WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

INTERIM ACTION REPORT
WASHINGTON ELEMENTARY SCHOOL
WENATCHEE, WASHINGTON

October 9, 2006

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Toxics Cleanup Program
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1.0 INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose of this report is to detail cleanup activities conducted at Washington Elementary School during the summer of 2006.

1.2 AREA WIDE INTRODUCTION

Area-wide soil contamination is defined as contamination above state cleanup levels that is dispersed over a large geographic area. The soil contamination in this case is a result of central Washington's orchard industry. Much of the region consists of current or former orchard land, where long-term pesticide application has taken its toll. Lead-arsenate, a pesticide commonly used between the years of 1905 and 1947 to control the codling moth, has been identified as the primary source of increased lead and arsenic concentrations.

Due to their chemical structure, lead and arsenic tend to bond with soil particles and often remain at or near ground surface level for decades, creating an exposure pathway through inhalation and/or ingestion.

Although lead and arsenic are naturally occurring elements, elevated concentrations have been proven to have a negative impact on human health. Young children are generally more susceptible than adults, which is why Ecology has focused remediation efforts on elementary schools.

Because of the unique nature of area-wide contamination, traditional methods of remediation are not feasible. Therefore, the Area-Wide Soil Contamination Task Force was established in 2002 to identify and pursue effective statewide strategies. Recommendations from the Task Force included soil testing, qualitative evaluations, and protective measures at child-use areas.

In the central Washington region, Okanogan, Chelan, Douglas, and Yakima counties were targeted based on the large volume of apple and pear production during the first half of the 20th century. Aerial photography from 1927 and 1947 showed a high number of school properties located on former orchard land in the Wenatchee area. Therefore, Ecology's Central Regional Office (CRO) began initial sampling and analysis during the spring of 2002.

Sampling results from the Wenatchee area showed several schools with soil contamination exceeding state cleanup standards. Based on these results, soil testing was implemented in the four priority counties. Over 100 public schools were tested for lead and arsenic during the summer of 2005. Of the schools sampled, Ecology's CRO identified 35 schools with soil contamination exceeding state cleanup standards.

The 35 schools were then prioritized for remedial activities. Remedial activities started during the summer of 2006. Four Wenatchee area schools, including Washington Elementary, were chosen for initial activities due to close proximity between properties and summer break schedule. North Omak Elementary, Brewster High School, Manson Elementary, and Naches Valley Intermediate were chosen for remediation following completion of soil excavation and mixing activities in Wenatchee.

2.0 SITE DESCRIPTION

Washington Elementary School is located at 1404 Washington Street within the City of Wenatchee in Chelan County, Washington. More specifically, the site is located at 46º34'26"N and -120º29'29" (GPS Coordinates) in the NE ¼ of the NW ¼ of Section 9, Township 22 North, Range 20 East. The site is approximately 1 mile west of State Highway 285 as it extents north-south through downtown Wenatchee and 3 ¼ miles south of State Highway 97. See Vicinity Map located in Appendix A.

Situated on the eastern boundary of the Wenatchee Mountains, this location is approximately 840 feet above sea level within the Wenatchee Valley. Mission Ridge is located approximately 7 miles west of the site and the Columbia River is located about 1 ¼ mile east of the site. Relief is approximately 5% across the site. Ecology well log records suggest depth to groundwater is about 40 feet below ground surface (bgs). Groundwater will generally flow east toward the Columbia River.

According to the United States Department of Agriculture (USDA) Soil Survey of Chelan Area Washington, local soils are described as Burch fine sandy loam. Burch soils were generally formed in valley fill and are primarily derived from sandstone. Burch soils are generally well-drained and composed of medium-textured and moderately coarse material. Burch fine sandy loam is commonly found on flat terraces and orchard cultivation is common.

The Soil Survey describes the following soil horizons:

- At 0-8 inches bgs, soil consists of a dark-gray fine sandy loam. Soil is composed of a fine, weak, granular structure and is slightly hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots with few fine tubular pores. Soil has a neutral pH.
- At 8-17 inches bgs, soil is brown loam with a weak, medium, prismatic structure. Soil is slightly hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots and fine tubular pores. Neutral pH.
- Between 17 and 26 inches bgs, soil is brown loam with a weak, medium, prismatic structure. Soil is hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots and very fine tubular pores. Neutral pH.
- At 26-36 inches bgs, soil becomes yellowish-brown loam that is slightly hard and has homogeneous texture. Soil is very friable and non-sticky and non-plastic. Soil is well impregnated with fine roots and fine tubular pores. Neutral pH.
- 33-60 inches bgs, soil is yellowish-brown loam that is slightly hard and has homogeneous texture. Soil is very friable, slightly sticky and slightly plastic. Fine roots are uncommon. Many fine tubular pores. Neutral pH.

During excavation and deep mixing activities, soil appeared generally as described above.

3.0 SITE HISTORY

Washington Elementary School was identified as a candidate for Area-Wide cleanup in 2002 as part of a pilot project conducted by Ecology's Central Regional Office (CRO). The project focused on devising appropriate sampling and analytical methods for historic orchard land. Based on the analysis of aerial photos from 1947, Washington Elementary was formerly occupied by an orchard. Analytical results showed lead and arsenic contamination in excess of MTCA Method A cleanup levels, as illustrated in the figure on the next page.

Lead and Arsenic samples were analyzed by portable x-ray fluorescence (XRF) unit and laboratory verified by inductively coupled plasma (ICP). For an explanation of XRF technology, its impact to Area-Wide cleanup efforts, and comparison of XRF accuracy to the standard ICP laboratory method, see Appendix B.

Although results from pilot project sampling identified the need for soil remediation in 2002, work was delayed until Area-Wide cleanup efforts began in 2006. In March of 2006, further soil sampling was conducted to better delineate contamination across the property. Of 31 samples analyzed, 27 showed arsenic levels in excess of Method A cleanup levels. Arsenic concentrations of more than 100 parts per million (ppm) were present in ten samples. The maximum detected arsenic concentration of 312 ppm is more than 15 times greater than the cleanup level. Lead cleanup levels were exceeded in 16 samples, with a maximum detected concentration of 1500 ppm.

Figure 1-1: Pilot Project Samples

4.0 SITE CONTACT INFORMATION

Contractual and planning phases of the project were reviewed by the Wenatchee School District (WSD) prior to beginning field operations. Requests in addition to the original scope of work were issued by Bryan Visscher, Director of Maintenance and Operations. Ecology maintained contact with WSD staff throughout the remedial process to maintain a positive working relationship and exchange information as needed.

CBA Environmental was contracted for deep soil mixing and acted as the general contractor for all school sites in the WSD. George Williams was the onsite representative for CBA Environmental and was responsible for managing deep mixing operations and other general contractor activities. WSD Maintenance & Operations staff was onsite to provide information and suggestions.

The following table contains contact information for individuals responsible for various roles in the completion of remedial activities.

Table 4-1: Contacts

Name	Organization	Position	Phone Number
Les Vandervort	Wenatchee School District	Chief Financial Officer	(509) 663-8161
Bryan Visscher	Wenatchee School District	Maintenance & Operations Director	(509) 663-0555
Pam Peer	Wenatchee School District	Secretary to Maintenance & Operations	(509) 663-0555
George Williams	CBA Environmental	General Contractor/Deep Mixing	(570) 682-8742
Greg Smith	Smith Excavation	Excavation & Hauling	(509) 782-0446
Mike Stubblefield	Mountain View Landscaping	Landscaping & Irrigation	(509) 663-3168
Kevin Pearl	Washington Elementary School	Principal	(509) 662-9227

5.0 REMEDIAL PROCESS

5.1 RISK

The potential exposure pathways for lead and arsenic in soil are inhalation, ingestion, and dermal absorption. It is important to note that ingestion is not considered as an exposure pathway in the site hazard assessment ranking method. For the purpose of this cleanup, ingestion was considered as a significant exposure pathway. Ingestion of contaminated soil is expected to be the primary route of exposure for metals, particularly with young children. Metals in dust or soil can be ingested accidentally by hand-to-mouth activity. Pica behavior in young children, that is, eating of non-food items, will increase this exposure. Ingestion or inhalation of wind-blown soil or dust are additional pathways of exposure to lead and arsenic. Children are considered a sensitive population because they tend to ingest more soil and dust than adults and because they tend to absorb more of the lead they ingest. Metals are not readily absorbed through the skin, so dermal absorption of metals is not a significant concern at the concentrations found at schools in the area-wide cleanup program.

