Lead in Seattle School Drinking Water: A Review of the Health Implications

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Executive Summary

The University of Washington based Northwest Pediatric Environmental Health Specialty Unit (NW PEHSU) reviewed the health implications of lead in school drinking water. This report describes our findings.

Recent district wide testing revealed that many schools have at least one drinking fountain with lead levels that exceed the US EPA guideline for lead in school drinking water (20 parts per billion or 20 ppb). There has been minimal public information describing the potential health implications of these exposures. NW PEHSU undertook this effort to help inform all interested parties regarding:

> *Will the level of lead found in Seattle Public School drinking water cause harm to the children who drink it?*
>
> *Are special medical tests or treatments needed because of this lead exposure?*
>
> *What can be done to ensure children are not harmed from lead exposure in school drinking water?*

Will the level of lead found in Seattle Public School drinking water cause harm to the children who drink it?

Most of what is known about health problems and lead exposure come from studies where the level of lead in a person's blood has been related to symptoms and health problems. We used a US EPA model to estimate what blood lead levels in Seattle school children might have been based on the concentrations of lead observed in the recent comprehensive sampling of school drinking fountains. We also reviewed blood lead levels measured in children in Washington DC who had high (over 300 ppb) levels of lead measured in their home water supply. **These sources of data suggest that the exposures typically experienced by Seattle School children would result in predicted blood lead levels in the range of 1-3 micrograms per deciliter (mcg/dL).** This is comparable to what has been observed in recent years when King County school aged children have had their blood lead level tested and recent data that determines the national average blood lead level among young school aged children. **It is extremely unlikely that any child will have a blood lead level exceeding the current CDC goal of identifying children with blood lead levels over 10 micrograms per deciliter (mcg/dL).** This is a level for which there are well established public health guidelines for follow up testing and evaluation of a child's environment to reduce ongoing exposure.

Whether or not exposure to lead causes health problems depends upon how much lead exposure occurs and the susceptibility of the person who is exposed. Those children at highest risk would be:

Children less than 6 years of age who drink from school water that is *consistently* exceeding a lead level of 200-300 ppb. (See Figure 1 for a graph of maximum standing and running water levels observed in schools for which predicted blood lead levels using these maximum levels were over 5 mcg/dL.)

Children less than 6 years of age with medical conditions such as nutritional deficiencies – anemia, iron deficiency, calcium deficiency, vitamin D deficiency - which may increase their absorption of lead.

Children with pre-existing neurological problems (e.g. autism, seizure disorders, ADHD) may be more vulnerable to the toxic effects of lead but there is currently no clear evidence to support or refute this.

Children with pre-existing blood lead levels that are higher than expected due to other significant exposure sources (e.g. children with a history of an elevated blood lead test, children who have work or hobbies that involve lead exposure such as stained glass, pottery with lead based glaze, radiator repair, firing range or children whose parents have jobs that involve them accidentally bringing home lead dust on their shoes and clothing). The additional exposure from lead in the school drinking water may boost these children's already elevated lead burden to a more concerning level.

Are special medical tests or treatments needed because of this lead exposure?

The most appropriate medical test to determine if lead exposure has occurred that is likely to cause health problems is a blood lead test. Other types of tests including hair tests and urine tests are not recommended. Blood lead testing is readily available from doctors and clinics.

NW PEHSU determined that elevated blood lead levels that would prompt follow up testing or interventions are extremely unlikely (see question above). Blood lead testing is best when exposure is recent and ongoing. Based on this, NW PEHSU does not recommend comprehensive testing of all Seattle school children.

Individual families may have special and unique concerns regarding their child's lead exposure. They may request blood lead testing for their children. These needs should be addressed and can be met on an individual basis with their health care providers and/or NW PEHSU.

What can be done to ensure children are not harmed from lead exposure in school drinking water?

There has been a lot of attention to studying and preventing lead exposure in very young, pre-school aged children. This is because low level lead exposure can damage the developing brain and most brain development occurs in the fetus and young child. There is less known about how lead exposure in older children and adolescents may affect their brains or other aspects of their health.

The relative lack of information on lead exposure and health impacts on older school aged children warrants a cautious approach. NW PEHSU supports efforts to ensure that a child's blood lead is as low as possible.

Based on this NW PEHSU endorses the School District's adoption of the EPA guidelines (goal < 20 ppb) and recommends ongoing water testing and assurance that lead levels in school drinking water do not contribute to potentially harmful lead exposure in Seattle public school children. Building in future goals for reducing this level further are reasonable given the lack of a known threshold or safe level of exposure in children.

In the last decade, the lack of attention and public communication on this problem has fostered parental and community distrust and disgruntlement. Based on this, NW PEHSU also recommends that the School District form an independent Task Force charged with formulating a school lead and water policy. The process should be transparent to all interested parties. Task Force members should be selected by the interested parties including concerned parents, the PTSA, the School Board, local public health officials, and the District administration.

Introduction

Northwest Pediatric Environmental Health Specialty Unit (PEHSU)

This report was prepared by the University of Washington based Northwest Pediatric Environmental Health Specialty Unit (NW PEHSU), a U.S. Agency for Toxic Substances and Disease Registry (ATSDR) funded consultation resource serving residents of Washington, Oregon, Idaho, and Alaska. Founded in 1998, NW PEHSU provides special expertise to medical professionals, public health officials, families, and communities regarding environmental health problems that affect children. While not initially directly contacted for consultation, NW PEHSU became aware of the concerns regarding lead in school drinking water through media coverage in 2004. NW PEHSU felt their unique expertise in assessing the risk of low level exposure to environmental toxicants in children could provide important and useful information for all of the affected parties. This report summarizes our effort to understand the health implications of the lead levels measured in the school drinking water.

The report contains two main sections. Part I provides general background information on how the problem of lead in the school drinking water came to light and what is known about lead and children's health. Part II describes NW PEHSU's effort to understand how much lead exposure Seattle school children may have experienced from the water supply at school and ways to interpret how this exposure may affect their health.

A less detailed 2 page hand-out summarizing the content as frequently asked questions is also available from NW PEHSU.

Part I: Background Information

History of concern for lead contamination in Seattle schools water

Testing for lead in the Seattle School District became a priority in 1990 after a Ballard High School parent noticed orange discoloration in the water from a school drinking fountain and requested the water be tested for metal contaminants. Initial testing revealed elevated levels of lead which prompted district wide testing of drinking fountains. This demonstrated that several school drinking fountains had lead levels above the EPA guideline for school drinking water of 20 parts per billion (ppb). In response, the school district undertook remediation efforts which included changing bubbler heads and instituting a flushing system. Despite this remediation effort, re-testing of fountains revealed that approximately a third of these fountains remained above the guideline. A majority of these recalcitrant fountains were located in Fairmount Park, Schmitz Park, Wedgewood, and Mann Schools. In their 1993 final report the District recommended all water piping be replaced in these four schools.

