AN IN-DEPTH LOOK AT SOIL LEAD CONCENTRATIONS AND REDLINING PRACTICES

Redlining practices and lead in soil across Springfield, Ohio

Wittenberg University | Environmental Science

Abstract:

The study performed at Wittenberg University in collaboration with a larger study across 8 cities in the United States aimed to understand how the distribution of lead related to historical redlining practices established by the Home Owner's Loan Corporation (HOLC). At Wittenberg, students in the Environmental Science Research Methods class (ESCI 250) collected and analyzed soil in Springfield, Ohio after exploring other social and environmental variables in relation to redlining. Wittenberg students collected soil samples from 24 homes across the city and 10 parks. The 24 home samples were collected in from "A", "B", "C", "D" zones designated by the HOLC, for a total of six homes per district. These zones were largely determined by racist criteria and established subsequent inequities in housing and community development practices through predatory loans and disinvestment in housing. Parks sampled were between zones. To gain environmental methods experience students analyzed all the soil collected using an XRF. Lead concentrations showed some patterns with housing age, and setting (drip, middle of yard, near street) and parks had the lowest concentrations. There were some general patterns by redlining zone.

Introduction:

Lead is a problem that is affecting millions of people in America. Most notably and publicly is the lead contamination of our water pipes. The images and stories from Flint, Michigan are not isolated. Cities across the country are struggling to combat lead piping and as a result lead in their water. The water problem has gained national attention, but the danger of lead goes deeper than the lead running through pipes. It extends to the soil in people's front lawns, the soil in playgrounds and the soil we grow our food in. Lead is a heavy mineral that does not

disappear from the soil over time. While lead does occur naturally in soils, the concentration of lead that is detrimental to a person's health is above the naturally occurring levels of 50 parts per million (ppm) according to the Center for Disease Control (CDC) (Environmental Health Medicine Education 2017). Lead was used in paint and gasoline for years before the effects it had our people's health was discovered. Because of this, homes were painted inside and outside with lead paint and cars drove with lead running through the engine until 1978 and 1995 respectively. Both of these sources of excess lead are factors that cause the high levels today.

Lead in Springfield:

The city of Springfield has noticed a problem in the blood lead levels of children in the city, the entire city is within high risk zip codes. With high levels of lead in their blood, children are at risk for many developmental issues as they grow up. Children are exposed to lead while playing in exposed soil, the paint in their homes, and the pipes that carry their water. According to the Environmental Protection Agency (EPA) and the CDC lead levels under 200 parts per million (ppm) are considered safe for gardening, while lead levels under 400 ppm are considered safe for children to play on and residential soil not being played on is considered safe when under 1200 ppm (Environmental Health Medicine Education 2017). The city of Springfield looked at their housing market and options in early 2019, the problem of lead in the city was not addressed (Ohio 2019).

A study done by Penn State in 2010 looked at what happened once lead entered a child's body. The study determined that lead was nearly impossible to be remove from the body after a child was exposed to it. Because of this the best way to cure the effects of lead on a child's

development is to prevent the exposure in the first place (Stehouwer 2019). Another national study conducted by the Environmental Health Perspectives looked at lead levels in children and following them through life found a link between higher lead levels in elementary school and lower high school graduation rates. This means that if a child has higher blood lead levels, they are less likely to graduate high school. The study also found that children with elevated blood lead levels also were more likely to commit a crime (Gould 2009). The Penn State study also found that children with elevated blood lead levels were more likely to be hyperactive, have impaired growth, have a learning disability, have a shorter attention span and a lower IQ. Looking at both studies together shows the importance in identifying the locations and possible children impacted by high lead levels. According to these two studies, being able to identify children and locations with high lead levels can help the city with overall health and safety. In identifying high blood lead levels at an early age and addressing the health impact on children the high school graduation rate across Springfield could increase. A higher graduation rate could lead to a more knowledgeable work force and lower crime rates. All three positive outcomes for the city.

Redlining:

Throughout the United States, redlining, or systemic disinvestment in marginalized communities took place in cities for most of our history. The four designations our class explored were established by federal employees at the HOLC in the 1920s and 1930s. The hope was in increase home ownership while protecting banks at the same time. Banks assessed the risk of lending to a potential homeowner based on the location of the home. Areas that were classified as “D” or redlined areas were “hazardous” for banks to lend to, leading to high interest rates.

