Final Report:
Assessment of Cumulative Lead Exposure in Los Angeles Children

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1. Executive Summary

Lead is a potent neurotoxin that can interfere with brain development to cause lower IQ, hearing loss, underperformance in school, damage to the brain, nervous system, kidneys, anemia, and a myriad of other related complications. This danger is compounded in children, especially those under the age of 5, who are in a critical window of brain development and physical growth. Despite the scientific and governmental consensus of the harms of lead, lackluster enforcement of lead testing and remediation efforts have resulted in an estimated existing 1.2 million children in the US with elevated blood lead levels and half of them are undiagnosed or untreated, according to the Public Health Institute.

In collaboration with Early Head Start and Allies for Every Child, we aim to identify risk factors for lead exposure in Los Angeles and perform home risk assessments. This was achieved through self-collected home samples of dust, water, and foom from 5 families enrolled in EHS/Allies programs. Soil samples at participant homes and secondary sampling of nearby and attended parks were collected by team members. Risk factors were determined from existing census and mapping data.

Our findings reveal the extent of certain risk factors for exposure and implications of family survey responses. From historical travel way data and census data, our risk index show that the biggest determinants in our criteria are living in census blocks where more housing stock is aged before 1950, within 150 m of a freeway, within 500 m of an airfield, within 100 m of a railway, with the Exide exclusion zone, having population that is over half Black or Latinx, and having a greater proportion of residents in poverty than the LA County average. 8 of the 24 parks sampled had soil lead levels above the actionable EPA Threshold of 80 ppm, all of which are within 2 miles of a major road. Surveys from 5 family participants report that most of their children frequent parks and that most drink bottled water, confirming parks soil as a potential exposure route and suggesting common distrust in the integrity of water sources.reveal that the extent of certain risk factors for exposure and implications of family survey responses. From historical travel way data and census data, our additive and unwighted risk index show that the biggest determinors in our criteria are living in census blocks where more housing stock is aged before 1950, within 150 m of a freeway, within 500 m of an airfield, within 100 m of a railway, with the Exide exclusion zone, having population that is over half Black or LatinX, and having a greater proportion of residents in poverty than the LA County average. 8 of the 24 parks sampled had soil lead levels above the actionable EPA Threshold of 80 ppm, all of which are within 2 miles of a major road. Surveys from 5 family participants report that most of theor children frequent parks and that most drink bottled water, confirming parks soil as a potential exposure route and suggesting common distrust in the integrity of water sources.

2. Introduction

Lead continues to endanger the health and wellbeing of communities across the greater Los Angeles area. Our 2020-21 Senior Practicum Team will be partnering with Allies for Every Child and Early Head Start to conduct research that characterizes the extent and severity of lead contamination in Los Angeles and create a framework for the equitable remediation of lead hazards across the city. Early childhood centers and programs such as Allies for Every Child and Early Head Start, respectively, are important in efforts to mitigate child lead exposure. Allies for Every Child provides child development and family support services to pregnant people and children from birth to the age of three. We will work with parents and children enrolled in their programs to ensure that our prevention plan is robust and informed by the voices of people who are directly impacted by lead contamination.

50 years have passed since the enactment of critical federal and state legislation aimed to prevent the gradual ingestion and inhalation of lead from media such as air, water, biota, and soil; yet in 2017, elevated blood lead levels (BLLs) still affected over 500,000 children in the United States. The Center for Disease Control and Prevention (CDC) defines elevated BLLs or lead poisoning at BLLs exceeding 4.99 ug/dL. However, scientific literature emphasizes that there is no safe level of lead contamination since cognitive deficits associated with blood lead concentrations can occur below 5ug/dL. Regulatory intervention from the Environmental Protection Agency (EPA) starting in 1970 showcased early efforts to reduce incidences of lead poisoning. Although heavy opposition from industries delayed these efforts, the complete phase-out of leaded gasoline in commercial uses was achieved via an amendment to the Clean Air Act in 1996. Lead air quality standards were then tightened by revisions to the National Ambient Air Quality Standards in 2008 which brought down the pollution level from 1.5 to 0.15 ug/m^3. The implications of such amendments reduced national lead air levels by 97.7%, decreased BLLs and increased the IQ in children by an average of 5 points across the country (Grandijean, 2015.)

Although the phasing out of leaded gasoline marked an environmental and public health triumph, other sources of lead exposure in parks, schools, and residential areas remain a public health threat in the greater Los Angeles area. Efforts concerning lead prevention fall short due to the lack of enforcement power of the regulatory state and the financial costs associated with meeting standards. Modern environmental tragedies such as the 2014 Flint Water Crisis not only demonstrated the serious health effects of lead contamination in children; kidney troubles, low IQ, and poor cardiovascular health but also revealed a breach of the regulatory system that was created to protect vulnerable populations from lead exposure. Moreover, the tragedy caused uproar as a meta-analysis revealed that most communities affected by hazardous lead waste were low socioeconomic communities of color (Johnston & Hircko, 2017). Given the imminent risks posed by lead contamination, eliminating lead hazards remains the most effective way to reduce the risk of lead exposure. Our goal is to provide adequate technologies and widespread support for remediation efforts through our multimedia lead exposure assessment. Ultimately, we aim to promote the protection and health of vulnerable community members who are disproportionately exposed to lead in Los Angeles.

3. Methodology

3.1. Overall Study Design

Potential risk factors were assessed from lead levels in household and public samples of media. Primary household data consists of participant self-collected samples of dust, water, food and soil, as well as a survey of demographic information including race, ethnicity, education level and occupation of parents, and age and schools/parks attended by children. Secondary multimedia assessment includes soil from local parks near participant families.

3.2. Field sampling and site selection

The lead exposure index study area encompasses the entirety of Los Angeles County. Los Angeles county covers a land area of 10,500 square kilometers and has a population of just over 10 million people.