Evidence of groundwater contamination or the threat of groundwater contamination has not been found relative to area wide lead and arsenic contamination. Extensive soil profile sampling in Central Washington has demonstrated that lead and arsenic contamination does not extend below 30 inches bgs in undisturbed situations. High levels of lead and arsenic contamination (above 50 ppm for arsenic and above 500 ppm for lead) were not found below 12 inches bgs. These results may vary in climates with more precipitation, but in this region, the findings were very consistent. Due to the depth of groundwater found in the vicinity of the school, combined with the distribution of the contamination, the risk of lead and arsenic contamination in groundwater is minimal.

5.2 REMEDIAL PROCESS

5.2.1 SAFETY AND HEALTH

The site was restricted from public access throughout the construction period by a 6-foot high chain link fence. The contractor was required to provide a specific Safety & Health Plan for the site construction activities.

5.2.2 DUST CONTROL PLAN

The contactor was required to control dust and to prepare a dust control plan. Dust control measures at a minimum included a water truck.

5.2.3 REMEDIAL ACTIVITIES

The initial remediation plan for Washington was based upon sampling conducted across the site to a depth of approximately 8 inches bgs. This data indicated that there were areas with lead and arsenic contamination high enough that some excavation would be required prior to applying deep mixing technology.

The deep mixing technology was supplied by CBA Environmental Inc. (CBA) from Hegins, Pennsylvania. The deep mixer is a piece of heavy equipment manufactured by Vermeer Manufacturing and modified by CBA for the purpose of deep soil mixing. The machine is track mounted and weighs between 50 and 120 tons depending on model. A large rotating drum mounted on the front of the machine is lowered to a maximum depth of 4.5 feet bgs where it rotates and mixes the soil. It travels at average speeds between 4 and 8 feet per minute and typically covers between ⅓ and ½ acre per day. Studies conducted by Ecology and CBA have shown a mixing efficiency between 70% and 95% depending on soil types. After the deep mixer has made a mixing pass, a windrow of overburden is deposited next to the mixed soil. This windrow is created as a result of the decompaction caused by deep mixing.

Prior to beginning remedial excavation, additional sampling was conducted to create a more detailed delineation of the lead and arsenic concentrations. This sampling data indicated that areas of lead and arsenic requiring excavation were more extensive than previous sampling had shown. The entire east end of the site had arsenic concentrations exceeding 100 ppm between 2 inches and 12 inches bgs. The western end of the site had a large area with concentrations exceeding 200 ppm and a small area with arsenic concentrations exceeding 300 ppm. As a general rule, any contamination above 100 ppm cannot be deep mixed without some excavation to remove some of the contaminant load. Concentrations in the 60-99 ppm range may or may not need to be excavated depending on the depth of contamination and the background concentrations found in the clean soil below.

Though lead and arsenic concentrations were more extensive than expected in the top 12 inches of soil, they dropped quickly with depth. After removing 8-12 inches of soil from the areas of highest contamination, the remaining surface concentrations rarely exceeded 50 ppm arsenic. As a result, deep mixing was very successful at the site.

A bulldozer was used for excavation prior to deep mixing. After the bulldozer had excavated an area down to a prescribed depth, the XRF was used to analyze post-excavation surface concentrations and determine whether more excavation was required. Extensive sampling demonstrated that arsenic concentrations of approximately 70 ppm were the transition point between the higher surface concentrations and the lower concentrations of the deeper clean soils at this particular site. When surface concentrations of 70 ppm were reached, excavation was considered complete for that area. A front-end loader was then used to load the stockpiles into trucks for transport to the landfill.

Approximately 2200 cubic yards of contaminated soil were excavated from Washington Elementary and disposed of at the Greater Wenatchee Landfill, operated by Waste Management, Inc.

Soil sampling was conducted continuously throughout the remedial process. Samples were collected directly from the deep mixing rows with a clean nitrile glove and placed in a new, clean, sealed plastic bag. Sample collection was varied between the overburden row and various depths in the mixing row itself. As the deep mixer completed each row, that row was sampled and analyzed to ensure the mixing was successful in reducing contaminant levels below MTCA standards. In the event that lead and arsenic levels were not reduced below MTCA cleanup standards, a row could be remixed with deeper soils to reduce concentrations further. No re-mixing was required at Washington, though there was one area that did not mix successfully. After mixing a section in the center of the property, confirmation samples indicated concentrations exceeded 100 ppm in a 10,000 square foot section. Additional sampling in an adjacent unmixed area showed that surface soils were below 100 ppm, but there was a layer between 12 and 20 inches bgs with arsenic concentrations exceeding 300 ppm. This was not detected during pre-remediation sampling. As a result, this 10,000 square foot area could not be successfully remediated by deep mixing and it had to be excavated and transported to the landfill for disposal.

5.3 SAMPLE RESULTS

Remedial activities at Washington Elementary School were successful in reducing the majority of lead and arsenic concentrations below MTCA cleanup levels for unrestricted land use. Of the 168 samples collected after remediation, 13 exceeded MTCA cleanup levels. Statistical analysis indicates that less than 10% of samples exceed MTCA standards. According to MTCA cleanup guidelines, a site may be considered clean if no more than 10% of samples exceed MTCA cleanup levels and no samples are greater than twice MTCA cleanup levels. Based on these guidelines, no further action is required for the site.

Pre-remediation arsenic samples had an average concentration of 76 ppm and a maximum concentration of 329 ppm. Pre-remediation lead samples had an average concentration of 258 ppm and a maximum concentration of 2025 ppm. Post-remediation arsenic samples had an average concentration of 16 ppm and maximum concentration of 39 ppm. Post-remediation lead samples had an average concentration of 46 ppm and a maximum concentration of 234 ppm. The tables below contain pre and post remediation sample data. Maps containing a general representation of this data are located in Appendix A.

<u>MTCA Method A State Cleanup Levels</u>

As-20 ppm

Pb- 250 ppm

Table 5-1: Pre-Remediation Samples

Date	As	Pb	Sample ID	School
21-Jun-06	**13.26**	**61.65**	WT-1 1-4"	Washington
21-Jun-06	**30.09**	**99.10**	WT-1 5-8"	Washington
21-Jun-06	**160.70**	**672.58**	WT-2 1-4"	Washington
21-Jun-06	**112.59**	**149.27**	WT-2 5-8"	Washington
21-Jun-06	**12.94**	**66.72**	WT-3 1-4:	Washington
21-Jun-06	**21.52**	**63.05**	WT-3 5-8"	Washington
21-Jun-06	**55.35**	**233.19**	WT-4 1-4"	Washington
21-Jun-06	**103.52**	**455.68**	WT-4 5-8"	Washington
21-Jun-06	**44.41**	**201.25**	WT-5 1-4"	Washington
21-Jun-06	**8.33**	**10.64**	WT-5 5-8"	Washington
21-Jun-06	**126.31**	**707.29**	WT-6 1-4"	Washington
21-Jun-06	**252.75**	**1163.38**	WT-6 5-8"	Washington
21-Jun-06	**82.41**	**275.12**	WT-7 1-4"	Washington
21-Jun-06	**63.69**	**303.70**	WT-7 5-8"	Washington
21-Jun-06	**130.86**	**825.58**	WT-8 1-4"	Washington
21-Jun-06	**86.26**	**119.16**	WT-8 5-8"	Washington
21-Jun-06	**75.88**	**357.02**	WT-9 1-4"	Washington
21-Jun-06	**51.30**	**113.50**	WT-9 5-8"	Washington
21-Jun-06	**75.41**	**754.74**	WT-10 1-4"	Washington
21-Jun-06	**218.70**	**968.28**	WT-10 5-8"	Washington
21-Jun-06	**54.38**	**314.72**	WT-11 1-4"	Washington
21-Jun-06	**56.19**	**67.86**	WT-11 5-8"	Washington
21-Jun-06	**90.40**	**284.81**	WT-12 1-4"	Washington