Between 1990 and 2003, the Seattle School District performed lead tests on isolated drinking fountains in approximately 20 schools and had not yet replaced pipes at the four schools noted above. In December of 2003, the parent of a Wedgewood elementary school student noticed orange water running from a drinking fountain in his child's school classroom. He sent water from four drinking fountains in the school for lead testing which revealed lead levels of 22 ppb, 30 ppb, 58 ppb, and 200 ppb. Concerned about potential health implications for his children and the children of others, he brought these findings to the attention of school officials.

The School District's initial response was to shut down water to school drinking fountains that were above the 20 ppb guideline and urged students to bring filled water bottles from home. The schools supplied bottled water to those who did not bring their own.

Media coverage of these events in early 2004 caught the eye of NW PEHSU. Struck by the relative lack of specific information translating what these exposures meant in terms of potential harm to children's health, NW PEHSU decided to undertake a special effort to better understand the health risk of these exposures. NW PEHSU anticipated being called upon to answer the important questions parents and health care providers would have:

> *Will the level of lead found in my child's school drinking water cause harm to my child?*
>
> *Does my child need special medical tests or treatments because of this lead exposure?*
>
> *What can be done to ensure my child is not harmed from lead exposure at school?*

In the spring of 2004 NW PEHSU reviewed historical information about lead in school drinking water. Our understanding of the health implications was provided in an editorial published in the Seattle Post-Intelligencer in July 2004 by Dr. Catherine Karr, NW PEHSU Director.

Subsequently, NW PEHSU has followed the comprehensive testing of all Seattle Public Schools initiated by the School District in the Spring/Summer of 2004. This report focuses on these most recent and complete test results.

Lead and children's health

Lead is a well-described environmental poison. Lead can be found in the air, soil, food, and water. Whether or not exposure to lead causes health problems depends upon how much lead exposure occurs and the susceptibility of the person who is exposed.

There has been a lot of attention to studying and preventing lead exposure in very young, pre-school aged children. This is because low level lead exposure can damage the developing brain and most brain development occurs in the fetus and young child. There is less known about how lead exposure in older children and adolescents may affect their brains or other aspects of their health. One recent study focused on effects of lead exposure on puberty in 8-18 year old girls. This study provides some preliminary evidence that low level exposure to lead may be related to slight delays in puberty in girls (2-6 months). In general, this study and other studies of older children have not been able to separate out whether effects seen in older children are due to exposures that occurred when these children were much younger versus more recent exposures.

Children with underlying health problems may be at increased risk of harm from lead. For example, children who are anemic or who have nutritional deficiencies may absorb more lead than healthy children. It is not clear whether children with neurological problems such as seizures, autism, or ADHD may have brains that are more sensitive to exposure to lead, but it is reasonable to be more cautious in these children.

Most of what is known about health problems and lead exposure come from studies where the level of lead in a person's blood has been related to symptoms and health problems. When the blood lead level is very high, over 100 micrograms per deciliter (mcg/dL) children have seizures, may go into a coma, and die. With blood lead levels over 25 mcg/dL more subtle symptoms such as decreased appetite, nausea, vomiting, stomach pain and constipation may occur. At these levels, children may also have behavioral problems, learning problems, and be more irritable.

Fortunately, high level exposure to lead causing these high blood lead levels is rare today. Nationally and locally average childhood blood lead levels have drastically declined since the 1960's and 1970's as public health interventions were put in place (removing lead from gasoline, paint, and solder in cans). In Washington State, most children who have their blood lead level tested have blood lead levels that are less than 5 mcg/dL and these levels do not cause obvious symptoms. However, these lower blood lead levels have consistently been associated with subtle effects on brain function based on studies of exposure in young children (pre-school age). There is no threshold or clear safe level of exposure to lead in young children and we know much less overall about potential health impacts from exposures that occur in older school age children. Recognizing these limitations and the potential for harm, the public health community goal is to ensure that a child's blood lead is as low as possible. To identify children most at risk, the CDC (Centers for Disease Control and Prevention) and the American Academy of Pediatrics have specified a blood lead level over 10 mcg/dL as a level of concern for children's health. When blood lead levels exceed 10 mcg/dL there are clear recommendations for follow up testing and evaluation of the child's environment to prevent ongoing exposure.

Diagnosis and treatment of lead poisoning

In Washington State and the U.S. today, most children meeting this definition of a "level of concern" or having blood lead levels just over 10 mcg/dL, do not have noticeable symptoms. To identify them requires a suspicion of excess exposure and a blood lead level test. There are clear public health community guidelines that provide recommendations for how to respond to elevated blood lead levels, depending on the result of the test. This includes recommendations for when to re-test a child's blood, when to investigate the child's environment for sources of ongoing exposure, and when and which type of treatment is appropriate. More details of these guidelines are provided in Appendix A.

Recommended Method of Diagnosis: Blood Lead Level Test

Determination of the blood lead level is the medical and public health community's recommended and standard method for identifying children who have concerning levels of lead exposure. This is because there is much known about the relationship between blood lead levels and health risk, the test is readily available, and is relatively affordable (approximately $25-$40, usually covered by insurance). The test is done by taking a sample of blood from the child's vein or from a drop of blood taken from a finger prick. The finger prick test can be falsely high if it gets contaminated. If the result using the finger prick test is a high lead level, it should be re-checked with a blood test sample from the vein.

Your child's health care provider can order this test.

This test provides a snapshot of how much lead is circulating in the blood. It is a good indicator of recent and ongoing exposure (last 1-2 months). In general, lead in blood is removed from the body (mostly through the urine) or stored in other organs (mostly bones) after 1-2 months. So the blood lead level does not directly measure lead that is stored in the body in organs and the bones. Nonetheless, if a child had a very high level of lead exposure from the drinking water or any other source in the last several months, the blood lead level would be expected to remain elevated for several months due to the overall higher body stores of lead. Also, since lead can move from where it is stored in the body in organs and bones back into the blood, this portion of the body's lead will also be measured by this test. It is not a perfect test for children who have been exposed only to lead in the Seattle schools drinking water because lead exposure in this way will have stopped some months ago. However, there is no better or more useful available test for this scenario.