While “A” areas were considered minimal risks and loans were easy to obtain. The “B” and “C” areas we in between “A” and “D” financially. With “B” areas being a little riskier for the bank than “A” and “C” being a little safer for the bank than “D”. In most areas the race of the homeowners was a dominant factor when giving out classifications. This racism made it harder for Black Americans to get fair loans because most were living in segregated neighborhoods in the “C” or “D” areas. During this time in the United States racial segregation of housing was in full force and the implementation of redlining practices made it nearly impossible for African American families to integrate in to the wealthier and whiter neighborhoods. Redlining practices were banned at a federal level in 1975 but the impact from the policies can still be felt and seen today in many American cities, including Springfield. In the maps below, the four HOLC districts are highlighted. The “A” areas are green, the “B” areas are blue, the “C” areas are yellow, and the “D” areas are red (Mapping Inequality).

Process:

The Environmental Research Methods course at Wittenberg University in Springfield, Ohio explored the lead legacy of redlining. They hypothesized that the homes in the “C” and “D” districts would have higher soil lead levels than the “A” or “B” areas because they had previously calculated that residential housing vacancy was greatest in “C” and “D” zones. They also believed the parks lead levels could potentially relate to the HOLC district they were closest to given that some lead is transported locally via water and wind. To gain environmental research methods experience, students explored sampling strategies for lead and reviewed the protocols for the cross city redlining exploration. They collected three samples were collected from each home: one from the drip line of the home, one from the middle of the yard and one from the

street. Drip lines are typically elevated with lead from paint legacy and streets typically supply lead relict from leaded gasoline. Samples were taken from six homes in each of the four HOLC designations. Twenty-four homes were sampled across the city. For the city parks, ten parks were sampled in the city with three samples taken from each park at different locations. Each city park was sampled in areas that people would spend leisure time.

A main goal of this project and its design which incorporated literature, field, and lab methods was to help students learn the process working on health focused research in residential areas. Students even conducted canvassing learn from and share lead literacy habits with residents. After the collection process took place, the study helped students develop their processing soil skills through the use of the X-Ray Fluorescence (XRF) machine, development of ArcGIS skills and scientific communications. In the end, the project helped students communicate with the public the levels of lead in their soils and the possible health risks at those lead levels.

To collect samples the class identified streets and intersections to target for sample collection. They identified streets in the “A”, “B”, “C” and “D” districts that were not connected to the two major roads in Springfield, Limestone and North Fountain. They decided that picking homes on either one of these roads could possibly skew the sample from near the road because of the high volume of traffic on each street daily. By avoiding these streets, the class felt as though the street sample would be a better reflection of a normal home in this area. The groups followed the pre-identified streets as much as possible based on the availability of homeowners that answered the door when they were collecting soil. To the best of their ability brick homes were

avoided for consistency. Each home that soil was collected from was done at the permission of the homeowner or renter of the home. The exception of this was vacant homes because there was no one residing in the home. The groups tried to fill a third of a quart sized Ziploc bag at each sample site ensuring enough soil for analysis.

After the samples were collected, they were analyzed at Wittenberg University. Soils were dried overnight in the bag that they were collected and large aggregates and grass were removed before being tested by the XRF. The level of lead of each sample was recorded in parts per million (ppm) along with the error. After the lead levels were tested, each location's samples were combined into nine grams. Three grams from each soil collection location (drip line, middle of the yard and street) were combined for a nine-gram sample from each home to be further processed using shared methods across the 8 cities in the national study. While all three samples locations from a park were combined to create the nine-gram sample.

Analysis:

After the samples were analyzed, the class wanted to be able to identify homes and areas with high lead levels and the possibility of child contamination. They hoped the be able to provide the city with the locations of residential areas and parks that would have the largest benefit from the removal of lead. Safe gardening soil has lead concentrations of less than 200 ppm and this was the main threshold for the class analysis in the residential areas. While in parks, they used the 400 ppm threshold for safe play areas for children.