MTCA Method A State Cleanup Levels

As-20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
21-Jun-06	**52.99**	**314.06**	WT-12 5-8"	Washington
21-Jun-06	**160.42**	**776.03**	WT-13 1-4"	Washington
21-Jun-06	**81.59**	**76.30**	WT-13 5-8"	Washington
21-Jun-06	**101.95**	**599.82**	WT-14 1-4"	Washington
21-Jun-06	**58.72**	**504.36**	WT-14 5-8"	Washington
21-Jun-06	**102.22**	**549.70**	WT-15 1-4"	Washington
21-Jun-06	**105.61**	**79.29**	WT-15 5-8"	Washington
21-Jun-06	**147.95**	**776.06**	WT-16 1-4"	Washington
21-Jun-06	**177.14**	**594.98**	WT-16 5-8"	Washington
21-Jun-06	**105.80**	**423.13**	WT-17 1-4"	Washington
21-Jun-06	**145.68**	**713.36**	WT-17 5-8"	Washington
21-Jun-06	**108.57**	**558.91**	WT-18 1-4"	Washington
21-Jun-06	**138.71**	**710.59**	WT-18 5-8"	Washington
21-Jun-06	**108.76**	**520.32**	WT-19 1-4"	Washington
21-Jun-06	**141.54**	**939.82**	WT-19 5-8"	Washington
21-Jun-06	**90.15**	**718.33**	WT-20 1-4"	Washington
21-Jun-06	**126.94**	**726.54**	WT-20 5-8"	Washington
21-Jun-06	**77.44**	**321.78**	WT-21 1-4"	Washington
21-Jun-06	**45.36**	**37.20**	WT-21 5-8"	Washington
21-Jun-06	**89.54**	**541.42**	WT-22 1-4"	Washington
21-Jun-06	**155.15**	**503.47**	WT-22 5-8"	Washington
21-Jun-06	**119.35**	**570.88**	WT-23 1-4"	Washington
21-Jun-06	**111.48**	**143.63**	WT-23 5-8"	Washington
21-Jun-06	**82.00**	**597.81**	WT-24 1-4"	Washington
21-Jun-06	**329.02**	**2025.38**	WT-24 5-8"	Washington
21-Jun-06	**113.75**	**603.95**	WT-25 1-4"	Washington
21-Jun-06	**134.79**	**278.39**	WT-25 5-8"	Washington
21-Jun-06	**243.62**	**882.79**	WT-26 1-4"	Washington
21-Jun-06	**135.04**	**62.38**	WT-26 5-8"	Washington
21-Jun-06	**122.59**	**578.34**	WT-27 1-4"	Washington
21-Jun-06	**103.56**	**115.48**	WT-27 5-8"	Washington
21-Jun-06	**33.01**	**57.38**	WT-28 1-4"	Washington
21-Jun-06	**20.22**	**16.20**	WT-28 5-8"	Washington
21-Jun-06	**34.47**	**100.32**	WT-29 1-4"	Washington
21-Jun-06	**25.88**	**44.32**	WT-29 5-8"	Washington
21-Jun-06	**20.34**	**143.93**	WT-30 1-4"	Washington
21-Jun-06	**54.53**	**172.91**	WT-30 5-8"	Washington
21-Jun-06	**34.23**	**152.89**	WT-31 1-4"	Washington
21-Jun-06	**21.70**	**69.27**	WT-31 5-8"	Washington
21-Jun-06	**74.47**	**367.37**	WT-32 1-4"	Washington
21-Jun-06	**37.31**	**88.91**	WT-32 5-8"	Washington
21-Jun-06	**50.59**	**152.05**	WT-33 1-4"	Washington
21-Jun-06	**56.43**	**21.18**	WT-33 5-8"	Washington
21-Jun-06	**125.18**	**820.55**	WT-34 1-4"	Washington
21-Jun-06	**90.59**	**85.30**	WT-34 5-8"	Washington
21-Jun-06	**101.92**	**948.65**	WT-35 1-4"	Washington
21-Jun-06	**154.71**	**608.02**	WT-35 5-8"	Washington

MTCA Method A State Cleanup Levels

As-20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
22-Jun-06	**31.21**	**16.88**	WT-36 1-4"	Washington
22-Jun-06	**13.46**	**24.83**	WT-36 5-8"	Washington
22-Jun-06	**21.17**	**88.97**	WT-37 1-4"	Washington
22-Jun-06	**19.60**	**18.55**	WT-37 5-8"	Washington
22-Jun-06	**27.94**	**20.63**	WT-38 1-4"	Washington
22-Jun-06	**13.47**	**18.37**	WT-38 5-8"	Washington
22-Jun-06	**15.04**	**35.02**	WT-39 1-4"	Washington
22-Jun-06	**13.42**	**18.11**	WT-39 5-8"	Washington
22-Jun-06	**22.57**	**58.66**	WT-40 1-4"	Washington
22-Jun-06	**70.76**	**396.25**	WT-40 5-8"	Washington
22-Jun-06	**15.81**	**90.32**	WT-41 1-4"	Washington
22-Jun-06	**14.73**	**40.89**	WT-41 5-8"	Washington
22-Jun-06	**14.53**	**50.89**	WT-42 1-4"	Washington
22-Jun-06	**24.39**	**102.26**	WT-42 5-8"	Washington
22-Jun-06	**86.55**	**477.35**	WT-43 1-4"	Washington
22-Jun-06	**164.80**	**692.83**	WT-43 5-8"	Washington
22-Jun-06	**25.33**	**101.78**	WT-44 1-4"	Washington
22-Jun-06	**30.88**	**34.63**	WT-44 5-8"	Washington
22-Jun-06	**28.87**	**116.81**	WT-45 1-4"	Washington
22-Jun-06	**29.56**	**90.50**	WT-45 5-8"	Washington
28-Jun-06	**72.97**	**17.08**	WT-46 5-8"	Washington
28-Jun-06	**72.79**	**17.62**	WT-46 9-12"	Washington
28-Jun-06	**78.36**	**17.39**	WT-46 9-12"	Washington
28-Jun-06	**77.67**	**18.66**	WT-47 3-6"	Washington
28-Jun-06	**54.41**	**18.43**	WT-47 7-10"	Washington
28-Jun-06	**260.35**	**1079.90**	WT-48 5-8"	Washington
28-Jun-06	**51.16**	**20.73**	WT-48 9-12"	Washington
28-Jun-06	**158.27**	**666.95**	WT-49 5-8"	Washington
28-Jun-06	**122.33**	**24.54**	WT-49 9-12"	Washington
28-Jun-06	**12.64**	**17.20**	WT-50 5-8"	Washington
28-Jun-06	**13.05**	**18.09**	WT-50 9-12"	Washington
28-Jun-06	**87.86**	**256.07**	WT-51 1-4"	Washington
28-Jun-06	**94.63**	**210.19**	WT-51 5-8"	Washington
28-Jun-06	**57.42**	**17.78**	WT-52 5-8"	Washington
28-Jun-06	**43.77**	**16.59**	WT-52 9-12"	Washington
28-Jun-06	**64.61**	**17.70**	WT-53 5-8"	Washington
28-Jun-06	**22.81**	**17.49**	WT-53 9-12"	Washington
29-Jun-06	**91.47**	**18.57**	WT-54	Washington
29-Jun-06	**124.15**	**48.67**	WT-55 ex	Washington
29-Jun-06	**78.12**	**41.50**	WT-56 ex	Washington
29-Jun-06	**121.99**	**20.53**	WT-57 ex	Washington
29-Jun-06	**234.45**	**861.74**	WT-58 ex	Washington
29-Jun-06	**186.70**	**379.10**	WT-59 ex	Washington
29-Jun-06	**73.27**	**18.86**	WT-60 ex	Washington
29-Jun-06	**71.02**	**41.86**	WT-61 ex	Washington
29-Jun-06	**159.80**	**534.21**	WT-62 ex	Washington
29-Jun-06	**89.53**	**103.17**	WT-63-ex	Washington

