains were selected based on the location of the first fountains. Fountains as far as possible from the first ones were considered, or those in remote wings of the schools were picked as low use fountains. Normally, this selection process enabled the sampling of one fountain close to where the water enters the building and one farther away from the point of entry to the school.

Water samples were collected from the two drinking water fountains first draw (after water had been sitting in the pipes undisturbed for at least 8 hours), after allowing the fountain to run for 10 minutes, and just before the school's first lunch break, generally 3-5 hours after the flushed sample was collected. These samples are designated at first draw (FD), 10 minute flushed (10MIN) and lunchtime (LUNCH).

Immediately after sample collection, the samples were preserved with nitric acid and stored on ice until delivered to the lab for analysis. The Bureau of Radiological and Inorganic Analytical Services (BRIAS) at DEPE conducted the analyses using standard EPA methods 239.2 involving graphite furnace atomic absorption spectroscopy and 220.1 involving direct aspiration flame atomic absorption.

### **RESULTS**

#### **LEAD AND COPPER LEVELS BY SAMPLE TIME**

Water samples from each fountain were collected first draw, after a 10-minute flush, and

lunchtime, as described in the Methods section. A first draw sample is one collected after the water has sat in pipes overnight; it is the first use or first draw water for the day and represents an overnight static equilibrium between water and piping due to nonuse. Immediately after collecting the first draw sample, the tap was opened and water allowed to run for 10 minutes. At this point, the second sample was collected. The same fountains were sampled again just before the first lunch break, generally 3-5 hours after the 10-minute flushed sample.

The box plots for lead and copper in Figure 1 show the distribution of the data according to the time of day the samples were taken. As expected, the highest overall lead and copper levels were in samples taken first draw. It is also not surprising to see that lead and copper levels decreased after 10 minutes of flushing. Lead concentrations in the first draw samples were significantly higher than 10 minute flushed samples at the 0.05 level using both nonparametric and paired parametric statistical tests.

The increase in lead and copper levels in water samples taken just before the first lunch break at the schools was unexpected. In some cases, the levels increased to the same or just below first draw levels. This pattern was more evident for lead levels than for copper. Lead levels taken just before lunchtime were significantly higher than levels taken after 10 minutes of flushing. For copper, there was no significant difference.

It is evident in the graphs in Figure 1 that lead levels may increase in school water during the interval between morning flushing and lunchtime. This means that, in many instances, lead can be leached from plumbing and into school drinking water in a shorter time than previously considered. In schools where first draw lead levels are especially high, lunchtime levels were more likely to be high than in schools where first draw levels were low.

The corrosivity of water affected the leaching of lead and copper from plumbing. Corrosivity of water is described by the Aggressive Index (AI), which is a value calculated using the pH, alkalinity and hardness of the water

sample. The data presented 10) had higher overall lead and copper levels than equal or above 12). Lead concentrations in corrosive for moderately or noncorrosive water. Levels in moderately corrosive water were not significantly different from those in noncorrosive water. This indicates that lead leaching can be expected in corrosive waters but is unpredictable in moderately or noncorrosive water.

Some first draw water samples containing elevated lead levels were noncorrosive according to the AI. Corrosivity, while helpful in the prediction of a school building's vulnerability to leaching of lead to drinking water, is not the only parameter of importance. The amount of time the water is left standing in the plumbing system is significant as well. Even noncorrosive water may leach lead from school building plumbing if it remains in contact with the plumbing materials a sufficient length of time. On the contrary, non-corrosive water does not appear to leach copper from plumbing at all.

## CONCLUSIONS

The most significant observation to be made from this study is that one-time, morning flushing of schools' drinking water does not provide day-long protection for children. Schools currently using flushing as a temporary remedy to control lead exposure to students should consider periodic flushing; that is, running drinking water fountains for 5-10 minutes every 2-3 hours during the school day. Longer flushing may be needed in the mornings, after vacations, weekends and holidays.

More research is needed to investigate potential competitive complexation reactions occurring in plumbing systems where corrosive water is in contact with the pipes for extended periods of time. Other investigators have indicated that this may be occurring, and the results described here support this hypothesis.

Finally, as lead solder is phased out of potable water plumbing systems, other sources of lead are becoming more important. Plumbing fixtures may contain up to 8% lead, by law. The results described here indicate that these fixtures may contribute to elevated lead levels in school

drinking water. It is important that school drinking water be monitored for metals that may leach from plumbing and that samples be taken first draw, after a flushing period and at some point during the school day. In this way, school administrators can determine if a potential lead or copper problem exists, whether flushing can alleviate the problem for day-long protection, and what the source of contamination is. Once this information is generated, school officials can take action to remove or ameliorate the problem.

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## FUNDING SOURCE

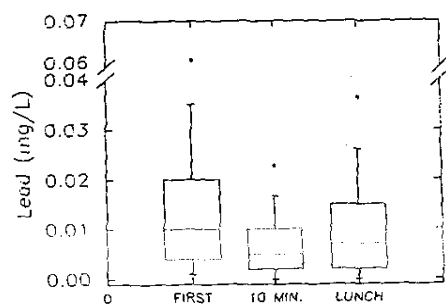
This project was funded by the A-280 SafeDrinking Water Research Fund. A DEPE/DSR technical report describing the results in detail of this project is available from DSR or Bureau of Safe Drinking Water (BSDW) by calling (609) 292-9692. Further information regarding other research efforts by the division can be obtained by calling (609) 292-6071. DSR Reference No. 93002.

This project was conducted largely by personnel within DSR. Other participants included the Bureau of Radiological and Inorganic Analytical Services, which conducted all analyses on water samples, and Professor Gene Hall of Rutgers University who conducted external comparison analyses of lead and copper using alternate methods.

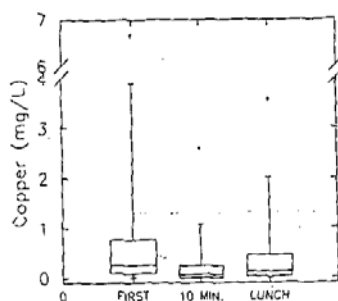
Eileen Murphy is a Research Scientist in DSR working with BSDW staff on research projects involving inorganic contamination of drinking water.

**Figure 1. Lead and Copper Distributions According to Sample Time.**

LEAD Levels in School Water



COPPER Levels in School Water



**Figure 2. Lead and Copper Distributions According to the Aggressive Index of Water.**