Residential:

The median and the average for each of the four red lining zones was calculated and can be seen in Table 1. These calculations include all three locations at a home and all six homes in each of the four HOLC districts. Based on the median lead concentrations in each of the four red lining districts, all four of the of the residential areas were within the safe levels for gardening. The averages however for each area show a different result. The "A" area is well within the safe levels for gardening while the other three areas are either above or close to being above the 200 ppm. When looking specifically at the data there are some outlier data points which drove the averages up specifically in the "B" area. The next step in the analysis was to calculate the

Area	A	B	C	D
Median (ppm)	49.8	130.55	150.7	98.3
Average (ppm)	69.22222	451.5556	175.0056	235.3778

Table 1: The chart on the left shows the median and average lead levels in the four HOLC districts. The calculations include the drip line, middle of the yard and the street. Based on the median the four districts are safe for gardening and children to play on the soil (under 200 and 400 ppm). While the average shows that the "B" and "D" areas are not safe for gardening, and "C" is close to the threshold for gardening. According to the averages, the "B" areas are not safe for children to play on.

average and median of the drip line, middle of the yard and street in the four HOLC districts. Which can both be seen in Figure 1 and Figure 2 respectively. When looking at the data for each location in the yard, the drip line was the highest for both the median and the average calculations in all four districts. After the average and the median were calculated for the three locations in the yard more analysis was done at the drip line. The drip line being the highest for all four HOLC districts makes sense. The drip line was the closest soil collected to the home and because Springfield is a city with older homes built before 1978. Only two of the 24 homes

sampled would have been built after lead was removed from paint. As the lead paint wore off, it would have chipped into the yard contaminating the soil closest to the house. Figure 3 below is a scatter plot of the year the home was built compared to the lead levels at the drip line of the home. The results showed higher levels of lead levels in the soil of older homes with a decrease in concentration at newer homes.

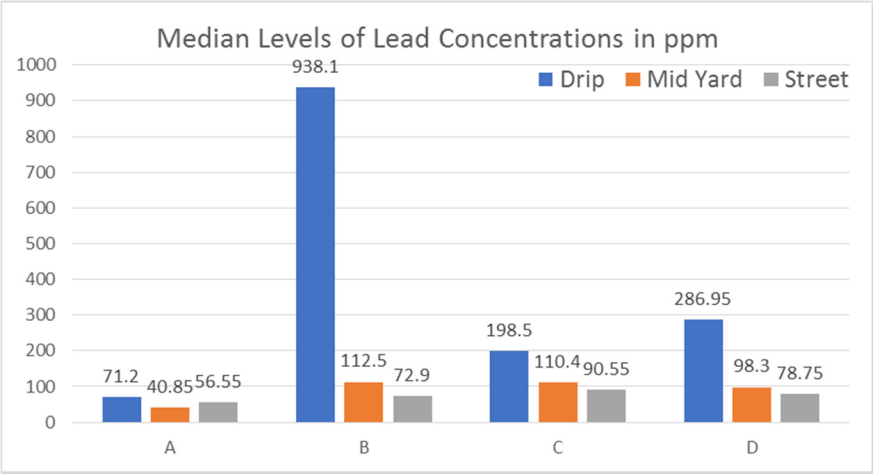

Figure 1: This bar chart shows the median lead concentrations in each of the four HOLC districts based on location at the home. This shows that for each area across the city the highest level of lead concentration occurred at the drip line.