MTCA Method A State Cleanup Levels

As-20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
29-Jun-06	**182.94**	**551.55**	WT-64-ex	Washington
29-Jun-06	**111.61**	**10.56**	WT-65-ex	Washington
29-Jun-06	**94.85**	**19.87**	WT-66-ex	Washington
29-Jun-06	**33.97**	**10.18**	WT-67 12-15"	Washington
29-Jun-06	**8.30**	**10.18**	WT-67 16-20	Washington
29-Jun-06	**7.34**	**9.51**	WT-67 21-24"	Washington
29-Jun-06	**66.01**	**10.31**	WT-68 12-15"	Washington
29-Jun-06	**30.11**	**31.90**	WT-68 16-20 ex	Washington
29-Jun-06	**8.35**	**10.45**	WT-68 21-24"	Washington
29-Jun-06	**48.99**	**61.94**	WT-69 9-12 ex	Washington
29-Jun-06	**13.77**	**9.99**	WT-69 12-15"	Washington
29-Jun-06	**8.42**	**11.54**	WT-69 16-20 ex	Washington
30-Jun-06	**189.00**	**658.76**	WT-70	Washington
30-Jun-06	**90.68**	**364.37**	WT-71	Washington
30-Jun-06	**117.03**	**109.25**	WT-72	Washington
30-Jun-06	**89.75**	**107.30**	WT-73	Washington
30-Jun-06	**39.69**	**77.10**	WT-74	Washington
30-Jun-06	**67.55**	**13.56**	WT-75	Washington
30-Jun-06	**21.01**	**223.78**	WT-76	Washington
30-Jun-06	**220.55**	**947.73**	WT-77	Washington
30-Jun-06	**56.50**	**30.03**	WT-78	Washington
30-Jun-06	**72.92**	**228.03**	WT-79	Washington
30-Jun-06	**118.88**	**599.06**	WT-80	Washington
30-Jun-06	**66.87**	**9.79**	WT-81	Washington
18-Jul-06	**84.10**	**156.63**	WT-82 1-5"	Washington
18-Jul-06	**43.68**	**152.94**	WT-83 1-5"	Washington
19-Jul-06	**10.83**	**36.19**	WT-86	Washington
19-Jul-06	**12.79**	**39.02**	WT-87	Washington
19-Jul-06	**195.64**	**506.99**	WT-88	Washington
19-Jul-06	**120.77**	**334.27**	WT-89	Washington
19-Jul-06	**44.96**	**42.66**	WT-90	Washington
19-Jul-06	**64.60**	**50.80**	WT-91	Washington
13-Jul-06	**15.89**	**48.25**	WT-PG-1	Washington
13-Jul-06	**13.58**	**62.85**	WT-PG-2	Washington
13-Jul-06	**15.87**	**38.29**	WT-PG-3	Washington
13-Jul-06	**14.85**	**40.08**	WT-PG-4	Washington
13-Jul-06	**12.83**	**56.17**	WT-PG-5	Washington
13-Jul-06	**20.43**	**182.61**	WT-PG-6	Washington
13-Jul-06	**12.17**	**54.67**	WT-PG-7	Washington
17-Jul-06	**21.34**	**421.51**	W-PG-5	Washington
17-Jul-06	**22.03**	**10.76**	W-PG-6	Washington
17-Jul-06	**28.08**	**15.62**	W-PG-7	Washington
17-Jul-06	**29.73**	**249.52**	W-PG-8	Washington
17-Jul-06	**23.36**	**132.22**	W-PG-9	Washington
17-Jul-06	**21.47**	**19.96**	W-PG-10	Washington
17-Jul-06	**14.41**	**78.41**	W-PG-11	Washington
17-Jul-06	**19.32**	**17.38**	WPG-12	Washington

MTCA Method A State Cleanup Levels

As-20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
17-Jul-06	**10.21**	**9.73**	WPG-13	Washington
17-Jul-06	**16.54**	**12.57**	WPG-14	Washington
Average	**75.87**	**258.22**		
Maximum	**329.02**	**2025.38**		

Table 5-2: Post-Remediation Samples

Date	As	Pb	Sample ID	School
29-Jun-06	**15.04**	**201.24**	WM-1 1s	Washington
29-Jun-06	**18.19**	**113.40**	WM-1 2c	Washington
29-Jun-06	**16.74**	**156.31**	WM-1 4c	Washington
29-Jun-06	**12.85**	**137.08**	WM-1 4c	Washington
29-Jun-06	**17.69**	**44.06**	WM-2 1s	Washington
29-Jun-06	**19.91**	**21.73**	WM-2 2s	Washington
29-Jun-06	**8.80**	**18.18**	WM-2 3s	Washington
29-Jun-06	**11.09**	**11.06**	WM-2 4c	Washington
29-Jun-06	**19.86**	**25.09**	WM-3 1s	Washington
29-Jun-06	**9.90**	**9.93**	WM-3 2c	Washington
29-Jun-06	**17.66**	**10.61**	WM-3 3c	Washington
29-Jun-06	**17.59**	**10.29**	WM-3 4s	Washington
29-Jun-06	**10.04**	**30.93**	WM-3 5c	Washington
29-Jun-06	**14.15**	**9.86**	WM-4 1s	Washington
29-Jun-06	**8.26**	**15.11**	WM-4 2c	Washington
29-Jun-06	**14.71**	**21.73**	WM-4 3s	Washington
29-Jun-06	**14.64**	**11.59**	WM-4 4c	Washington
29-Jun-06	**18.07**	**28.38**	WM-4 5c	Washington
30-Jun-06	**13.74**	**11.69**	WM-5 1c	Washington
30-Jun-06	**18.33**	**14.45**	WM-5 2c	Washington
30-Jun-06	**19.56**	**18.11**	WM-5 3c	Washington
30-Jun-06	**14.26**	**13.40**	wM-5 4c	Washington
30-Jun-06	**21.10**	**9.82**	WM-6 1c	Washington
30-Jun-06	**16.04**	**10.06**	WM-6 2c	Washington
30-Jun-06	**12.28**	**9.74**	WM-6 3c	Washington
30-Jun-06	**14.21**	**43.49**	WM-6 4c	Washington
30-Jun-06	**20.68**	**10.73**	WM-7 1c	Washington
30-Jun-06	**9.90**	**9.91**	WM-7 2c	Washington
30-Jun-06	**19.75**	**79.42**	WM-7 3c	Washington
30-Jun-06	**9.19**	**25.79**	WM-7 4c	Washington
6-Jul-06	**11.00**	**25.98**	WM-8 1s	Washington
6-Jul-06	**14.04**	**10.02**	WM-8 2s	Washington
6-Jul-06	**12.77**	**22.27**	WM-8 3s	Washington
6-Jul-06	**23.01**	**26.81**	WM-9 1s	Washington
6-Jul-06	**18.06**	**16.10**	WM-9 2s	Washington
6-Jul-06	**21.51**	**9.81**	WM-9 3s	Washington
6-Jul-06	**13.92**	**26.00**	WM-10 1s	Washington
6-Jul-06	**19.62**	**35.53**	WM-10 2s	Washington
6-Jul-06	**15.31**	**34.54**	WM-10 3s	Washington

MTCA Method A State Cleanup Levels

As- 20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
6-Jul-06	**21.96**	**33.97**	WM-11 1s	Washington
6-Jul-06	**12.08**	**50.73**	WM-11 2s	Washington
6-Jul-06	**15.73**	**26.93**	WM-12 1s	Washington
6-Jul-06	**28.45**	**23.41**	WM-12 1s	Washington
6-Jul-06	**14.11**	**36.52**	WM-12 2s	Washington
6-Jul-06	**19.09**	**39.13**	WM-12 3s	Washington
6-Jul-06	**14.14**	**87.01**	WM-13 1s	Washington
6-Jul-06	**19.40**	**59.88**	WM-13 1s	Washington
6-Jul-06	**15.44**	**233.88**	WM-14 1s	Washington
6-Jul-06	**15.70**	**46.17**	WM-14 2s	Washington
6-Jul-06	**17.44**	**58.99**	WM-15 1s	Washington
6-Jul-06	**16.87**	**204.70**	WM-15 2s	Washington
6-Jul-06	**17.05**	**95.85**	WM-15 3s	Washington
6-Jul-06	**14.23**	**140.89**	WM-15 4s	Washington
6-Jul-06	**30.62**	**103.53**	WM-16 1s	Washington
6-Jul-06	**15.40**	**53.87**	WM-16 2s	Washington
6-Jul-06	**10.06**	**49.92**	WM-16 3s	Washington
6-Jul-06	**14.71**	**38.21**	WM-16 4s	Washington
6-Jul-06	**18.24**	**28.67**	WM-16 5s	Washington
6-Jul-06	**27.69**	**77.66**	WM-17 1c	Washington
6-Jul-06	**15.05**	**39.57**	WM-17 2c	Washington
6-Jul-06	**12.86**	**22.04**	WM-17 3c	Washington
6-Jul-06	**11.04**	**69.44**	WM-17 4c	Washington
6-Jul-06	**15.57**	**10.24**	WM-17 5c	Washington
6-Jul-06	**12.45**	**39.10**	WM-18 1c	Washington
6-Jul-06	**10.83**	**26.41**	WM-18 2c	Washington
6-Jul-06	**14.37**	**51.07**	WM-18 3s	Washington
6-Jul-06	**19.77**	**58.15**	WM-18 4c	Washington
6-Jul-06	**10.70**	**10.08**	WM-18 5s	Washington
7-Jul-06	**16.29**	**152.59**	WM-19 1c	Washington
7-Jul-06	**16.54**	**70.26**	WM-19 2c	Washington
7-Jul-06	**13.43**	**71.47**	WM-19 3c	Washington
7-Jul-06	**18.72**	**28.73**	WM-19 4c	Washington
7-Jul-06	**11.59**	**12.02**	WM-19 5c	Washington
7-Jul-06	**11.92**	**37.94**	WM-20 1c	Washington
7-Jul-06	**16.29**	**85.90**	WM-20 2c	Washington
7-Jul-06	**19.57**	**43.81**	WM-20 3c	Washington
7-Jul-06	**12.10**	**91.14**	WM-20 4c	Washington
7-Jul-06	**11.61**	**14.70**	WM-20 5c	Washington
7-Jul-06	**15.01**	**22.56**	WM-21 1c	Washington
7-Jul-06	**12.37**	**84.55**	WM-21 2c	Washington
7-Jul-06	**13.98**	**52.19**	WM-21 3c	Washington
7-Jul-06	**24.93**	**29.42**	WM-21 4c	Washington
7-Jul-06	**9.69**	**20.80**	WM-21 5c	Washington
7-Jul-06	**13.20**	**38.12**	WM-22 1c	Washington
7-Jul-06	**16.07**	**54.72**	WM-22 2c	Washington
7-Jul-06	**16.15**	**19.43**	WM-22 3c	Washington

