Attachment G –
Assessment of Lead Exposure from School Drinking Water

Attachment G
Exposure Assessment
Discussion of Consumption Levels

Note: This memorandum is intended to provide a starting point for further discussion regarding next steps for an Exposure Assessment in Seattle Public Schools. The analytical approach described below was not developed by experts in the field of lead exposure and before it can be used, it must be reviewed by experienced toxicologists.

Introduction

In the course of preparing the experimental methodology for an Exposure Assessment, it has become apparent that the largest unknown is the actual water consumption by students. Consider what happens when a student takes a drink from a fountain: once the handle is turned, drinking may commence immediately or the water may be allowed to run for several seconds before the student drinks. When the student drinks, some portion of the water coming out is swallowed, but not all. Depending on how long the student drinks and how frequent the swallows are, more or less may be consumed. It is fairly straightforward to determine the actual output of the fountain, but the actual percentage consumed could be as little as 5-10% of the output. Without some approach such as rigging buckets to collect waste water or testing individual students, there is no way to know how much is actually consumed. Any such approach would necessarily affect the behavior of the students drinking, and introduce even more uncertainty.

An alternative analytical approach is set forth below, which makes several conservative assumptions about actual lead intake and water consumption to determine what water consumption would have an impact on blood lead levels. This approach has four steps: (1) consideration of benchmarks for water consumption, (2) an assumption for the lead content of the water, (3) computing lead exposure resulting from the consumption and lead content information; (4) comparing this to available information about the effects of particular dosages on blood lead levels.

Benchmarks for Water Consumption

According to the District's Q&A "Findings on Lead in Drinking Water Health", published in early 2005[1], young students (ages 4-6) consume an average of 14 ounces of liquids per day and older students (ages 15-18) consume 26 ounces, per the U.S. EPA (Table 1).

[1] Intertox, Inc. 2005. Lead in Seattle Public School's drinking water: Technical document, prepared for Seattle Public Schools, Seattle, Washington, March 3 2005.

Bottled water consumption at schools with bottled water averages about 8 ounces per student per school day in elementary schools (Table 1), or an average annual rate of 4 ounces per calendar day.

Table 1. Daily and Total Water Consumption by Age Group

Age Group	Daily Bottled Water Consumption at School [a]	Daily Water Consumption at School [b,c]	Total Daily Water Consumption [b,c]
Children 4-6 yrs		7 oz/d (0.21 L/d)	14 oz/d (0.42 L/d)
Children 7-10 yrs		7.5 oz/d (0.225 L/d)	15 oz/d (0.45 L/d)
Children 11-14 yrs		10 oz/d (0.293 L/d)	20 oz/d (0.59 L/d)
Children 15-18 yrs		13 oz/d (0.38 L/d)	26 oz/d (0.76 L/d)
Elementary School	8.34 oz/schl d (0.25 L/d)		
Middle School	5.08 oz/schl d (0.15 L/d)		
High School	3.92 oz/schl d (0.12 L/d)		

[a] Based on Seattle Public School's record of purchased bottled water from September 2004 through June 2005 and the number of school days.
[b] Based on Lead in Seattle Public Schools' drinking water: technical document, prepared for Seattle Public Schools, Seattle, WA,.
[c] U.S. EPA. 2000. Child-Specific Exposure Factors Handbook (Interim Report), EPA/600/CP-00/002B, Research Triangle Park, NC, National Center for Environmental Assessment.

Considering that students are in school only 180 days per year, and that even on those days much of the day is spent away from school, and much of the liquids children consume is not water (e.g. milk or juice), a conservative assumption is that at most 50% of the student's liquid intake is school water. As such, a young student (4-6 yrs) can be expected to consume approximately one-half of their total daily water consumption of 14 ounces, or 7 ounces per day at school (see Table 1). The number compares well to the 8 ounces per student per school day experienced by the schools on bottled water.

Benchmarks for Lead Content of School Water

The School Board policy states that lead content must be under 10 ppb for both standing and flushed results. Preliminary variability testing results indicate that there is not a dramatic difference between one sample and another (of 344 samples taken at 43 locations previously testing under 10 ppb, only 1.7 percent were above 10 ppb and none were above 15 ppb).

A conservative assumption of lead intake would be to use 20 ppb.

Computed Lead Exposure

Computed lead exposures for students range from 2.4 to 4.2 μg/d as illustrated below.

<u>Conservative:</u> Assume <u>Child</u> Exposure of 20 ppb Pb in 7 oz. Of Water per Day (half of child's typical daily liquid intake occurs at school, per Intertox, 2005)

$$Child \cdot Intake = \frac{20\mu g}{L} \times \frac{0.21L}{day} = 4.2\mu g / day$$

As pointed out by the Q&A Document, it is highly unlikely that all of a student's liquid intake is in the form of water at school. Thus this figure represents a very conservative prediction of the lead dosage experienced, since they assume consumption every day, and students are at school only 180 out of 365 days per year.

