

Interior Dust Lead Levels In La Oroya, Peru

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Occupational Knowledge International is a non-profit organization based in San Francisco, California dedicated to improving public health through innovative strategies to reduce exposures to industrial pollutants. The organization seeks to address inequities in environmental standards by working in partnership with industry, government and non-governmental organizations (NGOs). See www.okinternational.org

Asociación Civil Labor is a non-governmental organization that was founded in 1981 in the city of Ilo, in the south of Peru. Currently, Labor is conducting activities to strengthen national air quality legislation and to establish a national policy on environmental health. See www.labor.org.pe

CooperAcción is a Peruvian non-profit organization based in Lima. CooperAcción works to ensure that natural resource extraction contributes to sustainable development – both locally and nationally, with a particular focus on mining and fishing areas. See www.cooperaccion.org.pe

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Table of Contents

Executive Summary

1. Introduction

- 1.1 Background of Health and Environmental Studies Conducted in La Oroya
- 1.2 Health Risks Associated with Lead Exposure

2. Objectives

3. Geography

- 3.1 Yauli Province
- 3.2 District of La Oroya
 - 3.2.1 Weather
 - 3.2.2 Population

4. Methods

- 4.1 Sample Location Selection Criteria
- 4.2 Materials
- 4.3 Sample Collection
- 4.4 Laboratory Analysis
 - 4.4.1 Method of Analysis in the U.S. Laboratory
 - 4.4.2 Method of Analysis in the Peruvian Laboratory

5. Sample Results

- 5.1 Dust Wipe Results (Peruvian Laboratory)
- 5.2 Dust Wipe Results (U.S. Laboratory)

6. Conclusions

7. Recommendations

Tables:

- Table 1 Symptoms Associated With Blood Lead Levels in Children and Adults
- Table 2 Summary of Interior Floor Dust Wipe Sample Results (Peruvian Laboratory)
- Table 3 Average, Range and Standard Deviation of Dust Wipe Sample Results (Peruvian Laboratory)
- Table 4 Summary of Interior Floor Dust Wipe Sample Results (U.S. Laboratory)
- Table 5 Average, Range and Standard Deviation of Dust Wipe Sample Results (U.S. Laboratory)
- Table 6 Dust Wipe Samples Collected at a School (U.S. Laboratory)
- Table 7 Dust Wipe Samples Collected at a School (Peruvian Laboratory)
- Table 8 Lead Dust Wipe Sample Results (U.S. Laboratory)
- Table 9 Lead Dust Wipe Sample Results (Peruvian Laboratory)

Figures:

Figure 1: Distribution of Dust Lead Level Results in La Oroya Antigua

Figure 2: Distribution of Dust Lead Level Results in La Oroya Nueva

Maps:

Map 1: Location of La Oroya Peru

Map 2: Area Map of La Oroya

Map 3: Lead Dust Wipe Sample Locations in La Oroya Antigua

Map 4: Lead Dust Wipe Sample Locations in La Oroya Nueva

Map 5: Lead Dust Wipe Sample Locations in Curipata

Appendix: Dust Wipe Sampling Procedures

Executive Summary

For over 80 years, a smelter has operated in the City of La Oroya, Peru producing copper, lead, cadmium, silver and gold. Since the 1960s, concerns have been raised regarding the public health impact of these operations on the local population. Several studies have been conducted to assess environmental contamination and resulting exposures to heavy metals. However, no effort has previously been made to measure heavy metal levels within area homes.

Our investigation was initiated to characterize dust lead levels in homes and other occupied areas in La Oroya and to compare these levels to international standards. The study also compares dust lead levels in two distinct neighborhoods (La Oroya Nueva and La Oroya Antigua) that differ in their proximity to the smelter. Two samples were collected from a third location in Curipata, a town outside of La Oroya, for comparative purposes.

The following summarizes study findings:

- A total of 80 dust wipe samples were collected from 35 homes, one school and three shops, and were analyzed for total lead content. Of the 50 samples collected on interior floors in homes in La Oroya, 25 were analyzed by a U.S. laboratory and 25 samples were sent to a Peruvian laboratory.
- For all dust wipe samples collected on interior floors, a total of 88% exceeded the standard for acceptable lead levels established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD) standard. Of the samples collected on floors in La Oroya Antigua, 100 % exceeded this regulatory level. Of the samples collected on floors in La Oroya Nueva, 71% exceeded this regulatory level.
- Three samples collected from a school exceeded the EPA/HUD regulatory level.
- The highest reported dust lead level on a kitchen floor was over 25 times the EPA/HUD standard of 40 $\mu\text{g}/\text{ft}^2$.
- Despite differences in analytical methods, results from the Peruvian and U.S. laboratories were consistent.

1. – Introduction

Peru is blessed with a variety of natural resources and has the highest levels of gold, zinc, lead and tin production in Latin America⁵. It is also the second largest silver and copper producer, in addition to producing other important metallic and non-metallic products that have contributed significantly to an increase in exports in recent years.

Approximately 175 km (109 miles) from Lima, in the heart of the central Andes of Peru, a city was abruptly established, without adequate land use planning, next to the site of the La Oroya smelter complex. At an altitude of 3,700 meters (12,140 feet) above sea level, the city of La Oroya coexists, side by side, with the smelter.

La Oroya is a densely populated city with approximately 30,234 inhabitants. The city has a very high poverty rate and is economically dependent (both directly and indirectly) on the smelter complex.

Climatic temperature inversion and the region's topography cause air pollution to become trapped among the mountains, preventing dispersion. This phenomenon, in addition to the ore and slag waste left behind by the production and transportation of the metals, has resulted in significant environmental contamination.

The smelter complex was built in 1922 by the American Cerro de Pasco Copper Corporation. After the initial copper smelter was completed, a lead circuit was added in 1928, and in 1952 an addition was made to include a zinc circuit. The refinery also produces cadmium, silver and gold.

The complex is divided into two main sites. The smelter located in La Oroya Antigua, and the refinery in La Oroya Nueva.

In 1997, Doe Run Peru (DRP), a subsidiary of the American company Doe Run, purchased the smelter complex. Upon purchase, DRP assumed the obligation of complying with the Environmental Management and Mitigation Program (EMMP) developed by the previous owner, Centromin. The EMMP is a custom-designed regulatory tool that sets out the company's particular environmental obligations.

In December 1998, DRP requested a modification of the Centromin EMMP. After consideration, the Peruvian Government agreed to modify the EMMP, allowing the company to delay the installation of pollution control devices until 2006. Other modifications to the EMMP have also been made, at the company's request.

⁵ Private Promotion Investment Agency (ProInversion). June 2004. *Reasons to Invest in Peru*. [http://www.proinversion.gob.pe/pqinvertir/razones/cont_4.htm](http://www.proinversion.gob.pe/pqinverdir/razones/cont_4.htm)

In July 2004, DRP requested an additional delay in the implementation of the existing agreement. The Peruvian Government has yet to respond to the company's most recent request.

1.1 - Background of Health and Environmental Studies Conducted in La Oroya

Beginning as early as 1967, studies have been undertaken to examine the health impact of the smelter complex in La Oroya. Although action has been taken to lower atmospheric emissions from the smelter, studies reveal that children's blood lead levels in the area are well above the recommended levels set by the World Health Organization (WHO) and the U.S. Centers for Disease Control (CDC).