MTCA Method A State Cleanup Levels

As- 20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
7-Jul-06	**12.80**	**27.88**	WM-22 4s	Washington
7-Jul-06	**17.84**	**44.84**	WM-22 5c	Washington
7-Jul-06	**29.39**	**51.00**	WM-23 1c	Washington
7-Jul-06	**14.86**	**39.63**	WM-23 2s	Washington
7-Jul-06	**20.00**	**30.40**	WM-23 3c	Washington
7-Jul-06	**12.36**	**63.94**	WM-23 4s	Washington
7-Jul-06	**15.57**	**24.21**	WM-23 5c	Washington
10-Jul-06	**18.28**	**28.67**	WM-24 1s	Washington
10-Jul-06	**12.60**	**51.80**	WM-24 2c	Washington
10-Jul-06	**9.07**	**14.68**	WM-24 3s	Washington
10-Jul-06	**8.03**	**9.96**	WM-24 4c	Washington
10-Jul-06	**17.88**	**26.92**	WM-24 5s	Washington
10-Jul-06	**13.22**	**44.55**	WM-25 1c	Washington
10-Jul-06	**15.03**	**12.08**	WM-25 2c	Washington
10-Jul-06	**12.62**	**13.75**	WM-25 3c	Washington
10-Jul-06	**10.35**	**25.54**	WM-25 4c	Washington
10-Jul-06	**19.39**	**56.02**	WM-26 1c	Washington
10-Jul-06	**19.38**	**18.43**	WM-26 2c	Washington
10-Jul-06	**10.83**	**20.76**	WM-26 3c	Washington
10-Jul-06	**17.27**	**31.81**	WM-27 1c	Washington
10-Jul-06	**17.77**	**19.80**	WM-27 2c	Washington
10-Jul-06	**18.51**	**20.43**	WM-27 3c	Washington
10-Jul-06	**18.78**	**39.12**	WM-28 1c	Washington
10-Jul-06	**39.06**	**38.94**	WM-28 2c	Washington
10-Jul-06	**18.82**	**33.50**	WM-28 3c	Washington
10-Jul-06	**13.00**	**62.59**	WM-29 1c	Washington
10-Jul-06	**17.83**	**56.07**	WM-29 2c	Washington
10-Jul-06	**12.11**	**71.31**	WM-29 3c	Washington
10-Jul-06	**10.22**	**131.38**	WM-30 1c	Washington
10-Jul-06	**19.51**	**158.88**	WM-30 2c	Washington
10-Jul-06	**12.40**	**209.74**	WM-30 3c	Washington
12-Jul-06	**12.90**	**19.50**	WM-31 1c	Washington
12-Jul-06	**17.90**	**36.26**	WM-31 2c	Washington
12-Jul-06	**19.90**	**51.02**	WM-31 3c	Washington
12-Jul-06	**15.91**	**34.52**	WM-32 1c	Washington
12-Jul-06	**12.21**	**26.86**	WM-32 2c	Washington
12-Jul-06	**11.82**	**16.47**	WM-32 3c	Washington
12-Jul-06	**13.39**	**23.07**	WM-32 4c	Washington
12-Jul-06	**13.41**	**13.93**	WM-32 5c	Washington
12-Jul-06	**36.50**	**65.57**	WM-32 6c	Washington
12-Jul-06	**18.47**	**20.66**	WM-33 1c	Washington
12-Jul-06	**10.54**	**35.47**	WM-33 2c	Washington
12-Jul-06	**12.67**	**10.39**	WM-33 3c	Washington
12-Jul-06	**19.83**	**50.64**	WM-33 4c	Washington
12-Jul-06	**17.11**	**80.67**	WM-33 5c	Washington
12-Jul-06	**11.02**	**35.33**	WM-33 6c	Washington
12-Jul-06	**12.31**	**140.98**	WM-34 1c	Washington

MTCA Method A State Cleanup Levels

As- 20 ppm

Pb- 250 ppm

Date	As	Pb	Sample ID	School
12-Jul-06	**17.47**	**138.29**	WM-34 2c	Washington
12-Jul-06	**16.59**	**31.07**	WM-35 1c	Washington
12-Jul-06	**12.76**	**49.27**	WM-35 2c	Washington
12-Jul-06	**15.13**	**136.16**	WM-36 1c	Washington
12-Jul-06	**18.36**	**96.33**	WM-36 2c	Washington
12-Jul-06	**13.09**	**110.86**	WM-37 1c	Washington
12-Jul-06	**19.55**	**95.74**	WM-37 2c	Washington
18-Jul-06	**18.05**	**10.53**	WM-43 1s	Washington
18-Jul-06	**11.56**	**35.40**	WM-43 2c	Washington
18-Jul-06	**12.01**	**27.15**	WM-43 3s	Washington
18-Jul-06	**14.19**	**12.77**	WM-43 4c	Washington
18-Jul-06	**17.09**	**38.16**	WM-43 5s	Washington
18-Jul-06	**18.31**	**12.26**	WM-44 1c	Washington
18-Jul-06	**18.52**	**14.25**	WM-44 2c	Washington
18-Jul-06	**19.46**	**33.20**	WM-44 3c	Washington
18-Jul-06	**15.40**	**19.91**	WM-44 4c	Washington
18-Jul-06	**18.85**	**28.78**	WM-44 5c	Washington
18-Jul-06	**14.09**	**51.57**	WM-44 6c	Washington
18-Jul-06	**11.07**	**111.43**	WM-44 7c	Washington
19-Jul-06	**18.97**	**17.56**	WM-46 1c	Washington
19-Jul-06	**14.28**	**19.13**	WM-46 2c	Washington
19-Jul-06	**16.99**	**18.67**	WM-46 3c	Washington
19-Jul-06	**14.96**	**19.42**	WM-46 4c	Washington
19-Jul-06	**10.19**	**51.21**	WM-47 1c	Washington
19-Jul-06	**11.60**	**29.58**	WM-47 2c	Washington
19-Jul-06	**19.59**	**19.58**	WM-47 3c	Washington
19-Jul-06	**13.05**	**17.48**	WM-48 1c	Washington
19-Jul-06	**14.34**	**21.55**	WM-48 2c	Washington
19-Jul-06	**18.93**	**18.45**	WM-48 3c	Washington
19-Jul-06	**11.19**	**18.80**	WM-49 1c	Washington
19-Jul-06	**18.02**	**37.29**	WM-49 2c	Washington
19-Jul-06	**18.58**	**42.36**	WM-49 3c	Washington
19-Jul-06	**13.31**	**19.31**	WM-50 1c	Washington
19-Jul-06	**14.72**	**39.69**	WM-50 2c	Washington
19-Jul-06	**14.75**	**99.58**	WM-50 3c	Washington
Average	**15.83**	**46.25**		
Maximum	**39.06**	**233.88**		

5.4 CONFIRMATIONAL SAMPLING

Though samples were analyzed by XRF continuously during the remedial process, it was decided that several samples should also be collected for certified lab analysis. Certified lab analysis serves two purposes: it provides additional third party data to validate remedial activities, and it provides additional data to correlate the relationship between XRF and wet chemistry.