The Practicum team measured levels of lead through dust, water, food, and soil assessments among 5 participating homes and a total of 24 local parks in an 119 sq mi radius found among Inglewood, Lennox, Hawthorne, Culver City, Boyle Heights and East Los Angeles.The Parks average size was 200,000-4,000 sq mi. The selection of the parks were based on their proximity to the homes of research participants, in addition to survey responses stating parks regularly visited by participating families.

Five recruited families were from Inglewood, Boyle Heights, and Brentwood. Media assessment kits were assembled among the practicum team and sent to the participating homes for self-collection. In the assembled kits, families were provided all required materials which are shown **Appendix 1**. along with instructions that are to be followed visually or manually. A practicum team member had completed a collection once triplicate soil assessments were collected and all water, dust, and food samples were back in the lab.

3.3. GIS Data sources

Data on race and ethnicity, housing stock age, and poverty level at the census block group level were downloaded from the results of the United States Census Bureau 2019 American Community Survey 5-year estimates. Shapefiles of Los Angeles census block groups, highways, and airports were downloaded from the Los Angeles County GeoHub. KML files with the locations of past and present railroads were downloaded from an anonymous Google My Maps user, then verified by comparison to detailed archival railroad maps provided by Jared Nigro and the Los Angeles Railroad Heritage Foundation. Water data was provided by EdSource, and updated for public schools in Inglewood using Wayne Hung graciously provided sampling data from a 2018 analysis of bioavailable lead in soil at 100 parks in the Los Angeles area.

3.4. Lead Exposure Index Score Criteria

Census Block groups could receive points on the lead exposure risk index by meeting a number of different environmental criteria based on housing stock age, freeway, railroad, and airport proximity, and proximity to the contamination created by Exide technologies. Our Exposure Risk Index also takes into account demographic factors associated with lead exposure, including % Black residents, % Hispanic or Latino residents, and poverty level.

Housing

Research conducted by Graff in 2013 and Sutton et al. in 1995 determined that homes built before 1950 were highly likely to contain lead paint, while it was less commonly found in homes built before 1978. Data on housing stock age was collected from the 2019 American Community Survey Census. As a result, Census block groups with >50% housing stock built before 1950 were given a point, and those with >50% housing stock built before 1978 were also given a point. Homes built after the phase out of lead-based paint in 1978 were not considered a risk of lead contamination. Parcels with effective year “0000” or “n/a” or “null” were excluded from the data set.

Freeways

Results from numerous studies in Los Angeles associate lead levels in various media with proximity to high traffic regions (Wu et al., 2010; Lejano & Ericson, 2005). Data on vehicle traffic for Los Angeles County as a whole is not publicly available, so freeway proximity was used as a proxy for all heavily trafficked thoroughfares. The highest concentrations of lead are commonly found within 150m of roadways, with soil lead concentrations decaying to ambient levels within a range of 500-750m (Mielke et al., 2010; Wu et al., 2010). Census block groups 0-150m and >150m - 500m were each awarded a point to represent the increased likelihood of soil contamination.

Airports

Leaded gasoline known as 100LL is still used to fuel piston-driven aircraft, which are commonly found at smaller general aviation (GA) airports. Proximity to GA airports where planes utilize 100LL has been associated with 2-4% increase in childhood blood lead levels (Miranda et al., 2011). Airport runway boundary shapefiles were retrieved from LA County Geohub and buffers of distance 500m and 1000m were created surrounding all ten airports in Los Angeles County. 1 point was assigned to census block groups within 1000m of a GA airfield and an additional point was assigned to census block groups <500m from the runway edge. The impact of prevailing wind patterns on lead deposition was not accounted for.

Railroads

Proximity to historical railroads is associated with elevated concentrations of lead in soil, but few studies conducted in Southern California have explored the relationship between railway proximity and soil or blood lead concentration (Ma et al., 2009). Census block groups within a 500m “warning zone” for soil lead were given 1 point, while block groups within the 100m “slight pollution zone” near historical railways were given 1 additional point.

Exide Technologies

Contamination from the Exide Technologies battery recycling facility in Vernon is the largest and most well-known example of an environmental lead hazard in Los Angeles County. Decades of neglect from government regulators and industry resulted in deposition of massive amounts of lead in neighborhoods that are almost entirely Hispanic or Latino. Census block groups within the 1.7 mile (2636 m) exclusion zone were given 1 point on the risk index. The impact of prevailing wind patterns on lead deposition was not taken into account.

Race and Ethnicity

Wu et al., 2010 found that census block groups with >50% Black or >50% Hispanic or Latino residents were associated with increases in bioavailable soil lead. Our risk index assigned a score of 1 point to residents in census tracts that are >50% Black and 1 point to residents in census tracts that are >50% Latino.

Poverty

Lead levels in Los Angeles County have not been strongly associated with poverty status, when variables like race or housing stock age are taken into consideration. Despite this, our exposure risk index gave a point to census block groups in which the poverty rate was above the 14% average for Los Angeles county. This was done in an effort to account for the fact that people living in poverty are less likely to have the funds necessary to encapsulate or remediate potential lead hazards.

3.5. Research Participant Recruitment

In Los Angeles, five families with children aged between 2-10 years old volunteered to participate in the survey and sample collection for the study. Participants were recruited through their enrollment in Los Angeles Early Head Start program

3.5.1. Soil

Soil assessments were taken at 23 local parks and 5 participating homes. The park sampling information regarding park names, location address, recent park renovations, proximity to major freeways and roads, and park size is found in **Appendix 2**. Parks were selected by geographic proximity to participants' homes. Sampling sites were drawn near areas based on notable children play locations, minimum canopy, and frequent access by children (Hung, 2018). These locations are increasingly susceptible to lead contamination and increase hotspots for child lead consumption.

Soil samples were obtained by single use plastic spoons and quarter ounce sandwich bags (King, 2007). The spoons were to remove disturbed topsoils that included rocks, leaves, and roots. Soil was removed up to 2 inch, for risk management and remedial decision-making during analysis (King, 2007). For parks, triplicate samples were taken in a $1/2m^2$-5 m^2 area, near areas close to children play spaces and no canopy cover. In each sample, even size homogenous soil spoonfuls were drawn from the land and placed in half ounce sandwich bags. Spoons and gloves were replaced at each sample. This process was then repeated in triplicates.

