Identifying High Priority Areas for Addressing Lead-in-Water Potential in Fort Worth

Annaliese Miller, B.S. Environmental Science, School of Geology, Energy and the Environment
Faculty Advisors: Dr. Omar Harvey, SGEE & Tamie Morgan, SGEE

Introduction

In 2016, the Fort Worth Independent School District (FW IS D) conducted voluntary lea d testing of drinking/drinkable water at 127 schools and administrative locations across the district to assess whether students were being exposed to high lead levels in drinking water at school (2). Because children are still in the developmental phase of growth, they are particularly vulnerable to the negative health effects associated with exposure to lead contamination (4). Results from the FWISD study showed that 60 of 127 locations ha d lea d levels that exceeded the United States Environmental Protection Agency's lead action level of 15 parts per billion (ppb) at one or more sample points (2,4). This infra structure was older and was suspected to be the primary ca use of the lead contamination due to the leaching of lea d from lead-containing components (1). However, the issue of lea d contamination and its potential link to old infra structure transcends the school system and necessitates a comprehensive assessment on a citywide level.

The literature indicates that lead in drinking water originates m a inly from the corrosion of lead service pipes, plumbing, fixtures, and solder (5). These lead-containing elements were banned nationally in 1986 (4). Therefore, the likelihood that water infra structure contains lead components is directly correlated to the age of the system (3,5). Given that schools are developed around communities of similar age, the FWISD lead data may be useful as a proxy for assessing wider citywide potential lead-in-water and infra structure replacement issues. In this project, lea d da ta from the FWISD study was combined with infrastructure-related data , spatial analysis, and spatial statistics techniques to identify potential high priority areas for the city's lead pipe replacement project and for residential plumbing renovations.

Objectives

- To identify areas in Forth Worth that have the greatest potential for lead-in-water issues.
- To identify which areas should receive highest priority for addressing potential lead-in-water issues.

Figure 1: Building Age vs. Maximum Lead Rating

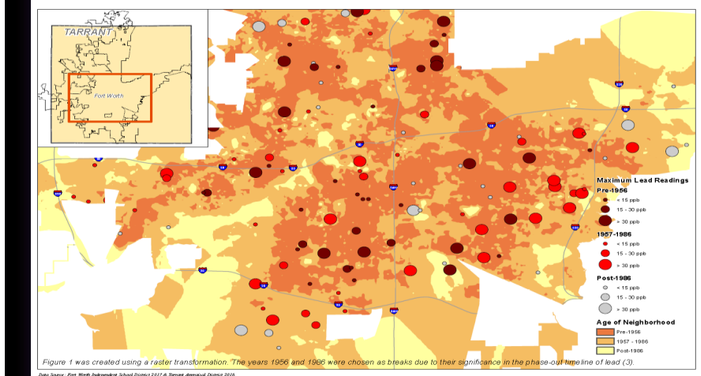

Figure 1 was created using a raster transformation. The years 1956 and 1986 were chosen as breaks due to their significance in the phase-out timeline of lead (3).

Data Source: Fort Worth Independent School District 2017 & Tarrant Appraisal District 2016.

Spatial Data

Fort Worth Independent School District. 2017. FW IS D Water Test Results. Fort Worth: Fort Worth Independent School District.
Fort Worth Water Department. 2017. Water M a in Lines. Fort Worth: City of Fort Worth.
North Central Texas Council of Governments, 2014. Highways. Arlington: NCT COG Regional Data Center.
Tarrant Appraisal District. 2016. Parcels Geodatabase. Fort Worth: Tarrant Appraisal District.
United States Census Bureau. 2010. T IGER/Line: 2010 United States Census. Washington, D.C.: Bureau of the Census.
United States Census Bureau. 2015. T IGER/Line with S elected Demographic and Economic Da ta : 2011-2015 Detailed Tables - Block Group. Washington, D.C.: Bureau of the Census

Hot Spot Clustering & Predictive Surfaces Based on School Lead Data

Figure 2: Minimum Lead Levels

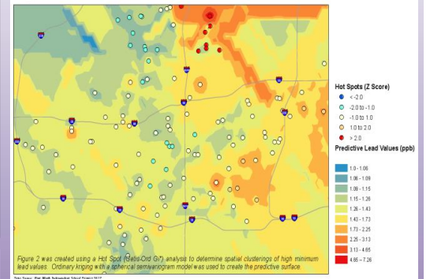

Figure 2 was created using a Hot Spot (Getis-Ord Gi*) analysis to determine spatial clusterings of high minimum lead values. Ordinary kriging with a spherical semivariogram model was used to create the predictive surface.

Data Source: Fort Worth Independent School District 2017.

Figure 3: Median Lead Levels

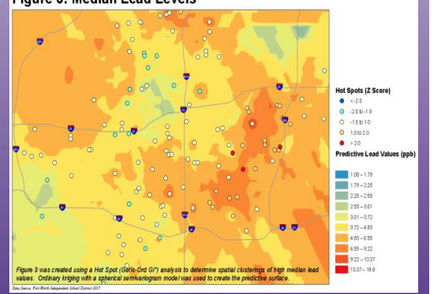

Figure 3 was created using a Hot Spot (Getis-Ord Gi*) analysis to determine spatial clusterings of high median lead values. Ordinary kriging with a spherical semivariogram model was used to create the predictive surface.