Samples collected for laboratory analysis were collected after all remediation was complete in 2006. A clean soil probe was used to collect a sample from 1-8 inches bgs. This sample was thoroughly mixed in a clean stainless steel bowl to homogenize the sample. The sample was then split into two portions. One portion was placed in a new, clean, sealed plastic bag and analyzed with the XRF. The other portion was placed in a clean, laboratory supplied, glass jar for laboratory analysis. The samples collected for laboratory analysis were then sent under sealed chain-of-custody to CCI Analytical Laboratory in Everett, Washington for lead and arsenic analysis.

Table 5-3: XRF-Lab Split Samples

Date	As Lab	As XRF	Pb Lab	Pb XRF	Sample ID	School
12-Sep-06	10.00	9.46*	10.00	14.84*	WE-lab-1	Washington
12-Sep-06	18.00	9.48*	33.00	19.61	WE-lab-2	Washington
12-Sep-06	12.00	9.26*	14.00	21.41	WE-lab-3	Washington
12-Sep-06	9.90	8.66*	10.00	13.76*	WE-lab-4	Washington
12-Sep-06	12.00	11.02	15.00	29.92	WE-lab-5	Washington
12-Sep-06	13.00	11.38	16.00	39.90	WE-lab-6	Washington
12-Sep-06	12.00	9.12*	18.00	14.17*	WE-lab-7	Washington
12-Sep-06	15.00	9.14*	18.00	16.91	WE-lab-8	Washington
12-Sep-06	14.00	11.80	18.00	23.43	WE-lab-9	Washington
15-Sep-06	18.00	23.02	84.00	146.23	WE-Lab-10	Washington
15-Sep-06	18.00	15.00	89.00	117.87	WE-Lab-11	Washington
15-Sep-06	19.00	12.45	94.00	67.45	WE-Lab-12	Washington
15-Sep-06	22.00	15.21	92.00	111.93	WE-Lab-13	Washington
15-Sep-06	10.00	11.97	48.00	54.76	WE-Lab-14	Washington
15-Sep-06	23.00	20.99	110.00	109.77	WE-Lab-15	Washington
15-Sep-06	24.00	24.16	100.00	125.23	WE-Lab-16	Washington
15-Sep-06	19.00	21.98	110.00	66.43	WE-Lab-17	Washington
15-Sep-06	17.00	14.47	80.00	68.52	WE-Lab-18	Washington
15-Sep-06	21.00	22.88	100.00	103.54	WE-Lab-19	Washington
15-Sep-06	13.00	13.37	57.00	78.94	WE-Lab-20	Washington

* These XRF values represent the detection limit of a non-detect sample. They are not actual values.

6.0 PROJECT SUMMARY

Soil samples collected at Washington Elementary School during sampling events in 2002 and 2006 indicated lead and arsenic contamination existed in surface soils at concentrations above MTCA cleanup levels. Deep mixing technology was used to blend the contaminated surface soil with deeper clean soils. As a result, lead and arsenic concentrations at the site were spread throughout a four foot soil profile and the majority of soil on site no longer contained concentrations above MTCA cleanup levels. Though some samples still slightly exceeded MTCA cleanup levels, statistical analysis was used to show that fewer than 10% of samples exceeded MTCA cleanup levels and none were twice the MTCA cleanup level. MTCA cleanup guidelines require no further action at a site when these conditions are met. Following remediation, the site was restored to its original condition.

7.0 APPENDICES

Appendix A: FIGURES

Figure A-1: Vicinity Map

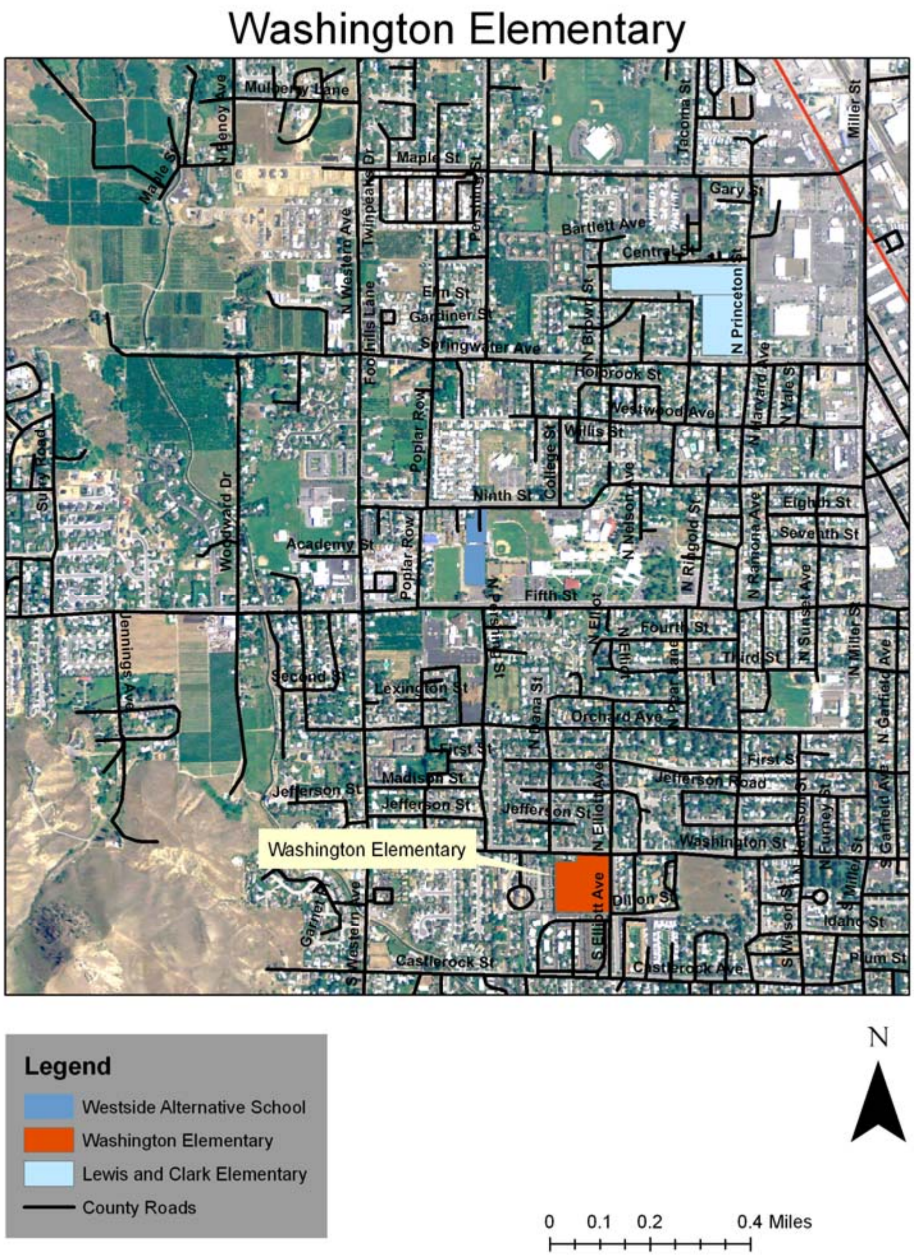
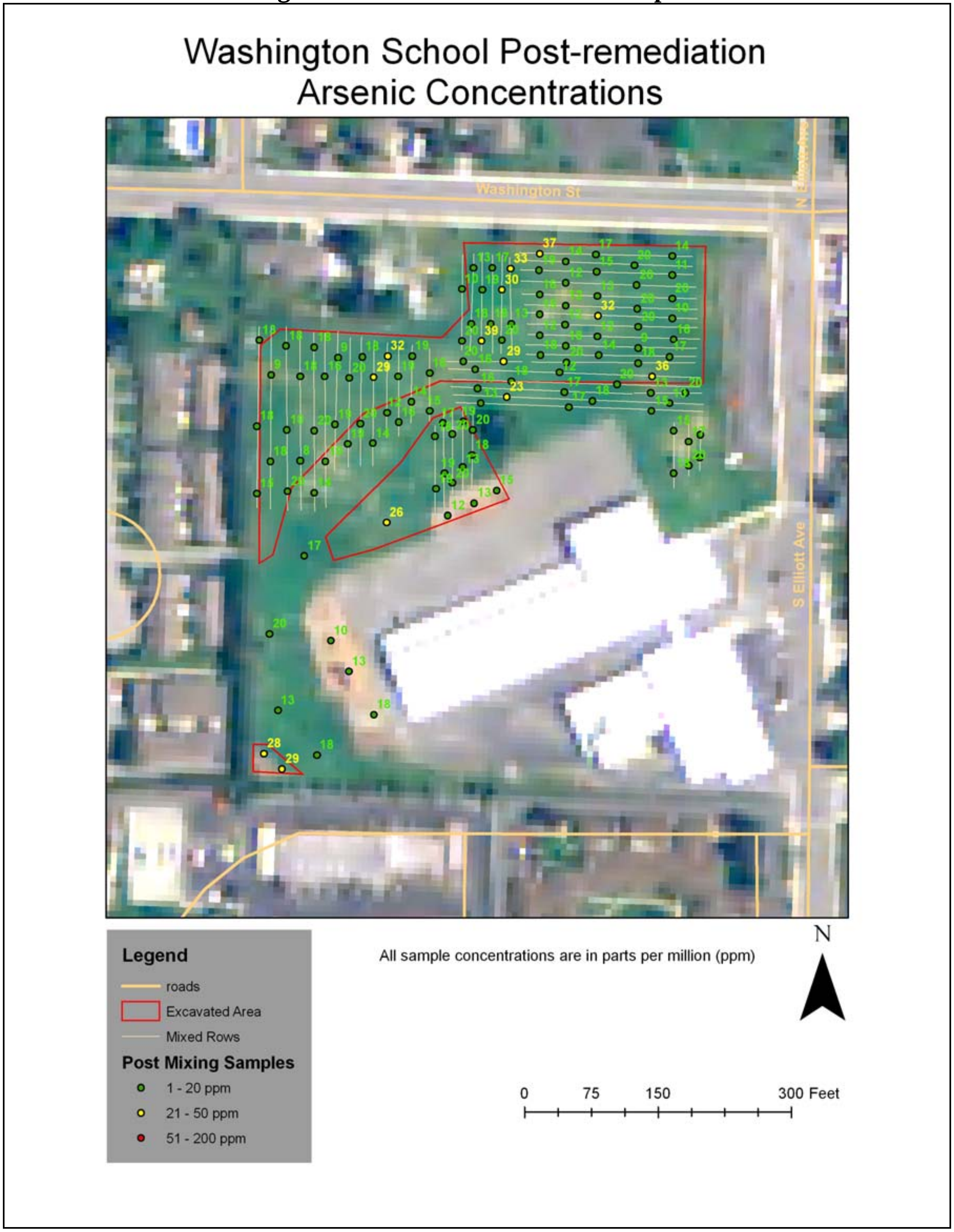