3.5.2. Water

Water assessments were collected from local parks and participating residential homes. Residential water sampling was drawn from faucets that remained motionless for at least six hours (New England States, 2015). The location of the samples were drawn from areas that do not have "water softeners" or "other treatment devices", only exception of devices are aerators (New England States, 2015). One liter cold water samples were drawn at each residential home twice. The sample bottles held the location of the sample and the time/date. The inclusion of "water softener" or "other treatment device" and "any plumbing repairs that have been done in this home since the previous sampling event", was also included in the supplementary testing document provided to the participants, so further quantification can be done at the lab (New England States, 2015).

Local Park water samples were drawn from faucets that were accessible to the population. One liter water samples were drawn and labeled, two samples were drawn from one location. Significant errors may have occurred due to insufficient timing of accessibility to the faucets and the water sampling was limited to three parks in, Lennox, Eucalyptus,and Rogers Park.Thus, the practicum team will use this data as supplementary when providing the results.

3.5.3. Dust

Dust assessments were collected from 5 participating homes in areas that are accessible to children's consumption or play that underwent minimal dusting. Two samples were taken from each home, one from the windowsill and a control. Following EPA's Lead Dust Sampling Technician Field Guide, participants were asked to place the 2"X8" template on the windowsill, by taping it to the windowsill.With gloves, a sample was drawn with a wipe inside the rectangle template that is placed on the windowsill from left to right. We then had them fold the wipe in ½ and wipe up and down, ending at your initial starting point. Then fold the wipe in half again with the dust sample enclosed. The dust wipe was then secured and labeled in the test tube. Participants noted the measurement of the tested area to the supplementary testing document provided to the participants, so further quantification can be done at the lab (EPA, 2021). In addition to the one sampling location, a control is necessary by opening and shaking the third dusting wipe provided in your testing kit. Participants also noted the location of the window in the home and the type of flooring, for categorization purposes.

3.5.4. Food

Food assessments were conducted according to Michigan Department of Agriculture and Rural Development (MDARD) and Michigan Department of Health and Human Services (MDHHS) procedures. Food sampling was taken from solids and liquids into ⅔ quarter size ziploc bags and single use 4 oz containers (MDHHS, 2020). The foods were preferred to be prepared food for the participating child. Samples were collected in a 24 hour period to ensure food did not perish. In addition to the sampling, a supplementary food journal consisted of questions pertaining to favorite foods of the child and the quantity per serving, time frame, and duration of eating the food.

3.6. Quantification

3.6.1. Soil preparation and assessment

Following oven drying of topsoil at 100 ℃ and removal of extraneous material from collected samples, the soil was compacted into XRF sample cups and sealed with XRF thin film. A blank was run each work day to ensure accuracy of subsequent readings. Each sample cup was read three times and the average was recorded as the final concentration of that sample.

3.6.2. GFAAS procedure/sample preparation

3.6.2.1. Food

Food samples were pretreated with fast digestion technique (Liu, 2018) then assessed with GFAAS. Each sample weighed 1 gram food amounts that were transferred to 50 mL polypropylene tubes. Each tube received 2 mL of concentrated trace metal grade HNO_3, then was digested by heating at 98 ℃ for 45 minutes to 1 hour in a 1000 mL beaker filled with 200 mL of distilled water on top if a hot plate. The digested samples were then diluted with MilliQwater up to 25 mL. A GFAAS calibration curve was run each work day to ensure accuracy of subsequent readings. Each tube was read three times and the average was recorded as the final concentration of that sample. Participants also completed a Food questionnaire to use as supporting data to quantify. Food lead levels, data is shown in (**Table 1-3**).

Table 1: Supplementary Food Assessment Questionnaire

	Top Favorite Snacks and Brands	Breakfast (Food or Drink, Estimated Amount, Was this food collected?, What is the container Number?)
Family 1	Goldfish, Annies organic S-ck Mix, Chobannis Drinkable yogurt, Woosa yogurt, Furit all kinds	beans and eggs (1/4 cup), bread (1 slice)
Family 2	cheese-its, gogurt, lil critters vitamins, baby carrots	cereal (lucky charms chocolate (2spoons), milk, Do-nimals yogurt
Family 3	Dole banana, peanut butter sandwich, chicken with vegetables and rice, green apples, beans	Banana, pan de barra
Family 4	-	Oatmeal, slice of toast bread with butter, apple juice(?)
Family 5	Goldfish, Cheese-it	Bread, Small Piece, YES, Solid Food #2

Table 2: Continued Supplementary Food Assessment Questionnaire

	Lunch (Food or Drink, Estimated Amount, Was this food collected?, What is the container Number?)	Dinner (Food or Drink, Estimated Amount, Was this food collected?, What is the container Number?)
Family 1	bacon(2slices) Bread (1 slice)spinch (5leaves)	Chicken soup (1 tbsp), tortilla-corn(1 tbsp)
Family 2	guerrero tostadas, spaguetti (few strings, sour cream (some for dinner), tostilos chips	air fried chicken (6 pieces) , rice soup, mexican sour cream (table spoon)
Family 3	Chicken	Beans
Family 4	Annie's mac and cheese, White steamed rice, Tyson: Chicken nuggets, Red delicious Apples - slices, Danimals Yogurt Strawberry Smoothie	Bean tostada, tomato soup, Fairlife lactose free 2% milk, water
Family 5	BLANK	Mac & Cheese, small container, yes, #1

Table 3: Continued Supplementary Food Assessment Questionnaire

	Snack or Other (Food or Drink, Estimated Amount, Was this food collected?, What is the container Number?)	Are any of your food samples perishable?
Family 1	pineapple (1/4 cup) spinch(1/4 cup)	[X] Yes [ ] No
Family 2	baby snacks "puffs" (apple & broccoli puffs 13)strawberrys, lil critters vitamins (3)baby food "apples"	[ ] Yes [ ] No
Family 3	Green apple	[ ] Yes [ ] No
Family 4	Gold fish crackers	[x] Yes [ ] No
Family 5	Papaya, 1 small piece, yes, solid food #1	[X] Yes [ ] No