Other ways to measure lead exposure in children have been used historically or in research settings. Some health care practitioners may promote the use of these tests in their clinics. Due to the potential for misuse and inaccurate interpretation, NW PEHSU does not endorse the use of other available methods of lead exposure determination in clinical practice and advises against them. A description of these other types of tests and the rationale for not recommending them is provided in Appendix B.

Methods of Treatment
For high levels of lead exposure (blood lead levels over 44 mcg/dL), treatment with chelation drugs is recommended (see Appendix A). This should be done under the supervision of a physician with experience and training in childhood lead poisoning (e.g. physician affiliated with a poison control center, physician who is board certified by the American Board of Medical Toxicology). Unfortunately, for low level lead exposure there is no medication or other intervention that will safely remove the lead from the body or reverse any damage that might have been done. Well-designed research studies of chelation for children with blood levels of 20-44 mcg/dL have not shown any benefit on brain function or behavioral effects in children receiving this treatment. In addition to no evidence for benefit from chelation in the setting of lower levels of lead exposure, the concern for potential for harm from this treatment is described in the section entitled "urine lead mobilization test" in Appendix B.

Lead exposure and water

In the United States, young children are primarily exposed to lead from unintentional ingestion of lead contaminated particles, such as dust from paint or soil. Historically, drinking water has not been a major source of exposure for children but does contribute to a child's overall lead exposure that accumulates over time. The amount of lead a child receives from drinking water reflects how much water he/she drinks and how high the lead level is in that water. There is some available information on how much water school-aged children drink each day, for example a 6-7 year old child drinks approximately 3 cups per day. However, it is not known how much of that is consumed at school and will vary from child to child.

Most lead in drinking water enters the system from lead-based plumbing materials in the water distribution system. Lead-based components might include pipes, caulking compounds, bubbler heads, and water main joints. When lead is present in the pipes, joints, faucets, or fittings it can dissolve as the water sits in the pipes. How much lead dissolves into the water depends on the chemical properties of the water and how long that water has been sitting in the pipes, faucets, etc. The most common cause is corrosion, a reaction between the water and the lead pipes or solder. Dissolved oxygen, low pH (acidity) and low mineral content in water are common causes of corrosion. Older pipes and small lead-based components associated with drinking fountains are likely the biggest contributors to the lead burden in Seattle school drinking water.

Lead levels are usually highest at first draw (also known as standing water), after the water has been sitting in the pipes overnight. These samples are felt to estimate a worst-case scenario of lead exposure. Flushing is a mechanism used to decrease lead levels by letting water run through the pipes, fixtures and components for a number of minutes thereby getting rid of lead-rich water that has been sitting stagnant.

Regulations and guidelines for lead in drinking water

The Environmental Protection Agency created the Safe Drinking Water Act - Lead and Copper Rule in 1991 to regulate national drinking water standards in public water systems. Its jurisdiction does not extend to individual buildings or schools. For public systems, it recommends a non-enforceable maximum contaminant level goal of 0 ppb for lead in drinking water and defines an “action level” if more than 10% of tap water samples exceed 15 ppb. At these levels, water systems must take additional steps to reduce corrosivity by corrosion control, lead service line replacement, monitoring, and public education.

School drinking water is not regulated but the Environmental Protection Agency has published a manual entitled, “Lead in Schools Drinking Water” strongly encouraging schools and day care facilities to test their water for lead, particularly if food, drinks, and/or formula are prepared on-site. The EPA recommends all drinking fountains with lead levels greater than 20 ppb in the first-draw (standing) sample should be replaced, taken out of service, or attempts should be made to reduce corrosivity. Washington State code follows the national standards for public drinking water and does not make specific recommendations for school drinking water systems.

Part II: Assessing the Health Risk of Lead in Seattle Public Schools Drinking Water

Population Affected

Based on 2002 census data, 46,965 students were enrolled in the Seattle Public School District[11]. In addition, many adults work at these schools and ingest drinking fountain and tap water. We have reviewed the lead levels measured in the School District's most recent and comprehensive testing effort and have summarized those findings including all schools.

While lead exposure can be toxic to individuals of any age, our assessment of health risk focuses on the group of children who are felt to represent the most vulnerable subgroup based on current scientific understanding. As such, our health risk assessment is based on what is known about the youngest students, those aged 6-7 years old and the schools they attend.

Exposure Assessment: Seattle School Sampling Results 2004

Drinking Water Sample Collection Methods

The Seattle School District collected drinking water samples from 97 school buildings during April – June 2004. Some samples were collected after the end of the school year. Schools not tested for planned or ongoing renovation reasons were Roosevelt, Garfield, Cleveland, Nova at Mann and Madison; bottled water was provided at these schools. Recently renovated Brighton elementary was not occupied last spring, and testing is in progress.

First draw (standing overnight) and running water samples were collected at drinking fountains or faucets throughout each building. First draw (standing overnight) samples were collected following non-use of the faucet or drinking fountain for 8 to 18 hours prior to sample collection, as suggested in the EPA guidelines. A running sample was collected after the faucet or drinking fountain water was running for 30 seconds. Sample collection volume was 250 ml (about 1cup) for both the standing and running samples.

Water Samples Results

First draw (standing overnight) water samples

The Seattle School District collected 2,422 *first draw* samples (Table 1). The amount of lead in the first draw samples ranged from less than the amount able to be measured by the laboratory to 1600 ppb (parts per billion). From all first draw samples, 524 (22%) had a lead level that was above the 20 ppb EPA guideline. The number of samples that met the EPA guideline of ≤ 20 ppb was 1,898 (78%). For seventy-nine schools (81%) at least one of their first draw water samples was above the EPA 20 ppb guideline. For eighteen schools (19%) all of their first draw water samples met the EPA guideline.

Running water samples

The District collected 2,396 running samples and 2,318 (97%) met the EPA guideline of ≤ 20 ppb (Table 1). Seventy-eight (3%) samples exceeded the EPA guideline. The highest level measured in the running samples was 370 ppb. For 42 schools (43%) at least one of their sampled fountains or faucets was above the EPA guideline. For 55 schools (57%) all of their running water samples met the EPA guideline.