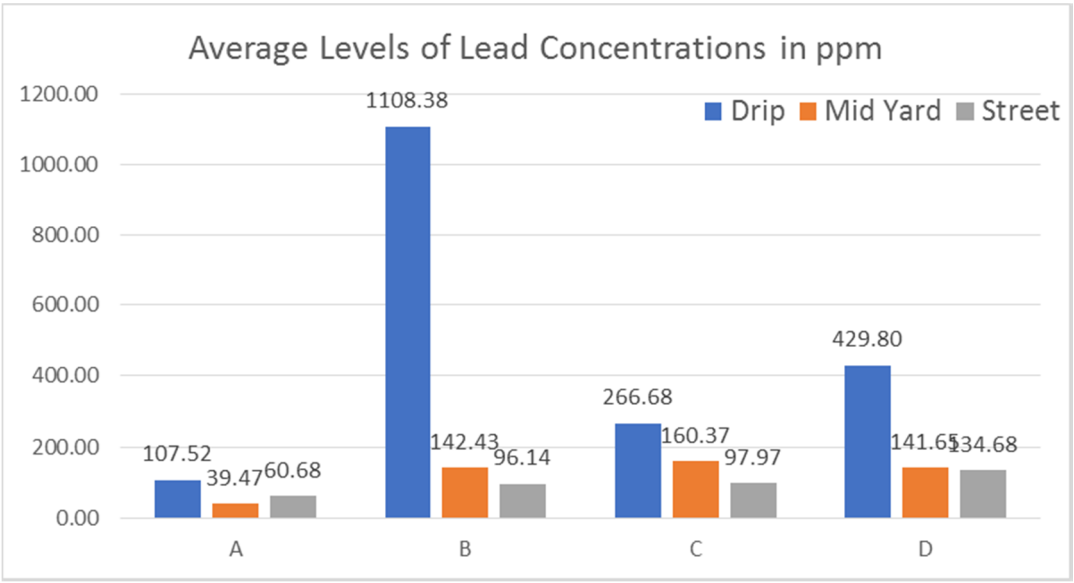

Figure 2: This bar chart shows the average lead concentrations in each of the four HOLC districts based on location at the home. This shows that for each area across the city the highest level of lead concentration occurred at the drip line. The averages calculated was higher for each location except the "A" mid yard.

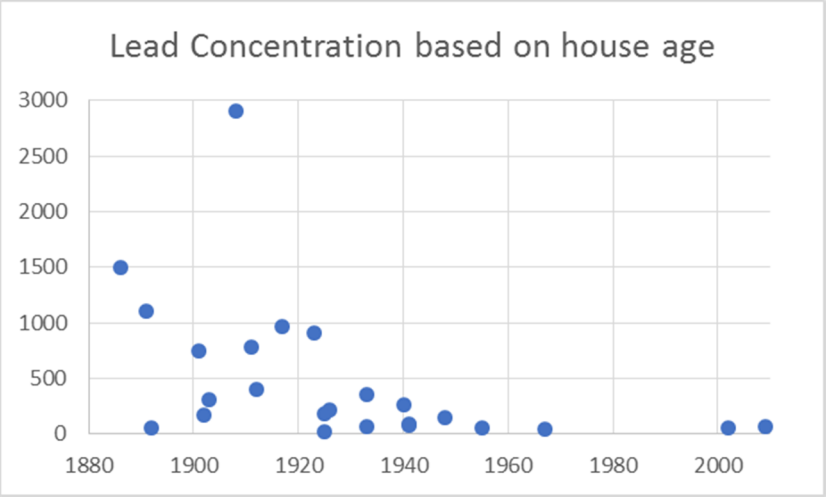

Figure 3: This graph shows the soil lead levels at the drip line of a house based on the year the home was built. While there are low concentrations across the range of years the lowest concentrations were at the newest homes while older homes were more likely to have higher lead levels.

When looking at the distribution of the soil lead levels across the city median values largely increase sequentially by HOLC district with the exception of "B" areas. There is even better agreement by use with drip samples generally having the highest concentrations. When looking at the soil collected at the drip line of a home as seen in Figure 4, there are high lead levels in the "B" areas with lower levels in the "C" and "D" areas. Looking at the street soil samples seen in Figure 5, there are low concentrations across all four HOLC districts. In the samples collected at the middle of the yard as seen in Figure 6, the highest concentration is seen in the "C" area with only one home above the 400 ppm threshold for child play areas. The following three maps were created using ArcGIS and using the data collected by the students. Looking at the spatial layout

of the data is helpful to see how the lead levels are distributed across the city. All three maps group the data points based on the EPA and CDC regulations outlined earlier.