3.6.2.2. Dust

Dust samples were pretreated with acid digestion (EPA, 1996) then assessed with GFAAS. Each dust wipe weighed approximately 1 gram dry and was transferred to a 250 mL polypropylene tube. Each tube received 10 mL of 1:1 HNO_3, then was digested by heating at 95 °C for 10 to 15 minutes a 1000 mL beaker filled with 200 mL of distilled water on top if a hot plate. The tube was cooled, had 5 mL of concentrated trace metal grade HNO_3, and heated for an additional 30 minutes. This step of cooling, addition of concentrated HNO_3, and heating was repeated until all oxidation by HNO_3 was completed, indicated by the cessation of brown fumes. The solution was evaporated to 5 mL by heating at 95 °C for 2 hours. 2 mL of MilliQ water and 3 mL 30% H_2O_2 was added to the reduced and cooled solution. It was returned to heat and allowed to cool when effervescence subsided. Cycles of heating, addition of 1 mL of 30% H_2O_2, and cooling was repeated until there was little effervescence or change in solution appearance. No more than a total of 10 mL 30% H_2O_2 was added. The solution was evaporated to 5 mL by heating at 95 °C for 2 hours. It was then allowed to cool and was diluted to 100 mL with MilliQ water. Particulates were removed through centrifugation for 10 minutes prior to GFAAS assessment. Participants also completed a dust questionnaire to use as supporting data to quantify dust lead levels, data is shown in (**Table 4**).

Table 4: Supplementary Dust Assessment Questionnaire

	Dimensions of Window	Window Location	Does your home have carpet?
Family 1	2X8	neighbors home	no
Family 2	-	-	-
Family 3	32 x 36	backyard	no
Family 4	35 x 47 in	driveway, westside of home	yes
Family 5	4 inches x 4 inches	street	yes

3.6.2.3. Water

Water samples were acid preserved by transferring 50 mL of water to a 50 mL polypropylene tube and addition of 1.15 1:1 HNO_3. Acid preserved waters then underwent GFAAS assessment. A calibration curve was run daily. Participants also completed a water questionnaire to use as supporting data to quantify water lead levels, data is shown in (**Table 5**).

Table 5: Supplementary Water Assessment Questionnaire

	Collection Location	Water treatment device	Additional Home repairs, replacements, lead testing prior
Family 1	Kitchen Faucet	-	plumbing repair
Family 2	Bathroom Faucet	-	replaced bathroom faucet
Family 3	Kitchen Faucet	-	new kitchen faucet and sink, lead test at home prior
Family 4	Kitchen Faucet	-	-
Family 5	Kitchen Faucet	-	-

3.6.3. Community surveys

Community Surveys were collected from recruited families to asset lead exposure pathways in participating children's day to day activities. The community surveys pertained to demographic questions including age,race, and education. Additionally,the community surveys included space to answer the number of visits to local parks and school locations. Guardians were asked to complete demographic information about occupation, education, and zip code, and water sources in the home,seen in (**Table 7**). Additionally,the community surveys included space to answer about the type of water used and the filtration of the water, seen in Table 5. For analysis and confidentiality, we provided each of the six families with labels, from Family 1 to Family 5. These provisions allowed the team to preliminarily quantify lead exposure pathways among the participating family. Survey results are found in (**Table 8-9**).

Table 7: Summary of Participating Children's Education and Park Visits

	Child	Age	Attending School	Virtual Class Currently	Attend class in person weeks	Local Parks visited	How often do you visit the parks?(weeks)	How long do you visit the parks?(hrs)
Family 1	1	11 months	-	-	-	-	-	-
Family 1	2	5 years	Worthington Elementary	yes	-	Holly Park and Center Park and Darby Park and Helen Keller Park	weekly	2hrs
Family 2	1	4 years	-	-	-	Centinela park	weekly	-
Family 2	2	17 months	-	-	-	-	-	-
Family 3	1	4 years	Teach for America	yes	-	Salazar park, Whittier Narrows	once/twice a week	45 min -1hr
Family 4	1	4 years	Volunteers of America	yes	-	-	-	-
Family 4	2	4 years	-	yes	-	-	-	-
Family 5	1	2 years	-	-	-	-	-	-
Family 5	2	4 years	yes	yes	-	-	-	-

Table 8: Supplementary Reporters Demographic Information Questionnaire

	Which racial or ethnic group(s) do you belong to?	What is the highest level of education you have completed?	What is your occupation?
Family 1	Latino or Hispanic (Mexican American, Central or South American, Puerto Rican)	masters	Teacher
Family 2	-	-	shift leader
Family 3	Latino or Hispanic	Associate's degree	Unemployed
Family 4	Latino or Hispanic (Mexican American, Central or South American, Puerto Rican)	High school degree; Master's	Unemployed
Family 5	Latino or Hispanic (Mexican American, Central or South American, Puerto Rican)	High school degree/GED	Stay at Home Mom

Table 9: Continued Supplementary Reporters Demographic Water Source Questionnaire

	Do you drink tap or bottled water in the household?	Is your drinking water source filtered	If yes, what filtering device do you use? (ex: Brita
Family 1	Bottled	no	Water Store-pick up gallons at local market- #1 Drinking Water
Family 2	5 gallons at water station at work		-
Family 3	Bottled	No	-
Family 4	Bottled	No	-
Family 5	Bottled	No	-

3.7. Neighborhood Profile

First, TRI sites, or Toxic Release Sites, inform the reader of facilities that make or use toxic chemicals that can be released into the air. While many facilities in the region may fall under TRI site characteristics, for the purpose of providing a lead information guide, many have been excluded. Instead, the TRI sites discussed in the neighborhood profiles are sites that work with or process metals. In addition, selected sites are those in accordance with rule 1420 set by Air Quality Management District (AQMD). The rule highlights owners or operators of metal melting facilities that process lead-containing materials. Facilities may include primary or secondary lead smelters as well as producers of brass or bronze products.