Table 1
Seattle Public Schools Water Samples Information (April – June 2004)

	Standing Samples	**Running Sample Data**
Number of samples collected	2422	2396
Lead concentration range of samples	LOD* – 1600 ppb	LOD – 370 ppb
Number of samples > 20 ppb lead	524	78
Percentage of samples > 20 ppb lead	22%	3%
Number of schools with at least one sample > 20 ppb lead	79	42
Percentage of schools with at least one sample > 20 ppb lead**	81%	43%

*LOD means the lowest level of lead the laboratory instrument can measure in the drinking water
** Number of schools tested was 97

Assessing health risk – Modeling to predict the blood lead level

To help understand the potential health concerns related to the exposure levels described above, NW PEHSU felt it would be useful to translate these exposure levels to predicted blood lead levels. This is because there is much experience in the medical and scientific community in determining the health impacts of lead exposure based on blood lead levels. There are also well-defined public health guidelines that promote the importance of identifying children with a blood lead level over 10 mcg/dL and specific actions recommended for those children, depending on their specific blood lead level.

We used a tool created by the US EPA. Their Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) is designed to take into account all of the ways a child can be exposed to lead and make a best guess or predict what the blood lead level would be in a child depending on their age and the level of lead in the air they breathe and the food, water, and soil/dust they eat. We used this model to assess blood lead levels for a 6-7 year old child. This modeling suggests that it is extremely unlikely that any child exposed to lead in Seattle school drinking water will have a blood lead level exceeding the current CDC goal of identifying children with blood lead levels over 10 mcg/dL.

In using the model, we had to make a number of decisions (assumptions) regarding how much lead exposure we think school children are exposed to from the air, diet, and soil/dust in Seattle. We also had to make an assumption about how much water we think a child drank at school versus at home or other places. We assumed half of all water a child drank came from school fountains. From all of the sampling results, we had to choose what level of lead in the school drinking water represented a child's exposure. Lastly, we had to make an assumption about how much of a child's water at school came from a "standing sample" versus a "running sample." We assumed that 25% or about one fourth of the school water a child drank came from a "standing sample" and the rest was from a "running sample". The rationale for all of these assumptions is described in Appendix C . Generally, the choices we made were designed to be cautious and provide a worst case scenario or extreme case of exposure to lead containing school drinking water.

For each school housing 6-7 year old children, we used the EPA tool to estimate what the blood lead level of a 6-7 year old would be if he or she drank standing and running water at school every day with levels of lead that were the highest determined at the child's school. We refer to this as the *Highest School Water Level Risk Estimate*. We also estimated what the child's blood lead level would be if he or she drank standing and running water at school every day with levels of lead that were the median or "middle" level of lead detected in any fountain. (This means that half of the fountains had higher levels and half had lower levels when they were actually monitored). We call this the *Median School Water Level Risk Estimate*.

Obviously, these assumptions are a simplification of what truly occurs. Children vary in which fountains they drink from, how much of their total water they drink from fountains or faucets at school versus at home, and how much of their school water comes from the first standing sample after water was sitting overnight. Since this level of detail is not known for each child, both the *Highest School Water Level Risk Estimate* and the *Median School Water Level Risk Estimate* include a number of decisions as described in the paragraph above which erred on the side of caution or worst/extreme case. However, in general, the *Median School Water Level Risk Estimate* will be closer to representing the experience for a typical child at each school.

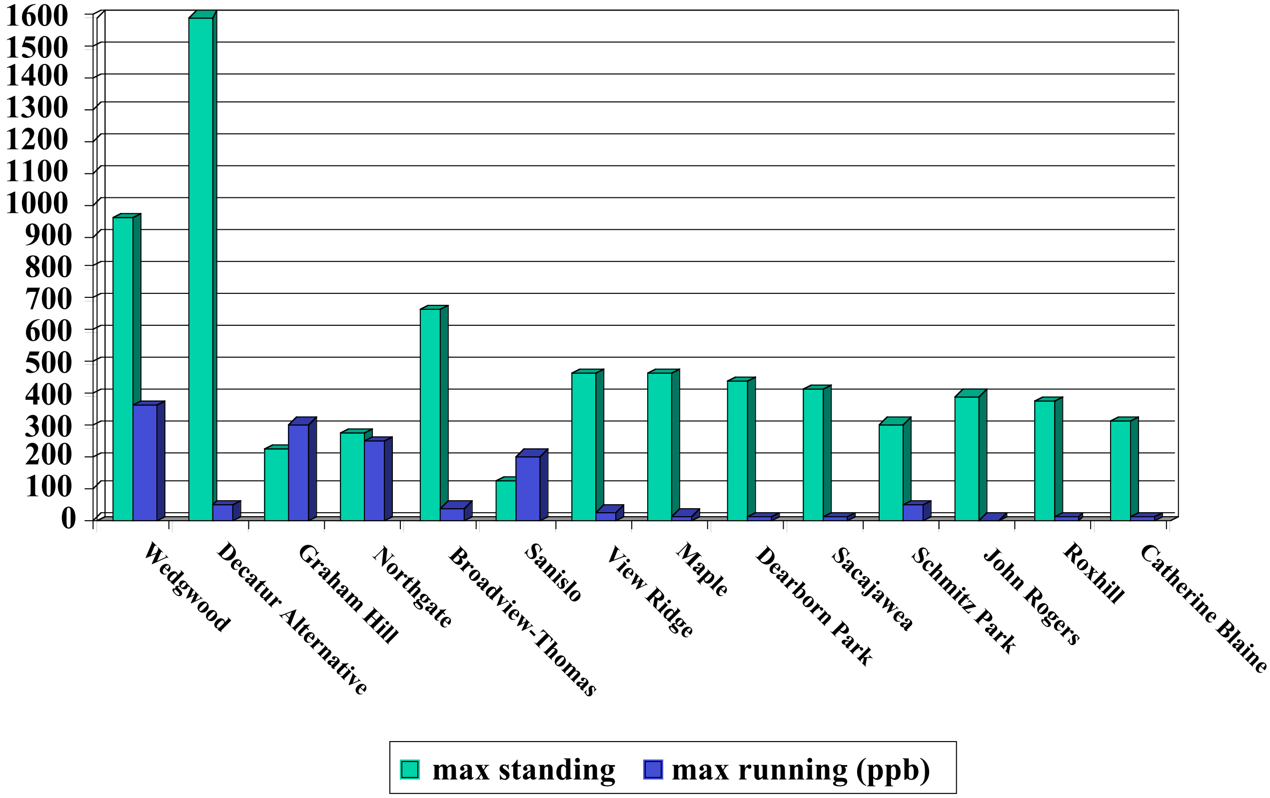
*Highest School Water Level Risk Estimate*s predicted blood lead levels from a low of 1.7 mcg/dL to a high of 16.9 mcg/dL. Using the fountain with the highest lead level measured to represent a child's exposure, four schools (6 %) could have potentially led to exposures that exceed the CDC guideline of 10 mcg/dL and were in the range that would prompt a blood level retest in 2-3 months. These schools and the predicted blood lead levels for a child drinking water from the highest lead level fountain were: Wedgewood 16.9 mcg/dL, Decatur 15.3 mcg/dL, Graham Hill 11.1 mcg/dL, and Northgate 10.2 mcg/dL. The blood lead levels predicted for the more likely or typical scenario, the *Median School Water Risk Estimates,* ranged from a low of 1.6 to a high of 2.5 mcg/dL; all well below the CDC guideline level of concern and in the range of average blood lead levels in children of this age in the U.S.