Several of these reports include "Blood Lead Study in a Selected Population from La Oroya" released in November 1999 by the Director General of Environmental Health (DIGESA) of the Peruvian Ministry of Health⁶, "Study of Blood Lead Levels of the People of La Oroya" conducted by DRP in 2000-2001⁷ and "Blood Lead Exposure Levels and the State of Health of a Population of Children Aged 5 to 9 in the City of La Oroya." undertaken by CooperAcción⁸. These studies demonstrate that lead exposure continues to be a significant risk for the population in La Oroya.

The DIGESA study demonstrates that lead poisoning is a widespread health problem among children in La Oroya. Study data show that 18.3% of the children in the study should be urgently admitted to the hospital for medical attention and their homes subjected to environmental assessment according to CDC Guidelines⁹. The current CDC level of concern for children begins at 10 µg/dl. In this study only 0.9% of the children had blood lead levels lower than 10 µg/dl.

The highest lead levels observed were found in La Oroya Antigua, very close to the smelter. Lower, but significant exposures occurred in other outlying areas including La Oroya Nueva and Santa Rosa de Sacco.

DRP has also undertaken considerable testing for airborne lead and other contaminants in La Oroya. Results from this monitoring activity show consistently high levels of lead and other heavy metals in the area. Limited environmental testing has also been conducted to measure lead and other heavy metals in soil and settled dust on exterior surfaces. No prior study has been undertaken to measure interior dust lead levels in La Oroya.

⁶ "Estudio de Plomo en Sangre en una Población Seleccionada de La Oroya" 1999 - DIGESA - Perú.

⁷ "Estudios de Niveles de Plomo en la Sangre de la Población de La Oroya" 2000-2001 - DRP

⁸ "Niveles de Exposición de Plomo en Sangre y Estado de Salud de la Población de Niños de 5 a 9 Años de la Ciudad de La Oroya". Mayo, 2003 - CooperAcción.

⁹ La Oroya Cannot Wait: Analysis of the environmental pollution caused by the metallurgic complex and their health impacts. Anna K. Cederstav – Alberto Barandiaran 2002.

1.2 – Health Risks Associated with Lead Exposure

There is great variability in the symptoms shown by individuals exposed to lead. Lead exposure is particularly dangerous for children, as relatively low exposures can cause them irreversible neurological damage. Children are more susceptible than adults to the other health effects associated with lead exposure, as well. The following table summarizes the range of symptoms that are generally observed at different blood lead levels in both children and adults.

Table 1 Symptoms Associated with Blood Lead Levels in Children and Adults

Effect in children	Level of lead in the blood ($\mu\text{g}/\text{dl}$)	Effect in adults
	150	
Mortality		
	100	Encephalopathy
Encephalopathy		
Nephropathy		Anemia
Anemia		
Abdominal pain		
	50	Decrease in hemoglobin synthesis
Decrease in hemoglobin synthesis	40	Infertility (men)
		Nephropathy
Diminished Vitamin D metabolism	30	Hearing loss
Diminished nerve conduction	20	
Erythropoietic protoporphyria		
Learning disabilities/IQ deficit	10	Hypertension
Hearing loss		Miscarriages
Reduced growth		

Source: Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Case Studies in Environmental Medicine*, No. 1.

For physiological and behavioral reasons, children's exposure to lead and other environmental contaminants is higher than that of adults, placing them at special risk. Children are exposed to lead in soil and dust when they play on the ground and through frequent hand-to-mouth contact. Children also generally absorb a greater percentage of ingested lead than adults. Moderate exposures to lead put children at risk for anemia, abdominal pain, and muscular weakness. Absorption of even a small amount of lead can affect the blood and nervous systems, impacting children's neurological and physical development. The effect of lead on the developing fetus can also result in higher rates of premature births, low birth weight, and learning disabilities.

2. - Objectives

This study was designed to determine the extent of lead contamination in interior environments in La Oroya, as measured by dust lead levels in homes and a school.

The study aims to:

- determine dust lead levels in the interior of homes in La Oroya (La Oroya Nueva and La Oroya Antigua); and
- compare results with international standards (e.g. U.S. EPA – Floors: 40 $\mu\text{g}/\text{ft}^2$).

3. - Geography

3.1 - Yauli Province

Yauli is located in the northern part of the Department of Junín in Peru. More specifically it is located south of Pasco, west of the provinces of Junín and Tarma, north of the province of Jauja and east of Lima. The Yauli capital is La Oroya.

Yauli is made up of several districts including: La Oroya, Chacapalca, Paccha, Morococha, Yauli and Santa Rosa de Sacco, covering an area of approximately 3,260 square kilometers (1,259 square miles).

3.2 - District of La Oroya

La Oroya is located in the central Andes in Peru, at 3,745 meters (12,286 feet) above sea level and approximately 175 km (109 miles) from Lima (See Map 1).

3.2.1 - Weather

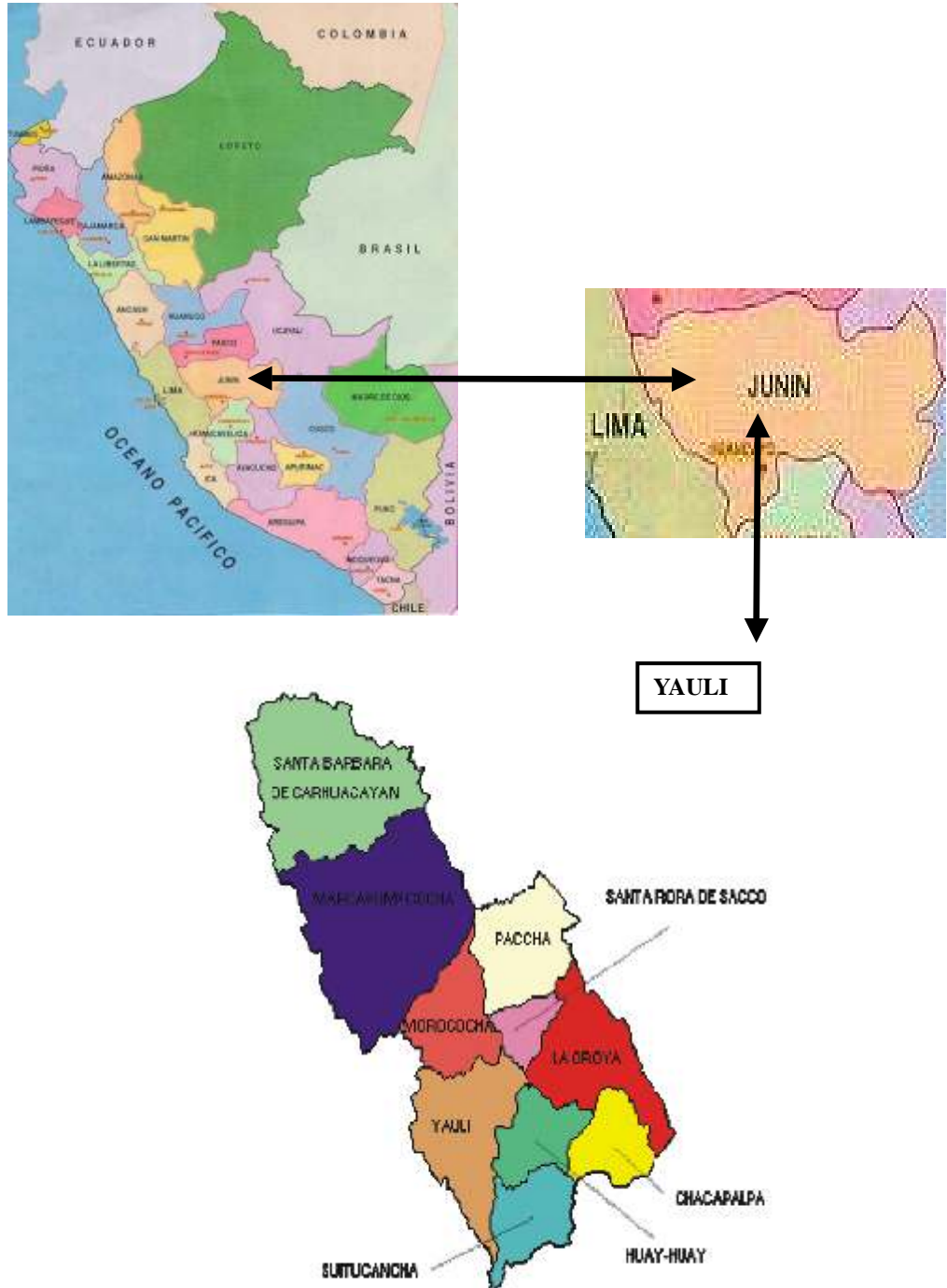
La Oroya has both dry and wet seasons. The dry season begins in April and ends in September. Temperatures are extremely cold in the morning and during the night. The wet season begins in October and ends in March, during which there is considerable rain and snowfall.