Next, park soil data (Hung et al., 2018) was included to show how lead in park soil varied throughout the neighborhood. Edsource data from 2019 also provided information on water tested for lead in California schools. In combination, this data will assist families in learning more about the lead hazards in their neighborhood and in facilities their children frequent. Demographic and housing stock age information are also included. Demographic information such as the percent of Black or Latino residents were an important aspect as studies have found Black and Hispanic neighborhoods experienced higher lead toxicity rates than White neighborhoods (Sampson and Winter, 2016).

Another key factor in understanding lead exposure risk has been housing stock age. For the purpose of comparison, the years 1980 and 1950 were used where 1980 represents the banning of lead-based paint in homes by 1978. However, 1950 may be a greater indicator of risk as homes built before 1950 may contain higher concentrations of lead, and therefore, pose a greater risk for children (Department of Health).

Additionally, a comprehensive guide was created to better serve participating families. The guide defines values and terms mentioned in the neighborhood profiles that may be difficult to understand. The guide also defines acceptable and concerning levels of lead in soils. It is important to note that the guide emphasizes the idea that no level of lead is acceptable in the human body.

3.8. Data Analysis

After considering the median lead concentration values of collected park soil samples, the following parks were identified to have concentrations above the the advisory limit of 80 ppm in public park soils (Office of Environmental Health Hazard Assessment of California):

1. Fox Hills Park (Culver City)
2. Prospect Park (Los Angeles)

3. Harvard Park (Los Angeles)
4. Hawthorne Memorial Park (Hawthorne)
5. Jim Thorpe (Hawthorne)
6. Salazar Park (South Los Angeles)
7. Hollenbeck Park (South Los Angeles)

There were no outliers in the data after using the following equations:

$$Q_1 - 1.5 \cdot IQR$$

$$Q_3 + 1.5 \cdot IQR$$

With $Q_1 = 35$, $Q_3 = 76.25$ and IQR = 41.25

The parks listed with elevated lead levels were then analyzed to find the proximity to major highways and roads, as previous studies noted close proximity has led to lead contamination to soils nearby (Swaileh et al., 2004). The findings are shown on (**table 10**).

Table 10: Parks with (<80ppm) Relationship to Highway and Major Roads.

Park Name	Address	Proximity to Highways, major roads
Harvard Park	1535 W 62nd St, Los Angeles, CA 90047	110 (2.2 miles) Western Ave (0.3 mile)
Salazar Park	3864 Whittier Blvd Los Angeles CA 90023	5 (0.5 miles)710 (1.6 miles), 60 (2.1 miles)
Fox Hills	Green Valley Cir &, Buckingham Pkwy, Culver City, CA 90230	I-405 (0.5 miles)
Hollenbeck Park	8701 S St Andrews Pl, Los Angeles , CA,90047	western ave (0.2 miles)
Prospect Park	Echandia St,Los Angeles Ca, 90033	101 (1 mile), 5 interstate (0.5)
Jim Thorpe	14100 Prairie Ave, Hawthorne, CA 90250	I-405 (2 miles)
Hawthorne Memorial Park	3901 W El Segundo Blvd, Hawthorne, CA 90250	105 freeway (1.9 miles)

In addition to proximity to major highways and freeways, renovations to parks have become a clean up method by adding fresh layers of soil to the area (Hung et al,, 2018). This interrupts the levels of lead that may have accumulated since the establishment of the park.The following parks had renovations completed since 2009: Edward Vincent Park, Del Aire Park, Holly Park, Hollenbeck Park, Boyle Heights Sports center Park, Salazar Park, and Harvard Park. However, Renovated parks 2015, Harvard Park, 2015 Salazar Park and 2020 Hollenbeck Park had increased levels beyond 80ppm after their renovation dates.

4. Results

4.1. Risk index

The preliminary results presented in the exposure risk index map are a combination of risk factors selected from research studies conducted in Los Angeles or similar large metropolitan areas. Like many lead exposure risk indices, ours incorporates data on housing stock age, race, ethnicity, and poverty status. Our exposure risk index stands out from most previous characterizations of lead exposure risk because it takes proximity to historical transportation corridors and general aviation airports into consideration. It also includes proximity to the former Exide battery recycling plant as a significant risk factor.

4.2. Community surveys

From our surveys, The notable results are divided between Demographics and Potential routes of lead. Under the demographics section all of the family participants belong to the Latinx or Hispanic racial and ethnic group. The majority of the children in the study are 5 years or younger (**Figure 11a**). The reporters of the survey hold diverse levels of education (**Figure 11b**), with the majority unemployed. For our exposure routes, the reporter shared more information about the participating childrens' habitual activities, including the name of their physical school location,Worthington Elementary. The parks visited, Salazar park, Whittier Narrows, Edward Vincent Park, Holly Park, Center Park, Darby Park, and Helen Keller Park. A notable component drawn from the survey was the source of water in the homes. The majority of the homes drink from bottled water. We also found that 4 out of the 5 families that participated have no filtered water source in their homes.With this data we were able to use as our foundation for the sampling procedures and collection.