Figure 1 shows the maximum standing and running water levels observed in schools where modeling predicted blood lead levels over 5 mcg/dL. These levels would be higher than expected based on Washington State experience with blood lead levels which are rarely over 5 mcg/dL. In general, the model predicted these higher blood lead levels when the level of lead in the school water supply (standing and/or running) that a child consumed was over 200-300 ppb.

The results for all schools listed by school are available in Appendix F.

Figure 1

Maximum Standing and Running Water Lead Levels Observed in Schools Where IEBUK Modeling Predicted Blood Lead Levels Over 5 mcg/dL



Assessing health risk – Insight from other data

Other information that may help determine the risk of the school drinking water would be any blood lead level testing of children attending a Seattle Public School in the last academic year. It is not known how many or which children had this testing but several presumably did. The State of Washington does track all blood lead tests performed in children by county of the physician ordering the test. The number of blood lead tests done in children by King County providers in 2004 will likely exceed the number of blood lead tests done in 2003, based on information from the first half of 2004. 232 children aged 5-15 years had a first time blood lead level test in all of 2003. Almost as many children in this age range had first time blood lead level testing done in the first half of 2004 (210 tests from January to June 2004). This may reflect some increased interest and testing based on knowledge of school water problems reported in the media in 2004. It may be that a higher proportion of these King County results in 2004 are from Seattle Public School children but this is not known. Elevated blood lead levels (over 10 mcg/dL) are rare in King County. For tests done by King County physicians on children 5-15 years of age in 2003, one of these was above the 10 mcg/dL CDC guideline. To date in 2004 (January to June), one test exceeded the guideline.

In addition, recent experience with high lead levels measured in the water of Washington DC homes and blood lead testing of children who lived in those homes provides some additional information on the relationship between the amount of lead in water and the effect on blood lead level. Available blood lead levels for children 6 - 15 years of age who lived in homes where the running water sample was above 300 ppb were between 1 – 4 mcg/dL).

The most recent estimate of the average blood lead level for children aged 6 – 11 years old in the United States is 1.5 mcg/dL (1999-2000 National Health and Nutrition Examination Survey).

Interpretation of risk based on model results and other data sources

In the Seattle school system, individual child exposure to lead will have varied according to school, drinking fountains used, quantity of water intake, and individual body chemistry. Based on what is known about the concentrations measured in the school drinking water, the EPA model assumptions and predictions, and related information from the Washington DC blood lead testing of children in homes with high water lead levels, NW PEHSU has concluded that it is extremely unlikely that a child will suffer identifiable symptoms of lead toxicity or have a blood lead level exceeding the current CDC goal of identifying children with blood lead levels over 10 mcg/dL.

In the school population, the children at highest risk would include:

Children less than 6 years of age who drink from school water that is *consistently* exceeding a lead level of 200-300 ppb. (See Figure 1 for a graph of maximum standing and running water levels observed in schools for which predicted blood lead levels using these maximum levels were over 5 mcg/dL.)

Children less than 6 years of age with medical conditions such as nutritional deficiencies – anemia, iron deficiency, calcium deficiency, vitamin D deficiency - which may increase their absorption of lead.

Children with pre-existing neurological problems (e.g. autism, seizure disorders, ADHD) may be more vulnerable to the toxic effects of lead but there is currently no clear evidence to support or refute this.

Children with pre-existing blood lead levels that are higher than expected due to other sources of exposure (e.g. children with a history of an elevated blood lead test, children/teens who have work or hobbies that involve lead exposure such as stained glass, pottery with lead based glaze, radiator repair, or firearm firing range or children whose parents, as a result of their employment accidentally bring home lead dust on their shoes and clothing). The additional exposure from lead in the school drinking water may boost these children's already elevated lead burden to a more concerning level.

NW PEHSU Concluding Perspectives and Recommendations

NW PEHSU supports efforts designed to reduce sources of lead exposure in children of all ages. The subtle effects of lead on brain intellectual function are in direct conflict to the goals of education. The lack of a good understanding of lead exposure and health impacts on older school aged children warrants a cautious approach. NW PEHSU feels strongly that it is an appropriate responsibility of the school district to ensure that the school drinking water supply does not contribute to potentially harmful lead exposure in Seattle public school children.

Drinking water monitoring

1. NW PEHSU endorses the Seattle Public School District's adoption of the EPA guidelines, recommending ongoing testing and assurance that lead levels in school drinking water supplies do not exceed a level of 20 ppb. Building in future goals for reducing this level further are reasonable given the lack of a known threshold or safe level of exposure in children.

2. NW PEHSU recommends that the School District provide timely risk assessment and risk communication information to parents and the public based on monitoring results. NW PEHSU is pleased that the school district has begun this effort.

3. Accomplishment of 1 and 2 above should be done through the context of an independent Task Force with a transparent process that builds trust and agreement among interested parties. Task Force members should be selected by the interested parties including concerned parents, the PTSA, the School Board, local public health officials, and the District administration.

Health monitoring

1. NW PEHSU does not recommend *comprehensive* blood lead testing or other health based screening for all Seattle Public School children at this time. This is based on the available school exposure information, the modeled assessment of blood lead levels described above, the timing now that the water sources have been altered (improved), and the national experience with blood lead levels and contaminated water supplies (e.g. Washington, DC). In addition, our general community level of exposure to lead through other important sources is low and as a community we have lower than national average blood lead levels in our children.

2. On a case by case basis, individual parents and their health care providers may determine that a blood lead test is appropriate due to a child's higher risk. We have provided a list of some of the considerations in determining high risk. NW PEHSU is happy to discuss individual questions and concerns with families or their health care providers about testing for lead exposure in children.