3.2.2 - Population

In June 2002, the population in La Oroya was 30,234 people according to the Peruvian National Institute of Statistics and Informatics (INEI)¹⁰.

¹⁰ Instituto Nacional de Estadísticas e Informática del Perú (INEI). Junio, 2002. www.inei.gob.pe

MAP 1 - LA OROYA PERU



4. - Methods

4.1 – Sample Location Selection Criteria

The following criteria were used in selecting sample locations:

The city of La Oroya is divided in three sectors, which vary in distance from the metallurgical complex (See Map 2).

- The first sector, La Oroya Antigua, is very close to the smelter (approximately 0.6 km)¹¹.
- The second sector, La Oroya Nueva, is a little further from the smelter (approximately 3 km).
- The third sector, Curipata, is considerably distant (approximately 12 km) from the smelter complex and was included for comparison purposes.

Three months prior to sampling, representatives from CooperAcción contacted residents in the three study areas to request access to their homes. Permission was obtained to sample a total of 40 homes.

To minimize the possibility of sampling in areas more highly contaminated from lead in gasoline, efforts were made to select sample locations away from high traffic areas. Within each sector, only homes located at least one block from main streets and intersections were considered for inclusion.

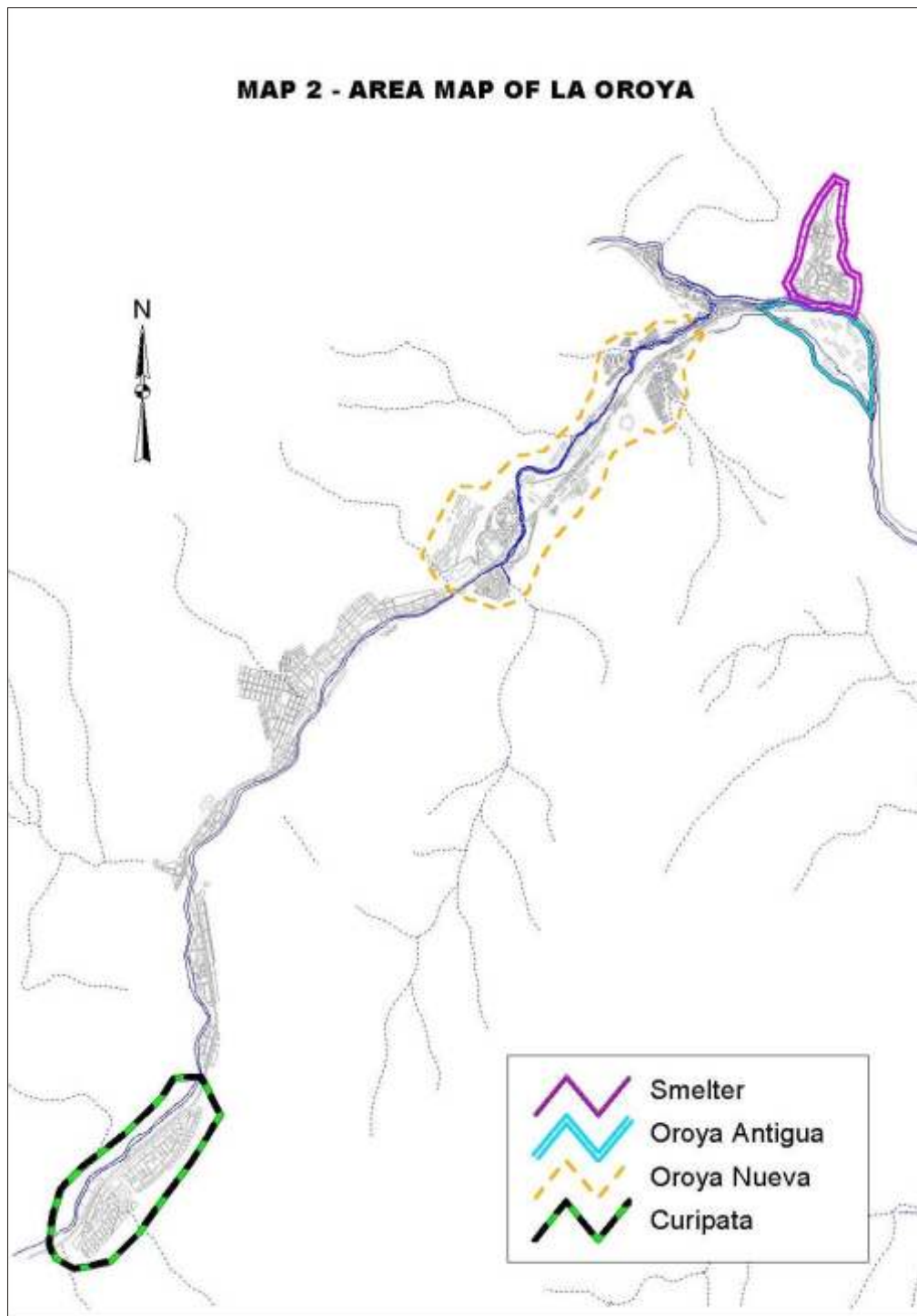
The sampling was conducted by representatives of Association Civil Labor and CooperAcción on October 18th and 19th, 2003, during the dry season.