<u>More Likely Result</u>: Assume <u>Child</u> Exposure of 20 ppb Pb in 4 oz. (average bottled water consumed per calendar day per student at schools with bottled water, per SPS) of Water per Day

$$Child \cdot Intake = \frac{20\mu g}{L} \times \frac{0.12L}{day} = 2.4\mu g / day$$

<u>Conservative</u>: Assume <u>Adult</u> Exposure of 20 ppb Pb in 40 oz. (1.18 liters, the entire typical adult liquid consumption) of Water per Day

$$Adult \cdot Intake = \frac{20\mu g}{L} \times \frac{1.18L}{day} = 23.6\mu g / day$$

Benchmarks for Lead Intake

Two sources have been identified for acceptable lead intake: The US Food and Drug Administration, and the 1982 National Academy of Sciences Report referenced by the EPA in 2000. These reported values should be compared to updated published information for allowable lead intake levels.

Table 2. Daily Lead Intake Limits

Age Group	Tolerable Daily Lead Intake per U.S. FDA [1]	Recommended EPA Maximum Daily Lead Intake [2]
Children under 6 months	-	100 μg/d
Children under 1 year	60 μg/d	-
Children 6 mos. to 2 yrs	-	150 μg/d
Children 7 years old	150 μg/d	-
Pregnant women	250 μg/d	-
Adults	750 μg/d	-

[1] Source: Clement et al. (2000)[2]; based on U.S. FDA sources of information; reported tolerable daily intake levels have not been independently confirmed.
[2] Assuming chronic exposure and a daily water intake for children of 1 liter per day and no exposure from other sources based on Mahaffey (1977) and National Academy of Sciences (1982). Source: Federal Register 40 CFR Parts 9, 141, and 142 National Primary Drinking Water Standards for Lead and Copper; Final Rule, Jan 12, 2000.

From this information (Table 2), an exposure of 150 μg/d would be deemed "tolerable". The highest child exposure, using conservative assumptions for both lead content and volume consumed, is 4.2 μg/d, or approximately 3% of the "tolerable" lead intake level for 7 year olds. The adult exposure is conservatively calculated at 23.6 μg/d, or about 3% of the adult exposure of 750 μg/d.

According to 40 CFR, "Mahaffey (1977) concluded that water containing 50 ppb lead would not be a hazard to infants and children when other lead exposures were minimized."[3]

Effect on Blood Lead Levels

This information is supported by the District's own research on the impact of particular dosages on blood lead levels. In 2004 the District had research conducted by toxicologists and had a study prepared (and peer reviewed) which predicts the blood lead levels from a particular lead dosage. The Q&A document notes that the CDC considers blood lead levels below 10 μg/dL to not be of concern (although some research previously provided to the committee would provide

[2] Clement, M., R. Seux, S. Rabarot. 2000. A practical model for estimating total lead intake from drinking water, *Water Research* **34**(5):1533-1542.

[3] Federal Register 40 CFR Parts 9, 141, and 142 National Primary Drinking Water Standards for Lead and Copper; Final Rule, Jan 12, 2000.

support for setting the level of concern at 5 μg/dL[4]). The study then predicted blood lead levels at dosages of 10 ppb and 20 ppb, concluding:

> "Toxicologists used the lead exposure model to predict what effect added lead would have on students. . . . A child with an exposure to 20 ppb lead in water at school would probably experience an increase of less than 0.3 μg/dL from kindergarten to 12th grade. Exposures to 10 ppb compared to background levels would result in an increase of about 0.1 μg/dL."

A similar result was reached by the Pacific Northwest Environmental Health Safety Unit, using different modeling approaches.

Thus the Q&A document and study predicts that exposure at 20 ppb would result in an increase of less than 0.3 μg/dL to blood lead levels, or about 3% of the 10 μg/dL threshold (or 6% of 5 μg/dL if that were adopted as the threshold of concern).

Conclusion

The above information needs to be reviewed by qualified experts in the field. If validated, it would provide an alternative means of analyzing the lead dose received by students from water in schools and its effect on blood lead levels, in lieu of the uncertainties posed by the experimental methods considered to date.

[4] Canfield, RL, Henderson, CR, Cory-Slechta DA, Cox C, Jusko TA, Lanphear BP. 2003. Intellectual impairment in children with blood lead concentrations below 10 μg per deciliter, *N Engl J Med* **348**(16):1517-1526.

Lanphear, BP,Hornung, R, Khoury J, Yolton K, Baghurst P, Bellinger DC, Canfield RL, Dietrich KN, Bornschein R, Greene T, Rothenberg SJ, Needleman HL, Schnaas L, Wasserman G, Graziano J, Roberts R. 2005. Low-level environmental lead exposure and children's intellectual function: an international pooled analyses, *Environ Health Perspect* **113**(7):894-899.

Committee on Environmental Health [CEH]. 2005. Lead exposure in children: prevention, detection, and management, *Pediatrics* **116**(4): 1036-1046.