Figure 11a: Participating age of Children in study

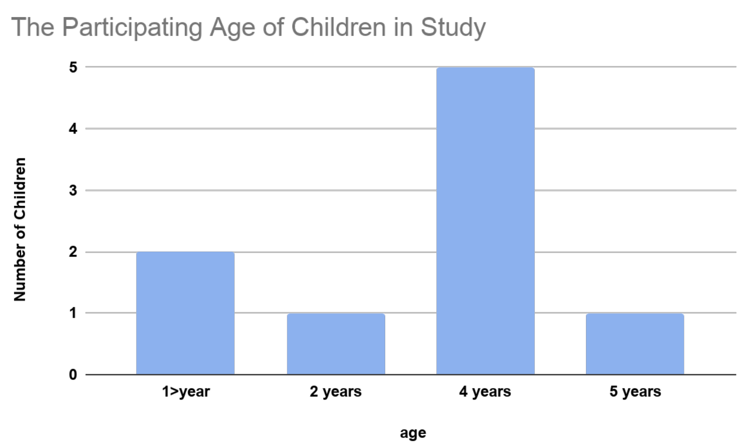
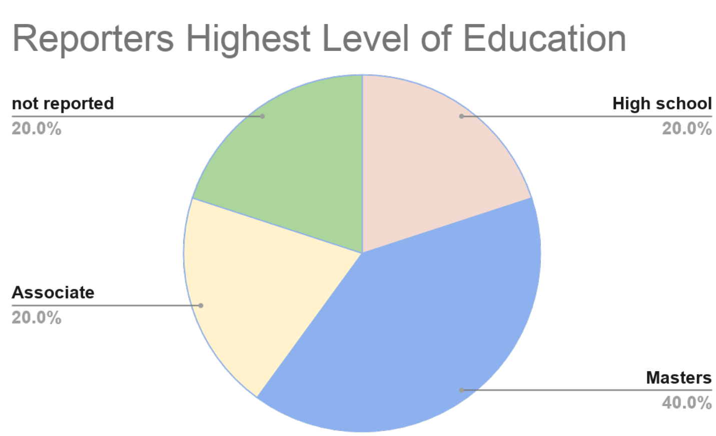


Figure 11b: Reporters Highest Level of Education



5. Discussion

5.1. Limitations

Sample Collection

For best results, water sampling must be drawn from faucets that remained motionless for at least six hours (New England States, 2015). However, due to the uncertainty of timing and usage at the sources we are unable to quantify the results and were limited to 3 parks. The samples drawn from the 3, were easily accessible and drawn at earliest opportunity.

Sample Analysis

Food analysis took an extensive period of time and was limited due to the available food samples provided from the families. Food samples will be used for supplementary data. Preliminary results show no evidence of lead levels, thus a collection of more food samples is needed for a deeper analysis. Food surveys were revised in the intermediate of recruitment and the team concluded that the non descriptive surveys were to be used as qualitative information for families. Our samples were also only collected during the spring and summer months, which may obscure seasonal fluctuations in soil lead levels.

Lead Exposure Index

The results of the Lead Exposure Index are based on variables associated with increased risk of exposure to lead, but lack standardization and do not control for potentially confounding variables. Blood lead data was sparse and stratified by income due to a lack of universal screening, and therefore could not be used to test the predictions of our lead Exposure Index. In its current state, the lead exposure index is strictly preliminary and is not yet adequate for purposes of guiding remediation efforts or predicting levels of lead in various media. Future development should include further analysis of demographic trends and environmental lead exposure risk, incorporation of parcel-level data, and standardization.

COVID-19

Contact limitations and inclusion of safety precautions due to Covid-19, changed the directions and plan for sampling the five assessments among participating homes. Due to these circumstances, the team optimized the best plan and implementation methods to carry out the study.

5.2. Takeaways

Limited, Outdated, and Inconsistent Lead Screening Data

Lead in School Taps

In 2017, the Division of Drinking Water declared that any schools served by a public water system could request testing and possible remediation from their servicer (CITE). Since 2019, the California State Board of Education has collaborated in mandating testing of all drinking water at all public K-12 schools out of concern for lead pipe fixtures. However, in the course of our research we found that water quality data concerning lead in public water systems and in school taps is also outdated, difficult to verify due to relaxed screening and reporting practices, and is inconsistent in specifying fountain locations. In a effort to improve this data, we updated the results of previous screening reported by EdSource

Blood Lead Data

Blood screening is one of the main ways to determine lead poisoning or monitor any lead in the body. In 1991, the CDC put forth a recommendation urging universal blood lead screening for children of ages one to five. And, in 1993, the Centers for Medicare and Medicaid Services (CMM) adopted the recommendation for all the children enrolled in its program. Universal screening was never passed and after the failed attempt, the CDC released a recommendation in 1997 to prioritize screening efforts and resources on high-risk populations based on two components: sociodemographic risk factors and age of housing. Both components were suggestive of underlying problems where children in low-income, Person of Color neighborhoods were more likely to experience conditions such as malnutrition on top of lead poisoning. Moreover, the age of housing was indicative of lead paint as homes built before 1978 were most likely to contain lead-based paint. Even with CMM spearheading universal screening initiatives with its service recipients who tend to be at higher risk for lead exposure, lead screening efforts are strained. A 2019 audit of the California Department of Public Health revealed that 1.4 million of the 2.9 million one- and two-year-old children enrolled in Medi-Cal did not receive any of the mandated blood lead screening tests.

Diminishing returns of broad strokes lead legislation, increasing need for local remediation solutions with community guidance.

Beginning in the 1970s, laws, programs, and regulations were formed to mitigate and prevent lead exposure, especially in children as it was found that there was no safe level of exposure for lead. Organizations such as the EPA, CDC, OSHA, CPSC, DHHS, and FDA have worked to stringently regulated lead exposure in various media yet 50 years have passed since the enactment of some legislation and elevated lead exposure today still affects more than 1.2 million children in the United States, creating a need for local remediation solutions with community guidance in addition to universal screening procedures (Lanphear, 2017).

Environmental injustice, only a subpopulation tested.