Data Source: Fort Worth Independent School District 2017.

Figure 4: Maximum Lead Levels

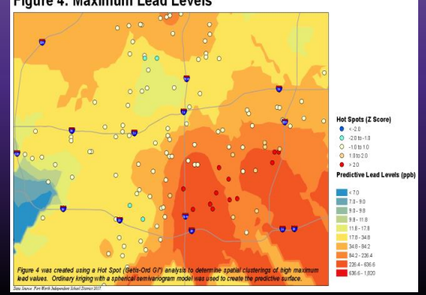

Figure 4 was created using a Hot Spot (Getis-Ord Gi*) analysis to determine spatial clusterings of high maximum lead values. Ordinary kriging with a spherical semivariogram model was used to create the predictive surface.

Data Source: Fort Worth Independent School District 2017.

Figure 5: Population Vulnerability

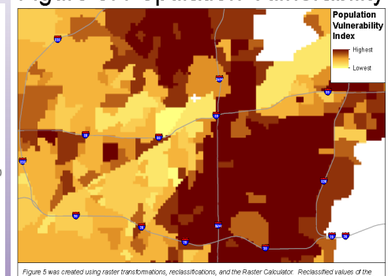

Figure 5 was created using raster transformations, reclassifications, and the Raster Calculator. Reclassified values of the three following parameters were weighted and summed to create the index: 1) percent of the total population under age 18 (50%), 2) percent of the total population identifying as a minority (25%), and 3) median household income (25%).

Data Source: United States Census Bureau 2010 & United States Census Bureau 2015.

Discussion

Figure 1 confirms the correlation between building age and lead levels in drinking water. The majority of schools with lead readings exceeding the action level were built prior to 1986 and have aging infrastructure. Schools were also found to be located in neighborhoods of corresponding age, thus confirming the assumption that the age of the school is related to the age of the community.

- The two areas of Fort Worth with significant spatial clusters of high lead values are north Fort Worth west of I-35W and southeast Fort Worth, according to Figures 2 & 4.
- Based on the findings in Figure 5, the highest concentrations of vulnerable populations are located in north Fort Worth west of I-35W and southeast Fort Worth.
- The areas of greatest priority to address lead-in-water potential, according to Figure 6, are located in north Fort Worth to the west of I-35W and in southeast Fort Worth.

Figure 6: Priority Index for Addressing Lead-in-Water Potential

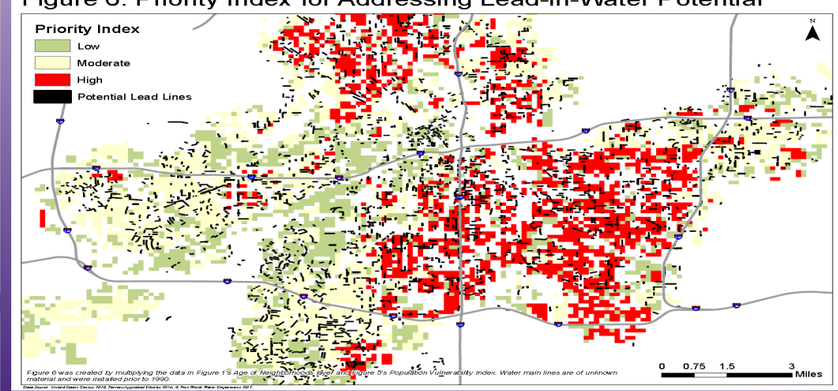

Figure 6 was created by multiplying the data in Figure 1's Age of Neighborhood layer and Figure 5's Population Vulnerability Index. Water main lines are of unknown material and were installed prior to 1990.

Data Source: United States Census 2010, Tarrant Appraisal District 2016, & Fort Worth Water Department 2017.

Conclusions

- The areas of highest priority for addressing lead-in-water potential are north Fort Worth to the west of I-35W and southeast Fort Worth. These a rea s have the greatest potential to experience high lead levels in drinking water due to aging infra structure and experience high population vulnerability.
- These results may be useful in informing decisions on where to allocate funds to address areas of greatest concern for lead in drinking water.

Sources

1. Carman, John (Director of Fort Worth Water Department) in discussion with Annaliese Miller, Omar Harvey, and Tamie Morgan. Personal interview. Fort Worth, 3 March 2017.
2. Fort Worth Independent School District. 2017. "Fort Worth ISD Water Testing Program (Updated 3/22/2017)."
3. Rabin, Richard. 2008. "The Lead Industry and Lead Water Pipes 'A Modest Campaign.'" *American Journal of Public Health* 98 (9): 1584-1592. . https://doi.org/10.2105/AJPH.2007.113555.
4. U.S. Environmental Protection Agency. 2016. "Basic Information about Lead in Drinking Water." *Ground Water and Drinking Water.*
5. Wang, Devine, Zhang, and Waldroup. 2014. "Using a GIS and GIS -Assisted Water Quality Model to Analyze the Deterministic Factors for Lead and Copper Corrosion in Drinking Water Distribution Systems." *Journal of Environmental Engineering* 140 (9). https://doi.org/10.1061/(AS CE)EE.1943-7870.0000816.