Figure A-2: Pre-Remediation Samples

Figure A-3: Post-Remediation Samples



Appendix B: XRF USE

The summer 2006 area-wide contamination clean-up projects involved the collection and analysis of a vast number of soil samples. Concentrations of lead and arsenic in these soil samples provided information as to whether or not an area was contaminated, and this information was used to determine how the remedial activities would proceed. Therefore project staff needed a way to quickly and reliably evaluate soil arsenic and lead concentrations. This was achieved through the use of two portable X-Ray Fluorescence (XRF) Analyzers manufactured by Innov-x Systems.

The instruments use x-ray technology to excite elemental electrons in a soil sample and cause these elements to emit characteristic x-rays. The intensity of these elemental x-rays is then measured to determine the amount of a particular element present in the sample. The entire analysis is performed in approximately one minute and the data is stored in a removable Hewlett-Packard (HP) iPAQ personal data assistant which can transmit the information to a laptop.

The use of portable XRF units for the determination of soil elemental concentrations has been described by EPA Method 6200 and has been found to provide, "a rapid field screening procedure" for site characterization [1]. Results from the study conducted by Ecology in 2002 (as shown in the graphs below) found that a portable Niton XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.8057 for lead and 0.933 for arsenic. In addition, a verification study conducted by the EPA Superfund Innovative Technology Evaluation (SITE) Monitoring and Measurement Technology (MMT) Program provides additional support for the use of this technology. The investigation compared an Innov-x XRF model, similar to the one used by Ecology, with reference laboratory data and showed a correlation coefficient of 0.8762 for arsenic and 0.91 for lead [2]. All of this data shows that an XRF can be an effective tool for characterizing large contamination sites.

Figure B-1: 2002 Arsenic Comparison

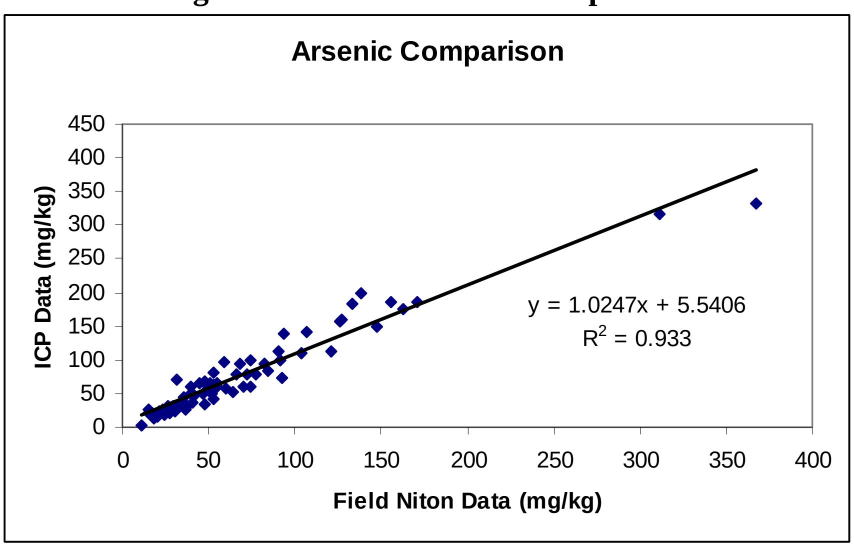
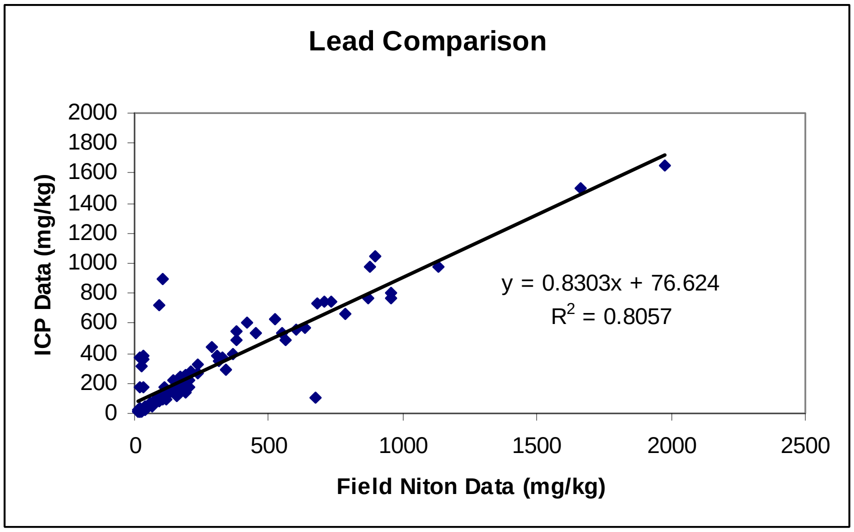


Figure B-2: 2002 Lead Comparision



During the summer 2006 projects, soil samples were collected and analyzed with the XRF instruments from a variety of locations. These locations included: undisturbed portions of the school playfields, sections of the playfields where initial soil excavations had occurred, and areas that had been processed by the deep mixer. As timely decision making was often required to keep the projects on schedule, the ability to assess the effectiveness of remediation activities with on-site soil analysis was invaluable to the overall success of the project. The XRF could determine concentrations of lead and arsenic in minutes. Sending samples for laboratory analysis at standard rates takes 2-3 weeks and would have drastically reduced the efficiency of remedial activities. Real-time results from these field analyses enabled project staff to make decisions such as whether the removal of additional soil was necessary or whether the barrel of the deep mixer should be raised to mix less soil or lowered to mix more.

Following the completion of the remediation projects conducted in 2006, additional samples were collected for comparison between XRF and Lab ICP methods. A total of 95 additional samples were collected and analyzed by both methods. These samples were analyzed by XRF prior to packaging in clean sealed jar. The analysis (as shown in the graphs below) found that the Innov-X XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.779 for arsenic and 0.893 for lead. It should be noted that many of the data points were actually detection limits of both analysis methods for samples where lead or arsenic was not detected. When those non-detect data points are removed, the analysis found that the Innov-X XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.838 for arsenic and 0.879 for lead.