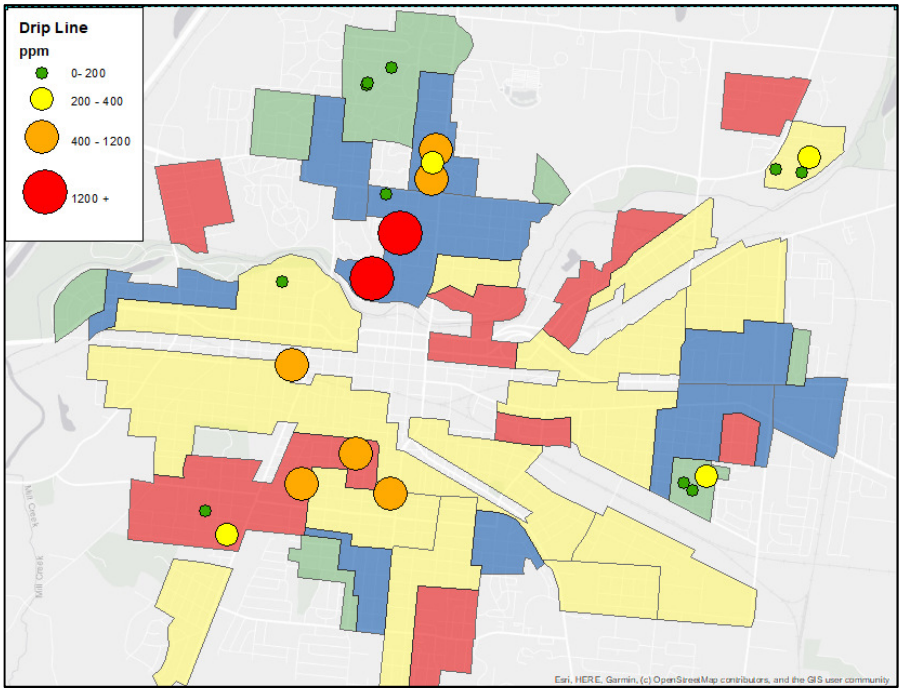

Figure 4: Shows the lead concentrations of the soil collected at the drip lines of homes. Of the 24 homes sampled, 12 had lead concentrations below 200 ppm and 16 below 400 ppm. None of the homes in the "A" areas were above the 400 ppm levels while the "B" areas had the most homes above the 400 ppm threshold.

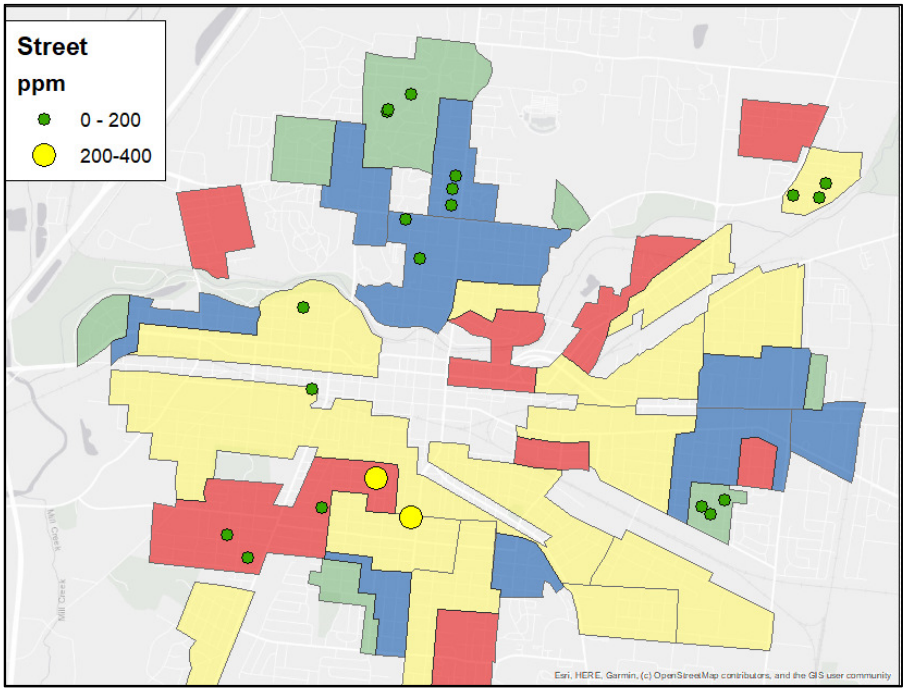

Figure 5: Shows the lead concentrations of the soil collected at the street of homes. Of the 24 homes sampled, all but two had lead concentrations below 200 ppm levels. This was a little surprising because run off from the street does not seem to be impacting the soil quality like originally predicted.