Most CMM recipients are low-income Black and Latinx families who not only were not tested for lead but are also affected by lead through multiple sources. An audit done on the risks factors conducted by the Public Health Institute in 2017 has found more than 1,200,000 children in the United States between the ages of 1-5 to have elevated blood lead levels (Public Health Institute, 2017) 600,000 of these children are untreated and undiagnosed due to poor blood lead screening initiatives with most of this burden affecting Black and Latinx communities. But, lead poisoning is not just a recent problem. It is an environmental injustice that has roots in the mid 1990s with the Repair and Maintenance Study conducted by Kennedy Krieger Institute in affiliation with Johns Hopkins. The study recruited 108 African American families whose children's bodies were used to test partial lead abatement techniques since full lead abatement innovations were expensive. The researchers promised to warn the families of any hazards and if their children had high blood lead levels, but the institution deliberately failed to inform the parents that they were living in a unit with lead paint and that their children exhibited high blood lead levels. This lead disaster was not the only one as Flint, Michigan and widespread lead contamination in Baltimore, both predominant communities of Color, have shown how lead issues disproportionately affect Black and Latinx populations.

No safe level of lead.

Although lead poisoning can be treated, the effects on the long term health and well-being are nonreversible. Moreover, a child may not show any symptoms of lead poisoning or elevated blood lead levels and for this it is imperative that they get tested early if there is any perceived risk. Children's tendencies of "hand-to-mouth" behavior paired with their developing brain and nervous system constitutes them as a vulnerable population that's more likely to absorb lead and get impacted by it than adults.

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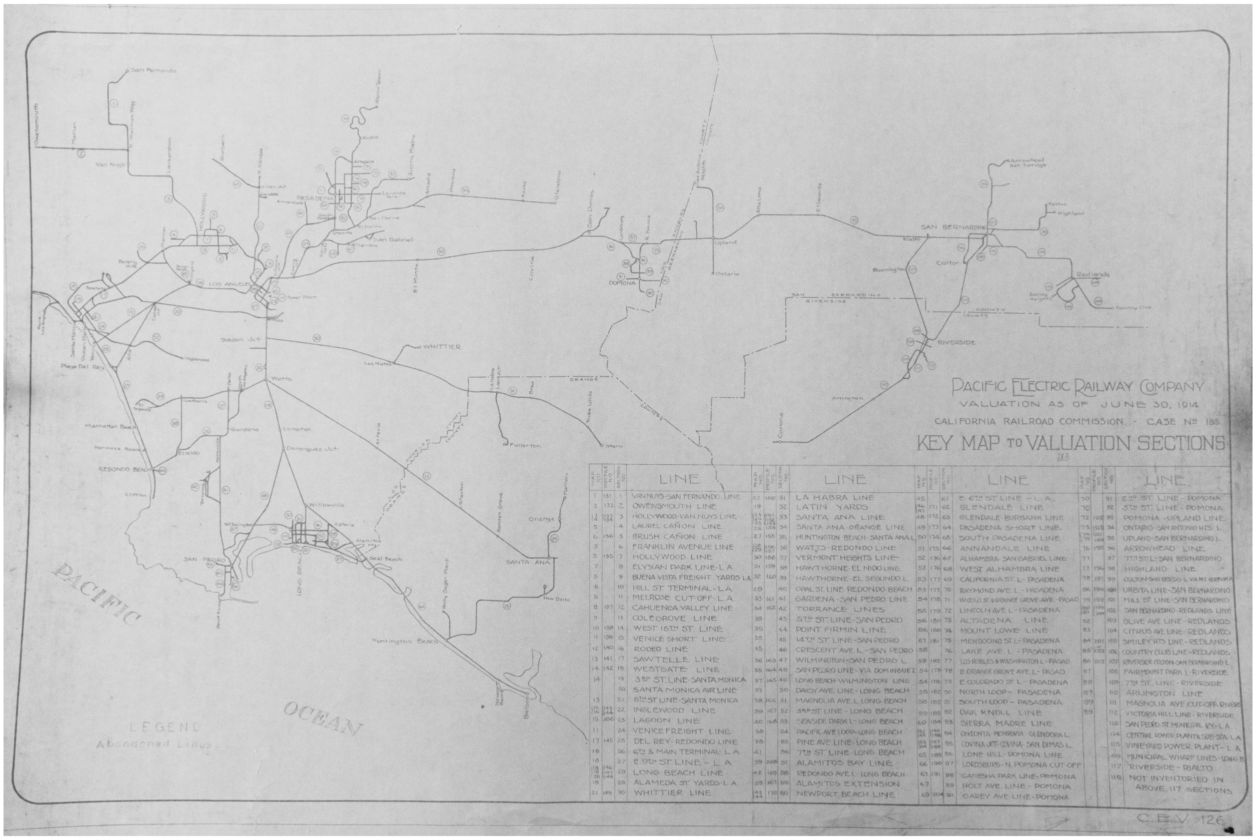
Appendix

I. Sampling Instructions and provided Home Assessment supply list
II. Park Research Data
III. Archival railroad maps provided by Jared Nigro and the Los Angeles Railroad Heritage Foundation