4.2.- Materials

The following materials were used for dust wipe sampling:

- Disposable Ghost Wipes™ meeting "ASTM E 1792" standards
- Gloves
- Centrifuges tubes (50 ml)
- Plastic 1' X 1' Template
- Masking tape
- Measuring tape
- Sample collection forms
- Markers, trash bags, labels, envelopes, pens.

¹¹ The reference point is the midpoint of each area of the city to the smelter.



4.3 – Sample Collection

A total of 80 samples were collected from 35 homes, three stores, and a school. Two blank samples were also submitted for analysis.

Two samples were collected from each home or building. One of these samples was analyzed by a Peruvian laboratory (Ecolab of Lima) and the other by a U.S. laboratory (Schneider Laboratories of Richmond, Virginia). Samples submitted to alternative laboratories were not intended as duplicate or quality control samples, but can indicate trends for comparison in the aggregate.

Table 8 shows the results from the U.S. laboratory and Table 9 presents the results from the Peruvian laboratory.

Maps 3 and 4 show the geographic distribution of homes tested in La Oroya Antigua and Nueva. Samples were taken from as wide a range of locations within a geographical area as possible. In addition, two samples were collected from a home in Curipata approximately 11.5 km (7 miles) from La Oroya for comparison purposes and are listed in the attached tables.

The sample collection method used is the U.S. Department of Housing and Urban Development (HUD) standard “Testing for Lead-Contaminated Dust”¹².

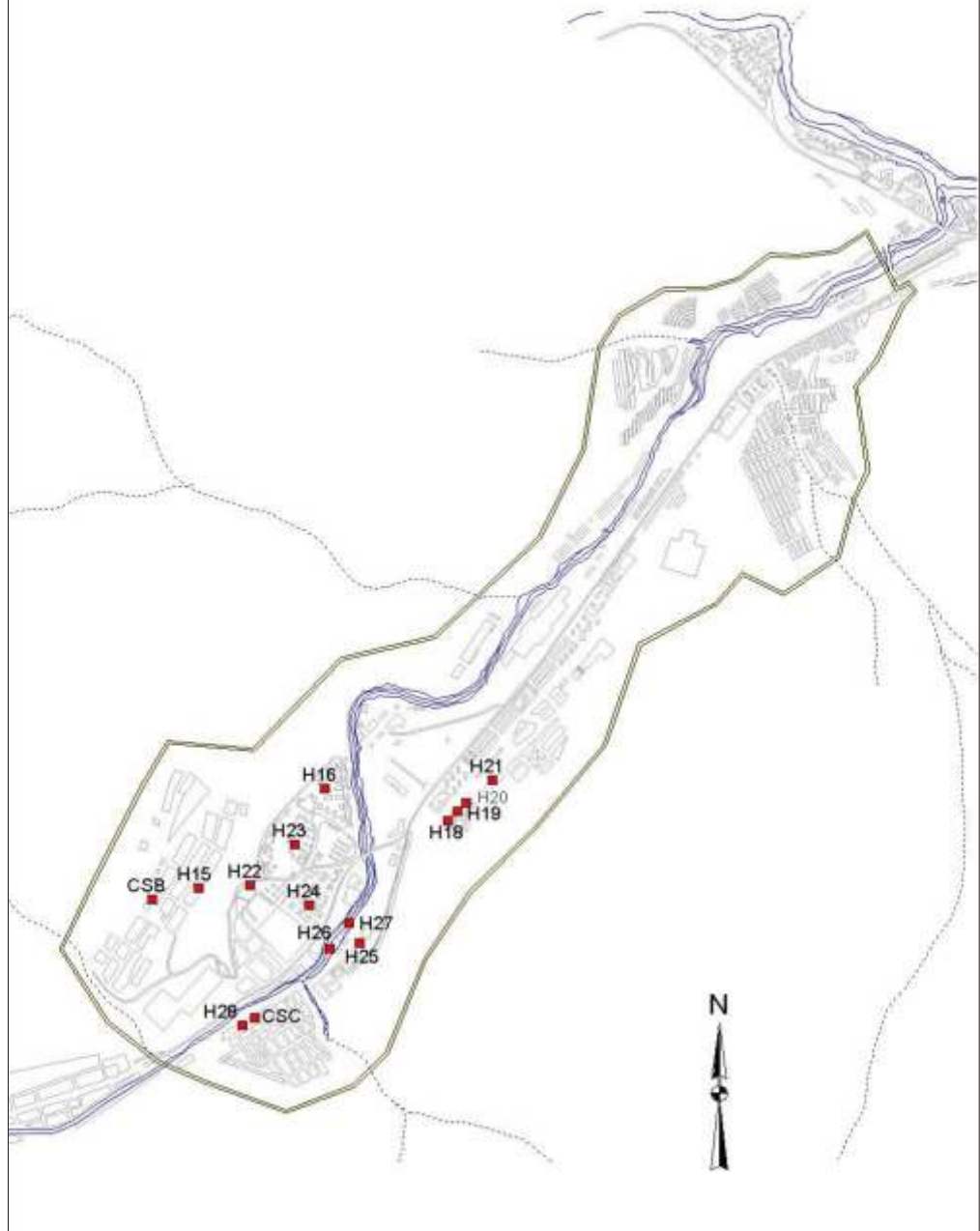
The dust wipe sampling was conducted in selected locations in each house including the bedroom, kitchen, and dining room. Samples from the exterior of some of the homes were also taken. Samples were primarily taken from floors. However, some samples were also taken from other horizontal surfaces, such as furniture, that can also contribute to occupant exposures. Most of the samples were taken from private houses, but three stores and one school in La Oroya Antigua were also tested. At each sample location, an area of one square foot (30.2cm X 30.2 cm) was wiped with a commercial dust wipe.

¹² Office of Healthy Homes and Lead Hazard Control, U.S. Department of Housing and Urban Development. February, 2001. *Testing for Lead-Contaminated Dust*. <http://www.hud.gov/offices/lead/index.cfm>.

MAP 3 - LEAD DUST WIPE SAMPLE LOCATIONS IN LA OROYA ANTIGUA



MAP 4 - LEAD DUST WIPE SAMPLE LOCATIONS IN LA OROYA NUEVA



The standard used for comparison is the U.S. EPA and HUD regulatory level indicated below. This standard indicates the maximum desired lead level in the dust deposited on floors for the purpose of a risk assessment or for clearance to reoccupy a home following lead abatement.

HUD and EPA Standard for Risk Assessments	HUD and EPA Standard for Clearance (following abatement)
Floors: 40 $\mu\text{g}/\text{ft}^2$	Floors: 40 $\mu\text{g}/\text{ft}^2$

4.4. – Laboratory Analysis

The analytical methods used by each of the laboratories are listed below:

4.4.1 - Method of Analysis in the U.S. Laboratory

Schneider Laboratories, accredited under the Environmental Lead Laboratory Accreditation Program (ELLAP), used EPA method 3050B for digestion and Atomic Absorption Spectrometry (AAS) method EPA 7420.

4.4.2 - Method of Analysis in the Peruvian Laboratory

Ecolab Laboratory, in Lima, is recognized by the Peruvian Ministry of Energy and Mines. Samples were analyzed by Atomic Absorption Spectrometry (AAS) in accordance with National Institute for Occupational Safety and Health (NIOSH) method 7105.