Appendix A

Centers for Disease Control Childhood Lead Poisoning Management Guidelines:

Response to confirmed venous blood lead levels over 10 mcg/dL

IF SCREENING BLOOD LEAD LEVEL IS	REPEAT DIAGNOSTIC VENOUS BLOOD LEAD TESTING BY
10 to 19 mcg/dL	3 mo
20 to 44 mcg/dL	1 mo to 1 wk (sooner with higher lead concentrations)
45 to 59 mcg/dL	48 h
60 to 69 mcg/dL	24 h
≥70 mcg/dL)	Immediately

Medical Management Recommendations

DIAGNOSTIC BLOOD LEAD LEVEL	CDC Recommends
10 to 14 mcg/dL	Repeat within 3 mo
15 to 19 mcg/dL	Repeat within 2 mo
15 to 19 mcg/dL on 2 measurements or ≥20 mcg/dL	Medical, nutritional, environmental history; physical examination; environmental inspection; possible chelation therapy
45 to 69 mcg/dL	As above, plus single-drug chelation therapy
> 69 mcg/dL	As above, plus two-drug chelation therapy

Appendix B

Non-recommended methods for evaluation of elevated lead exposure among children in clinical settings

Zinc Protoporphyrin Test
This blood test is not recommended because it is not sensitive enough to detect lower but still concerning levels of lead exposure (not sensitive to lead levels less than 25 micrograms per deciliter).

Urine Lead Level Test
Some of the lead that enters the body will leave the body in the urine. A test of the urine can measure this lead. This test is not recommended because the amount of lead that leaves the body in the urine varies a great deal from person to person, and compared to the blood lead level test, there is little information to help translate what levels of lead in urine mean in terms of health consequences for children. It is also not helpful in the school lead exposure incident because lead is quickly removed from the body after exposure occurs, usually in a matter of several days.

Urine Lead Mobilization Test
This is also a test which relies on a urine sample. It relies on treating the child with a drug called a chelator and measuring the lead that is excreted by this drug in the urine.
Chelation drugs act by latching on to available lead in the blood and tissues and helping this lead get removed from the body through the urine. Because of this action, these drugs are used for treatment of lead poisoning in certain high exposure situations (see "Methods of Treatment" section p. 5). For lower level lead exposure, such as may have occurred through the school drinking water, this test/treatment is not recommended for a number of reasons. There are no established, standardized reference levels for interpreting the results of these tests in children. In other words, there is no valid way to tell from the test result if a child had concerning exposure to lead. The chelating drugs used for this test have potentially serious side effects. In addition, these drugs do not just latch on to lead in the blood, they also remove other important nutrients such as copper, calcium, manganese, iron, and zinc, causing the body to become run down. Importantly, if there is ongoing exposure to lead in a child's environment, the chelation drugs will actually increase the child's absorption of lead. Finally, the FDA does not consider the urine mobilization test an indication for the use of chelation drugs. Due to all of these issues, urine lead mobilization testing for diagnosis of childhood lead exposure is not recommended by NW PEHSU or the consensus of the public health and medical community.

Hair Lead Test
Lead that is absorbed in the body leaves the body mostly through the urine but also may leave the body in smaller amounts through the feces, hair and nails. Hair testing has become increasingly available. The amount of lead in hair can be measured but unfortunately has not been shown to be reliable or useful for diagnosing overexposure to lead in children. The hair is easily contaminated from sources of lead outside the body and laboratories differ in how they obtain and analyze samples. This has made it difficult to standardize results. Importantly, unlike the blood lead test there is not a reliable way to translate what a hair level means in relation to potential for health harm in children. For these reasons, NW PEHSU along with the consensus

opinion of the medical and public health community do not find this test useful for quantifying exposure to lead in children.

Bone Lead Test

Since much of lead that is stored in the body is stored in bones, research scientists have used a special x-ray test called x-ray fluorescence (XRF) to measure bone lead as a marker of lifetime exposure to lead. Similarly, the amount of lead in children's teeth (a type of bone) has been measured in research settings. This type of testing of bone lead has been very useful in research studies but is not currently available outside of research settings.

Appendix C

Rationale for the decisions/assumptions that were made using the IEUBK model to estimate a child's blood lead level

Rationale: Amount of Water that a 6-7 year old drinks

The value used was the default provided in the IEUBK model for a 6-7 year old child (0.6 liters per day or about 2 _ cups

Rationale: Amount of Water consumed at home and at school

We estimated that a child drank half of their total daily water at home and half at school or about 0.3 liters (1 _ cup) at home and 0.3 liters (1 _ cup) at school.

Rationale: Amount of Water consumed at school that is from a standing water source (first draw) versus running water source.

We estimated that a child drank _ or 25 % of their school drinking water as a standing water sample and the rest (_ or 75 %) as a running water sample. This would be about one third of a cup as standing and about 1 cup as running.

Rationale: Level of lead in water consumed at home

We estimated a home level of lead in the drinking water of 7.9 ppb. This is the 90th percentile of what's been measured in high risk (copper pipes with lead solder) Seattle homes as reported by the Seattle Public Utilities 2003 Annual Report. This means that if one hundred homes were sampled, 90 would have lead levels that are less than this. (http://www.ci.seattle.wa.us/util/stellent/groups/public/@spu/@fob/@wqs/documents/spu_informative/cos_002504.pdf)

Rationale: Lead Content in Soil

The value used in the model for the lead content in soil was 24 ppm or 24 ug/g. The Department of Ecology, in conjunction with other agencies, collected 490 soil samples from selected regions in Washington state in order to determine the background levels of metals, including lead, in Washington state soil. The lead content in soil ranged form 11 ppm – 24 ppm, with the highest levels found in Puget Sound. Thus, 24 ppm was used for the soil lead concentration in the model. (Natural Background Soil Metals Concentrations in Washington State, Department of Ecology, Publication #94-115).

Due to the Asarco Plume, soil lead concentrations are elevated at some locations in West Seattle, with a maximum of 530 ppm (530 ug/g)(Executive Summary, King County Mainland Soil Study, Tacoma Smelter Plume Site, Toxics Cleanup Program, Figure 4, page March 2002; (http://www.ecy.wa.gov/programs/tcp/sites/tacoma_smelter/executive_summary_020404/exec_summary.htm). This information was not incorporated into our analysis because all Seattle School District schools located in West Seattle (Highland Park, Arbor Heights, and Concord) were visited and play areas were covered by either wood chips or asphalt, and areas where children could contact soil were not evident (Tacoma Smelter Plume Mainland King County, WA Child Use Area Final Report, Prepared by Science Applications Internatilanl Corporation for Washington Department of Ecology, June 2003; http://www.ecy.wa.gov/programs/tcp/sites/tacoma_smelter/tsp_King_county_studies/Mainland_CUA/KC%20Mainland%20CUA%20report.pdf).