PACIFIC ELECTRIC RAILWAY COMPANY
VALUATION AS OF JUNE 30, 1914
CALIFORNIA RAILROAD COMMISSION - CASE No 185
KEY MAP TO VALUATION SECTIONS
MAP NO. PROFILE NO. SECTION NO. LINE
1 131 1 VAN NUYS-SAN FERNANDO LINE
2 132 2 OWENSMOUTH LINE
13 14 133 134 3 HOLLYWOOD VAN NUYS LINE
5 4 LAUREL CAÑON LINE
6 136 5 BRUSH CAÑON LINE
5 6 FRANKLIN AVENUE LINE
5 135 7 HOLLYWOOD LINE
7 8 ELYSIAN PARK LINE-L.A.
5 9 BUENA VISTA FREIGHT YARDS L.A.
5 10 HILL ST TERMINAL-L.A.
5 11 MELROSE CUT-OFF-L.A.
8 137 12 CAHUENGA VALLEY LINE
9 13 COLEGROVE LINE
10 138 14 WEST 16TH ST LINE
11 139 15 VENICE SHORT LINE
12 140 16 RODEO LINE
13 141 17 SAWTELLE LINE
14 142 18 WESTGATE LINE
14 19 3RD ST. LINE-SANTA MONICA
20 SANTA MONICA AIR LINE
13 21 8TH ST LINE-SANTA MONICA
15 16 143 144 22 INGLEWOOD LINE
15 206 23 LAGOON LINE
11 24 VENICE FREIGHT LINE
17 145 25 DEL REY-REDONDO LINE
18 26 6TH & MAIN TERMINAL L.A.
18 27 E. 9TH ST. LINE - L.A.
18 19 20 146 147 148 28 LONG BEACH LINE
18 29 ALAMEDA ST YARDS-L.A.
21 149 30 WHITTIER LINE
22 150 31 LA HABRA LINE
19 32 LATIN YARDS
23 24 25 151 152 153 33 SANTA ANA LINE
26 154 34 SANTA ANA-ORANGE LINE
27 155 35 HUNTINGTON BEACH-SANTA ANA L.
28 29 156 157 36 WATTS-REDONDO LINE
30 158 37 VERMONT HEIGHTS LINE
31 159 38 HAWTHORNE-EL NIDO LINE
32 160 39 HAWTHORNE-EL SEGUNDO L.
29 40 OPAL ST. LINE-REDONDO BEACH
33 161 41 GARDENA-SAN PEDRO LINE
34 162 42 TORRANCE LINES
35 43 5TH ST. LINE-SAN PEDRO
35 44 POINT FIRMIN LINE
35 45 14TH ST. LINE-SAN PEDRO
35 46 CRESCENT AVE. L.-SAN PEDRO
36 163 47 WILMINGTON-SAN PEDRO L.
35 164 48 SAN PEDRO LINE-VIA DOMINGUEZ
37 165 49 LONG BEACH-WILMINGTON LINE
37 50 DAISY AVE. LINE-LONG BEACH
38 166 51 MAGNOLIA AVE. L. LONG BEACH
39 167 52 3RD ST. LINE-LONG BEACH
40 168 53 SEASIDE PARK L.-LONG BEACH
38 54 PACIFIC AVE LOOP-LONG BEACH
38 55 PINE AVE. LINE-LONG BEACH
41 56 7TH ST. LINE-LONG BEACH
39 208 57 ALAMITOS BAY LINE
42 169 58 REDONDO AVE. L.-LONG BEACH
39 167 59 ALAMITOS EXTENSION
43 44 170 60 NEWPORT BEACH LINE
45 61 E. 6TH ST. LINE - L.A.
46 47 171 62 GLENDALE LINE
48 172 63 GLENDALE-BURBANK LINE
49 173 64 PASADENA SHORT LINE
50 174 65 SOUTH PASADENA LINE
51 175 66 ANNANDALE LINE
52 176 67 ALHAMBRA-SAN GABRIEL LINE
52 176 68 WEST ALHAMBRA LINE
53 177 69 CALIFORNIA ST. L.-PASADENA
53 177 70 RAYMOND AVE. L.-PASADENA
54 178 71 W. COLO. ST. & ORANGE GROVE AVE.-PASAD.
55 179 72 LINCOLN AVE. L.-PASADENA
56 180 73 ALTADENA LINE
56 180 74 MOUNT LOWE LINE
57 181 75 MENDOCINO ST. L.-PASADENA
58 76 LAKE AVE. L.-PASADENA
58 182 77 LOS ROBLES & WASHINGTON L.-PASAD.
54 178 78 E. ORANGE GROVE AVE. L.-PASAD.
54 178 79 E. COLORADO ST. L.-PASADENA
58 182 80 NORTH LOOP-PASADENA
58 182 81 SOUTH LOOP-PASADENA
59 183 82 OAK KNOLL LINE
60 184 83 SIERRA MADRE LINE
61 62 185 186 84 ONEONTA-MONROVIA-GLENDORA L.
63 64 187 188 85 COVINA JCT.-COVINA-SAN DIMAS L.
65 189 86 LONE HILL-POMONA LINE
66 190 87 LORDSBURG-N. POMONA CUT-OFF
67 191 88 GANESHA PARK LINE-POMONA
67 89 HOLT AVE. LINE-POMONA
69 204 90 GAREY AVE LINE-POMONA
70 91 2ND ST. LINE-POMONA
70 92 5TH ST. LINE-POMONA
72 192 93 POMONA-UPLAND LINE
73 193 94 ONTARIO-SAN ANTONIO HTS. L.
74 75 207 208 95 UPLAND-SAN BERNARDINO L.
76 195 96 ARROWHEAD LINE
77 97 7TH ST. L. SAN BERNARDINO
77 196 98 HIGHLAND LINE
78 197 99 COLTON-SAN BERDO-L. VIA MT. VERNON A
86 194 100 URBITA LINE-SAN BERNARDINO
79 198 101 MILL ST. LINE-SAN BERNARDINO
80 81 199 200 102 SAN BERNARDINO-REDLANDS LINE
82 103 OLIVE AVE LINE-REDLANDS
83 104 CITRUS AVE LINE-REDLANDS
84 201 105 SMILEY HTS LINE-REDLANDS
85 202 106 COUNTRY CLUB LINE-REDLANDS
86 203 107 RIVERSIDE-COLTON-SAN BERNARDINO L.
87 108 FAIRMOUNT PARK L.-RIVERSIDE
88 109 7TH ST. LINE-RIVERSIDE
87 110 ARLINGTON LINE
89 111 MAGNOLIA AVE CUT-OFF-RIVERS
89 112 VICTORIA HILL LINE-RIVERSIDE
113 SAN PEDRO ST. MUNICIPAL RY.-L.A.
114 CENTRAL POWER PLANT & SUB-STA.-L.A.
115 VINEYARD POWER PLANT-L.A.
116 MUNICIPAL WHARF LINES-LONG B
117 RIVERSIDE-RIALTO
118 NOT INVENTORIED IN ABOVE 117 SECTIONS
PACIFIC
OCEAN
LEGEND
Abandoned Lines
LOS ANGELES
PASADENA
SAN BERNARDINO
RIVERSIDE
POMONA
WHITTIER
SANTA ANA
LONG BEACH
SAN PEDRO
REDONDO BEACH
C.E.V. 126