5 – Sample Results

This discussion is limited to samples collected on interior floor locations as no applicable standards have been published for dust lead levels on furniture or other fixtures. In addition, HUD/EPA do not apply their standards to exterior floor surfaces. However, lead contamination of such surfaces is expected to present similar health dangers when children are present in these locations.

5.1 - Dust Wipe Results (Peruvian Laboratory)

Of the 40 samples sent to Ecolab for analysis, 25 were collected from floors inside homes in the following locations:

Table 2 Summary of Interior Floor Dust Wipe Sample Results (Peruvian Laboratory)

	LA OROYA NUEVA	LA OROYA ANTIGUA	TOTAL
Total number of samples	10	15	25
Number of samples exceeding HUD/EPA standard	7	15	22
Percentage	70 %	100 %	88 %

Of these 25 samples, 22 (88%) exceeded the HUD/EPA standard. All of the samples from La Oroya Antigua were above the acceptable level and 70% of the samples from La Oroya Antigua exceeded the standard.

Table 3 shows the average, range and standard deviation of values, in $\mu\text{g}/\text{ft}^2$, for these 25 samples.

Table 3 Average, Range and Standard Deviation of Dust Wipe Sample Results (Peruvian Laboratory)

Sector	Minimum ($\mu\text{g}/\text{ft}^2$)	Maximum ($\mu\text{g}/\text{ft}^2$)	Average ($\mu\text{g}/\text{ft}^2$)	Standard Deviation
La Oroya Antigua	87.2	1040.0	356.0	242.4
La Oroya Nueva	16.4	386.0	127.0	133.8

5.2 - Dust Wipe Results (U.S. laboratory)

Of the 40 samples sent to Schneider Laboratories for analysis, 25 were collected from floors in homes with the following locations.

Table 4 Summary of Interior Floor Dust Wipe Sample Results (U.S. Laboratory)

	LA OROYA NUEVA	LA OROYA ANTIGUA	TOTAL
Total number of samples	11	14	25
Number of samples exceeding HUD/EPA standard	8	14	22
Percentage	72.7 %	100 %	88 %

Consistent with the results from Peru, 88% of the samples taken from floors were above the acceptable level. All 14 samples from La Oroya Antigua exceeded the HUD/EPA clearance level, as did 73% of the samples taken from La Oroya Nueva.

Table 5 shows the average, range and standard deviation of values, in $\mu\text{g}/\text{ft}^2$, for the 25 samples collected from floors.

Table 5 Average, Range and Standard Deviation of Dust Wipe Sample Results (U.S. Laboratory)

Sector	Minimum ($\mu\text{g}/\text{ft}^2$)	Maximum ($\mu\text{g}/\text{ft}^2$)	Average ($\mu\text{g}/\text{ft}^2$)	Standard Deviation
La Oroya Antigua	119.8	653.7	314.6	180.0
La Oroya Nueva	20.2	531.0	148.4	163.0

In addition, two samples were collected from a home in Curipata approximately 11.5 km (7 miles) from La Oroya (See Map 5). The results from dust lead levels collected on floors in Curipata are:

- 33.2 $\mu\text{g}/\text{ft}^2$ U.S. laboratory
- 31.2 $\mu\text{g}/\text{ft}^2$ Peruvian laboratory

These limited results suggest that dust lead levels in this district are generally lower than in the other areas tested.

Finally, one sample was collected from a classroom floor and one from an outdoor playground at a school in La Oroya Antigua and the results for these samples are listed below.

Table 6 Dust Wipe Samples Collected at a School (U.S. Laboratory)

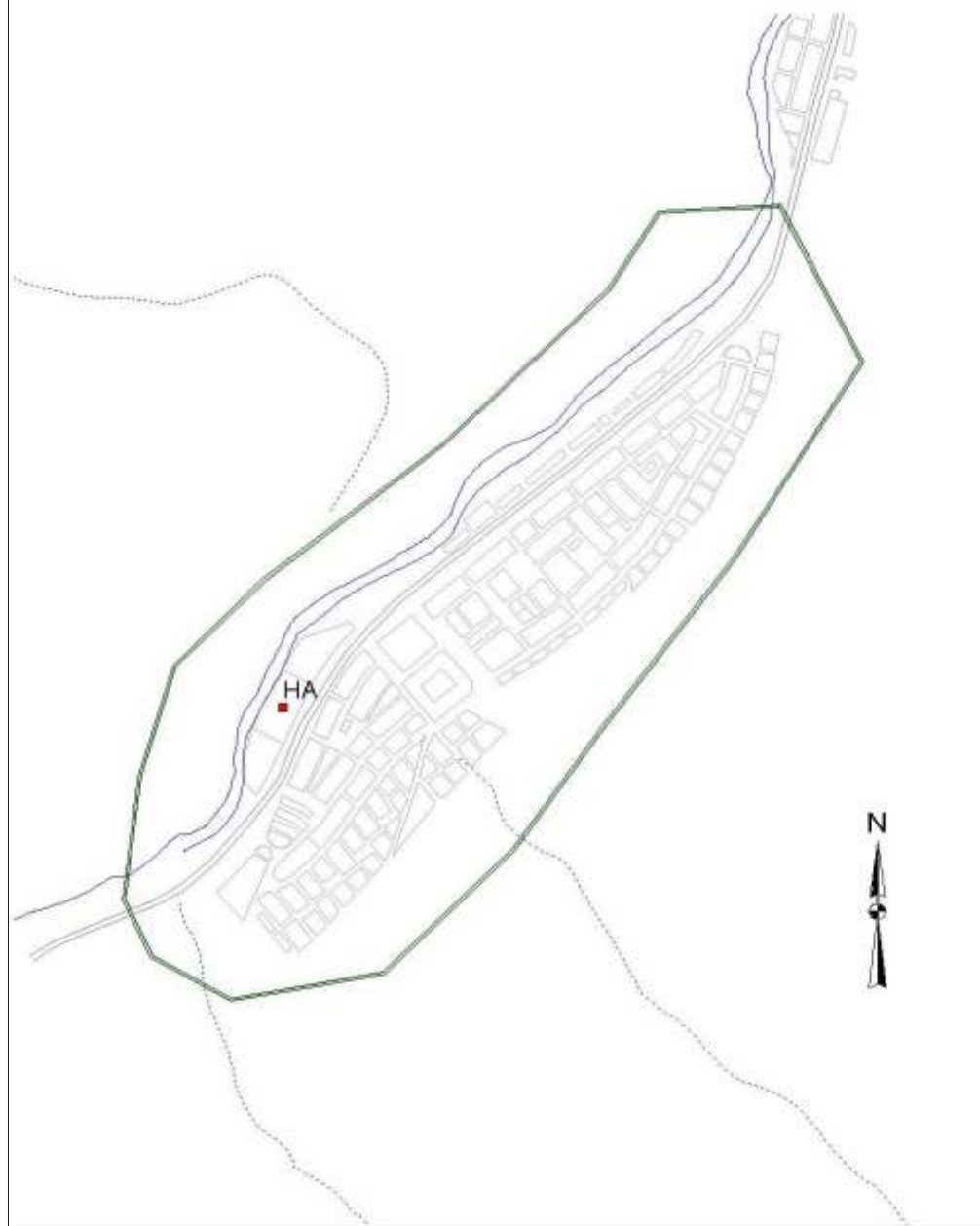
Sample Number	Structure	Room	Surface Sampled	Lead $\mu\text{g}/\text{ft}^2$
101803-6-a	School	Play Area (exterior)	Floor	1321.8
101803-6-c	School	Classroom	Table	40.4

Table 7 Dust Wipe Samples Collected at a School (Peruvian Laboratory)

Sample Number	Structure	Room	Surface Sampled	Lead $\mu\text{g}/\text{ft}^2$
(*)101803-6-b	School	Classroom	Floor	451.0
101803-6-d	School	Play Area (exterior)	Floor	1930.0

(*) Only this sample is included in the summary average above.