Rational: Lead Concentration in Air

The value used in the model for lead concentration in air was 0.1 ug/m^3, the default value for the IEUBK model. Since closure of a lead smelter on Harbor Island in 1998 (maximum concentration that year was 2.03 ug/m^3 measured in close proximity to the smelter), air concentrations of lead in the Puget Sound have been less than the 0.1 ug/m^3. **Average** lead levels in 2001 and 2002 were 0.00349 ug/m^3 at the Beacon Hill air monitoring station, 0.00428 ug/m^3 at the Maple Leaf Reservoir site, and 0.00930 ug/m^3 in Georgetown neighborhood (Keill, L; Maykut,N, Puget Sound Air Toxics Evaluation, Puget Sound Clean Air Agency in conjunction with Washington State Department of Ecology, pg 17, October 2003; http://www.pscleanair.org/news/other/psate_final.pdf). The EPA has done additional monitoring, and in 2002 reported a peak value for Seattle/Bellevue/Everett of 0.03ug/m^3. The IEUBK EPA model indicates an average US outdoor background range of 0.1 - 0.3 ug/m^3.

Appendix D

Home Water, Soil & Paint Testing for Lead - Resources

Home Water Testing

To test your home water for lead, a water sample must be sent to a laboratory for analysis. For $27, the Washington State Public Health Laboratory located in Seattle will send you a kit with sample collection directions and a sample container. The $27 also includes the laboratory cost to analyze the sample. They recommend you collect the sample first thing in the morning before the faucet is used (a standing sample) and at a location used frequently for drinking and cooking (i.e. kitchen). If you are interested in testing for the lead level in running water, you will need to order a second kit. Collect the running sample after you have let the water run for 3-8 minutes; frequently a drop in water temperature can help signal your home pipes has been flushed. Deliver the sample to the Washington State Public Health Laboratory at 1610 Northeast 150th Street, in Seattle, Washington. To order your lead test kit, call the lab at (206) 361-2898.

A private laboratory can also be used. A list of laboratories certified by the Washington State Department of Ecology to analyze water for lead is provided below. Contact the laboratory in order to learn the sample analysis price, collection and submission procedures.

Water Reference Value

Because the school and residential sample collection methods differ, the lead level guideline is also different. The EPA action level for lead in residential water is > 15 ppb, as compared to > 20 ppb for schools. Standing samples from residences require only 6 hours of stagnation, compared to the 8-18 hours for schools. In addition, the sample collection volume for residences is 1000 ml, compared to the 250 ml sample collection volume for schools. If the lead source is the faucet, the higher volume collected in residences will serve to dilute or decrease the concentration of lead, when compared to the smaller volume of water collected in school samples.

Washington State Labs
Certified to Conduct Drinking Water Lead Analysis
Seattle Area

AM Test, Inc. 14603 NE 87th Redmond, WA (425) 885-1664	Analytical Resources Incorporated 4611 South 134th Place, Suite 100 Tukwila, WA (206) 695-6205
Aquatic Research, Inc. 3927 Aurora Avenue N Seattle, WA (206) 632-2715	Everett Environmental Laboratory 3200 Cedar Street Everett, WA (425) 257-8230
North Creek Analytical - Bothell 11720 North Creek Parkway N, Suite 400 Bothell, WA (425) 420-9223	Laucks Testing Laboratories, Inc. 940 South Harney Street Seattle, WA (206) 767-5060
NVL Laboratories, Inc. 4708 Aurora Avenue N Seattle, WA (206) 547-0100	

Home Soil Testing

To test your soil for lead content, a soil sample must be sent to a laboratory. Residential soil can be tested for $30 - $48 per sample. A list of accredited labs is provided at the end of this section. The primary lead sources leading to soil contamination are historical use of lead-containing exterior paint and lead in gasoline. Soil samples are generally collected from bare soil areas (no grass or other covering) where children play, near the home foundation, and/or within a few feet of high traffic areas. Soil covered with grass or asphalt is not considered a lead health hazard even if contaminated. Typically the top _ to 1 inch of soil is collected; garden soils should be sampled from the surface to about 4 inches in depth. To save money, multiple samples of about the same volume can be mixed, and a 1 cup in volume sample of the mixture (called a "composite" sample) can be submitted in a clean container for analysis. Contact the laboratory for details prior to sample submission.

Soil Reference Values

In 2001, the EPA addressed residential lead-based hazards in paint, dust and soil. Under the new standards, lead is considered a hazard if there are greater than:

- 400 parts per million (ppm or micrograms lead/gram soil (ug/g)) of lead in bare soil in children's play areas; or,
- 1200 ppm (ug/g) average for bare soil in the rest of the yard.

For more information on lead contamination of soil, visit the WA Department of Ecology Toxics Reduction Program WEB page, which also provides links to the EPA reference values (http://www.ecy.wa.gov/programs/hwtr/demodebris/pages2/leadsample.html#Current%20EPA%20Guidance).

Home Paint Testing

Residential paint chips can also be analyzed for lead for $30 - $38/sample. If possible, collect chips that include ALL layers of paint (for example, down to bare wood), not just the top layer(s). Submit dime to quarter sized pieces. Paint chip samples may be combined to reduce the cost of chemical analysis. Contact the testing laboratory for detailed information prior to sample submission (see below for a list of labs).

Paint Reference Values

Lead-based paint is defined by HUD (US Housing and Urban Development) as paint with lead levels equal to or exceeding 1.0 milligram per square centimeter (1mg/cm^2) or 0.5 percent by weight.

For more information on lead in paint, visit the Department of WA Ecology Toxics Reduction Program WEB page, which also provides links to the EPA reference values (http://www.ecy.wa.gov/programs/hwtr/demodebris/pages2/leadsample.html#Current%20EPA%20Guidance).

Washington State Department of Ecology
Accredited Laboratories for Lead Soil Analysis
(Also Provide Lead Paint Analysis)
King County
September 2004

Lab_Name	**State**	**City**	**County**	**Address**	**Contact_phone**
AmTest, Inc. - Redmond	WA	Redmond	King	14603 NE 87th St	(425) 885-1664
Analytical Resources, Incorporated	WA	Tukwila	King	4611 South 134th Place, Suite 100	(206) 695-6205
Aquatic Research, Inc.	WA	Seattle	King	3927 Aurora Ave N	(206) 632-2715
Friedman & Bruya	WA	Seattle	King	3012 16th Avenue West	(206) 285-8282
Laucks Testing Laboratories, Inc. - Seattle	WA	Seattle	King	940 South Harney St.	(206) 767-5060
North Creek Analytical - Bothell	WA	Bothell	King	11720 North Creek Parkway N., Suite 400	(425) 420-9223
NVL Laboratories, Inc.	WA	Seattle	King	4708 Aurora Ave. N.	(206) 547-0100
OnSite Environmental, Inc.	WA	Redmond	King	14648 NE 95th Street	(425) 883-3881

Appendix E

Helpful resources providing information on preventing lead exposure in children.