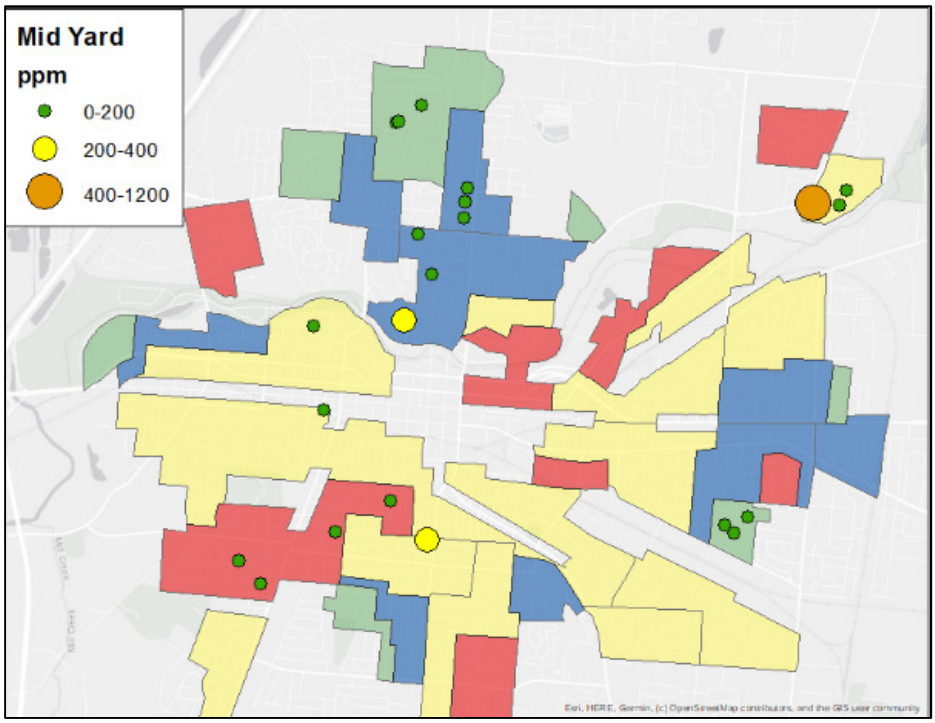

Figure 6: Shows the lead concentrations of the soil collected at the middle of the yard at each home. Of the 24 homes sampled, three homes had lead concentrations above 200 ppm and one had a concentration above 400 ppm. The yard under 400 ppm are safe for children to play on according to the EPA guide lines.

Parks:

Overall the parks in Springfield were much safer for people to spend time in based on lead levels. Of the thirty samples collected across ten parks four were at levels of lead above 200 ppm and none were above the 400 ppm threshold. Of the four soil samples collected above safe gardening levels, three were at Veteran's Park Memorial. The samples from this park were taken from around the memorial. Because of the location of the samples the high lead levels are not concerning because people are not gardening or playing in this area. These calculations show that the park areas that people play and relax in are safe for play and leisure. The average lead concentration at the parks was 68.28 ppm while the median was 35.1 ppm. Both of these are well below the safe gardening levels. Figure 6 shows the lead levels in the park soils based on their location in Springfield. There does not appear to be a strong connection to the parks lead levels and the HOLC districts they are near. This is because there are parks in the "C" districts with low lead levels but the park nearest the "B" district had the highest levels of lead.

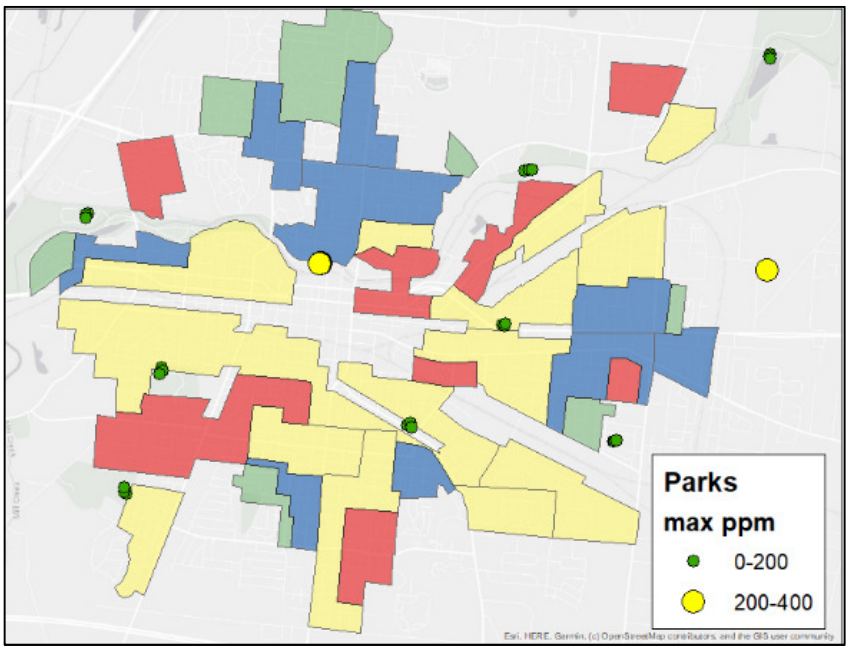

Figure 6: Shows the lead concentrations of the soil collected the public parks in Springfield. The parks are all below 400 ppm meaning they are all safe for children to play around. Of the 30 samples collected four samples were above the safe gardening levels.