MAP 5 - LEAD DUST WIPE SAMPLE LOCATIONS IN CURIPATA



6. - Conclusions

This study was undertaken to measure the extent of lead contamination in representative interior locations in La Oroya. Previous studies have demonstrated the link between lead levels in dust in residential environments and children's blood lead levels. Lead in house dust is considered a major cause of lead poisoning, as young children play close to the ground and have significant hand-to-mouth contact. Exposures from other sources including airborne lead, and contaminated soil, water and food also contribute to the overall body burden of lead.

Dust lead levels within homes are known to vary considerably due to differential dust loading on surfaces. In addition, dust wipe sample collection efficiencies vary depending on the porosity and unevenness of the tested surface. As a result, we would expect large variability in dust lead levels as reported in this study. The results summarized in Tables 3 and 5 above demonstrate that there is a wide range in dust lead levels on interior floors in La Oroya.

The high percentage of samples exceeding regulatory limits reveals a significant potential for lead exposure among children residing in this environment.

The extent of dust lead contamination can be summarized as follows:

- 88 % of the samples taken from floors on the interior of the homes tested in La Oroya exceeded the HUD/EPA standard. All of the samples collected from floors on interior locations in La Oroya Antigua exceeded the HUD/EPA standard.
- Over 70% of the samples taken from floors on the interior of homes in La Oroya Nueva exceeded the HUD/EPA standard.
- The average dust lead level on interior floors in La Oroya Antigua was approximately seven times the HUD/EPA standard.
- The average dust lead levels on interior floors in La Oroya Nueva were approximately three times the HUD/EPA standard.
- The dust lead levels from floors obtained in the school tested in La Oroya Antigua exceeded the HUD/EPA standard.
- Although a direct comparison between the Peruvian and U.S. laboratories is not possible, results from both facilities are consistent in demonstrating the trends outlined above.
- This study confirms that interior dust lead levels in all areas of La Oroya greatly exceed acceptable levels and are likely to result in significant lead exposures for children occupying these structures.

7. - Recommendations

- DRP and the Peruvian authorities need to implement programs that promote the appropriate cleaning of houses and educational institutions in order to reduce lead exposures.
- DRP must implement better emission control measures and utilize more advanced technologies to minimize future sources of contamination in La Oroya
- The Peruvian government should urgently implement a program in La Oroya to protect the citizens' public health and encourage community participation in this process.
- Programs are needed to initiate on-going cleaning of schools and other childcare facilities to remove lead dust contamination.
- It is necessary to promote a dialogue between governmental authorities, DRP, citizens, and civil society with the goal of improving public health in La Oroya.

Table 8
Lead Dust Wipe Sample Results (U.S Laboratory)

<i>Sample #</i>	<i>Area of City</i>	<i>Location</i>	<i>Room</i>	<i>Component</i>	<i>Surface Type</i>	<i>Sample Area</i>	<i>Results (ug/ft²)</i>
101803-1-a	Oroya Antigua	House 1	Kitchen	Shelves	Wood	1' x 1'	1617.6
101803-2-a	Oroya Antigua	House 2	Bedroom	Floor	Wood	1' x 1'	231.6
101803-3-a	Oroya Antigua	House 3	Kitchen	Floor	Concrete	1' x 1'	653.7
101803-4-a	Oroya Antigua	House 4	Living room	Floor	Wood	1' x 1'	361.5
101803-5-a	Oroya Antigua	House 5	Living room	Floor	Wood	1' x 1'	570.7
101803-6-a	Oroya Antigua	School 1	Play area (Exterior)	Floor	Concrete	1' x 1'	1321.8
101803-6-c	Oroya Antigua	School 1	Classroom	Table	Wood	1' x 1'	40.4
101803-7-a	Oroya Antigua	House 6	Bedroom	Floor	Wood	1' x 1'	282.1
101803-8-a	Oroya Antigua	House 7	Dining room	Floor	Wood	1' x 1'	206.3
101803-9-a	Oroya Antigua	House 8	Dining room	Floor	Cement	1' x 1'	372.3
101803-10-a	Oroya Antigua	House 9	Dining room	Table	Acrylic Tile	1' x 1'	65.6
101803-11-a	Oroya Antigua	House 10	Bedroom	Floor	Wood	1' x 1'	134.2
101803-12-a	Oroya Antigua	House 11	Living room	Floor	Wood	1' x 1'	188.3
101803-13-a	Oroya Antigua	House 12	All*	Shelves	Plaster	1' x 1'	159.4
101803-14-a	Oroya Antigua	House 13	Bedroom	Floor	Wood	1' x 1'	285.7
101803-15-a	Oroya Antigua	House 14	Kitchen	Floor	Wood	1' x 1'	119.8
101803-16-a	Oroya Antigua	Corner store A	N/A	Floor	Wood	1' x 1'	473.3
101803-17-a	Oroya Nueva	House 15	Living room	Floor	Cement	1' x 1'	325.4
101803-18-a	Oroya Nueva	Corner store B	N/A	Floor	Cement	1' x 1'	83.7
101803-19-a	Oroya Nueva	House 16	Living room	Floor	Acrylic Tile	1' x 1'	22.3
101903-1-a	Curipata	House A	Play area (Interior)	Floor	Cement	1' x 1'	33.2
101903-2-a	Oroya Nueva	House 17	Play area (Interior)	Floor	Wood	1' x 1'	531.0
101903-3-a	Oroya Nueva	House 18	All*	Floor	Cement	1' x 1'	40.4
101903-4-a	Oroya Nueva	House 19	Living room	Floor	Wood	1' x 1'	20.2
101903-5-a	Oroya Nueva	House 20	Bedroom	Shelves	Wood	1' x 1'	372.3
101903-6-a	Oroya Nueva	House 21	Living room	Floor	Concrete	1' x 1'	62.0
101903-7-a	Oroya Nueva	House 22	All*	Floor	Wood	1' x 1'	72.9
101903-8-a	Oroya Nueva	House 23	Living room	Floor	Acrylic Tile	1' x 1'	22.3
101903-9-a	Oroya Nueva	House 24	All*	Shelves	Plastic	1' x 1'	36.8
101903-10-a	Oroya Nueva	House 25	Living room	Shelves	Plastic	1' x 1'	256.8
101903-11-a	Oroya Nueva	House 26	All*	Floor	Concrete	1' x 1'	101.7
101903-12-a	Oroya Nueva	House 27	All*	Floor	Wood	1' x 1'	177.5
101903-13-a	Oroya Nueva	House 28	Play area (Interior)	Floor	Concrete	1' x 1'	256.8
101903-14-a	Oroya Nueva	Corner store C	N/A	Shelves	Glass	1' x 1'	852.1
101903-15-a	Oroya Antigua	House 29	All*	Shelves	Plastic	1' x 1'	852.1
101903-16-a	Oroya Antigua	House 30	Bedroom	Floor	Wood	1' x 1'	614.0
101903-17-a	Oroya Nueva	House 31	Living room	Floor	Wood	1' x 1'	256.8
101903-18-a	Oroya Antigua	House 32	Living room	Shelves	Wood	1' x 1'	426.4
101903-19-a	Oroya Antigua	House 33	All*	Shelves	Wood	1' x 1'	538.2
101903-20-a	Oroya Antigua	House 34	Bedroom	Floor	Wood	1' x 1'	127.0
110403-1-a	N/A	N/A	N/A	Blank	N/A	N/A	<2.0