NW PEHSU – free consultation service for health care providers, health professionals, communities, and individual families
1-877-KID CHEM
http://depts.washington.edu/pehsu/

The Washington State Department of Health childhood lead poisoning factsheet
http://www.doh.wa.gov/Topics/Childhood%20lead%20Poisoning.htm

CDC website with links to lead related health information
http://www.cdc.gov/health/lead.htm

EPA website with information on protecting your family from lead hazards
http://www.pueblo.gsa.gov/cic_text/housing/finlead/leadhelp.html

Appendix F

Median and maximum level of lead measured in school drinking water standing and running samples and corresponding predicted blood lead level using the EPA IEUBK model.

school	median standing	median running	median calculated BLL	max standing	max running	maximum calculated BLL
Adams	2	1	1.6	29	7	2.1
African American Academy	1	1	1.6	4	30	2.5
Alki	2	1	1.6	92	4	2.6
Arbor Heights	16	2	1.8	230	16	4.3
Beacon Hill	9	1	1.7	120	8	3
Broadview-Thomas	16	2	1.8	670	44	8.7
Daniel Bagley	6.5	1.5	1.7	120	72	4.7
Catherine Blaine	5.5	1	1.6	320	12	5
Bryant	2	1	1.6	9	7	1.9
Orca at Columbia	3	1.5	1.6	26	22	2.5
Concord	2	2	1.6	10	8	1.9
Coe	2	2	1.6	24	9	2.1
Cooper	1	1	1.6	34	3	2
Day	8	2	1.7	59	28	3
Dearborn Park	29	1	1.9	440	16	6.2
Decatur Alternative	24	2	1.9	1600	52	15.3
Dunlap	2	1	1.6	4	44	2.9
Emerson	1	1	1.6	23	7	2
Fairmount Park	92	5	2.6	260	28	4.9
Greenlake	66	2	2.3	280	21	4.9
Greenwood	2	1	1.6	17	6	1.9
Graham Hill	8	2	1.7	230	310	11.1
Gatzert	8	1	1.7	77	54	3.8
Gatewood	2	1	1.6	24	14	2.2
John Hay	7	1	1.7	16	7	1.9
Highland Park	1	1	1.6	5	4	1.7
High Point	7	1	1.7	86	11	2.7
Hawthorne	4	1	1.6	34	4	2
Kimball	9.5	1	1.7	250	14	4.4
Lafayette	2	2	1.6	41	12	2.3
Laurelhurst	16.5	2	1.8	140	5	3.1
Leschi	8	2	1.7	50	58	3.7
Lowell	4.5	2	1.7	44	29	2.8
Lawton	3	1	1.6	14	3	1.8
Loyal Heights	12.5	1	1.7	71	6	2.5
McDonald School	24	5	2	57	24	2.8
Madrona	2	1	1.6	28	4	2
McGilvra	4	2	1.7	71	28	3.1
Magnolia School	11	4	1.8	92	31	3.4
Martin Luther King	7	1	1.7	61	13	2.6
T.T. Minor	7	2	1.7	30	50	3.3
Maple	18	3	1.8	470	17	6.4
Thurgood Marshall	9	1	1.7	18	8	2
Montlake	4	2	1.7	75	17	2.8
John Muir	12	2	1.7	95	28	3.3

North Beach	3	1	1.6	40	3	2.1
Northgate	41	2	2	280	250	10.2
Olympic Hills	14	1	1.7	42	10	2.3
Olympic View	2	1	1.6	140	2	3
Pinehurst Alternative	3	2	1.7	36	73	4
Pathfinder at Genesse Hill	4	2	1.7	160	22	3.8
John Rogers	43	1	2	400	6	5.6
Rainer View	33	4.5	2	84	24	3.1
Roxhill	9	2	1.7	380	12	5.5
Sacajawea	29	3	1.9	420	16	6
Salmon Bay at Monroe	21	2	1.8	170	46	4.5
Schmitz Park	105.5	5	2.8	310	51	5.9
Summit	5	1.5	1.7	110	23	3.3
Sanislo	16	2	1.8	130	210	8.2
John Stanford International School at Latona	1	1	1.6	13	9	2
Stevens	2	2	1.6	4	8	1.8
TOPS K-8 at Seward	1	1	1.6	3	4	1.7
Van Asselt	9.5	1	1.7	290	12	4.7
Viewlands	6	1	1.7	46	14	2.4
View Ridge	45	3	2.1	470	31	6.8
Wedgwood	66.5	6	2.4	960	370	16.9
Wing Luke	7.5	1	1.7	42	7	2.2
Whittier	1	1	1.6	3	14	2
Whitworth	5	1	1.6	43	5	2.1
Wilson Pacific	3	1	1.6	49	6	2.2
Westwood	14	2	1.8	120	15	3.2

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American Academy of Pediatrics. Pediatric Environmental Health 2nd Edition. 2003

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http://www.doh.wa.gov/HWS/doc/EH/EH_CLP.doc

ATSDR Report on State of the Science of Hair Analysis
http://www.atsdr.cdc.gov/HAC/hair_analysis/pdfs.html

School water lead monitoring

Seattle Public Schools Water Quality Website
http://www.seattleschools.org/area/facilities/WaterQuality/water_quality_update_sept30.htm

EPA School Drinking Water Standards. 2002.
http://www.epa.gov/safewater/lead/schoolanddccs.html

Regulation of drinking water for lead

Safe Drinking Water Act Lead and Copper Rule. 1991.
http://www.epa.gov/safewater/standard/leadfs.html

Childhood Blood Lead Levels

Washington State Department of Health Lead Reporting Update March 2003. Statewide Childhood Blood Lead Screening
http://www.doh.wa.gov/EHSPHL/Epidemiology/NICE/Lead/LeadReportingUpdateMar2003.pdf

Centers for Disease Control and Prevention. Second National Report on Human Exposure to Environmental Chemicals. Lead. January 2003.
http://www.cdc.gov/exposurereport/2nd/pdf/lead.pdf

Centers for Disease Control and Prevention. Mortality and Morbidity Weekly Report. Washington DC blood lead levels in residents whose homes had water levels > 300 ppb. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm53d330a1.htm

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http://www.epa.gov/superfund/programs/lead/ieubk.htm

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