Proposals:

After looking at the data collected in this study more samples could be used to better understand Springfield specific concerns. Another step would be to cross reference the lead levels in the soil and children blood lead levels. Being able to collect samples from all areas of the city will give a better understanding of the impact of lead in different neighborhoods. Because there wasn't a strong connection to the HOLC districts and lead levels like hypothesized, more data would be helpful to see if a correlation is present and was not clear in the current data. Collecting more samples would allow for better averages to be calculated and outlying data points to have less weight. By adding more soil collection to the study, it could also increase community engagement and involvement. Allowing the public to have more contact with the project would raise more awareness. Some possible ideas would be raising awareness at restaurants/bars in Springfield or the "Frist Friday Event" downtown. Because those establishments are frequented by Springfield residents it would allow for more awareness of warning signs to high lead levels. Being able to target establishments around the city would

allow for a wide range of people to be exposed to the study. When collecting samples in the future, the students could provide these warning signs when they speak with homeowners. Increasing community involvement could increase the overall health of Springfield.

Changes to the study:

In the future being able to collect samples on multiple days of the week could increase the number of people home. In some areas, the student struggled to find people home because they collected during a workday in the middle of the week. Collecting after the workday has ended or on a weekend could help solve this problem. Another change that could help expand the study is to collect samples throughout the year. This study collected samples in early November. Collecting samples in the late summer months (August or September) then in early winter months (November or December) could help explore lead mobility, which may be important. This could also increase community involvement by providing more contact times and awareness.. Another short coming was not sampling from multiple areas that children play in. School and church playgrounds should also be tested. This is where children spend their time playing and would be exposed to the most lead contamination potential.

Personal Reflection:

From this project I learned a lot about community engagement. This was the first class that I did community engagement in this way. I felt like I was helping make a difference in Springfield and was helping people be more informed. Being able to use skills like canvasing, data processing and GIS on data and samples that I helped collect gave the skills more meaning. I was able to learn a lot and improve my skills in all three areas which will help me in the future

when I need to use them again. This project helped me with my leadership skills in leading my classmates to make sure that everything that needed to be accomplished got done. It also helped me with my fear of talking to new people and strangers while we were canvasing. I was able to work on communicating what we were doing to people and helping the city understand the possible health impacts this study could identify.

Acknowledgements:

A special thanks to the Springfield Promise Neighborhood Association, Dr. Sheryl Cunningham (Wittenberg University, Communications), Dr. Sarah Fortner (Wittenberg University, Environmental Science), and Dr. John Ritter (Wittenberg University, Environmental Science) for the help and support of this project.

Bibliography:

Environmental Health and Medicine Education. (2017, June 12). Retrieved December 10, 2019, from https://www.atsdr.cdc.gov/csem/csem.asp?csem=34&po=8.

Gould, E. (2009). Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. *Environmental Health Perspectives*, *117*(7), 1162–1167. doi: 10.1289/ehp.0800408

Mapping Inequality. (n.d.). Retrieved December 10, 2019, from https://dsl.richmond.edu/panorama/redlining/#loc=5/39.1/-94.58&text=intro.

Muennig, P. (2009, September). The social costs of childhood lead exposure in the post-lead regulation era. Retrieved December 10, 2019, from https://www.ncbi.nlm.nih.gov/pubmed/19736339.

Ohio, G. (2019, August 14). Housing in the Champion City: Comprehensive Housing Analysis for Springfield, OH. Retrieved December 10, 2019, from https://www.greaterohio.org/publications/springfield-housing-study.

Siemering, G., & Soldat, D. (2015). Reducing exposure to lead in your garden soil (A4088). Retrieved December 10, 2019, from https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A4088.pdf.

Stehouwer, R. (2019, November 26). Lead in Residential Soils: Sources, Testing, and Reducing Exposure. Retrieved December 10, 2019, from https://extension.psu.edu/lead-in-residential-soils-sources-testing-and-reducing-exposure.

Vacant and Abandoned Properties: Turning Liabilities Into Assets: HUD USER. (2014). Retrieved December 10, 2019, from https://www.huduser.gov/portal/periodicals/em/winter14/highlight1.html.