* All indicates that the house has a single room used for the bedroom, kitchen and living room

Table 9
Lead Dust Wipe Sample Results (Peruvian Laboratory)

<i>Sample #</i>	<i>Area of City</i>	<i>Location</i>	<i>Room</i>	<i>Component</i>	<i>Surface Type</i>	<i>Sample Area</i>	<i>Results (ug/f²)</i>
101803-1-b	Oroya Antigua	House 1	Living room	Floor	Cement	1' x 1'	164.0
101803-2-b	Oroya Antigua	House 2	Bedroom	Floor	Wood	1' x 1'	318.0
101803-3-b	Oroya Antigua	House 3	Bedroom	Floor	Wood	1' x 1'	364.0
101803-4-b	Oroya Antigua	House 4	Kitchen	Floor	Wood	1' x 1'	666.0
101803-5-b	Oroya Antigua	House 5	Living room	Floor	Wood	1' x 1'	479.0
101803-6-b	Oroya Antigua	School 1	Classroom	Floor	Acrylic Tile	1' x 1'	451.0
101803-6-d	Oroya Antigua	School 1	Play area (Exterior)	Floor	Concrete	1' x 1'	1930.0
101803-7-b	Oroya Antigua	House 6	Kitchen	Floor	Wood	1' x 1'	233.0
101803-8-b	Oroya Antigua	House 7	Bedroom	Table	Wood	1' x 1'	160.0
101803-9-b	Oroya Antigua	House 8	Bedroom	Floor	Wood	1' x 1'	87.2
101803-10-b	Oroya Antigua	House 9	Bedroom	Floor	Cement	1' x 1'	314.0
101803-11-b	Oroya Antigua	House 10	Play area (Exterior)	Floor	Cement	1' x 1'	8120.0
101803-12-b	Oroya Antigua	House 11	Bedroom	Floor	Wood	1' x 1'	280.0
101803-13-b	Oroya Antigua	House 12	All*	Floor	Wood	1' x 1'	123.0
101803-14-b	Oroya Antigua	House 13	Kitchen	Floor	Concrete	1' x 1'	1040.0
101803-15-b	Oroya Antigua	House 14	Living room	Shelves	Wood	1' x 1'	51.3
101803-16-b	Oroya Antigua	Corner store A	N/A	Shelf	Metal	1' x 1'	1150.0
101803-17-b	Oroya Nueva	House 15	Living room	Floor	Cement	1' x 1'	316.0
101803-18-b	Oroya Nueva	Corner store B	N/A	Floor	Cement	1' x 1'	106.0
101803-19-b	Oroya Nueva	House 16	Living room	Floor	Acrylic Tile	1' x 1'	26.8
101903-1-b	Curipata	House A	Bedroom	Floor	Wood	1' x 1'	31.2
101903-2-b	Oroya Nueva	House 17	Living room	Floor	Cement	1' x 1'	100.0
101903-3-b	Oroya Nueva	House 18	All*	Floor	Wood	1' x 1'	38.8
101903-4-b	Oroya Nueva	House 19	Bedroom	Floor	Wood	1' x 1'	16.4
101903-5-b	Oroya Nueva	House 20	Living room	Floor	Wood	1' x 1'	386.0
101903-6-b	Oroya Nueva	House 21	Living room	Floor	Concrete	1' x 1'	68.8
101903-7-b	Oroya Nueva	House 22	All*	Shelf	Wood	1' x 1'	15.2
101903-8-b	Oroya Nueva	House 23	Bedroom	Floor	Acrylic Tile	1' x 1'	44.2
101903-9-b	Oroya Nueva	House 24	All*	Shelves	Concrete	1' x 1'	103.0
101903-10-b	Oroya Nueva	House 25	Living room	Shelves	Plastic	1' x 1'	134.0
101903-11-b	Oroya Nueva	House 26	All*	Floor	Plastic	1' x 1'	229.0
101903-12-b	Oroya Nueva	House 27	All*	Shelf	Concrete	1' x 1'	94.0
101903-13-b	Oroya Nueva	House 28	Bedroom	Floor	Wood	1' x 1'	44.1
101903-14-b	Oroya Nueva	Corner store C	Bedroom	Shelves	Concrete	1' x 1'	83.0
101903-15-b	Oroya Antigua	House 29	All*	Floor	Glass	1' x 1'	251.0
101903-16-b	Oroya Antigua	House 30	Bedroom	Floor	Acrylic Tile	1' x 1'	400.0
101903-17-b	Oroya Nueva	House 31	Kitchen	Floor	Wood	1' x 1'	171.0
101903-18-b	Oroya Antigua	House 32	All*	Shelves	Wood	1' x 1'	551.0
101903-19-b	Oroya Antigua	House 33	All*	Shelves	Wood	1' x 1'	531.0
101903-20-b	Oroya Antigua	House 34	Bedroom	Floor	Wood	1' x 1'	159.0
110403-1-b	N/A	N/A	Blank	N/A	N/A	N/A	<2.0

* All indicates that the house has a single room used for the bedroom, kitchen and living room