Figure B-3: 2006 Arsenic Comparison

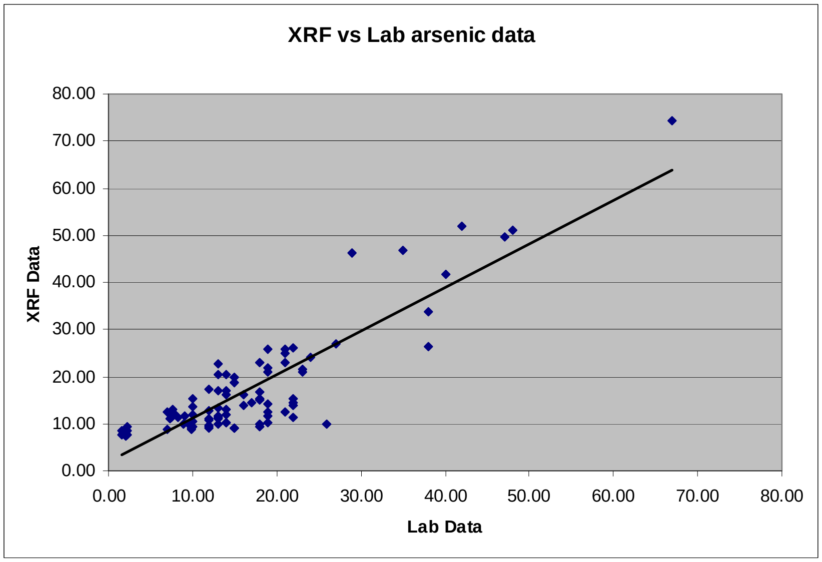
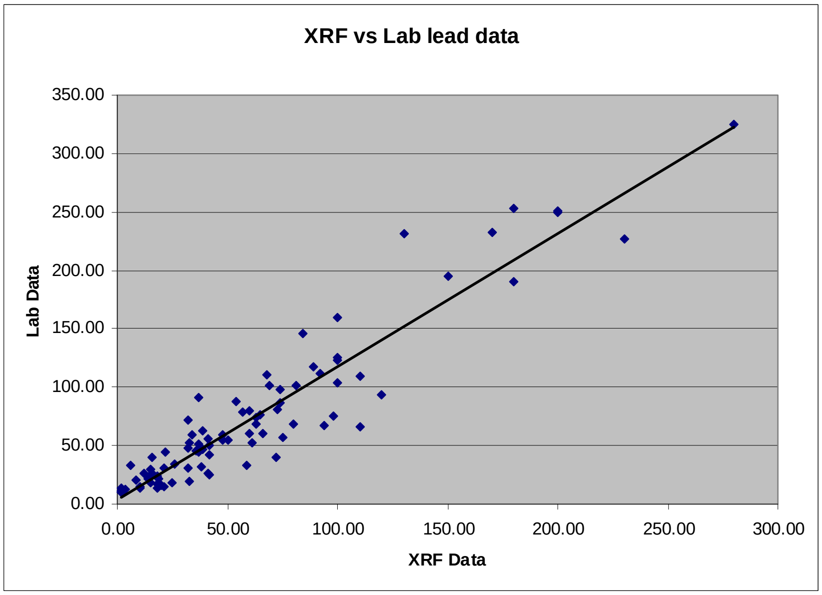


Figure B-4: 2006 Lead Comparison



Project staff followed all safety protocols for use of the XRF instruments including completion of mandatory information and safety trainings before sampling analysis began. In order to reduce health risks associated with radiation exposure, the instruments were operated while in a docking station and careful attention was paid to eliminate direct x-ray exposure. Actual amounts of radiation exposure as regulated by OSHA were monitored with the use of dosimeters which were carried by all sampling personnel.

Finally, in addition to the time saving benefits of the XRF instruments, their use proved to be a cost effective option for sample analysis. Due to the area (total acreage) covered during the school remediation projects, a large number of samples were required to characterize site progress. Use of the instruments resulted in a significant reduction in the number of soil samples sent off for laboratory analysis at a cost of $62-$66 per sample. Therefore, instead of project money being spent on one time analyses, it was invested in a second XRF instrument which enabled remediation work to occur simultaneously in several locations. Not only has the instrument paid for itself over the course of a single summer, but it will now be available for use in many future projects.

Appendix C: Costs

Remediation costs for Washington Elementary School were higher than anticipated for two primary reasons:

- Previous grading at the site had disturbed the distribution of lead and arsenic, forcing additional excavation before deep mixing could take place.
- Higher than expected values for the arsenic layer, which also resulted in additional excavation.

Washington Elementary School Remediation Costs

Mobilization	
Soil Disposal and Transport	$90,685
Final Grading	$2,475
Maintenance Bldg Soil Transport	$4,145
Import Clean Fill	$5,808
Maintenance Bldg Soil Disposal	$10,257
Debris Disposal	$460
Deep Mixing Costs	
Vertical Mixing	$99,180
Excavation Costs	
Shallow Excavation	$24,200
Maintenance Bldg Shallow Excavation	$798
Landscaping	
Soil Amendments, Rototilling, Raking	$21,344
Hydroseeding	$14,375
Sod Installation	$21,560
Irrigation	
Removal and Disposal of Piping	$1024
Irrigation System	$71,077
Miscellaneous	
Repair Sewer Line	$993
Fencing	$2442
Line Repair	$3,780
Total	$374,603
Acres remediated	4.21
Cost per acre	$88,081
Square feet remediated	18,338
Cost per square foot	$20

Appendix D: PHOTO LOG

Photo D-1: Excavation and dust control at Washington Elementary

Photo D-2: Grading taking place at Washington Elementary

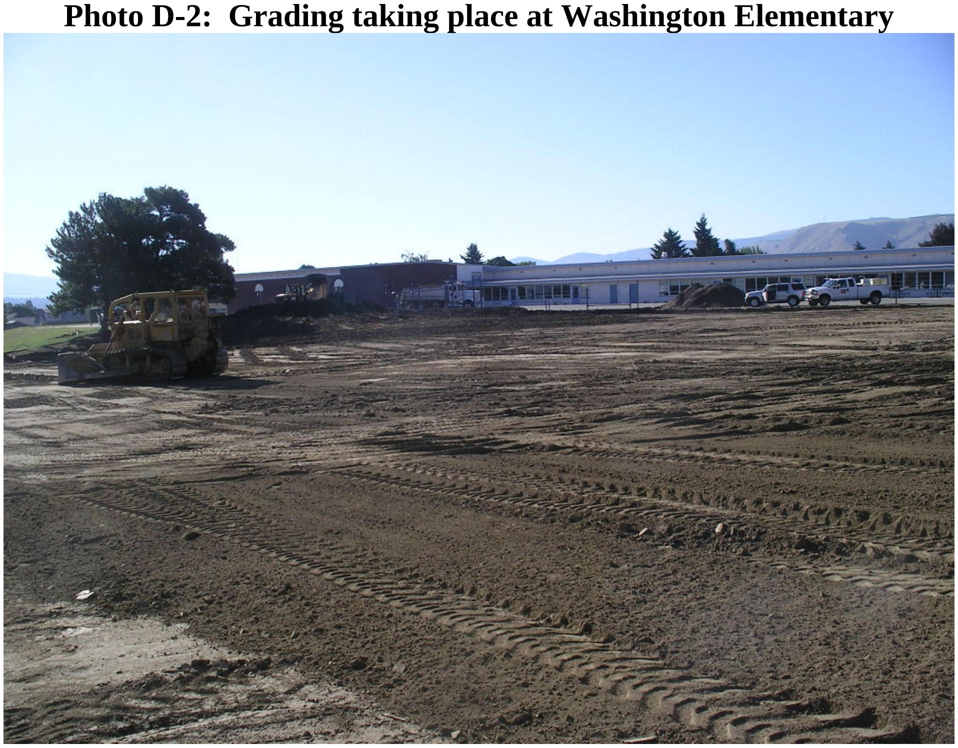


Photo D-3: Washington Elementary after seeding and sod installation

Photo D-4: Washington Elementary after germination

Appendix E: BIBLIOGRAPHY

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US EPA. "Innovative Technology Verification Report: XRF Technologies for Measuring Trace Elements in Soil and Sediment: Innov-X XT400 Series XRF Analyzer". EPA/540/R-06/002. February 2006.

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