Figure 1: Distribution of Dust Lead Level Results in La Oroya Antigua

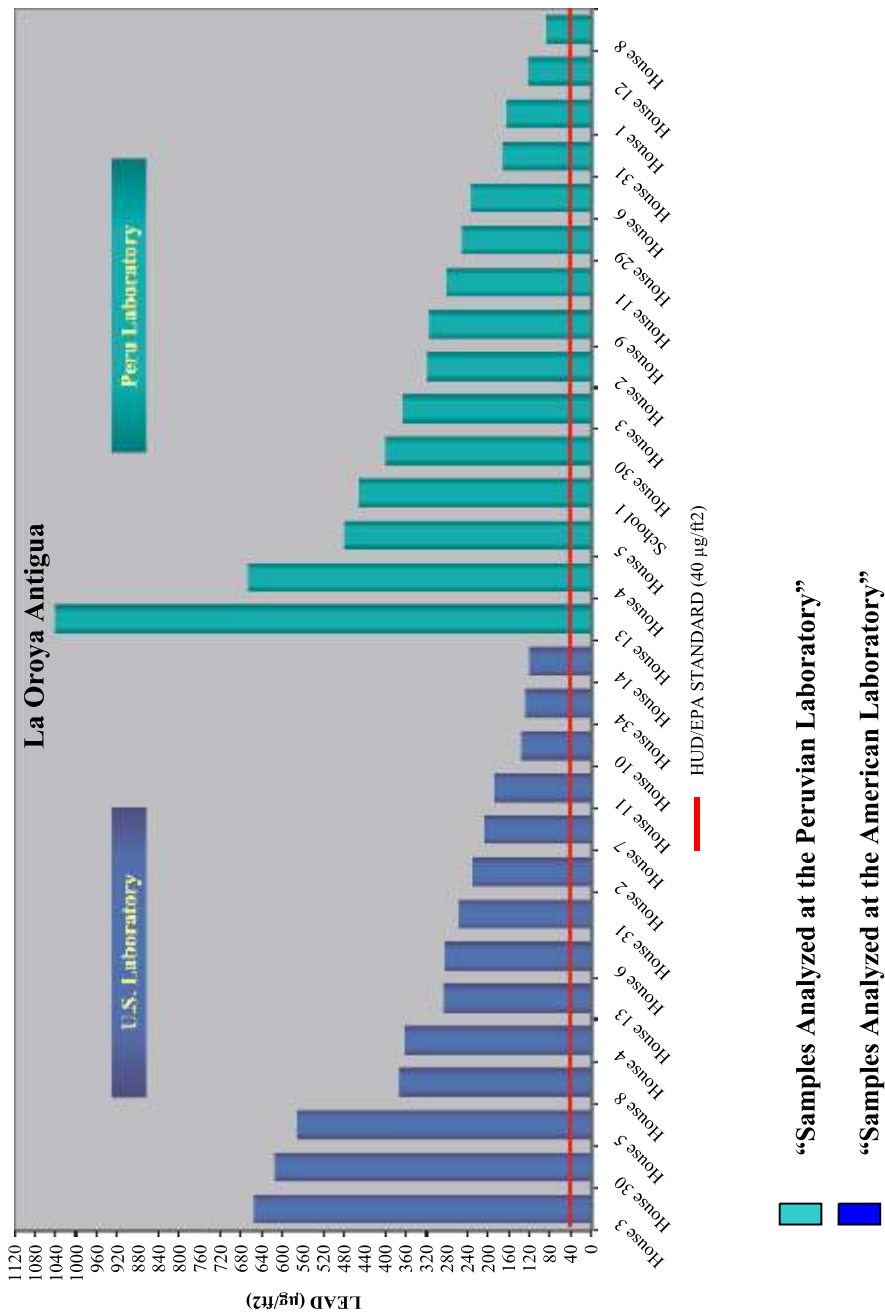
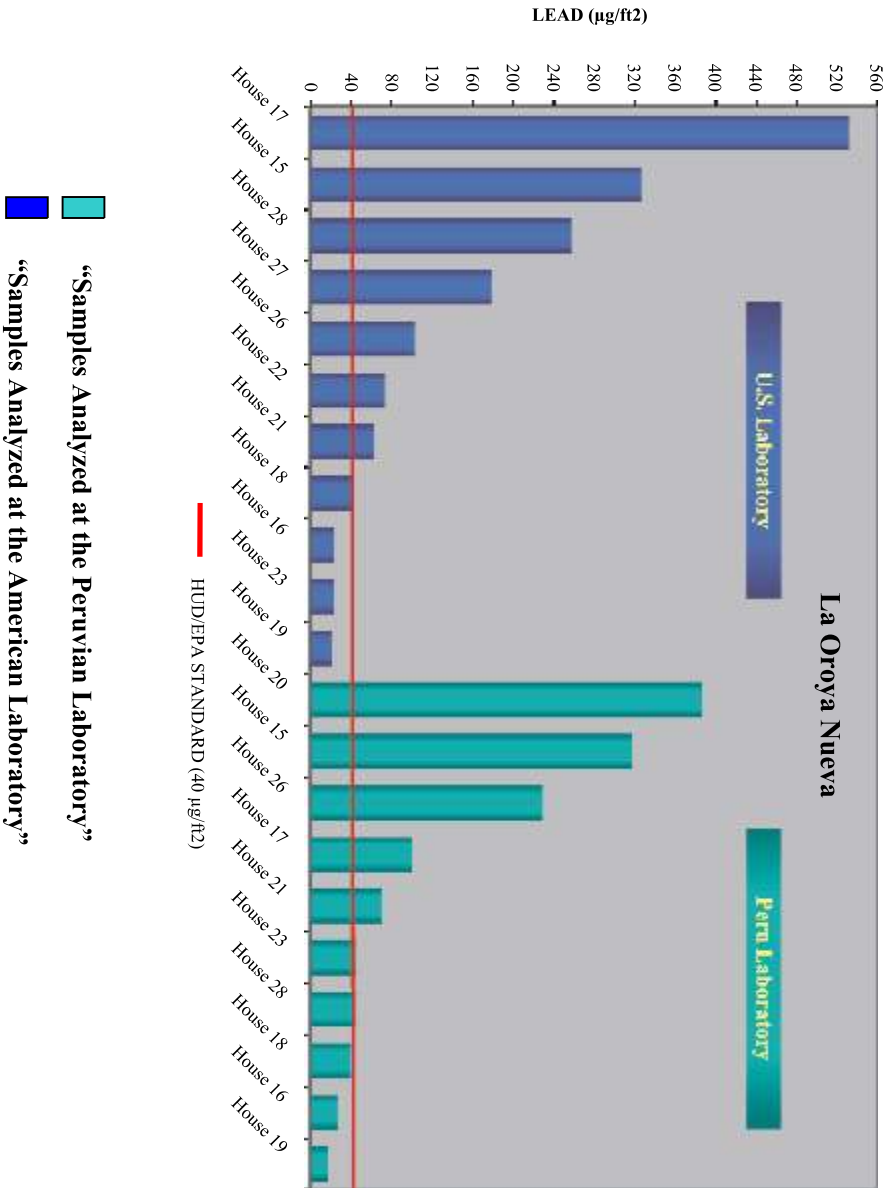


Figure 2: Distribution of Dust Lead Level Results in La Oroya Nueva



Appendix: Dust Wipe Sampling Procedures

- Sample locations were selected as indicated above. Each sample area was outlined using a template or tape. Efforts were made not to touch or disturb the area inside the template or tape.
- Information collected from owner of the house included: name, address, how many persons living in the house, number of adults and children, and Global Positioning System (GPS) information was recorded.
- Sample tubes were placed near the anticipated sample. Before sampling, the tubes were labeled with a unique identification number which was also recorded on the sample collection form.
- A new pair of gloves was used before collecting each sample.
- To wipe the sample area, Ghost Wipes meeting ASTM E 1792 standards were used. The wipe was passed over the entire area inside the template or tape. The wipe was moved over the surface with an “S” like motion as need to wipe the entire sample area, while moving from side to side. The wipe was then folded in half, keeping the dirty side in, before repeating the “S” motions. The finished wipes were then folded and placed in the tube or sampling container.
- The sample location and area were noted along with all other data collected.
- After each sample was collected the sampling equipment, including the template was cleaned.